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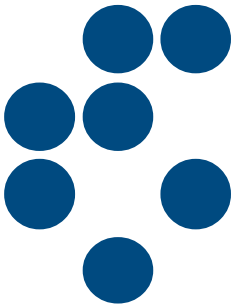
MAY 2007



Jožef Stefan Institute - Annual Report 2006

Jožef Stefan Institute, Ljubljana, Slovenia

Annual report 2006

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Ljubljana, May 2007

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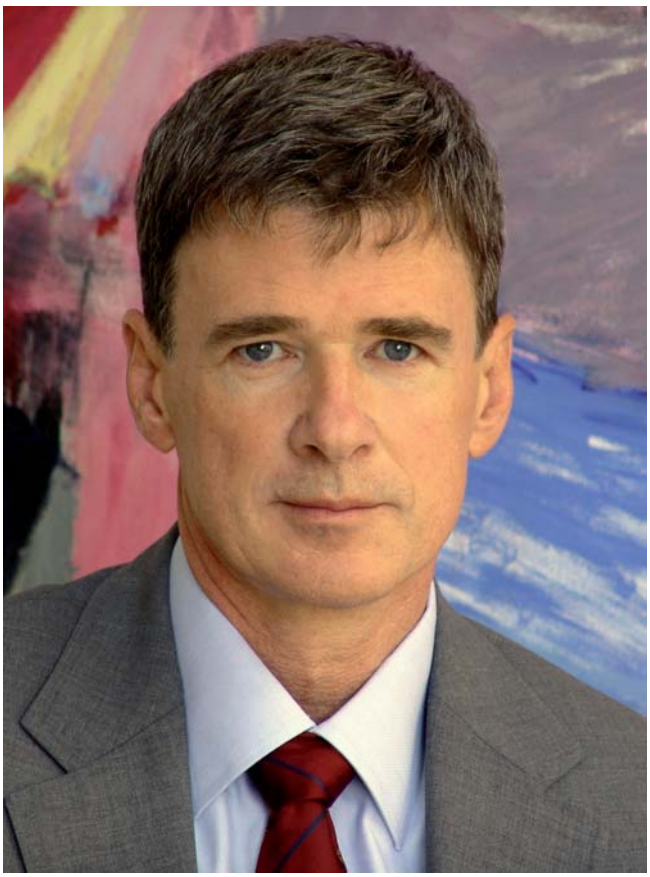


Director of the Jožef Stefan Institute
Prof. Jadran Lenarčič

The Jožef Stefan Institute is named after the famous Slovenenian scientist, and one of the most important physicists of the nineteenth century. Stefan, of course, is best remembered for his law about the temperature of a radiating black body. From its beginnings as a physics institute, established in 1949, the JSI has developed into the largest public research institution in Slovenia, with currently more than 800 employees. Its main areas of activity are natural sciences, the life sciences and technical sciences.

At the JSI we develop new technologies, in particular I would like to mention nanotechnologies, new materials, biotechnologies, process-management and production technologies, communication technologies, computer and knowledge technologies, environmental technologies and reactor technologies. The JSI is financed entirely by domestic and international projects, which the JSI wins by bidding for tenders or by direct marketing with companies.

It is clear from the Annual Report for 2006 that the JSI has achieved a number of top-level scientific and development results, and that in several areas our researchers are among the most high-ranking in their fields. In this respect we have become a little spoiled at the JSI, taking our successes for granted and not publicising them enough. I am also very pleased that the JSI had excellent financial results in 2006, as we significantly improved on the results for 2005, as well as on our expectations for 2006. The biggest growth was recorded in development and international projects, as well as in the projects in the 6th Framework Programme of the EU. I can say, perhaps a little ironically, that our performance was maybe too good, as we made full use of our capacities, and now there is hardly any room for further improvements in 2007.

At the JSI we are well aware of the fact that our activities cannot just be limited to our work in laboratories, but that we also have to be involved in the wider activities of our society, and contribute to the creation and promotion of genuine intellectual effort, creative freedom, and culture in its broadest sense. Similarly, we are aware of our role in Slovenia's development plans, and the role assigned to us by European development documents.

In 2006 our efforts were aimed, to a large extent, to further our links with industry. As a result, we began a project called "An open door for industry". Any company can choose a day when the JSI will open all its doors to that company. Some companies have already made use of this opportunity, and others are making arrangements for their visits. During the Jožef Stefan Days we organised a meeting called "The JSI and Opportunities", which was attended by more than 100 company presidents and directors; the then minister Jože P. Damijan, and minister Jure Zupan were also present. In October we organised a meeting called "The JSI, the Environment and Space", and again a significant number of important users of our research results were present, as well as the ministers Bručan, Podobnik and Zupan. We will continue to organise similar meetings, this time dealing with the topics of nuclear energy, creativity at school, and the linking of science and art.

One of the most important events of last year was the visit of Janez Janša, the Slovenian Prime Minister. On this occasion the Government of the Republic Slovenia held a session at the JSI. Together with Andrej Vizjak, MA, the Minister of the Economy,

Dr Jure Zupan, the Minister of Higher Education, Science and Technology, and Dr Andrej Horvat, the Head of the Government Office for Growth, Janez Janša also visited the laboratories of the JSI, and we were able to present our development plans to the Prime Minister.

In 2006 the JSI made important steps in the area of university education. In 1996 the JSI established a polytechnic, which last year became the fourth Slovenian university, the University of Nova Gorica. In 2003 we established the Jožef Stefan International Postgraduate School, with which we offered a joint study programme for the first time in 2006. This was made possible by the new legislation in 2006 that also allowed us to sign a cooperation agreement in the areas of research and education with the University of Ljubljana and the University of Primorska.

Last year we presented to the public, for the first time, the project for building the JSI Centre for New Technologies. The main aim of this large project is to bring together science, education and industry to undertake joint development objectives. We believe that with this centre, which will be open to all Slovenian research and higher-education institutions, as well as to Slovenian and European industry, who will become part of the centre through their projects or as owners, Slovenia can make real breakthrough developments. The project is supported by several companies that are involved in the Centres of Excellence, Technology Platforms, and Technology Centres operating within the JSI, and special interest has been shown by the nineteen cofounders of the Jožef Stefan International Postgraduate School. This project brings about an entirely new vision of a joint activity involving researchers and development engineers from industry and from educational institutions. The project was included in the National Resolution on Development Projects for 2007–2013. However, whether the project will actually come to fruition in this time frame depends on the political will to do so.

The JSI's Annual Report for 2006 has been published in record time. Our aim is to communicate detailed information about our activities to the public as soon as possible, as the value of each of our achievements is multiplied once the information reaches the users. I would like to thank everybody who, in the past year, with their hard and excellent work, contributed to the development and progress of the JSI.

Prof. Jadran Lenarčič
Director of the Jožef Stefan Institute

Cabinet session of the Government of the Republic of Slovenia at the Jožef Stefan Institute, 20 September 2006

A BRIEF HISTORY OF THE JOŽEF STEFAN INSTITUTE

1946
- Decision taken by the Slovenian Academy of Science and Arts to build a Physics Institute

1949
- Research connected to the peaceful use of atomic energy started, financed by the Federal Government

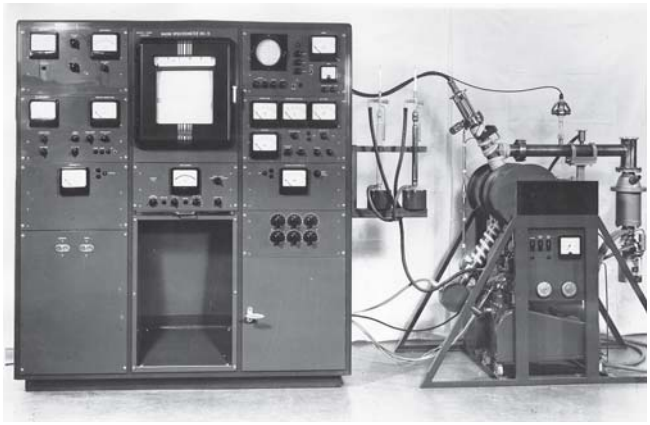
1952
- Institute renamed the Jožef Stefan Physics Institute and moved to new laboratories on its present site

1954
- The betatron and an electron microscope installed as the institute's first major pieces of equipment

1956
- Van de Graaff accelerator, constructed at the institute, started operation

1958
- Institute reorganised and new fields of activity defined: nuclear physics, solid-state physics, chemistry, and radiobiology

1959
- Institute renamed the Jožef Stefan Nuclear Institute. The major source of income was provided by the Yugoslav Atomic Energy Commission



Mass spectrometer at the JSI (about 1960)

1962
- One of the first compounds of a noble gas, XeF_6, synthesised at the institute
- The first computer for research, ZUSE Z 23, installed

1966
- Nuclear research reactor TRIGA starts operation

1968
- Yugoslav Atomic Energy Commission ceases to operate; The Republic of Slovenia becomes the institute's dominant source of research funding

1969
- Institute is renamed as the Jožef Stefan Institute

1970
- University of Ljubljana becomes a co-founder of the Jožef Stefan Institute, together with the Federal Executive Council

1971
- A new unit, INOVA, established with the aim of applying the institute's expertise and output to productive use in the national economy

The Reactor Centre, Podgorica, built in 1966

1972
- New computer Cyber 72 purchased, and the Republic Computer Centre established as an independent unit of the Jožef Stefan Institute

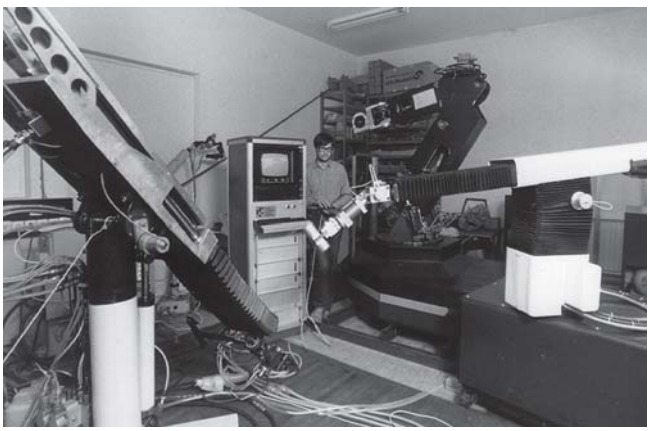
1974
- Collaboration with the international centre CERN in the field of high-energy physics started
- SEPO group for evaluating environmental interventions is established

1976
- First Yugoslav 8-bit processor computer Darta 80

1979
- Contract defining cooperation between the Jožef Stefan Institute and the Nuclear Power Plant Krško is signed
- First robot in Slovenia constructed

1982
- Ecological Laboratory with Mobile Unit established as a special unit of the Slovenian Civil Protection Organisation

1983
- Stefin, a cysteine proteinase inhibitor named after Jožef Stefan, isolated and its primary structure determined



The beginnings of robotics at the JSI, in 1985

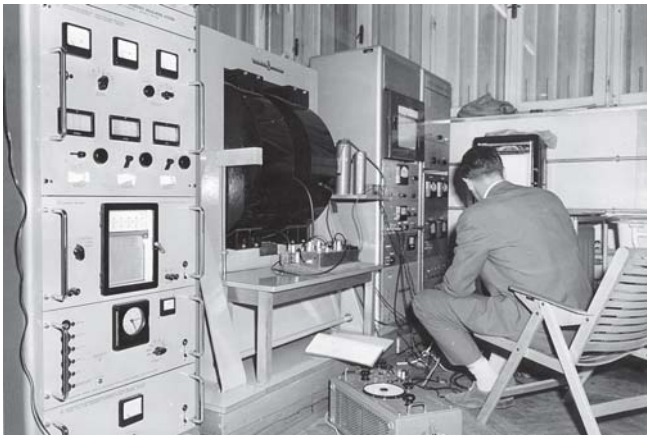
1985

~ "2000 New Young Researchers" project established by the Slovenian Research Council

~ Centre for Hard Coatings established by the Jožef Stefan Institute and the firm SMELT

1987

~ INEA established by the Jožef Stefan Institute as an independent company to promote technology transfer in the fields of cybernetics and energy management



Nuclear magnetic resonance spectrometer

1988

~ Milan Čopič Nuclear Training Centre established

1990

~ The first Slovenian supercomputer, CONVEX, installed at the Jožef Stefan Institute

~ Construction of new laboratories completed

1992

~ New technology centres established by the Ministry of Science and Technology

~ Jožef Stefan Institute restructured by the Slovenian Government as a public research institution

~ Jožef Stefan Technology Park founded, later to become the Ljubljana Technology Park

1995

~ Jožef Stefan Institute is a co-founder of the international postgraduate school for environmental sciences, the Nova Gorica Polytechnic

~ Research institutes in Velenje, ERICo and Valdoltra established by the institute

1997

~ 3.5-MeV electrostatic accelerator, TANDETRON, installed

1999

~ Jožef Stefan Institute celebrates its 50th anniversary

2003

~ Jožef Stefan International Postgraduate School established

2004

~ Jožef Stefan Institute is chosen as the coordinator of four Research Centres of Excellence

The M-2 analogue computer was designed and assembled at the JSI in 1959

FORMER DIRECTORS

Prof. Anton Peterlin, first Director of the Jožef Stefan Institute

Prof. Anton Peterlin, Founder and first Director of the Jožef Stefan Institute, 1949 - 1955
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Prof. Boris Frlec, 1975 - 1984
Prof. Tomaž Kalin, 1984 - 1992
Prof. Danilo Zavrtanik, 1992 - 1996
Prof. Vito Turk, 1996 - 2005

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National Institute of Chemistry
Lek
City of Ljubljana
Iskra Sistemi
IskraTel
Jožef Stefan Institute

ERICo Velenje Ecological Research Institute

Founders:
Šoštanj Thermopower Station
Premogovnik Velenje
Gorenje, Velenje
Jožef Stefan Institute

University of Nova Gorica

Founders:
Nova Gorica Municipality
Ajdovščina Municipality
Scientific Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana
Jožef Stefan Institute

Jožef Stefan International Postgraduate School

Founders:
Gorenje, Velenje
Kolektor Group, Idrija
Salonit, Anhovo
Slovenian Insurance Association, Ljubljana
Jožef Stefan Institute

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Technology Centre for Production Automation, Robotics and Informatics (ARI)

Security Technology Competence Centre (SETCCE)

Technology Centre for Circuits, Components, Materials, Technologies and Equipment for Electrotechnic (TC SEMTO)

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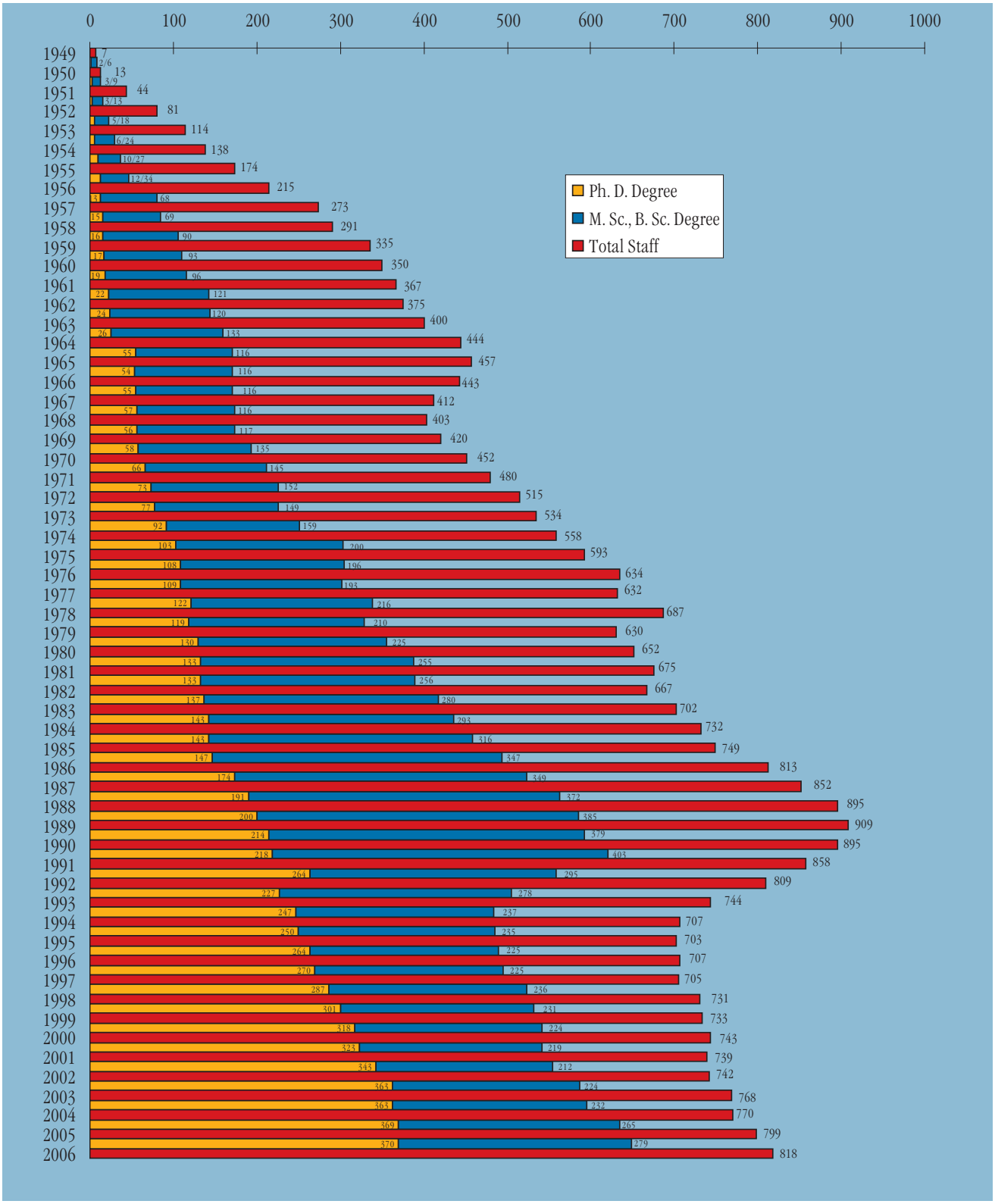
1949-2006



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Prof. Bernard Roth, member of the international advisory board, on the occasion of his lecture at the JSI, 24 March 2006

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Prof. H. Eugene Stanley, Boston University, Boston, Massachusetts, USA
Prof. Thomas Walcher, Universität Mainz, Mainz, Germany

INTERNATIONAL COOPERATION AGREEMENTS

In 2006, cooperation agreements were signed between the Jožef Stefan Institute and:

1. Deutsches Elektronen Synchrotron DESY, Hamburg, Germany
2. Stichting Katholieke Universiteit, The Faculty of Science at the Radboud University Nijmegen, Nijmegen, The Netherlands
3. Center for Integrated Nanotechnology, Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), Albuquerque, NM, USA
4. Princeton University, Princeton, New Jersey, USA
5. Odjel za fiziku Sveučilišta J. J. Strossmayer u Osijeku, Osijek, Croatia
6. European Commission, Directorate-General, Joint Research Centre, Institute for Energy, Petten, The Netherlands
7. Joanneum Research Forschungsgesellschaft mbH, Graz, Austria

A visit by a delegation from Joanneum Research, Graz, Austria

INTERNATIONAL COOPERATION

Multilateral international cooperation	No. of projects
6. FP (LIFESCIHEALTH, IST, NMP, AERO, TREN, SPACE, FOOD, ENERGY, TRANSPORT, GLOBAL, CITIZENS, SSP, NEST, SME, INCO, ERA-NET, MOBILITY, INFRASTRUCTURES, SCIENCE AND SOCIETY, RESEARCH/INNOVATION POLICIES)	89
6. FP - EURATOM	14
5. FP (QoL, IST, GROWTH, EESD, INCO, IPS, IHP)	11
IEE	10
LEONARDO DA VINCI	3
SOCRATES / MINERVA, ERASMUS	2
EUREKA	4
COST	16
NATO (SfP, CLG, RIG)	7
IAEA	16
INTERREG III C	2
EC, JRC	2
OTHERS (DELPHI, HERA-B, ATLAS, CERN RD-39, CERN RD-42, CERN RD-50, BELLE, CIMA, IHFSP, CAMP, IRE, PHARE, ESF, UNESCO-ROSTE, INTAS)	15
TOTAL	**191**

Bilateral cooperation	No. of projects
Argentina	2
Austria	8
Belgium	1
Bosnia and Herzegovina	3
Bulgaria	1
China	5
Croatia	23
Cyprus	1
Czech Republic	5
Finland	2
France (PROTEUS - 13)	15
Greece	7
Hungary	5
India	2
Italy	12
Japan	10
Korea	2

Bilateral cooperation	No. of projects
Macedonia	4
Germany	2
The Netherlands	1
Poland	7
Portugal	9
Romania	3
Russia	2
Serbia and Montenegro	7
Slovakia	2
Spain	1
Switzerland	1
Turkey	4
Ukraine	2
United Kingdom (PSP - 3)	4
USA	18
TOTAL	**171**

FORMAL DELEGATIONS AND VISITORS

Delegation of Lithuania:
Dr. Henrikas Mykolaitis, Executive director of the LINPRA Association
Mrs. Renata Dromantaite, Adviser to the Minister of the Economy
Mr. Marius Dekaminavicius, Ministry of the Economy
Dr. Kastytis Gecas, Director of the Lithuanian Innovation Centre
Mr. Kestutis Jasiunas, Director General of UAB "Ekspla", Board member and chairman of the R&D Committee of the LINPRA Association
January 16, 2006

Darinka Miklavčič, M. Sc., Director general, Univerzitetni Klinični center, Ljubljana
January 16, 2006

Mr. Guillaume Lapeyre, Science attaché of the French Embassy in Slovenia
February 16, 2006

Delegation of the Government of the Republic of Slovenia and a group of Slovenian managers:
Dr. Jure Zupan, Minister for Higher Education, Science and Technology
Dr. Jože P. Damijan, Minister without Portfolio Responsible for Growth
March 21, 2006

Delegation of Department of Defense and Department of Homeland Security of USA, USA:
Mrs. Tiffany Ferguson, International Technology Manager, USAITC
Mr. James Harvey, Technical Director USAITC
Mr. Mark Schmidt, USAITC
Mr. Eugene Moty, ODC Chief, Embassy of the United States to Slovenia, Ljubljana
Mr. Gašper Krešnik, Embassy of the United States to Slovenia, Ljubljana
May 25, 2006

Mr. Philippe Busquin, Member of the EC with responsibility for research (1999–2004)
June 6, 2006

Delegation of Hidria, d. o. o., Idrija
July 4, 2006

Delegation of Joanneum Research, Graz, Austria:
Dr. Georg Jakopič, Institute of Nanostructured Materials and Photonics
Dr. Wolfgang Waldhauser, Leoben Laser Centre/NanoSurface Engineering Center Leoben
Prof. Volker Ribitsch, Institute of Chemical Process Development and Control
Dr. Frank Sinner, Institute of Medical Technology and Health Management/ BioNanoNet
Prof. Emil List, University of Graz/NTC Weiz/Christian Doppler Laboratory
September 18, 2006

Delegation of the Government of the Republic of Slovenia:
Mr. Janez Janša, Prime Minister
Dr. Jure Zupan, Minister for Higher Education, Science and Technology
Andrej Vizjak, M. Sc., Minister of the Economy
Dr. Andrej Horvat, State Secretary, Government Office for Growth
Mrs. Nika Dolinar, Head of the Prime Minister's Office
Mrs. Nataša Šuštar, Adviser in the Prime Minister's Office
Jadranka Gustinčič, M. Sc., Public Information Officer
Mr. Valentin Hajdinjak, Press Officer of the Government
September 20, 2006

Delegation of Ukraine:
Mr. Viktor Svizhenko, Director of Department for Scientific and Technological Development, Ministry of Education of Ukraine
Mrs. Olena Maxymova, Chief Specialist, Department for International Cooperation and European Integration, Ministry of Education of Ukraine
September 21, 2006

Delegation of the participants of Environmental Science and Engineering workshop
September 27, 2006

Delegation of UK Trade & Investment:
Mr. Alan McArthur, UK Trade & Investment
Mrs. Nina Luznar, Trade and Investment Section, British Embassy Ljubljana
September 28, 2006

Delegation of the Government of the Republic of Slovenia:
Dr. Jure Zupan, Minister for Higher Education, Science and Technology
Andrej Bručan, MD, Minister of Health
Janez Podobnik, MD, Minister of the Environment and Spatial Planning
October 2, 2006

Mr. Pedro Pedreira, Executive Director GNSS Supervisory Authority, Brussels, Belgium
November 8, 2006

Delegation of Finland
November 17, 2006

Delegation of the Ministry of Education, Culture and Science of the Netherlands:
Dr. Cornelis A. van Bochove, Director, Research and Science Policy Department
Mr. Erik Martijnse, Deputy Director, Higher Education
Ms. Margo Keizer, Policy Advisor EU, Research and Science Policy Department
December 12–13, 2006

Delegation of the Republic of Korea:
Mr. Cha-Dong Kim, Ministry of Science and Technology
Mr. Chung-Taek Park, Embassy of the Republic of Korea in Austria
Ms. Seok-Hee Bae, Ministry of Science and Technology
Mr. Tae-Young Shin, Science and Technology Policy Institute
Mr. Sang-Bae Lee, Korea Institute of Science and Technology
Mr. Yong-Kyung Choe, Director; Korea Science and Engineering Foundation
Mr. Sang-Do Park, Korea Institute of Energy Research
Ms. Kyung-Mi Lee, Korea University Medical School College of Medicine
Mr. Jeon Jae-Ho, Korea Institute of Machinery and Materials
December 13–15, 2006

COOPERATION WITH UNIVERSITIES

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55. **Prof. Slobodan Žumer**, University of Ljubljana, Faculty of Mathematics and Physics

Assistants and researchers

1. **Dr. Marko Bračko**, University of Maribor, Faculty of Chemistry and Chemical Engineering
2. **Dr. Branko Kavšek**, University of Primorska, Koper
3. **Dr. Marijan Maček**, University of Ljubljana, Faculty of Electrical Engineering
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PART TIME FACULTY MEMBERS

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3. **Asst. Prof. Vid Bobnar**, Jožef Stefan International Postgraduate School, Ljubljana

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Assistants and researchers

1. **Zoran Arsov, B. Sc.**, University of Ljubljana, Faculty of Mathematics and Physics
2. **Matej Batič, B. Sc.**, Univerity of Nova Gorica
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34. **Anže Zupanc, B. Sc.**, University of Ljubljana, Faculty of Chemistry and Chemical Technology and Faculty of Mathematics and Physics

INSTITUTE COLLOQUIA

January 13, 2006: **Prof. Rainer Waser**
RWTH Aachen University, Aachen and Research Center Jülich, Jülich, Germany
Nanoelectronics - Prospects and Visions

February 1, 2006: **Prof. Antonio Bianconi**
Dipartimento di Fisica, Universitŕ degli Studi di Roma La Sapienza, Rome, Italy
Feshbach shape resonances and interband pairing in layered materials

March 1, 2006: **Prof. Theo Rasing**
Faculty of Science, Radboud Univesity Nijmegen, Nijmegen, The Netherland
Laser manipulation of spins and atoms: New tools for magnetic nanostructures

March 22, 2006: **Prof. Neera Borkakoti**
Medivir UK Ltd, Little Chesterford, Essex United Kingdom
Drug design

March 28, 2006: **Dr. Gordon Cheng**
Department of Humanoid Robotics and Computational Neuroscience, ATR Computational Neuroscience Laboratories, Kyoto, Japan
A concurrent Architecture for Humanoid Robots: Emulating Biological Processes

April 4, 2006: **Dr. Alexander Kotlyar**
Department of Biochemistry the George S. Wise Faculty of Life Science, Tel Aviv University, Tel Aviv, Israel
Enzymatic synthesis of novel DNA nanostructures

April 5, 2006: **Prof. Karlheinz Schwarz**
Institut für Materialchemie, Technische Universität Wien, Vienna, Austria
Simulation of solids in density functional theory

May 23, 2006: **Prof. Anders Lijas**
Molecular Biophysics, Center for Chemistry and Chemical Engineering, Lund University, Lund Sweden
How is protein synthesis catalyzed? The Cassiopeia synchrotron stations for protein crystallography at MAX-II

May 24, 2006: **Poteza skupina d. d., Ljubljana, Slovenia**
Presentation of a venture capital fund Poteza Venture, investing in Slovenian high tech companies

June 26, 2006: **Prof. Heino Finkelmann**
Institut für Makromolekulare Chemie, Albert-Ludwigs-Univerität Freiburg, Freiburg, Germany
Liquid Crystal Elastomers

August 21, 2006: **Prof. Lian-Mao Peng**
Key Laboratory for the Physics and Chemistry of Nanodevices and Department of Electronics, Peking University, Peking, China
In-situ Fabrication, Manipulation and Property Measurments of Single Nanotubes and Nanowires with Near Atomic Resolution

October 18, 2006: **Prof. Igor Muševič**
Jožef Stefan Institute, Ljubljana, Slovenia
Self-Assembly of Nematic Colloids

October 23, 2006: **Dr. Alex Smeets**
St. John´s Innovation Centre Ltd., Cambridge, United Kingdom
Technology Transfer - The Cambridge Experience

December 6, 2006: **Andrej Šircelj, M. Sc.**
Ministry of Finance, Ljubljana, Slovenia
Tax reform

ART EXHIBITIONS AT THE JSI

Claudio Ugussi, January 23–February 6, 2006
Erna Toncinich, February 27–March 17, 2006
Srečo Dragan, March 20–April 6, 2006
Polde Oblak, April 10–June 15, 2006
Anton Repnik, June 19–September 14, 2006
Marjan Tršar, September 18–October 20, 2006
Artgroup BridA, October 23–November 30, 2006
Berko, December 4, 2006–January 19, 2007

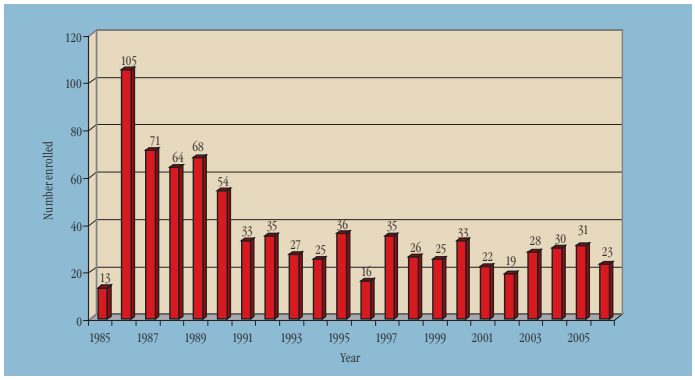
Artgroup BridA at the opening of an exibition of their work

FINANCING

REVENUES JSI (€) AND NUMBER OF PROJECTS

	2005	2006	2006/2005	contrib. 2006	No. of projects in the year 2006
Contracts with ministries of the RS	25,823,581	28,581,556	110.68 %	73.76 %	273
Other contracts	5,382,086	5,640,198	104.80 %	14.56 %	75
International contracts	3,365,465	4,526,022	134.48 %	11.68 %	362
TOTAL	**34,571,132**	**38,747,776**	**112.08 %**	**100.00 %**	**710**

POSTGRADUATES FINANCED BY ARRS*



1985-2006

** ARRS - Slovenian Research Agency*

JSI UNDERGRADUATE SCHOLARSHIPS

1977-2006

Year	FMF		FKKT	FFA	FDV	BF	FE and FRI	FS	EF	FG and FERI	MF	NGP	Total
	Physics	Mathematics											
... 1980	68	25	63				19	6	1				182
1980	20	5	19				8	1					53
1981	15	6	11				10	1	1				44
1982	12	2	7				13	1	1				36
1983	10	1	5				9			1			26
1984	11	3	7			1	12			1			35
1985	18	4	6			1	19			1			49
1986	16	8	4				22	2					52
1987	20	8	4				23	2					57
1988	26	7	8			1	27	1	1				71
1989	26	6	10	2		1	19	1		1			66
1990	26	5	11			2	25			1			70
1991	23	2	9	2		2	24			1			63
1992	22	3	16	1		3	17						62
1993	21	1	15	1		3	13						54
1994	7	1	8			3	6						25
1995	2		9			3	5						19
1996	2		9			3	5						19
1997	2		12			1	4			1			20
1998	1		6			1	7			1			16
1999	2		7			4	7						20
2000	1		5			3	9						18
2001	3		13			3	10						29
2002	4		20			3	10						37
2003	3		18			2	12				1		36
2004	4		17			1	15			2	1	2	42
2005	3		12		1	2	19			2		1	40
2006	2		12		1	1	17			2		2	37
TOTAL	370	87	343	6	2	44	386	15	4	14	2	5	1278

FMF Faculty of Mathematics and Physics, University of Ljubljana
FKKT Faculty of Chemistry and Chemical Technology, University of Ljubljana
FFA Faculty of Pharmacy, University of Ljubljana
FDV Faculty of Social Sciences, University of Ljubljana
BF Biotechnical Faculty, University of Ljubljana
FE Faculty of Electrical Engineering, University of Ljubljana
FRI Faculty of Computer and Information Science, University of Ljubljana
FS Faculty of Mechanical Engineering, University of Ljubljana
EF Faculty of Economics, University of Ljubljana
MF Faculty of Medicine, University of Ljubljana
FG Faculty of Civil Engineering, University of Maribor
FERI Faculty of Electrical Engineering and Computer Science, University of Maribor
NGP Nova Gorica Polytechnic

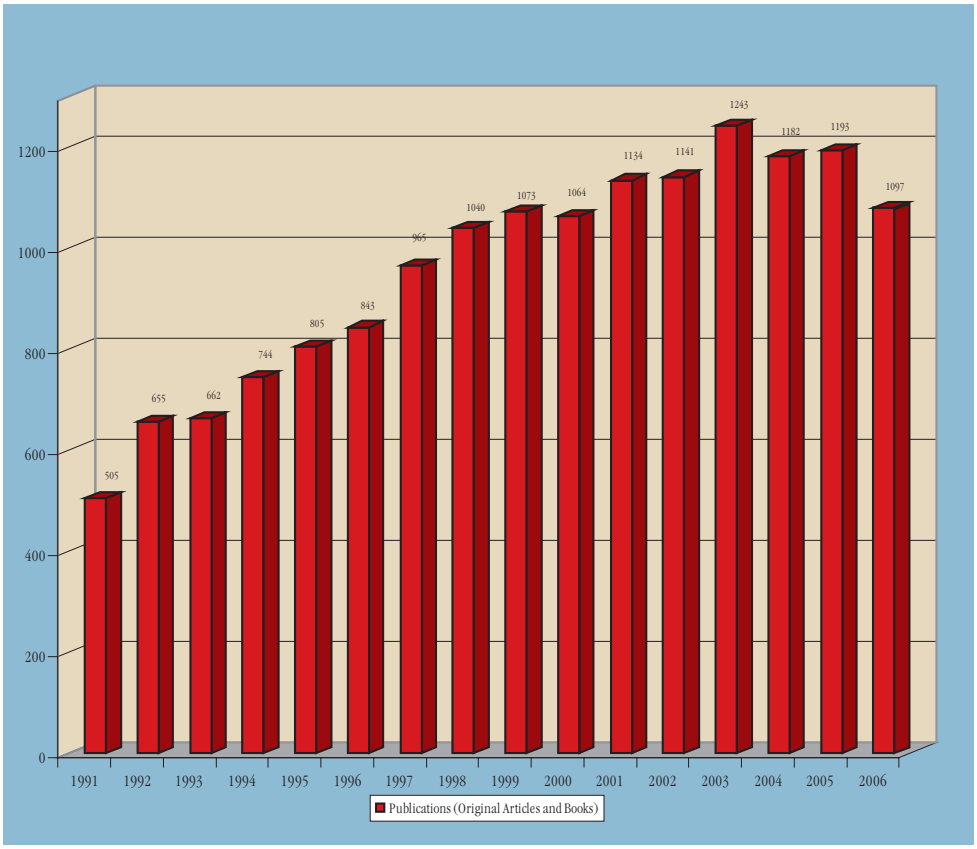
COMPLETED THESES

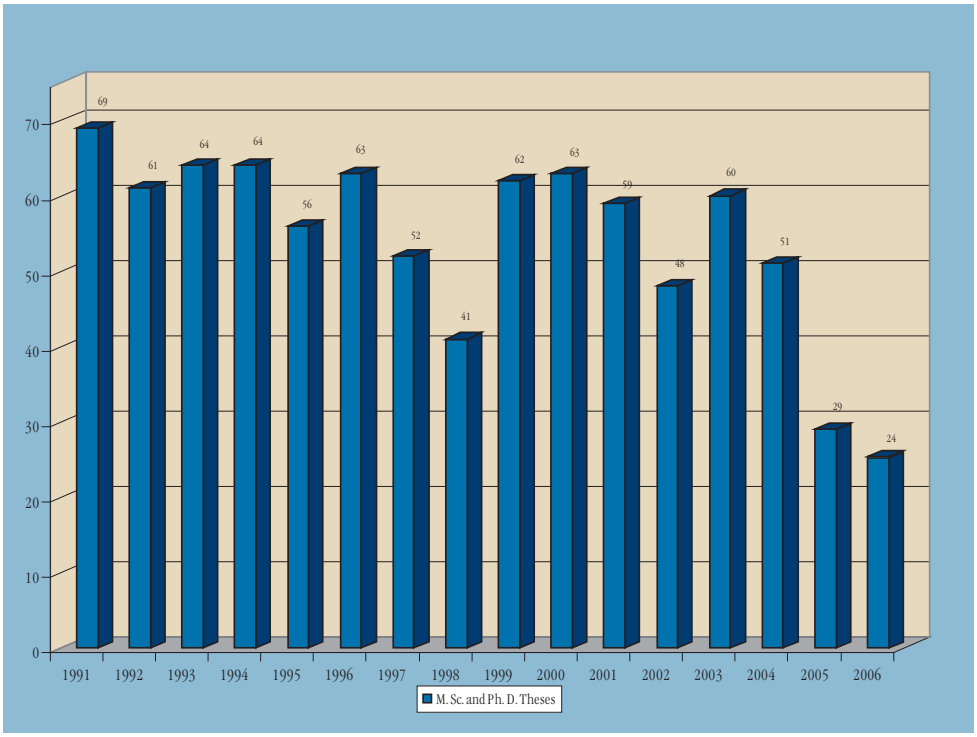
UNTIL 2006

Year	Ph. D. Theses	M. Sc. Theses	Total
...1962	15	6	**21**
1963	7		**7**
1964	7	2	**9**
1965	16		**16**
1966	2		**2**
1967		8	**8**
1968	4	8	**12**
1969	3	6	**9**
1970	2	12	**14**
1971	7	6	**13**
1972	11	24	**35**
1973	8	14	**22**
1974	21	10	**31**
1975	10	20	**30**
1976	6	31	**37**
1977	5	16	**21**
1978	10	20	**30**
1979	7	11	**18**
1980	13	10	**23**
1981	12	15	**27**
1982	13	18	**31**
1983	5	10	**15**
1984	14	17	**31**
1985	6	14	**20**
1986	8	15	**23**
1987	18	21	**39**
1988	12	26	**38**
1989	15	33	**48**
1990	16	41	**57**
1991	22	47	**69**
1992	19	42	**61**
1993	28	36	**64**
1994	27	37	**64**
1995	34	22	**56**
1996	38	25	**63**
1997	29	23	**52**
1998	21	20	**41**
1999	33	29	**62**
2000	36	27	**63**
2001	31	28	**59**
2002	29	19	**48**
2003	41	19	**60**
2004	31	20	**51**
2005	22	7	**29**
2006	22	2	**24**
TOTAL	**736**	**817**	**1553**

PUBLICATIONS

1991-2006





AWARDS AND APPOINTMENTS

AWARDS MADE TO JSI RESEARCHERS BY THE REPUBLIC OF SLOVENIA

Zois Recognitions and Award of the Republic of Slovenia

Prof. Marija Kosec, Zois Award for excellent scientific and research achievements in the field of ceramic materials

Prof. Iztok Arčon, Zois Recognition for important scientific achievements in the field of X-ray absorption spectroscopy

Asst. Prof. Zdravko Kutnjak, Zois Recognition for important scientific achievements

JSI AWARDS AND APPOINTMENTS

The Jožef Stefan Golden Emblem Prize

was awarded to the following for doctoral theses with high impact :

Dr. Nina Daneu, Jožef Stefan Institute
Inversion boundaries in zinc oxide

Asst. Prof. Janez Krč, University of Ljubljana, Faculty of Electrical Engineering
Analysis and modelling of thin-film optoelectronic structures based on amorphous silicon with rough and flat interfaces

Dr. Daniel Svenšek, University of Ljubljana, Faculty of Mathematics and Physics
Backflow-affected reorientation dynamics in liquid crystals

The winners of the Jožef Stefan Golden Emblem Prize

The Jožef Stefan Roll of Honour

was awarded to companies and institutions for successful scientific and technological cooperation with the Jožef Stefan Institute:

Domel, d. d., Železniki
Balder, d. o. o., Ljubljana
Alpina, d. d., Žiri

and personal awards to:
Dr. Tomaž Kmecl
Pavel Demšar
Miha Pesek
Bojan Marin
Andraž Kopač, M. Sc.
Martin Kopač, M. Sc.

INTERNATIONAL AWARDS TO JSI RESEARCHERS

Prof. Robert Blinc, elected for a foreign corresponding member of the Macedonian Academy of Science and Arts

Prof. Robert Blinc, re-appointed as associate professor of the University of Utah, Department of Physics, Salt Lake City, USA

Prof. Robert Blinc, elected as a honorary member of the Bureau Ampere

Prof. Robert Blinc, appointed as the president for the panel "Condensed matter in physics and chemistry European Research Foundation", Brussels, Belgium

Asst. Prof. Jure Demšar
Sofja Kovalevskaja reward, Alexander von Humboldt Foundation, Berlin, Germany

Blaž Fortuna
Best Demo Award, awarded by ESWC 2006 Conference audience, Budva, Montenegro

Tadeja Kosec, M. Sc. and Dr. Ingrid Milošev
Best poster award at the EUROCORR 2006, Maastricht, The Netherlands, September 23 – 29, 2006

Dr. Polona Umek, awarded a two-month fellowship of the Government of France for research at the Université Paris Sud

Dr. Polona Vreča, Forschung Austria Fellowship, Joanneum Research, Institut für WasserResourcenManagement, Graz, Austria

Prof. Boris Žemva
American Chemical Society Award for Creative Work in Fluorine Chemistry, American Chemical Society (ACS), Atlanta, USA

Slovenian Scientific Foundation and Experimental School of Chemistry
Best Science Event, Winners of Science Communication Activity Exchange: Slovenia to Madrid, WONDERS European Science Festival, Madrid, Spain

The winners of the Jožef Stefan Roll of Honour

AWARDS TO JSI RESEARCHERS BY SLOVENIAN INSTITUTIONS

Dr. Mateja Cegnar
Krka Award
Development and evaluation of polymeric nanoparticles for transport of cystatin into tumour cells

Boštjan Črnič
Student Prešeren Award, Ljubljana, University of Ljubljana, Faculty of Mathematics and Physics
Dose measurement with thermoluminescent dosimeters in the radiation field of a point source

Experimental School of Chemistry
Excellent Partnership; Prometeus of Science, Slovenian Scientific Foundation, Ljubljana

Matjaž Finšgar
Student Prešern award, University of Ljubljana
Study of corrosion inhibition of copper using electrochemical techniques and quartz nanobalance

Blaž Fortuna
Student Prešern award for best diploma, awarded by Faculty of mathematics and physics, University of Ljubljana
Canonical correlation analysis and its application to multilingual text documents

Janez Gale
Award for young author at International Conference »Nuclear Energy for New Europe 2006«, Portorož, Slovenia

Andraž Kocjan
Winning contribution of young scientists at the 14th Conference on Materials and Technologies, Portorož, Slovenija
Ti-Zr(Hf)-Ni Quasicrystals for Hydrogen Storage

Barbara Kolarič
Student Prešeren Award for B. Sc. Thesis
Preparation of staphylococcal protein A domain B analogs as potential cysateine protease inhibitors

Dr. Rajmund Krivec
Golden plaque from the General Staff of the Slovene Army "for extraordinary merit, in the Pilatus PC-9 aircraft investigation."

Alenka Kužnik
Student Prešeren Award for B. Sc. Thesis
Application of monoclonal antibodies CDI 315 for targeted delivery of nanoparticles

Ljerka Ožbolt, M. Sc.
Krka Award for M. Sc. Thesis
Determination of selenium compounds in buckwheat bred in particular conditions

Dr. Irena Pribošič
Henkel's golden ring for the best disertation in the area of chemistry and chemical technology at the University of Maribor for the year 2006

Research group "Structure of Hadronic Systems"
named Best Slovenian Research Group in 2005 by the Slovenian Research Agency

Research group "Thin film structure and plasma surface engineering"
named as one of the Best Slovenian Research Group in 2005 by the Slovenian Research Agency

Dr. Nina Slapar
Krka Award for Ph. D. Thesis
Molecular aspect of Colorado potato beetle adaption (Leptinotarsa decemlineata Say) to plant defense response

Polona Smrkolj
Jesenko Award, Biotehniška fakulteta, Ljubljana, Ph. D. Thesis
Determination of selenium species in cultivated plants exposed to increased selenium concentrations

Klemen Španinger
Student Prešeren Award for B. Sc. Thesis
The cross-talk between gene regulation of the circadian rhythm and cholesterol homeostasis

Dr. Jernej Šribar
Maks Samec Award for the best Ph. D. Thesis in the field of biochemistry
Intracellular ammodytoxin-binding proteins and their possible role in the process of neurotoxicity

Dr. Andrej Zorko, FUTURUM Fundation Prize for 2006 for best Ph. D. work in the field of natural medical and technical sciences

REVIEW OF PUBLICATIONS

FOR 2006

Department	Original Articles	Books	Patent Appl. and Grants	Theses
Department of Theoretical Physics (F-1)	75			
Department of Low and Medium Energy Physics (F-2)	58	2		3
Department of Thin Films and Surfaces (F-3)	19			
Department of Surface Engineering and Optoelectronics (F-4)	24		4	
Department of Solid State Physics (F-5)	100	5	6	1
Department for Complex Matter (F-7)	37		3	1
Department of Reactor Physics (F-8)	29	1		
Department of Experimental Particle Physics (F-9)	77	2		
Department of Inorganic Chemistry and Technology (K-1)	35	1	1	
Department of Physical and Organic Chemistry (K-3)	33			
Electronic Ceramics Department (K-5)	48		2	2
Engineering Ceramics Department (K-6)	12	1	1	
Department for Nanostructured Materials (K-7)	39		1	
Department for Advanced Materials (K-9)	33	1	3	2
Department of Biochemistry and Molecular Biology (B)	45			4
Department of Environmental Sciences (O-2)	84	1		4
Department of Automation, Biocybernetics and Robotics (E-1)	26		2	
Department of Systems and Control (E-2)	33		1	2
Laboratory for Open Systems and Networks (E-5)	29	1		
Department of Communication Systems (E-6)	31	3	2	
Department of Computer Systems (E-7)	21	2	1	1
Department of Knowledge Technologies (E-8)	92	3		2
Department of Intelligent Systems (E-9)	55			1
Department of Reactor Engineering (R-4)	52	9		
Energy Efficiency Centre (EEC)	14			
Centre for Knowledge Transfer in Information Technologies (CT-3)		1		
Milan Čopič Nuclear Training Centre (ICJT)	6			
Radiation Protection Unit (SVPIS)	5			
Technology Transfer Office (U-9)	1			1
TOTAL	**1113**	**33**	**27**	**24**

PATENTS GRANTED

1. **A device providing simultaneous visibility of images within the area of 360° around itself**
   Jan Babič
   Patent no. 21898
2. **Ceramic piston for hydraulic brakes**
   Tomaž Kosmač, Aleš Dakskobler, Zmago Stadler
   Patent no. 21859
3. **Method and device for local functionalization of polymer materials**
   Miran Mozetič, Alenka Vesel, Uroš Cvelbar
   Patent no. 22048, WO 2006/130122 A1
4. **Use of quasi one dimensional transition metal ternary compounds and quasi one dimensional transition metal chalcogeneide compounds as electron emitters**
   Vincenc Nemanič, Marko Žumer, Aleš Mrzel, Maja Remškar, Mihailović Dragan
   Patent no. EP 1540687
5. **Test bus locking mechanism**
   Franc Novak, Anton Biasizzo
   Patent no. 21978
6. **High contrast, wide viewing angle LCD light-switching element**
   Janez Pirš, Matej Bažec, Bojan Marin, Silvija Pirš, Andrej Vrečko
   Patent no. EP 1625445
7. **Process for the manufacturing of the polymer compensation layer for LCD optical light shutter and the construction thereof**
   Janez Pirš, Silvija Pirš, Bojan Marin, Robert Blinc, Martin Čopič, Rok Petkovšek
   Patent no. EP 1192499
8. **High contrast, wide viewing angle LCD light-switching filter**
   Janez Pirš, Andrej Vrečko, Silvija Pirš, Bojan Marin
   Patent no. WO O2006122679
9. **Process for preparing clopidrogel hydrogen sulfate of form I**
   Miloš Ružič, Berta Kotar-Jordan, Matej Smrkolj, Samo Gerkšič, Damir Vrančić, Milena Benedik, Mira Gričar
   Patent no. EP 1693375
10. **Triple resonance enhanced nuclear quadrupole resonance detection of TNT and other explosives**
    Janez Seliger, Robert Blinc, Tomaž Apih, Gojmir Lahajnar
    Patent no. 21715
11. **Capacitor comprising dielectric ceramic layer containing silver, niobium and tantalum**
    Helmut Sommariva, Christian Hoffmann, Matjaž Valant, Danilo Suvorov
    Patent no. EP 1314173 B1
12. **Process for flue gas desulphurization with integrated equipment**
    Andrej Stergaršek
    Patent no. 21956
13. **Method for high level authentication and protection of communication channels by way of message authentication codes**
    Denis Trček
    Patent no. 21902
14. **Ceramic ferrite materials for absorption .of electromagnetic waves in frequency range from 100 MHz to 12 GHz**
    Andrej Žnidaršič, Darja Lisjak, Vladimir Boštjan Bregar, Mihael Drofenik, Nevenka Rajnar
    Patent no. 21979
15. **Sheet absorbers for electromagnetic radiation with frequency range up to 12GHz**
    Andrej Žnidaršič, Vladimir Boštjan Bregar, Nevenka Rajnar
    Patent no. 22031

Auto-darkening welding filter with improved angular dependence: a patented product from research at the JSI

CENTRES OF EXCELLENCE

Research Centres of Excellence, a concept developed by the Ministry of Higher Education, Science and Technology and co-financed by the European Regional Development Fund, are a new form of cooperation between research institutes, academic institutions, and industry. Their main goal is the development of an innovative environment to facilitate the transfer, management, and development of new technologies in various priority areas of research and technology. For the period 2004-2006, the Jožef Stefan Institute has been chosen as the coordinator of four Centres of Excellence, with twenty R&D projects.

Nanoscience and Nanotechnology

Head: Prof. Dragan Dragoljub Mihailović

*Project Activity Group (*projects are partly cofunded by European Union)*:*

1. **Project for encouraging innovation, Measure 1.1.**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partner: LPFK, d.o.o., Zgornje Jezersko; Belinka Belles, d.o.o., Ljubljana; Iskra Feriti, d.o.o., Ljubljana; Keko Oprema, d.o.o., Žužemberk; MS Production, Bled; Iskra Mehanizmi, d.d., Kropa; Lek, d.d., Ljubljana; Acroni, d.o.o., Jesenice; Iskra Kondenzatorji, d.d., Semič; Eta Cerkno, d.o.o., Cerkno; Steklarna Hrastnik, d.d., Hrastnik; Steklarna Rogaška, d.d., Rogaška Slatina; HYB, d.o.o., Šentjernej; Balder, d.o.o., Ljubljana; Cinkarna Celje, d.d., Celje; HIDRIA-IP, d.o.o.; AET, d.o.o., Tolmin; Kolektor Pro, d.o.o., Idrija; Atotech, d.d., Podnart; Iskra Tela, d.d., Ljubljana; Predilnica Litija, d.o.o., Litija; Termo, d.d., Škofja Loka; Mo6, d.o.o., Ljubljana; National Institute of Chemistry, Ljubljana
2. **Synthesis of 1D Inorganic Nanostructures, Bionanostructures and Preparation of Composites**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partner: Termo, d.d., Škofja Loka; Mo6, d.o.o., Ljubljana
3. **Nanomaterials in Electrochemical Systems**
   Leading institution: National Institute of Chemistry, Ljubljana
   Cooperating partner: Atotech, d.d., Podnart; Iskra Tela, d.d., Ljubljana; Predilnica Litija, d.o.o., Litija
4. **Nanostructured Surfaces and Interfaces**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partner: HYB, d.o.o., Šentjernej; Balder, d.o.o., Ljubljana; Cinkarna Celje, d.d., Celje; HIDRIA-IP, d.o.o.; AET, d.o.o., Tolmin; Kolektor Pro, d.o.o., Idrija
5. **Characterisation on Nanometric Scale**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partner: Lek, d.d., Ljubljana; Acroni, d.o.o., Jesenice; Iskra Kondenzatorji, d.d., Semič; Eta Cerkno, d.o.o., Cerkno; Steklarna Hrastnik, d.d., Hrastnik; Steklarna Rogaška, d.d., Rogaška Slatina
6. **Synthesis of Nanoparticles and Nanocomposites**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partner: Belinka Belles, d.o.o., Ljubljana; Iskra Feriti, d.o.o., Ljubljana; Keko Oprema, d.o.o., Žužemberk; MS Production, Bled; Iskra Mehanizmi, d.d., Kropa
7. **Nanoelectronics and Nanotechnology Facilities**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partner: LPFK, d.o.o., Zgornje Jezersko

The Development of the Research Infrastructure:

8. **The Development of the Research Infrastructure of the Research Infrastructure of The Center of Excellence in Nanoscience and Naotechnology (CE NS and NT), Measure 1.4.**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Partners: LPFK, d.o.o., Zgornje Jezersko; National Institute of Chemistry, Ljubljana

Materials for Electronics of Next Generation and Other Emerging Technologies

Head: Prof. Marija Kosec

Project Activity Group:

1. **Magnetic Materials and Intermetallic Alloys**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: Institute of Metals and Technology, Ljubljana; Magneti, d. d., Ljubljana; Iskra Feriti, d. o. o., Ljubljana; Kolektor Pro, d. o. o., Idrija
2. **Microstructures and Microsystems**
   Leading institution: University of Ljubljana, Faculty of Electrical Engineering, Ljubljana
   Cooperating partners: Iskra Tela, d. d., Ljubljana; Iskra Avtoelektrika, d. d., Nova Gorica
3. **New generation of Elements and Devices for Protection Against Transient Surges**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: Milan Vidmar Electric Power Research Institute, Ljubljana; Zavod TC SEMTO, Ljubljana; VARSI, d. o. o., Ljubljana; Iskra Zaščite, d. o. o., Ljubljana; University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; Iskra Tela, d. d., Ljubljana
4. **Hybrid Materials and Structures**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: HIPOT-RR, d. o. o., Šentjernej; HYB, d. o. o., Šentjernej
5. **Complex Materials for New Technologies: From Soft Matter to Hard Coatings**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: Gorenje, d. d., Velenje; Balder, d. o. o., Ljubljana; University of Ljubljana, Faculty of Mathematics and Physics, Ljubljana; Institute for Mathematics, Physics and Mechanics in Ljubljana, Laboratory for NQR and weak magnetic fields, Ljubljana

Environmental Technologies

Head: Prof. Milena Horvat

Project Activity Group:

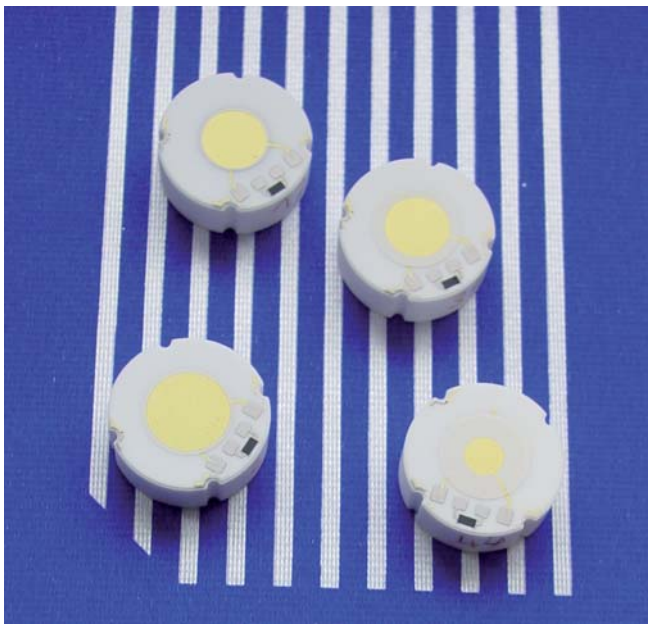
1. **Biological Methods of Wastewater Treatment**
   Leading institution: University of Ljubljana, Faculty of Civil Engineering and Geodesy, Ljubljana
   Cooperating partners: University of Ljubljana; National Institute of Biology, Ljubljana; Domžale – Kamnik Wastewater Treatment Plant, d. o. o., Domžale; Institute of Physical Biology, Grosuplje; National Institute of Chemistry, Ljubljana; Komunalno podjetje Velenje, d. o. o., Velenje; Esotech, d. d., Velenje; Nova Gorica Polytechnic, Nova Gorica; Limnos – Company for Applied Ecology, d. o. o., Ljubljana
2. **Ecoremediation Technologies**
   Leading institution: University of Ljubljana, Biotechnical faculty, Ljubljana
   Cooperating partners: Institute of Physical Biology, Grosuplje; University of Ljubljana ; Slovenian Forestry Institute, Ljubljana; GSF – National Research Center for Environment and Health, Institut for Soil Ecology, Neuherberg, Germany; Community of Celje, Celje; ERICo, Environmental Research & Industrial Co-operation Institute, Velenje; Nova Gorica Polytechnic, Nova Gorica; Limnos – Company for Applied Ecology, d. o. o., Ljubljana
3. **Recycling and Use of Waste**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: University of Maribor; Esotech, d. d., Velenje; National Institute of Biology, Ljubljana; Domžale – Kamnik Wastewater Treatment Plant, d. o. o., Domžale; National Institute of Chemistry, Ljubljana

Advanced Control Technologies

Head: Prof. Stanko Strmčnik

Project Activity Group:

1. **Advanced Control Methods**
   Leading institution: University of Ljubljana, Faculty of Electrical Engineering, Ljubljana
   Cooperating Partners: Jožef Stefan Institute, Ljubljana; Inea, d. o. o., Ljubljana; Metronik, d. o. o., Ljubljana; Goap Nova Gorica, d. o. o., Solkan; Liko Pris, d. o. o., Vrhnika; Špica International, d. o. o., Ljubljana; Telem, d. o. o., Maribor; Lek, d. d., Ljubljana; Domžale – Kamnik Wastewater Treatment Plant, d. o. o., Domžale
2. **Automatic On-line Supervision of Processes and Product Quality Control**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; Inea, d. o. o., Ljubljana; Domel, d. d., Železniki; Telem, d. o. o., Maribor; FDS Research, d. o. o., Trzin; Špica International, d. o. o., Ljubljana
3. **Technologies of Distant and Distributed Control**
   Leading institution: University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor
   Cooperating partners: Jožef Stefan Institute, Ljubljana; University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; Inea, d. o. o., Ljubljana; Špica International, d. o. o., Ljubljana; Telem, d. o. o., Maribor
4. **Decision Support for Control in Production**
   Leading institution: Jožef Stefan Institute, Ljubljana
   Cooperating partners: University of Ljubljana, Faculty of Electrical Engineering, Ljubljana; University of Maribor, Faculty of Electrical Engineering and Computer Science, Maribor; Inea, d. o. o., Ljubljana; Metronik, d. o. o., Ljubljana; Synatec, d. o. o., Idrija; Špica International, d. o. o., Ljubljana
5. **Product Information Management through Complete Lifecycle**
   Leading institution: University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana
   Cooperating partners: Domel, d. d., Železniki; Alpina, d. d., Žiri
6. **Project Control in System of Orders**
   Leading institution: University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana
   Cooperating partners: Eti Elektroelement, d. d., Izlake; Liv Plastika, d. o. o., Postojna



Thick-film piezoelectric resonant pressure sensors made on an alumina substrate. (HIPOT-RR and Jožef Stefan Institute, CoE R&D project: "Hybrid materials and structures" within the Centre of Excellence: "Materials for Electronics of the Next Generation and Other Emerging Technologies")

KNOWLEDGE TRANSFER

In 2006 the JSI paid a lot of attention to furthering its links with industry. Studies clearly show that both Europe and Slovenia are among the leaders in research worldwide. On the other hand, the transfer of knowledge to enterprises and industry is not as efficient as in, for example, the USA. Therefore, European commissioners state publicly that such cooperation should be encouraged and intensified. In keeping with European aims and the objectives of the Slovenian government, the JSI organized several important meetings on the subject of cooperation with enterprises and industry. In this way the JSI introduced a new method of cooperation, showing industry and the public that it is aware of its leading role, not only in research but also in the transfer of knowledge in practice.
A result of this growing attention to knowledge transfer is the signing of more than 250 R&D contracts in 2006.

R & D PROJECT PARTNERS

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135. Zavod za zdravstveno varstvo Maribor, Maribor

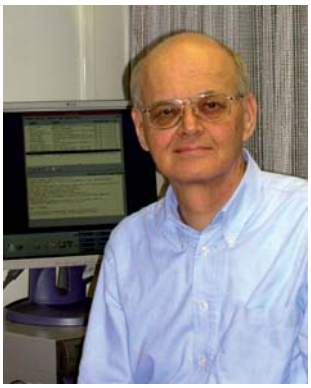
Prof. Jadran Lenarčič, Director of the JSI, speaking at the JSI during the visit of Dr. Jože P. Damijan, the Minister for Growth, and Dr. Jure Zupan, the Minister for Higher Education, Science and Technology.

RESEARCH DEPARTMENTS

DEPARTMENT OF THEORETICAL PHYSICS F-1

The research program of the Department of Theoretical Physics is focused on the theory of condensed-matter physics, statistical physics, the physics of nuclei, particles and fields, as well as biophysics and soft condensed-matter physics. The department also maintains its own high-performance computing facility, for which it develops the necessary software. These studies are carried out in close collaboration with several experimental groups at the Jožef Stefan Institute as well as with local and foreign universities or institutes. The department is also involved in various international projects.

The Group for the Theory of Condensed Matter and Statistical Physics has been investigating phase transitions and critical phenomena occurring in networks, ferroelectrics, and on solid surfaces. Another major activity was the study of strongly correlated electron systems, high-temperature superconductors, and quantum coherent-electron devices.



Head:
Prof. Raša Matija Pirc

A new mechanism of nonlinear dielectric response in relaxor ferroelectrics of the PMN type has been proposed, based on the deformation of polar nanoregions and their dipole moments due to homogeneous strain fluctuations. The temperature dependence of the anisotropic part of the third-order nonlinear response has been calculated in the framework of the spherical-random-bond–random-field model of relaxors, and compared with the experimental data for PMN.

As part of our research on complex networks we have studied three groups of subjects: the structure, the dynamics and the application of network theory to several real-world problems. We developed new algorithms for growing cellular types of networks. We also implemented a new continuous-time algorithm for current transport on cellular networks of nanoparticles via the quantum tunneling of electrons, which is driven by the voltage difference, and determined the nonlinear I–V curves. Finally, we applied network theory to model the bioinformatics data of gene expressions of yeast as a complex dynamical system.

We have studied numerically the magnetic properties of the homogeneous and doped Shastry-Sutherland model as it applies to a $SrCu_2(BO_3)_2$ crystal. During finite doping a spin polaron is formed around the impurity, leading to the formation of new states inside the spin gap and to substantial broadening of the collective excitations relative to the undoped case, as observed in the dynamical structure factor.

We have applied Wilson's numerical renormalization group technique to calculate the conductance and various correlation functions in the system of two side-coupled quantum dots. We have established the phase diagram of the system, depending on the gate voltage and the inter-dot tunneling rate. In the case of multiple quantum dots coupled to the leads in a sideways configuration, the spins on the side dots couple into a maximum spin state due to the ferromagnetic RKKY interaction.

In a study of the anisotropic s=1/2 spin Heisenberg model (XXZ) coupled to phonons we have shown that axial anisotropy (the XY model) can lead to a breakdown of the Wiedemann–Franz law, presumably due to inelastic scattering processes.

Within the Lanczos method of exact diagonalization, and partly analytically as well, we have studied the self-localization of holes within the Holstein t-J model. We showed that the critical spin-phonon coupling decreases as J increase. This result restricts the self-localization of holes in lightly doped cuprates.

We have carried out a phenomenological analysis of the resonant peak (RP) in the magnetic response in cuprate superconductors and have established the existence of two excitation branches emerging from the RP, as was also observed experimentally. By analyzing the experimental data we argue that the present method is superior to the commonly used random-phase approximation.

We investigated serially coupled double quantum dots, where capacitive coupling significantly renormalises the two competing energy scales: the Kondo temperature and the superexchange coupling. In the case of triple serially coupled quantum dots the phase diagram of possible regimes was deduced and we proved that conductance in the particle-hole symmetric case is unitary. The conductance of a molecule with centre-of-mass motion was also investigated. Such a system exhibits dynamical breaking of the inversion symmetry, which may lead to important consequences for the transport properties.

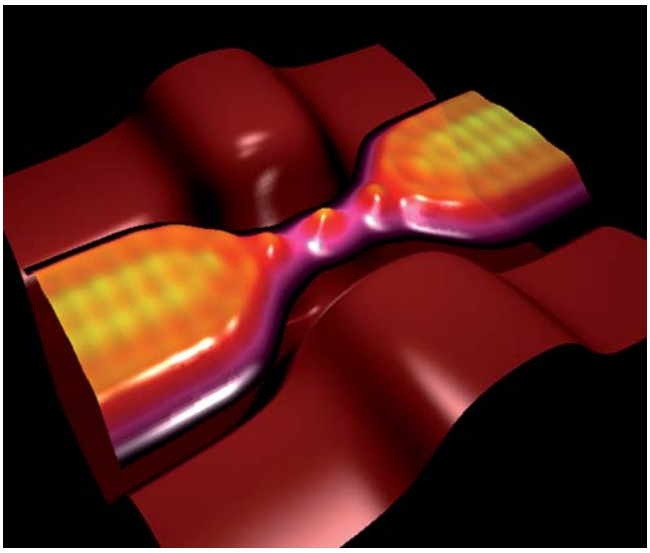


Figure 1: Spin-density of electrons in a quantum point contact in the 0.7 anomaly regime, T. Rejec and Y. Meir, Nature 442, 900 (2006)

We investigated the competition between the quantum entanglement of two spin qubits in double quantum dots attached to leads with various topologies and the separate entanglement of each spin with nearby electrodes and found universal behavior of the spin-qubit entanglement, depending on their mutual interaction, the coupling to their environment, the temperature and the magnetic field. We also derived several convenient formulae for the entanglement of two delocalized electrons. Entanglement can also be generated by two electrons in a spin-zero state of a carbon nanotube. We proposed a scheme to produce spin-entangled states for two interacting electrons transported along the quantum wire, trapped in a surface acoustic wave.

We investigated the structural, mechanical and electronic properties of Mo-based nanowires. Quite unexpectedly, high elastic moduli were obtained along the Mo_6S_6 wire. The compound is very susceptible to Li doping, which causes a decrease in the elastic modulus and acts as an electron donor. We also found that $Mo_6S_3I_6$ nanowires, upon longitudinal strain, have two energy minima and that the electrical conductivity is very strain dependent.

The Group of Theoretical Physics of Nuclei, Particles and Fields has investigated the structure of hadrons, the effective theories of weak and electromagnetic mesonic decays, the unified theory of elementary interactions, the relativistic theory of membranes and precise calculations of the properties of three-body systems in atomic physics.

We derived the coupled-channel formalism for the K-matrix and showed that the nucleon-sigma meson channel is responsible for the peculiar behavior of the P11 scattering amplitudes in the Roper region.

We studied light scalar mesons within the lattice QCD, using the so-called dynamical staggered quarks. We provided an analytic explanation for why the scalar correlation function with I=1 behaves like $e^{-2m\pi t}$ instead of $e^{-(m\pi+m\eta)t}$, as expected in proper QCD.

We determined the possible effects of the Littlest Higgs model on the rare charm meson decays. The effects were found to be small in spite of the tree-level flavour-changing coupling of the c and u quarks in this model.

We have studied helicity amplitudes of semileptonic charm meson decays into a light vector meson. When taking into account the lowest excited charm meson states we obtained good agreement with the experimental data. We have studied chiral corrections to the strong decays of heavy mesons and the weak mixing of heavy neutral mesons within and beyond the Standard Model. We have considered contributions from the lowest-lying heavy-meson excited states. We have calculated the branching ratios of rare two- and three-body B meson decays, proceeding through the inclusive quark process $b \to d\ d\ \bar{s}$. These processes are very rare within the Standard Model, but they may receive large contributions within certain extensions of the Standard Model. Using the existing experimental upper limit on the branching ratio of the decay $B^- \to \pi^-\pi K^+$ we have put new constraints on effective parameters in several extensions of the Standard Model.

We have detailed how to obtain a new precise constraint in the $\bar{\rho}$-$\bar{\eta}$ plane from charmless three-body $B_s \to K\pi\pi$ decays with a small theoretical uncertainty. We have updated the bounds on CP asymmetries in $B^0 \to \eta K_S$ and $B^0 \to \pi^0 K_S$, we have presented the first calculation of semi-inclusive hadronic B decays in the endpoint region using the soft collinear effective theory. We have performed the first calculation of two-body B decays into isosinglet final states within SCET.

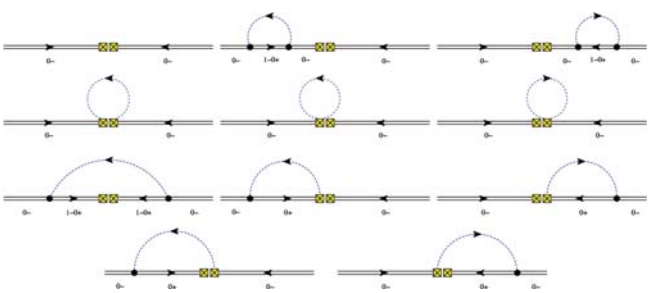


Figure 2: All diagrams that enter in the calculation of the chiral corrections to the mixing amplitude of neutral heavy B and Bs mesons. D. Bećirević, S. Fajfer, J. Kamenik, Chiral behavior of the B(s,d)-Bbar(s,d) mixing amplitude in the Standard Model and beyond, hep-ph/0612224.

We showed that the Higgs sector of the minimal supersymmetric grand unified SO(10) model constrains the fermionic masses. In the non-supersymmetric model SO(10) we studied the flavour structure.

We investigated a theory in which 4-dimensional space-time was generalized to 16-dimensional Clifford space (C-space). Curved C-space can be used in a possible model for the unification of fundamental interactions á la Klauza-Klein. We explored such a possibility in some detail and studied a generalized Dirac equation in curved C-space.

We have shown numerically for the anharmonic oscillator and the logarithmic, Wood-Saxon, double-well, and Breit-Coulomb potentials that

the quasilinearization method in physics (QLM) yields two-orders-of magnitude more accurate results in its first iteration than the WKB method, providing we use the Langer WKB solution as the initial approximation. Six iterations yield 20 decimal places. Using the CFHHM method we derived approximate second-order three-body wave functions near coalescence points and observed the vanishing of the Fock terms near the electron-nucleus coalescence line. Several new double-photoionization cross-sections were calculated.

The Group of Theoretical Biophysics and Soft Matter Physics focused on polyelectrolytes, liquid crystals, colloids, and phospholipid and biological membranes

We investigated the effective van der Waals interactions between two layers within a multilayer assembly and we estimated the effect of the non-additivity of such interactions. We showed that the linear connectivity between charges on a sphere leads to a modified solution of the classic Thomson problem. We have continued to investigate the properties of the bridging interactions mediated by polyelectrolytes between macroions. We analyzed the fundamental length scales in semidilute Na-DNA aqueous solutions using dielectric spectroscopy. The high-frequency relaxation mode at high DNA concentrations can be identified with the de Gennes–Pfeuty–Dobrynin correlation length, whereas the unusual behavior at low DNA concentrations can be associated with the hydrophobicity of the DNA backbone.

We probed the self-consistency of different models of effective colloidal interactions, and we proposed an empirical criterion that renders the predicted thermodynamic properties of the system based on the cell model self-consistent. We also focused on the condensed phases of hard-core/soft-shoulder colloids, and we reproduced the phase diagram of the aggregate phases obtained by numerical simulations.

We studied the structure of free-standing smectic film at an adsorbed colloidal sphere, and we showed that the adsorption depends both on the meniscus and on the partial indentation of the particle. We analyzed the achiral polar smectic systems where polar and tilt order appear consecutively upon cooling. We predicted a novel phenomenon whereby polarly ordered molecules tilt with respect to the layer normal if an achiral polar smectic is doped by a chiral dopant. We also studied the 2D modulated phases of such systems, and we showed that the different phases not only have the same origin, but also the same structure on different length scales.

We analyzed the aggregates of lipid vesicles, and we have shown that in the strong adhesion regime, the stable doublet is characterized by a sigmoid rather than a flat contact zone. We also investigated the coupling between the vesicle shape and the lateral distribution of mobile membrane inclusions. A simple mechanical model of the Golgi stack was proposed to study the effect of the membrane-bending energy and the adhesion between Golgi cisternae on their number and size.

We continued to investigate calcium dynamics within the context of intracellular communication in airway smooth muscle cells. We have unified the description of calcium oscillations in cytosol, complex molecular interactions between calcium, myosin light chain kinase and calmodulin and a four-level description of myosin binding to the actin fibre.

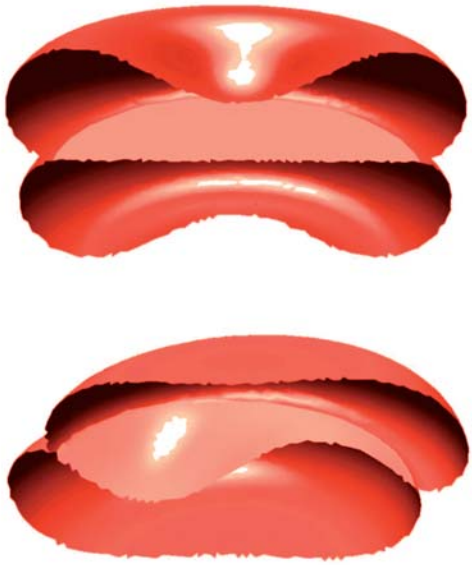


Figure 3: Cutaway view of the calculated lipid vesicle doublet: in the weak adhesion regime, the doublet is axisymmetric and the contact zone is flat (top), whereas in the strong adhesion regime the doublet is non-axisymmetric and characterized by a sigmoid contact zone (bottom).

Some outstanding publications in the past three years

1. P. Prelovšek, R. Zeyher, and P. Horsch: Self-Localization of Composite Spin-Lattice Polarons, Phys. Rev. Lett. 96, 086402 (2006)
2. T. Rejec and Y. Meir: Magnetic Impurity Formation in Quantum Point Contacts, Nature 442, 900 (2006)
3. A. R. Williamson, J. Zupan, Two body B decays with isosinglet final states in soft collinear effective theory. Phys. Rev., D Part. fields gravit. cosmol., 74, 014003 (2006)
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Awards and appointments

1. Dr. Rajmund Krivec received a Golden plaque from the General Staff of the Slovene Army “for extraordinary merit, in the Pilatus PC-9 aircraft investigation.”

Organization of conferences, congresses and meetings

1. Progress in Quark Models, Bled, Slovenia, 10–17 July 2006
2. Self-Assembly and Properties of Complex Patterns, Portorož, Slovenia, 3–6 September 2006

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2. S. Knez, Aerodynamics and mechanics of buoyancy breakdown (Department of physics, FMF UL, 2006), supervisor R. Podgornik.

INTERNATIONAL PROJECTS

1. Multifunctional Ceramic Layers with High Electromagnetoelastic Coupling in Complex Geometries
MULTICERAL
6. FP
NMP3-CT-2006-032616
EC; Prof. Andrei Kholkin, University of Aveiro, Dept. of Ceramics & Glass Engineering, Aveiro, Portugal
Prof. Raša Pirc, Prof. Robert Blinc, Prof. Marija Kosec, Dr. Janez Holc
2. Many- body Interactions in Charged Colloidal Suspensious
Many-body Colloids
MERG-CT-2005-031089
6. FP
EC
Dr. Jure Dobnikar
3. Fundamentals of Nanoelectronics
RTNNANO
6. FP
MRTN-CT-2003-504574
EC; Lancaster University, Lancaster, Great Britain
Prof. Anton Ramšak
4. Unifying Principles in Non-equilibrium Pattern Formation
PATTERNS
6. FP
MRTN-CT-2004-005728
EC; The University of Nottingham, Nottingham, Great Britain
Prof. Bosiljka Tadič
5. New Polaronic States and their Role in Giant Piezoelectric Effect Formation
NATO
PST.EAP.CLG 980378
Prof. Siegmar Kapphan, Universität Osnabrück, Osnabrück, Germany, Prof. Valentin Vikhnin, Russian Academy of Sciences, St. Petersburg, Russia
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1. Dr. Ilija Doršner, The Abdus Salam ICTP, Trieste, Italy, 12–13 Januaryy2006
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DEPARTMENT OF LOW AND MEDIUM ENERGY PHYSICS F-2

The Department of Low and Medium Energy Physics conducts basic and applied research in low- and medium-energy physics. Low-energy physics accounts for our atomic physics research, while the nuclear physics studied at the department can be classified as intermediate-energy physics. The third research field of the department is radiological environmental protection, which involves monitoring nuclear objects and environmental radioactivity. The department also operates the Ecological Laboratory, with its mobile unit, as a specialized civil protection unit.

Head:
Dr. Matej Lipoglavšek

Fundamental research in nuclear physics is performed by the Structure of Hadronic Systems Group. In the A1 Collaboration at MAMI (Mainz, Germany) we have performed the first part of the precise proton elastic form-factor measurements. The purpose is to obtain a consistent data set on the form factors which, during low-momentum transfers, are governed by the meson cloud. A significant portion of our research effort at MAMI was dedicated to double-polarized virtual Compton scattering on protons, with the main goal of obtaining the first results on the generalized polarizabilities of the proton or their linear combinations from the measured spin asymmetries. Some test runs were performed for the triple-coincidence process, 12C(e,e'pπ-), which might be an appropriate system to feature the creation of narrow delta resonances in nuclei.

In the Hall A Collaboration at the Jefferson Laboratory, a measurement of the neutron electric form-factor during high momentum transfer was performed for the first time with reasonable precision. No usable data exist for momentum transfers beyond approximately 1.5 GeV. The new large-acceptance spectrometer, BigBite, was used for the first time in its full detector configuration. We have also collaborated on two experiments devoted to the study of nucleon electromagnetic and spin structure at low energies. In the first measurement we measured the elastic structure function A(Q) at low Q, which is one of the key observables of the Standard Model of nuclear physics, and data from various laboratories exhibit large discrepancies. In the second experiment we attempted to determine the spin-transfer coefficients to the proton in the photo-disintegration of a deuteron with circularly polarized real photons. State-of-the-art theories predict a rather smooth energy dependence of these coefficients, which is not seen in practise.

At the BLAST detector at MIT-Bates, the data analysis on the tensor asymmetry in the elastic scattering of electrons off deuteron has been completed, as well as the analysis of the proton elastic form-factor measurement at very low momentum transfers from double-spin asymmetries. An earlier measurement of virtual Compton scattering at the OOPS Collaboration has also been completed [1].

As part of the ongoing study of the use of high-purity germanium detectors in environmental monitoring programs in 2006 we developed a computer code for the calculation of the total efficiencies of extended samples, which is a prerequisite for the determination of coincidence-summing correction factors. On this basis we were then able to realise an entirely new approach to the analysis of gamma-ray spectra, based on a search for the optimal combination of synthetic spectra belonging to the individual radionulcides contained in a context-sensitive nuclide library that matches the measured spectrum best. The required activities of the radionuclides actually present in the sample are simply obtained as the coefficients of the optimal linear combination. In this way, our approach reduces to a single step the many separate phases of the traditional analysis procedure, i.e., the energy and peak-width calibration phase, the peak location and peak-area-determination phase, the identification of the radionuclides in the sample, the subtraction of the background counts, the application of the interference correction algorithm and the final calculation of the activities. We elaborated methodologies for an estimation of the sampling, the sample preparation and the counting times of batches of samples for which the lower limit of detection for gamma-ray emitters of a defined decay time is minimal. The methodologies were elaborated for water samples and for aerosol samples.

In collaboration with Dr. Betak from the Institute of Physics of the Slovak Academy of Science we continued work on the development of a new approach to the description of the radiative capture of nucleons, in particular the comparison of the pre-equilibrium with the direct-semidirect (DSD) model. The latter shows that, in general, a proper description of direct reactions with an optical (non-hermitian) potential can only be achieved by using

effective interaction operators. We finished the analysis of an experiment at iThemba LABS on proton capture into the doubly magic nucleus ^{208}Pb. The analysis resulted in two publications [2,3]. Our work on the excited states of magic nuclei also resulted in the PhD thesis of Matjaž Vencelj.

Low-energy physics was dealt with mainly in the frame of the research program "Studies of atoms, molecules and structures with photons and particles" and two projects running under the Slovenia fusion association (EURATOM-MHEST). A member of our research program, Prof. Dr. Iztok Arčon, was awarded with the "Zois" prize for 2006 for his research in the field of absorption spectroscopy. We have continued to enable Slovenian as well as foreign labs to access modern analytical methods as they are available at synchrotrons abroad and at our domestic ion accelerator.

The most relevant achievements of the low-energy physics group in 2006 are:

- Successful photoabsorption measurements at the Elettra synchrotron (Bazovica) and DESY (Hamburg). We have performed the first full measurement of the atomic absorption of potassium in the region of the K threshold and of metallic potassium. We have determined the displacement of a titanium atom inside the oxygen octahedron in perovskite $SrTiO_3$. Among EXAFS and XANES structural analysis for many new materials, nanomaterials and the environmental and natural-heritage-oriented research the largest impact has been the study of the effects of old-fashioned iron-based ink on the stability of old manuscripts. We have published the results of an analysis of arsenic soil pollution within the region of the former mining area in Cornwall (England) to discuss the potential danger to local inhabitants due to the relatively high concentrations as well as due to the mobility and bioavailability of these compounds in the soil.
- We have performed two high-resolution experiments with the JSI spectrometer at the Elettra synchrotron to study anomalous elastic x-ray scattering around the K edge in argon and the fluorescence from doubly excited states just above the edge. In collaboration with a research group from the Physics Department of the University of Fribourg, Switzerland, we have prepared and performed a high-resolution study of the radiative K-MM Auger on Ca and Ti.
- We have studied the fluorescence decay of doubly excited states in helium in a strong static electric field. After we first published the first-order perturbation results these were later improved by the method of complex rotation [4]. The calculations explained recent photoionization measurements in high electric field strengths up to 100 kV/cm, which revealed the presence of new "dark" doubly excited states of even parity. We have predicted the shortening of the lifetimes of these new states with the increase of the field strength and experimentally verified the prediction at the Elettra GasPhase beam line, giving a statistically significant measure of lifetimes of the order of 30 ps [5].
- In collaboration with a research group of the Physics Department of the University of Miskolc, Hungary, we have prepared and performed the (e,2e) experiment, where we search for the quantum interference around the 2p edge in argon.
- On the ALOISA/HASPES beam line of the Elettra synchrotron we have studied the ordering of thin organic films on surfaces. From x-ray diffraction and absorption measurements we have determined the structure and adsorbed orientation of pentacene, and we have characterized the phase diagram of pentacene growth on the Au(110) surface.
- In collaboration with IPP, Forscungszentrum Jülich, Germany, and the Alfven Laboratory, Royal Institute of Technology, KTH, Stockholm, Sweden, we performed at the JSI a hydrogen-concentration measurement with a lateral resolution of 5 ěm using the ion-beam ERDA method on sample material from reactor walls that were previously exposed to a tokamak plasma.
- The ion-beam methods PIXE and STIM together with a proton microbeam were used to map the elemental concentrations in plant tissues with micrometer resolution. In collaboration with the Faculty of Biology, University of Ljubljana, and the Materials Research Group, iThemba LABS, South Africa, we continued to study the distribution of Zn and Cd in the tissue of the hyperacumulator plant Thlaspi praecox. In collaboration with the ATOMKI institut, Debrecen, Hungary, we have studied human hair follicles. Together with researchers from the Environmental Chemistry department at the JSI we have studied the intake of arsenic into Hypogymnia physodes. We also began with measurements of light-element concentrations in plants from salt-rich environments.
- In collaboration with the Institute of Nuclear Physics, NCSR "Demokritos", Athens, Greece, and the Institute of Optics and Atomic Physics, Technical University of Berlin, Berlin, Germany, we have, for the first time, performed the PIXE confocal measurement, which allows a 3D determination of elemental concentration due to combination of micro-beam sample excitation and the narrowed field of view of the x-ray detector.
- In collaboration with the research group from Laboratoire Pierre Süe, CEA-Saclay, France, we have set up PMMA ion-beam micromachining as a basic technology for micro-Petri-slide production.

- In the frame of the VEVOF Euroatom project we have studied, with an in-house-built spectrometer, the distributions of vibrationally excited hydrogen molecules (H_2 and D_2), which are formed via atomic recombination on the Ta, W, Cu and C surfaces. In collaboration with the Max-Planck Institut für Plasmaphysik, Garching, Germany, we have recorded the vibrational distribution from the atomic hydrogen source. Together with researchers from the Reactor Physics Department and FZJ Jülich, Germany, we started to study hydrogen plasma in a magnetic field with the method of optical spectroscopy to discover the relevance of vibrationally excited molecules from surfaces on the plasma quality. We have investigated the interaction of hydrogen and deuterium atoms and molecules with W by means of hydrogen permeation through the membranes. The ERDA method with a 4.2-MeV $^{7}Li^{2+}$ ion beam was used for this purpose. In collaboration with the Institut für Plasmaphysik, Forschungszentrum Jülich, Germany, we have focused on the calibration for deuterium measurements.
- The VEOVF and IBAF projects are a part of a broader European collaboration that is coordinated by the EU Task Force for Plasma-Wall Interaction (http://www.efda-taskforce-pwi.org/). This year the annual meeting of the TF-PWI was organized by us at the JSI.
- The work with Mössbauer spectroscopy has focused on the study of a nanoporous LiMPO4/C composite, which is a useful material for Li accumulators. In the $Li_{1.746}Nd_{4.494}FeO_{9.493}$ (LNF) phase, which is localized in the Li_2O-rich part of the Li_2O–Nd_2O_3–Fe_2O_3 system, we have quantized the presence of Fe^{3+}, Fe^{4+} and Fe^{5+} ions, which are distributed on two symmetry-invariant positions in the structure.

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Awards and appointments

1. Iztok Arčon: ' Zois award' for important scientific achievements in the field of x-ray absorption spectroscopy, Cankarjev dom, Ljubljana, 27 November 2006
2. Boštjan Črnič: Faculty Prešeren Award, Ljubljana, University of Ljubljana, Faculty of Mathematics and Physics, graduation thesis "Dose measurement with thermoluminescent dosimeters in the radiation field of a point source", 27 November 2006
3. Simon Širca: head of the "Structure of Hadronic Systems" Research group, named Best Slovenian Research Group in 2005 by the Slovenian Research Agency (ARRS), Cankarjev dom, Ljubljana, 26 October 2006

Organization of conferences, congresses and meetings

1. 2nd bilateral Forschungszentrum Jülich, - Jožef Stefan Institute (JSI) meeting on PWI, Ljubljana, Slovenia, 14–16 February 2006 (I. Čadež)
2. 5th meeting of contact persons of EU-PWI Task Force, Ljubljana, Slovenia, 13. –15. November 2006 (I. Čadež, contact person of TF PWI from the Slovenian Fusion Association)

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In: International conference on finite fermionic systems: Nilsson model 50 years: 14-18 June 2005, Lund University, Sweden(Physica scripta, Vol. T125, 2006), Stockholm, Royal Swedish Academy of Sciences, 2006, pp. 222-223.
12. Jernej Zidar, Elizabeta Tratar-Pirc, Iztok Arčon, Peter Bukovec
Vezava bakrovih(II) ionov na D-glukozamin
In: Slovenski kemijski dnevi 2006, Maribor, 21-22 September 2006, Peter Glavič, ed., Darinka Brodnjak-Vončina, ed., Maribor, FKKT, 2006, pp. [1-7].

TEXTBOOKS AND LECTURE NOTES

1. Iztok Arčon
Spletno študijsko gradivo za rentgensko absorpcijsko spektrometrijo
Nova Gorica, samozal., 2006.
2. Iztok Arčon
X-ray absorption spectroscopy
Nova Gorica, samozal., 2006.

THESES

Ph. D. Theses

1. Gregor Bavdek: Study of structural and electronic properties of thin metallic and organic films (D. Cvetko)
2. Andrej Mihelič: Fluorescence of doubly excited states of helium in a homogeneous electric field (M. Žitnik)
3. Matjaž Vencelj: Excitation of the doubly magic core of ^{98}Cd (A. Likar, M. Lipoglavšek)

B. Sc. Theses

1. Boštjan Črnič: Dose measurement with thermoluminescent dosimeters in the radiation field of a point source (S. Širca, B. Zorko)
2. Valerija Danč: Application of sonochemical method for the synthesis of maghemite doped with zinc (co-mentor D. Hanžel)
3. Anita Danč: Application of sonochemical method for the synthesis of maghemite doped with copper (co-mentor D. Hanžel)
4. Nina Gartner: Study of corrosion inhibitors in the simulated pore-water of the concrete (Ž. Šmit)
5. Petra Maver: Centricity measurements of the bearing yoke and its influence on the final properties of the electromotor (Ž. Šmit)
6. Uroš Medved: Earth-gas based central heating system for an apartment.(I. Arčon)
7. Matej Nardin: Quality assurance of planetary shafts (Ž. Šmit)

INTERNATIONAL PROJECTS

1. P5 - Application of Ion Beam Analytical Methods to the Studies of Plasma Wall Interaction in Tokamaks
EURATOM – MHST
6. FP, Fusion Association, EURATOM
FU06-CT-2004-00083, 3211-05-000017
EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Primož Pelicon
2. P2 - Interaction of Vibrationally Excited Hydrogen with Fusion Relevant Materials
EURATOM – MHST
6. FP, Fusion Association, EURATOM
FU06-CT-2004-00083, 3211-05-000017

EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Dr. Iztok Čadež, Prof. Milan Čerček

3. Non-destructive Analysis and Testing of Museum Objects
COST-G8
EC; European Science Foundation (ESF), Coordinator: Prof. Mieke Adriaens, University of Gent, Gent, Belgium
Prof. Žiga Šmit
4. Training of Mr Zuheir Sheaib
IAEA Fellow, SRY/04024
IAEA, Vienna, Austria
Dr. Matjaž Korun
5. Training of Mr Bojan Štrbac
IAEA Fellow, BOH/05013
IAEA, Vienna, Austria
Dr. Matjaž Korun
6. Training of Mr Adel Slimeni
IAEA Fellow, TUN/05006
IAEA, Vienna, Austria
Dr. Benjamin Zorko
7. Training of Ms Zeineb Chekir Bent Mohsen
IAEA Fellow, TUN/05009
IAEA, Vienna, Austria
Dr. Benjamin Zorko
8. Training of Mr Bijan Samimi
IAEA Fellow, IRA/05020
IAEA, Vienna, Austria
Dr. Benjamin Zorko
9. Training of Mr Mehmet Zeki Ince
IAEA Fellow, TUR/05008
IAEA, Vienna, Austria
Dr. Benjamin Zorko, Dr. Matej Lipoglavšek
10. Improvement of the XRF Quantification and Enhancement of the Combined Applications by EDXRF and Micro PIXE
13858/RBF, RO
IAEA, Vienna, Austria
Dr. Peter Kump
11. Nuclear Microprobe Analysis of Individual Microparticles Found Inside Fusion Reactors, Tissues, Paints and Environment; Development of Nuclear Microprobe Techniques for the Quantitative Analysis of Individual Microparticles
13264/RBF, RO
IAEA, Vienna, Austria
Asst. Prof. Primož Pelicon
12. Technical Cooperation Project RER/1/006: Nuclear Techniques for the Protection of Cultural Heritage Artefacts in the Mediterranean Region
IAEA, Vienna, Austria
Prof. Žiga Šmit
13. Development of Post-emergency Impact Assessment Capability
IAEA
SLO/9/012
Dr. Alain Cardoso, IAEA, Vienna, Austria
Dr. Matjaž Aleš Korun
14. Etude de la relaxation d'atomes par emissio de plusieurs particules a l'aide d'une bouteille magnetique
BI-FR/05-06/010
PROTEUS
Prof. Francis Penent, Lab. de chimie physique matiere et rayonnement, CNRS, Unite UMR, Numero 7614, Specialite SC, Paris, France
Asst. Prof. Matjaž Žitnik
15. Low Dose Cell Irradiation: Effect of Geometrical Confinement
BI-FR/06-PROTEUS-008
Dr. Hicham Khodja, Laboratoire Pierre Sūe, CEA-Saclay, Gif sur Yvette, France
Dr. Primož Pelicon
16. Application of a Novel Method for In-situ Determination of Radiocesium Depth Distribution in Soil
BI-GR/04-06-003
Prof. Alexander Clouvas, Aristotelian University of Thessaloniki, Dept. of Electrical and Computer Eng., Nuclear Technology Laboratory, Thessaloniki, Greece
Prof. Andrej Likar
17. Uspostavljanje sljedivosti standardnih dozimetrijskih laboratorija
Branko Vegić, M. Sc., Institut "Ruđer Bošković", Služba za zaštitu od zračenja od zračenja i Zavod za kemiju materijala, Laboratorij za radijacijsku kemiju i dozimetriju, Zagreb, Croatia
Dr. Matjaž Štuhec
18. Investigation of Electron Emission after Electronic and Ionic Cllision of Atoms by Coincidence Technique
BI-HU/06-07/015
Prof. Karoly Tokesi, Institute of Nuclear Research of The Hungarian Academy of Sciences, Debrecen, Hungary
Dr. Matjaž Kavčič
19. Application of Scanning Nuclear Microprobe Techniques in the Field of Nanotecnology and Microbiology
BI-HU/06-07/016
Prof. Imre Uzonyi, Institute of Nuclear Research of The Hungarian Academy of Sciences, Debrecen, Hungary
Dr. Primož Pelicon
20. Atomic Absorption in the L-edge Region
II-04-065 EC
Prof. Jochen R. Schneider, Dr. Konstantin Klementiev, Synchrotron Laboratory (Synchrotron Radiation Facility) HASYLAB (Hamburger Synchrotronstrahlungslabor), DESY (Deutsches Elektronen Synchrotron), Hamburg, Germany
Prof. Alojz Kodre
21. Development of Java GUI's for Use in DESY Accelerator Control
M. Clausen, DESY (Deutsches Elektronen Synchrotron), Hamburg, Germany
Dr. Mark Pleško
22. Nucleon Resonances in Chiral Models
BI-PT/06-07-005
Prof. Manuel Fiolhais, Physics Department, University of Coimbra, Coimbra, Portugal
Asst. Prof. Simon Širca, Prof. Bojan Golli
23. NAA and PIXE Techniques for Microcharacterization of Trace Elements and their Species in Environmental Samples
BI-PT/04-06-010
Dr. Miguel Reis, Instituto Technologico e Nuclear (ITN), Sacavem, Portugal
Dr. Matjaž Kavčič, Asst. Prof. Zvonka Jeran
24. Quantum Mechanics of Nuclear Radiative Capture Models based on Optical Potential
BI-SK/05-07-003
Asst. Prof. Rndr. Drsc. Emil Betak, Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovakia
Prof. Andrej Likar
25. Preparation and Characterisation of Ternary Metallic Nitride Coatings and Duplex Structures with Improved Corrosion and Oxidation Resistance
BI-ES/04-05-010
Dr. José Francisco Marco Sanz, Instituto de Química-Física "Rocasolano", Consejo Superior de Investigaciones Científicas, Madrid, Spain
Dr. Darko Hanžel
26. Studies of Parity Violation in H/He and Electromagnetic Structure of the Deuteron
BI-US/06-07-048
Gilad Shalev, Massachusetts Institute of Technology (MIT), Cambridge, MA, USA
Asst. Prof. Simon Širca

R & D GRANTS AND CONTRACTS

1. Study of thin organic films and nanostructured materials by synchrotron
Asst. Prof. Dean Cvetko
2. In Beam Spectroscopy
Dr. Matej Lipoglavšek
3. Processes with vibrationally excited molecules
Dr. Iztok Čadež
4. Fusion relevant research of plasma interaction with surfaces
Asst. Prof. Primož Pelicon
5. Non-destructive analytical methods as a basis of historical and art-historical researc
Prof. Žiga Šmit
6. Development and itroduction of new analisys methods in gamma-ray
Dr. Matjaž Aleš Korun
7. Inventary of Secovlje saltpan flora and optimisation of growth of autochtonus Salicornia species
Dr. Marijan Nečemer
8. Evaluation of peak areas and their uncertainties in gamma-ray spectrometry
Dr. Matjaž Aleš Korun
9. Dating of Waters by H-3 and Pb-210: groundwater dynamics and vulnerability of deep aquifers
Dr. Jasmina Kožar Logar
10. Application of x-ray analytical techniques
Dr. Peter Kump
11. Age, origin and dynamics of deep aquifer's groundwaters of Ljubljansko barje
Dr. Jasmina Kožar Logar
12. Tracing of tritium in the in the environment around the Krsko NPP
Dr. Matjaž Aleš Korun
13. Determination of geographical and botanical origin of honey
Dr. Marijan Nečemer
14. Assessment of the environmental impact of military training ground Krivolak with the aim of its ecological remediation
Dr. Matej Lipoglavšek

RESEARCH PROGRAMS

1. Structure of hadronic systems
Asst. Prof. Simon Širca

2. Studies of atoms, molecules and structures with photons and particles
   Asst. Prof. Matjaž Žitnik
3. Mobile archaeological heritage: archaeological and archaeometric investigations
   Prof. Žiga Šmit

NEW CONTRACTS

1. Ministry for Environment and Spatial Planning
   Monitoring of radioaactivity in the living environment
   Denis Glavič Cindro, M. Sc.
2. Sampling and measurements pf fodder samples
   Ministry for Agriculture, Forestry and Food
   Denis Glavič Cindro, M. Sc.
3. Development of system of actions at rbc contamination
   Ministry of Defence
   Denis Glavič Cindro, M. Sc.
4. Co-financing of ELMU in 2006
   Ministry of Defence, Civil Protection Board
   Denis Glavič Cindro, M. Sc.
5. Realisation of measurements according to the program of initial measurements on the location Vrbina
   Agency of Radwaste Management
   Denis Glavič Cindro, M. Sc.
6. Monitoring of radioactivity of drinking water
   Ministry of Health
   Dr. Matjaž Aleš Korun
7. Monitoring of Central LILW storage facility at Brinje
   Agency of Radwaste Management
   Dr. Marijan Nečemer
8. Maintenance of measurement traceability of reference standards
   Metrology Institute of Republic of Slovenia
   Dr. Matjaž Štuhec

VISITORS FROM ABROAD

1. Dr. Shalev Gilad, Massachusetts of Technology, USA, 8–11 January 2006
2. Dr. Andreas Karydas, Institute of Nuclear Physics, NCSR "Demokritos", Athens, Greece, 11–13 January 2006
3. Dr. Birgit Kanngiesser, Institut für Atomare Physik un Fachdidaktik, Technical University of Berlin, Berlin, Germany, 11–13 January 2006
4. Dr. Sebastijan Brezinšek and dr. Arkadi Kreter, Institut für Plasmaphysik, Forschungszentrum, Jülich, Germany, 14–16 February 2006
5. Dr. Marek Rubel, Alfven Laboratory, Royal Institute of Technology (KTH), Association EURATOM – VR, Stockholm, Sweden, 14–17 February 2006
6. Mr. Mehmet Zeki Ince, Turkey, 3 April – 3 June 2006
7. Prof. dr. Bogdan Povh, University of Heidelberg, Germany, 10 April 2006
8. Mr. Bijan Samimi, Atomic Energy Organization of Iran, National Radiation Protection Department, Tehran, Islamic Republic of Iran, 21 April – 21 June 2006
9. Dr. Zsofija Kertesz in dr. Zita Szikszai, ATOMKI, Debrecen, Hungary, 7–14 May 2006
10. Mr. Adel Slimeni, Office National de la Protection Civile, Tunis, Tunisia, 8 May –7 July 2006
11. Ms. Zeineb Chekir Bent Mohnsen, Centre National des, Tunis, Tunisia, 8 May –7 July 2006
12. Dr. Imre Uzonyi, dr. Laszlo Bartha and inž. Zoltan Pintye, ATOMKI, Debrecen, Hungary, 14–21 May 2006
13. Mag. Bojan Štrbac, Public Health Institute of Republic of Srpska, Radiation Protection Department, Banja Luka, Bosnia and Herzegovina, 14 May – 14 August 2006
14. Mr. Zuheir Sheaib, Atomic Energy Commission of Syria, Damascus, Syrian Arab Republic, 5 June – 4 August 2006
15. Dr. Bela Paripas and dr. Bela Palasthy, University of Miskolc, Hungary, 7–13 June 2006
16. Dr. Emil Běták, Institute of Physics, Slovak Academy of Science, Bratislava, Slovakia, 21–29 June 2006
17. Dr. B. Kangiesser and R. Shutz, TU-Berlin, Institut für Atomare Physik und Fachdidaktik, Berlin, Germany, 30 July – 5 August 2006
18. Dr. A. Karydas, Institute of Nuclear Physics NCSR Demokritos, Athens, Greece, 30 July – 5 August 2006
19. Dr. Thomas Schwarz-Selinger, Max-Planck-Institut für Plasmaphysik, Garching, Germany, 4–9 September 2006
20. Paula Cristina Chaves, Instituto Tecnológico e Nuclear de Sacavem, Sacavem, Portugal, 17–23 September 2006
21. Dr. Francis Penent, Laboratoire de chemie physique - matiere et rayonnement, UPMC, Paris, France, 5–13 October 2006
22. Prof. dr. Lidija Andrić, Laboratoire de chemie physique – matiere et rayonnement, UPMC, Paris, France, 15–18 November 2006
23. Dr. Hicham Khodja and dr. Caroline Rapsaet, Laboratoire Pierre Sue, CEA-Saclay, France, 18–23 November 2006
24. Dr. Károly Tökési, Atomki, Debrecen, Hungary, 24–29 November 2006

STAFF

Researchers

1. Prof. Iztok Arčon*
2. Asst. Prof. Dean Cvetko*
3. Dr. Iztok Čadež
4. Dr. Darko Hanžel
5. Dr. Matjaž Kavčič
6. Prof. Alojzij Franc Kodre*
7. Dr. Matjaž Aleš Korun
8. Dr. Peter Kump
9. Prof. Andrej Likar*
10. **Dr. Matej Lipoglavšek**, Head**
11. Dr. Rafael Martinčič
12. Dr. Marijan Nečemer
13. Asst. Prof. Primož Pelicon**
14. Dr. Mark Pleško
15. Prof. Milan Potokar
16. Asst. Prof. Simon Širca*
17. Prof. Žiga Šmit*
18. Dr. Tim Vidmar
19. Asst. Prof. Matjaž Žitnik**

Postdoctoral associates

20. Dr. Klemen Bučar**
21. Dr. Jasmina Kožar Logar
22. Dr. Jurij Simčič
23. Dr. Benjamin Zorko

Postgraduates

24. Gregor Bavdek,** B. Sc.
25. Sabina Markelj, B. Sc.
26. Dr. Andrej Mihelič**
27. *Matjaž Vencelj, M. Sc., left 01. 06. 2006*

Technical officers

28. Boštjan Črnič, B. Sc.
29. Denis Glavič Cindro, M. Sc.
30. Matjaž Mihelič, M. Sc.
31. Zdravko Rupnik, M. Sc.
32. Dr. Matjaž Štuhec
33. Branko Vodenik, M. Sc.

Technical and administrative staff

34. Drago Brodnik
35. Sandi Gobec
36. Zvonimir Grabnar
37. Mirko Ribič
38. Sonja Wostner

* Full-time faculty member
** Part-time faculty member

DEPARTMENT OF THIN FILMS AND SURFACES F-3

The main field of research in the Department of Thin Films and Surfaces is the development, deposition and characterization of hard, protective PVD coatings. However, research is also carried out on other fields of thin films and surface physics. The basic research is concentrated on the study of the physical and chemical properties of various multicomponent, multilayer and nanostructured coatings, as well as the study of processes during heat treatment. In the applied research, different coatings are developed for the protection of tools for various production processes in industry.

Head:
Dr. Peter Panjan

As in previous years, in 2006 the emphasis of our research and development was in the area of hard, protective coatings, in particular on multilayer coatings. We prepared a series of coatings, TiN/TiAlN and CrN/TiAlN, with a modulation period of a few tens of nanometres and a total thickness of several micrometres. Special attention was paid to the dynamics of the thin-film deposition with respect to the geometrical conditions in the chamber. For this purpose we developed a computer program that forecasts the depth profile of a multilayer coating based on input parameters (rotation speed of the substrate holders, the distance between the axes). In contrast to the relatively widespread opinion that multifold rotation ensures a uniform coating thickness on substrates, we found that the deposition dynamics depends significantly on the rotation mode and partially also on the initial conditions. During twofold, and especially during threefold rotation, a cyclic change of the individual layer thickness takes place. As a consequence, areas with a surplus of one element are followed by areas with a surplus of another. Each area encompasses several tens of layers. Such behaviour was forecast by the simulation as well as verified experimentally, using a high-resolution scanning electron microscope. Part of this research was conducted within the project "Nanostructured surfaces and interfaces", which is a topic of the Centre of Excellence "Nanotechnologies and nanosciences". We also analysed the mass and energy distribution of samples in plasma during different steps of hard-coating deposition. The research was centred on TiCN coatings.

We were one of the first groups in the world to simulate the deposition dynamics of multilayer coatings in systems with a multi-fold rotation. A comparison with high-resolution SEM pictures showed a very good agreement between the simulation and the real coatings.

The second research topic is also application oriented. Here, we analysed in detail the mechanisms of defect formation in thin films. This topic is relatively poorly investigated, although it is generally known that the defects are, in most cases, a consequence of impurities. The defects in hard protective coatings generally reduce their tribological properties as they increase the roughness, the coefficient of friction and the cold welding. They severely reduce the corrosion resistance of hard coatings, because at the spots where the defects are present, local corrosion attack takes place. We made cross-sections on typical hard coatings, both conventionally (by fracture or cutting) as well as by using the new technique of a focused ion beam, in collaboration with the University of Maribor. We found that some of the defects have the same composition as a normal thin film; however, they have a very different growth morphology. These are captured particles from the vacuum chamber or microdroplets from the target. The other defects are based on iron, which means that they are delaminated particles of components from the vacuum chamber. Based on these results we intend to reduce the number of defects. We also analysed in more detail which processes take place during the corrosion attack on the spot of a defect.

In the Hard Coatings Centre, which operates within the department, we are coating tools with hard, protective coatings for Slovenian industry. In addition to the coating of end-products, we collaborate with several partners in the development of coating applications for a given production process or help to solve various technological problems. Of particular importance was the successful implementation of hard-coating technology for the protection of tools for the pharmaceutical industry and the protection of tools for the forming of plastics.

We performed application-oriented research with several institutions, both research and industrial. In collaboration with the Faculty of Natural Sciences and Technology, Ljubljana, we performed wear tests of tools for hot forging, protected by different procedures of surface engineering. We performed a comparative analysis of various hard coatings for the protection of tools for sheet-metal cold forming for the company Končar Alati, d. d., Zagreb, Croatia. In the scope of a Eureka project, in collaboration with the Faculty of

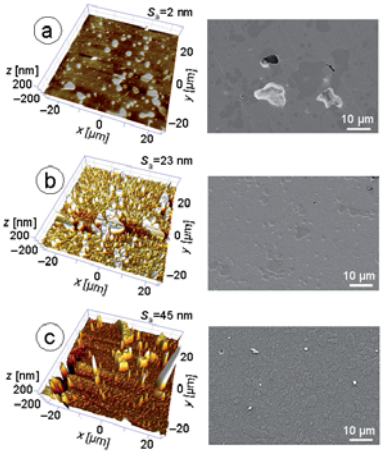

Figure 1: AFM (left) and SEM (right) morphology and surface roughness (S_a) of TiAlN hard coatings on ASP 30 (M2) tool steel: (a) after cleaning, (b) after ion etching, (c) after deposition.

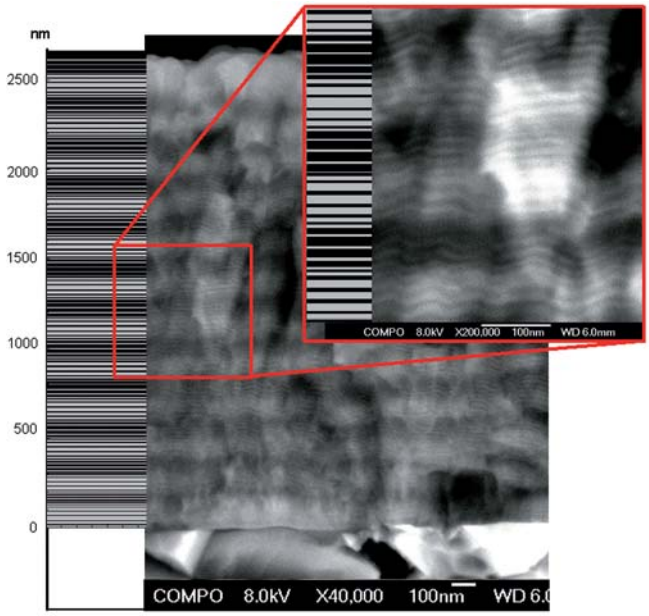

Figure 2: Comparison of cross-sectional SEM micrograph of CrN/TiAlN multilayer structure with individual layer thicknesses calculated by a computer simulation of the deposition process with four unbalanced magnetron sources and a threefold rotation of the substrate

Mechanical Engineering, Ljubljana, and the company TCG Unitech LTH-OL, d. o. o., from Škofja Loka, we were engaged in the protection of laser-sintered tools for the die casting of aluminium alloys. We are involved in another Eureka project, where we study the resistance of tools prepared by classical sintering. The partners are from four countries; from Slovenia there is the Institute for Metals and Technologies and the companies Unior and Iskra Mehanizmi.

In the scope of the Network of Excellence called "Complex Metallic Alloys", within the EU's 6FP, we are collaborating as partners in the field of the synthesis and characterization of thin-film alloys. Our task so far has been the synthesis of bi- and tri-layer coatings based on Al–Cr–Fe and the subsequent heat treatment. Based on the research of diffusion processes in these relatively simple structures we defined the parameters for the synthesis of multilayer coatings.

With the Institute of Nuclear Sciences "Vinča", Belgrade, we are working on the topic of the laser treatment of solid surfaces. Here, we prepared thin films and analysed the surface damage on the spots of laser interaction. In this topic we specialised in a 3D topographic analysis of the craters.

Some outstanding publications in the past three years

1. M. Čekada, P. Panjan, D. Jurić, J. Dolinšek, A. Zalar, Deposition and characterisation of Al–Cu–Fe thin films, Thin solid films, 459 (2004) 267–270
2. D. Kek-Merl, P. Panjan, M. Čekada, M. Maček, The corrosion behavior of Cr-(C,N) PVD hard coatings deposited on various substrates, Electrochim. acta, 49 (2004), 1527–1533
3. P. Panjan, M. Čekada, R. Kirn, M. Soković, Improvement of die-casting tools with duplex treatment, Surf. coat. technol., 180–181 (2004) 561–565
4. M. Maček, M. Mišina, M. Čekada, P. Panjan, Energy-resolved mass spectroscopy studies during the deposition of TiC films by ion plating under different magnetic fields, Vacuum 80 (2005) 184–188
5. P. Panjan, D. Dolinšek, M. Dolinšek, M. Čekada, M. Škarabot, Improvement of laser sintered tools with PVD coatings, Surf. Coat. Technol., 200 (2005) 712–716

Awards and appointments

1. Slovenian Research Agency proclaimed our research group "Thin film structure and plasma surface engineering" as one of the best in 2005.

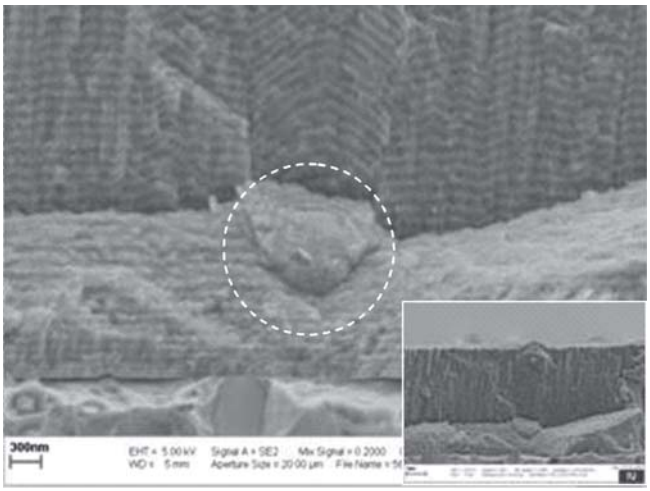

Figure 3: Cross-sectional SEM micrograph of a spherical cone defect, which extends through the CrN/TiAlN multilayer hard coating. The origin of this defect is the submicrometer-sized particle entrapped in the hard coating.

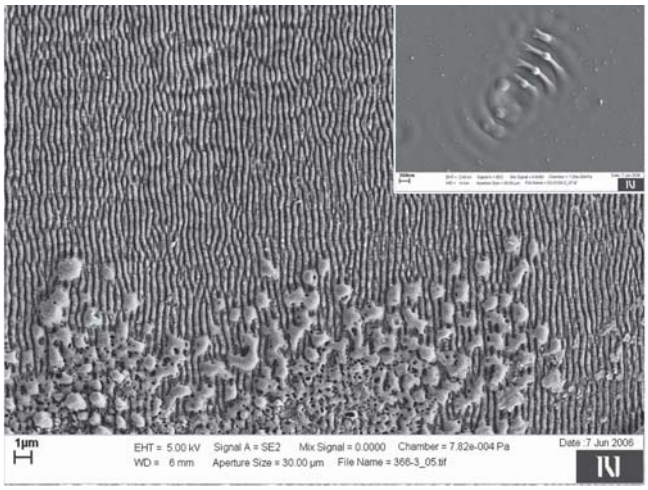

Figure 4: Periodic surface nanostructures on a TiN/TiAlN multilayer hard coating after modification with a Nd:YAG laser. This research work was performed in collaboration with the Institute of Nuclear Sciences Vinča, Belgrade and Universita degli Studi di Milano Bicocca, Milan.

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   Microindentation depth profiling of selected hard coating
   In: Surf. coat. technol., Vol. 200, pp. 6554-6557, 2006.
2. Peter Jurči, Peter Panjan
   PVD protection enhanced by plasma nitriding
   In: Met. Powder Rep., Vol. 61, pp. 28-31, 2006.
3. Darja Kek-Merl, Jyrki Lappalainen, Harry L. Tuller
   Electrical properties of nanocrystalline CeO_2 thin films deposited by in situ pulsed laser deposition
   In: J. electrochem. soc., Vol. 153, pp. J15-J20, 2006.
4. Mirko Soković, Peter Panjan, Miha Čekada
   Improvement of tool life of die-casting tools with dumplex treatment
   In: International Journal of Microstructure and Materials Properties, Vol. 1, pp. 231-240, 2006.
5. Milan Terčelj, Peter Panjan, Igor Urankar, Peter Fajfar, Radomir Turk
   A newly designed laboratory hot forging test for evaluation of coated tool wear resistance
   In: Surf. coat. technol., Vol. 200, pp. 3594-3604, 2006.
6. Milan Trtica, Biljana Gaković, Dimitri Batani, Tara Desai, Peter Panjan, Bojan Radak
   Surface modifications of a titanium implant by a picosecond Nd: YAG laser operating at 1064 and 532 nm
   In: Appl. surf. sci., Vol. 253, pp. 2551-2556, 2006.
7. Peter Panjan
   Novejši razvoj trdih zaščitnih prevlek
   In: IRT 3000, Vol. 1, No. 1, pp. 82-93, 2006.
8. Peter Panjan
   Zaščita orodij za oblikovanje plastike
   In: PlastForma (Celje), Vol. 11, No. 1, pp. 19-23, marec 2006.
9. Peter Panjan
   Zaščita orodij za oblikovanje plastike: primeri iz industrijske proizvodnje
   In: PlastForma (Celje), Vol. 11, No. 3, pp. 28-32, 2006.
10. Peter Panjan
    Trde PVD-prevleke za zaščito orodij za oblikovanje plastike
    In: Vakuumist, Vol. 26, No. 1-2, pp. 11-15, 2006.
11. Peter Panjan
    Merjenje temperature v vakuumskih sistemih med PVD-procesi nanašanja tankih plasti
    In: Vakuumist, Vol. 26, No. 1-2, pp. 47-49, 2006.
12. Peter Panjan
    Trde PVD-prevleke za zaščito orodij za oblikovanje plastike. 2. del. Part 2
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13. Peter Panjan
    Poliranje orodnega jekla
    In: Vakuumist, Vol. 26, no. 3, pp. 32-34, 2006.

REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Slavko Dolinšek, Peter Panjan, Tatu Syvanen, Jože Ramovš
   Lasersko sintranje orodja za tlačno litje aluminija
   In: Stroj. vestn., Vol. 52, No. 11, pp. 738-751, 2006.

PUBLISHED CONFERENCE PAPERS

Regular Papers

1. Slavko Dolinšek, Peter Panjan, Tatu Syvanen, Jože Ramovš
   Application of rapid tooling for aluminium die casting
   In: Euro-u Rapid 2006, Frankfurt/Main, November 26th-28th , 2006: international user's conference on rapid prototyping, rapid tooling and rapid manufacturing: proceedings, Rudolf Meyer, ed., [Magdenburg, Freunhofer Allianz Rapid Prototyping], 2006, 6 p.
2. Đurđica Goršćak, Peter Panjan, Lidija Čurković, D. Kapudija
   Mechanical properties and application of various PVD hard coatings in cold work tools
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   Trde PVD-prevleke za zaščito orodij za oblikovanje plastike
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THESES

B. Sc. Theses

1. Marjan Grilj: Adhesion of thin TiAlN ceramic coatings on tool steels (Janez Dolinšek, Miha Čekada)
2. Tomaž Peterman: Simulation of multilayer nitride coating deposition by magnetron sputtering (Janez Dolinšek, Miha Čekada)
3. Franc Perko: Existence of coated dies for casting Al-alloys (Mirko Soković, Peter Panjan)
4. Franc Setnikar: Analysis of end mills protected by hard PVD coatings (Marica Tonkovič Prijanovič, Peter Panjan)

INTERNATIONAL PROJECTS

1. Complex Metallic Alloys
   CMA
   6. FP; NMP3-CT-2005-500140
   EC; Centre National de la Recherche Scientifique, Paris, France
   Dr. Peter Panjan, Prof. Janez Dolinšek, Asst. Prof. Spomenka Kobe
2. Progressive Surfacing of Metals
   EUREKA Project E!3437
   Dr. Peter Jurči, Ecosond, s.r.o, Prague, Czech Republic
   Dr. Peter Panjan
3. Laser Sintered Aluminium Die Casting Tools
   EUREKA Project E!3372
   Prof. Slavko Dolinšek, University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana, Slovenia
   Dr. Peter Panjan
4. Thin Films Modification on Micro-and Nano-Level
   BI-CS/06-07-003
   Dr. Biljana Gaković, Institute for Nuclear Sciences "Vinča", Belgrade, Serbia and Montenegro
   Dr. Peter Panjan
5. PVD Coatings for Protection of Aluminium-based Substrates for Aircraft Applications
   Micael Pawlik, PPG Industries, Inc., One PPG Place, Pittsburg, Pennsylvania; Rosanna Drive, Allison Park, PA, USA
   Dr. Peter Panjan, Dr. Ingrid Milošev

R & D GRANTS AND CONTRACTS

1. Layered ceramic nanostructures and 2D nanoparticles arrays
   Dr. Peter Panjan, Dr. Miran Čeh
2. Smart functional coatings for improvement of structures and components used in defensive purpose
   Dr. Peter Panjan
3. Nanostructured surfaces and interlayers
   Dr. Peter Panjan, Prof. Igor Muševič

RESEARCH PROGRAM

1. Thin film structures and plasma surface engineering
   Dr. Peter Panjan, Prof. Anton Zalar

VISITORS FROM ABROAD

1. Dr. Biljana Gaković, Institute of Nuclear Sciences Vinča, Belgrade, Serbia, 4–8 June 2006
2. Dr. Milan Trtica, Institute of Nuclear Sciences Vinča, Belgrade, Serbia, 16–20 October 2006
3. Dr. Biljana Gaković and mag. Suzana Petrović, Institute of Nuclear Sciences Vinča, Belgrade, Serbia, 10–15 December 2006

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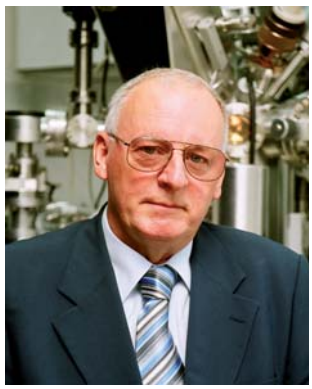
DEPARTMENT OF SURFACE ENGINEERING AND OPTOELECTRONICS F-4

The main activities of the Department of Surface Engineering and Optoelectronics are oriented towards surface engineering, surfaces, interfaces and thin-film characterization, plasma applications, vacuum optoelectronics, ultra-high-vacuum techniques and technologies. The department collaborates with other groups at the Jožef Stefan Institute as well as with other Slovenian and foreign institutes, universities and industry. The group is also active in the field of the education of students at two Slovenian universities and at the Jožef Stefan International Postgraduate School.



Head:
Prof. Anton Zalar

Surfaces, interfaces and thin films play an increasing role in advanced material science and technology. Owing to the considerable refinement of measurement techniques in past decades, the characteristics of surfaces and interfaces can be analyzed using an abundant variety of methods. The chemical, structural and electronic characteristics of surfaces and interfaces are usually different from those of the bulk phase. Thus, methods to be used for the analysis of surfaces must be selective in their response to the surface or interfacial region relative to the bulk. The choice of which analytical technique to use depends on the nature of the information sought about the interface.

In the department Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS) have been used successfully, both for basic research and for the characterization of technological samples. Our research group specialises in the depth profiling of thin films and multilayers. AES and XPS depth profiles are generated by alternately recording specific signals from elements and removing material from the sample surface via ion-beam-induced sputtering. Unfortunately, sputtering during ion bombardment can result in variations of the morphology and roughness of the surface. This is the reason why the measured depth profile is influenced by sputter-induced surface roughness, which is often on the nanometre scale. To study the surface morphology of the investigated samples, in spring 2006 a new atomic force microscope (AFM, model Solver PRO, NT-MDT) was installed at the department. The purchase of the AFM instrument was supported by the Agency for Research of the Slovenian Republic and two departments at the JSI (F-3 and F-4). The AFM can analyse surface roughness and topography (Fig.1), the distribution of magnetic and electric fields, and adhesive and repulsive forces.

In 2006 the research program "Thin-film structures and plasma surface engineering" (P2-0082), was chosen as being among the best research programmes in the technical field in Slovenia. Co-workers from the JSI F-3 and F-4 departments collaborate in this program.

In cooperation with the Max-Planck Institute for Metals Research in Stuttgart, the interdiffusion coefficients in two types of a-Si/c-Al multilayers were determined by AES depth profiling. X-ray diffraction (XRD) and transmission electron microscopy (TEM) were used to analyse the microstructures of the as-deposited multilayers. The multilayers showed different degrees of interface roughness and the c-Al sublayers exhibited different levels of macrostress and were of different grain sizes, corresponding to the sublayer thickness. The results indicated that the initial stage of diffusion annealing involved the diffusion of Si along grain boundaries in the Al sublayer. The data obtained for the interdiffusion coefficient were insensitive to the present differences in microstructure between the investigated multilayers. The crystallization of Si took place if an appreciable diffusion of Si along the Al grain boundaries took place.

Using the XPS and AFM methods we investigated the W_xC_y thin-film structures with different concentrations of carbon prepared at the F-3 department of the JSI. These structures show diamond-like properties and can be applied as solid lubricants. The high energy resolution of our XPS spectrometer allows the identification and quantification of the WC-carbide and C-graphite phases in the C 1s and W 4f spectra as a function of the carbon concentration (Fig.2). We found that the measured hardness of these structures was related to the concentration of the WC-phase.

The wide applicability of the XPS technique led to a large number of joint investigations with researchers from other departments of our institute, as well as with other research institutions and industrial partners. In the frame of such collaborations we investigated the following: W-oxide and Mo-S-I nanostructured materials, thin magnetic films, the sorption properties of natural zeolites, the effects of sintering and microstructure of Ti-oxide ceramics on the hydrophilicity of surfaces, the modifications of the surfaces of textile fibres of flax and polymers after treatments

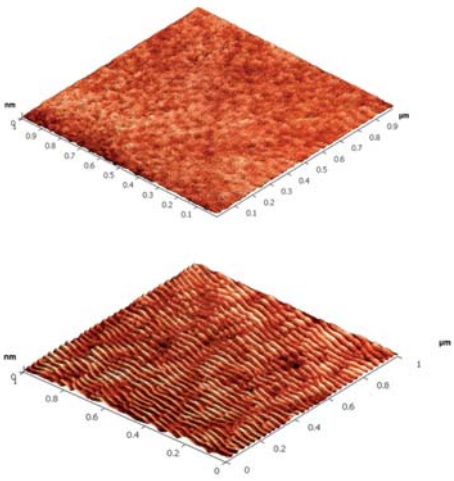


Figure 1: AFM images showing the surface structure of an as-deposited carbon layer (above) and the ripple structure obtained after 20 minutes of ion sputtering with 1 keV Ar^+ ions at an ion incidence angle of 71° (below).

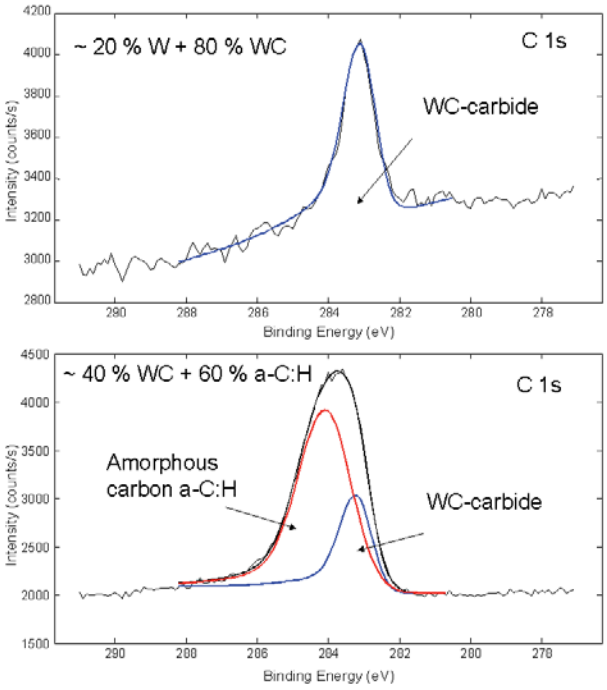


Figure 2: High-energy resolution XPS C 1s spectra obtained on the WC (60/40 at %) (above) and the WC (20/80 at %) (below) thin films, which show the chemical bonding of carbon atoms as a-C:H amorphous carbon and WC-carbide.

with enzymes, Al-based coatings of nano- and microparticles of SiC, the reactions at the interface between the multilayered metallic structure and the Si substrate in solar cells, the oxidation of TiW thin films, and the surface properties of Al-fluoride catalysts.

We collaborated with the Elettra synchrotron light source in Trieste, in particular on improvements to the experimental equipment of the Twinmic x-ray microscope, which was built in collaboration with other European partners. For the scanning-transmission mode, we introduced a configurable CCD detector to measure the transmitted x-ray light from every pixel of a sample during its scanning. The novel approach of our method is real-time data processing that allows the fast and simultaneous imaging of samples with absorption and phase contrasts, and the simple alignment of the microscope, which can also be applied in optical and electron microscopes.

Another important activity of our group is plasma surface engineering. We investigated the interaction of weakly ionized highly reactive thermodynamically non-equilibrium plasma with solid materials (Fig.3). The aim of these activities was to develop different plasma technologies, including the discharge cleaning of metals, the surface activation of polymers and composites, and plasma sterilization. The research was performed in collaboration with our partners from abroad (Universite Paul Sabatier, France, University of Louisville, Kentucky, USA, University of Ioannina, Greece, Solar centre Font Romeu, France, and Institute Ruđer Bošković, Croatia. The construction of the new ITER fusion reactor requires a method for removing the layer of hydrogenated carbon that is deposited on the inner walls of the fusion reactor. Systematic studies of layer removal by neutral oxygen atoms have been performed in order to develop a suitable method for cleaning the future reactor. The radicals readily react with the layer, even at low temperature. The removal efficiency depends on the layer structure and composition and may be as high as several 10 nm/s. Such a rate is suitable for cleaning the fusion reactor. Discharge cleaning was also performed for our industrial partner Plasmabull, Austria. A film of protective oil should be removed from steel in this case. High removal rates of the order of 100 nm/s have been achieved, which is important for the treatment of large quantities of steel sheet.

The new scanning projection field-emission microscope was developed and tested. It is a unique instrument for the investigation of field-emission currents and its angle distribution from a single emitter on flat nanostructured cathodes.

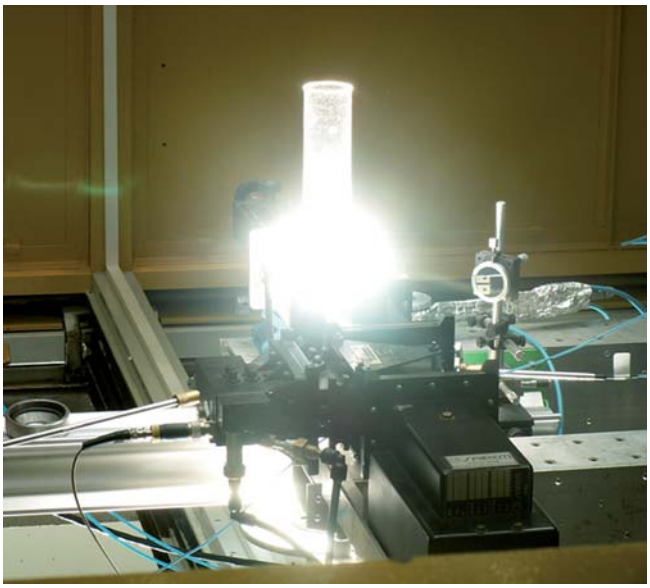


Figure 3: The 6-kW solar plasma reactor MESOX allows for sample heating up to 2500°C.

The mechanisms of the plasma activation of polymer and composite materials have been investigated. The surface energy of treated materials was measured using the contact angle of suitable liquids, while the nature of the surface functional groups responsible for a particular surface energy was determined using the XPS method. The activation mechanism can vary depending on the individual material. The C-O functional group was detected on pure carbon, while the majority of polymers are activated by the appearance of different functional groups, including C-O, C=O and O-C=O. The concentration of these functional groups depends on the nature of the material as well as the plasma's parameters. The typical treatment time needed to saturate the surface with functional groups is of the order of a second, making this treatment suitable for industrial applications. Other functional groups were detected on some polymers. The PPS polymer (PPS = polymer polyphenyl sulphide), for instance, becomes activated by the interaction of oxygen with sulphur atoms, causing a transformation from the sulphide to the sulphate. Only a prolonged plasma treatment of this polymer causes the formation of the C-O group.

The interaction of plasma radicals with vital forms of bacteria has been investigated. The bacterial capsule is particularly sensitive to radicals: it is effectively removed by a dose below 10^{22} oxygen atoms m^{-2}. A higher dose causes a slow inhomogeneous degradation of the bacterial cell wall. Localized damage was detected on the surface of the wall at a dose of about $10^{23} m^{-2}$, causing an outpouring of the cytoplasm (Fig.4). An even higher

dose causes complete degradation of bacteria and only the ash is left on the sample holder. This treatment is particularly suitable for the sterilization of biocompatible materials since it does not affect the substrate.

Hydrogen–metal interactions were investigated by very sensitive measurements of deuterium adsorption/absorption on the metal surface, followed by subsequent desorption. The first part was carried out by observing the pressure decrease at room temperature and 1 mbar, while the kinetics of the subsequent spontaneous release was observed after deuterium was pumped from the system. The problem is relevant since it is equivalent to gaseous tritium retention and spontaneous release, which relates to the safety conditions in future fusion reactors, like ITER. The total amount of tritium may not exceed a prescribed limit within the whole runtime. Using deuterium instead of tritium means a greatly simplified experiment. An extremely high sensitivity for deuterium absorption and release has been achieved in our lab by a precise pressure measuring technique, otherwise attributed exclusively to tritium scintillation methods.

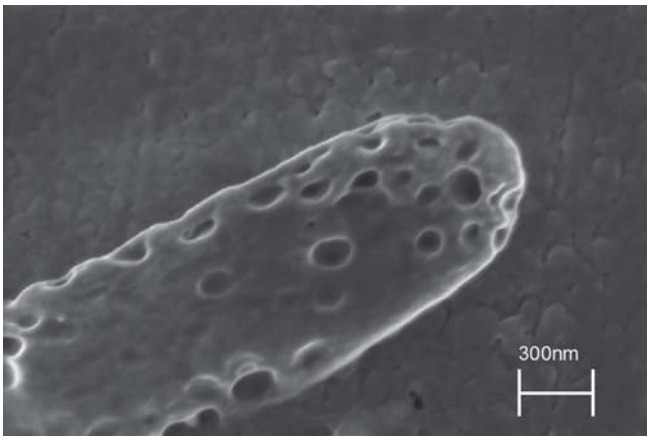
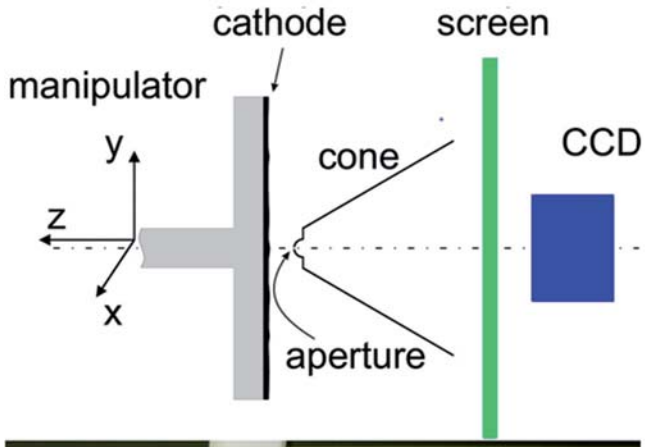


Figure 4: SEM micrograph of the bacteria Eshericia Coli after receiving a dose of 10^{23} oxygen radicals/m^2.

The field emission of electrons gives some of the best evidence for the quantum origin of the process on the atomic scale, which has attracted many investigators for decades. The motivation for engineers was to apply cold cathodes in several improved electronic devices, ranging from special electronic tubes to electron microscopes. The first reports in 1995 that carbon nanotubes exhibit stable field emission triggered a new interest in nanostructured materials. In the past ten years several new methods of synthesis and new materials were announced. Unfortunately, there are still unknowns about the true physical mechanism of individual sites embedded in broad-area cathodes. One of the reasons for this is also the lack of methods for characterization. In 2006 we designed, manufactured and tested a new scanning projection field-emission microscope. It is a unique instrument for the investigation of smooth and flat nanostructured cathodes. The principle of operation combines the precise movement of a 40-μm metal aperture representing the anode above the cathode and the projection of electrons towards the luminescent screen (Fig.5). These components are kept at a pressure of the order of 10^{-10} mbar.



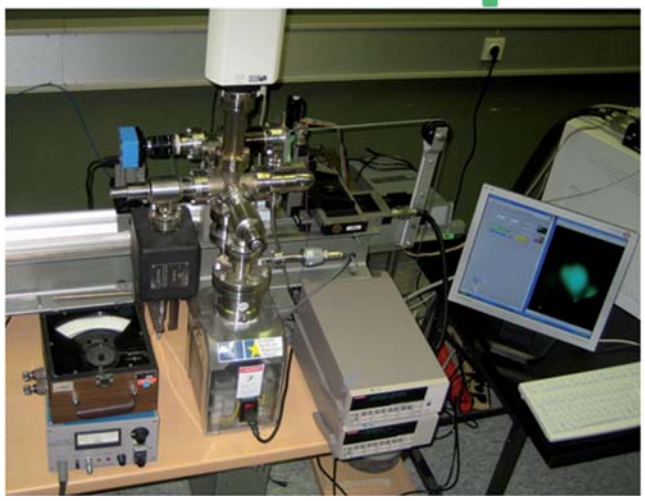


Figure 5: The principle of operation (above) and the complete setup for the control of the scanning projection field-emission microscope (below).

Some outstanding publications in the past three years

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2. J. Kovač, A. Zalar, B. Praček, Ripple structure developed on graphite layers during ion-sputtering, Surface and Interface Analysis, 38 (2006), 300–304
3. M. Mozetič, U. Cvelbar, M. Sunkara, S. Vaddiraju. A method for the rapid synthesis of large quantities of metal oxide nanowires at low temperatures. Advanced Materials, 17 (2005), 2138–2142
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   Method and device for local functionalization of polymer materials
   Patent No. SI 22048, WO 2006/130122 A1

Organization of conferences, congresses and meetings

1. International Workshop on X-ray Spectroscopy and Imaging for Improving Life Conditions and Human Health – XRI3CTP, Trieste Italy, 20–22 May 2006 (Dr. Janez Kovač, member of International Organizing Committee)
2. XIII International Meeting on Vacuum Science and Technique, Koprivnica, Croatia, 12–13 June 2006 (Dr. Miran Mozetič, member of International Programme Committee, Dr. Janez Kovač and Dr. Alenka Vesel, members of International Organizing Committee).
3. Joint Vacuum Conference – JVC 11, Prague, Czech Republic, 24–28 September 2006 (Dr. Janez Kovač, member of International Programme Committee)

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7. Miran Mozetič, Alenka Vesel, Uroš Cvelbar, Andre Ricard
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1. Danijela Vujošević, Zoran Vranica, Alenka Vesel, Uroš Cvelbar, Miran Mozetič, Aleksander Drenik, Tatjana Mozetič, Marta Klanjšek Gunde, Nina Hauptman
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PUBLISHED CONFERENCE PAPERS

Regular Papers

1. Uroš Cvelbar, Miran Mozetič, Nikša Krstulović, Slobodan Milošević
   Laser ablation of polymer - graphite composite
   In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 163-168.
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   Photo and field electron emission microscopy from sulfur doped nanocrystalline diamond films
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7. Miran Mozetič, Uroš Cvelbar, Alenka Vesel, Nikša Krstulović, Slobodan Milošević
   Characterization of RF nitrogen plasma by optical emission spectroscopy
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9. J. Y. Wang, D. He, Anton Zalar, E. J. Mittemeijer
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3. Alenka Vesel, Miran Mozetič
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INTERNATIONAL PROJECTS

1. P6 - Deuterium Retention and Release from Metal Surfaces -A Complementary Method to Nuclear Tritium Methods
   EURATOM – MHST
   6. FP, Fusion Association, EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Dr. Vincenc Nemanič
2. P3 - Heterogeneous Surface Recombination of Neutral Hydrogen Atoms on Fusion Relevant Materials
   EURATOM – MHST
   6. FP, Fusion Association, EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Asst. Prof. Miran Mozetič
3. Safe Production and Use of Nanomaterials
   NANOSAFE2
   6. FP; NMP2-CT-2005-515843
   EC; Commissariat a l"Energie Atomique, Grenoble, France
   Marko Žumer, B. Sc., Asst. Prof. Maja Remškar, Andrej Detela, B. Sc., Prof. Boris Turk
4. Fullerene-based Opportunities for Robust Engineering: Making Optimised Surfaces for Tribology
   FOREMOST
   6. FP; 515840-2
   EC; Fundacion Tekniker, Eibar, Spain
   Marko Žumer, B. Sc., Asst. Prof. Maja Remškar
5. Improving the Understanding of the Impact of Nanoparticles on Human Health and the Environment
   IMPART
   6. FP; 013968
   EC; Chalex Research Ltd., Torquay, Great Britain
   Dr. Vincenc Nemanič, Asst. Prof. Maja Remškar
6. Catalisators for plasma radicals
   U1-BL-F4-84/06
   Primož Eiselt, Plasmabull Engineering GmbH, Lebring, Austria
   Asst. Prof. Miran Mozetič
7. Characterization of Reactive Plasma
   PROTEUS
   Ph. D. Andre Richard, CPAT, Universite Paul Sabatier, Toulouse, France
   Asst. Prof. Miran Mozetič
8. Determination of N, O and H Radicals in Reactive Plasmas by Catalytic Probes and TALIF
   BI-FR/06-PROTEUS-006
   Prof. Freddy Gaborian, CPAT, Universite Paul Sabatier, Toulouse, France
   Asst. Prof. Miran Mozetič
9. Towards a Process for Ventilating Air Sterilization
   BI-GR/04-06-015
   Prof. Giorgos Evangelakis, Department of Physics, University of Ioannina, Ioannina, Greece
   Asst. Prof. Miran Mozetič
10. Characterization of Plasma for Treatment of Biocompatible Materials
    BI-HR/06-07-033
    Dr. Slobodan Milošević, Institut za fiziku, Zagreb, Croatia
    Asst. Prof. Miran Mozetič
11. Nano-scale Phenomena Atop of Inorganic Nanotubes inducing Stable Field Emission
    BI-CN/05-07/011
    Dr. Lian-mao Peng, Institute of Physical Electronics, Peking University, Department of Electronics, China
    Dr. Vincenc Nemanič
12. Experimental Measurements of Relative Sputtering Yields
    BI-HU/06-07/007
    Dr. Miklos Menyhard, Research Institute for Technical Physics and Materials Science, Budapest, Hungary
    Prof. Anton Zalar
13. Research of Bacteria Damages after Plasma Radical Interaction
    BI-CS/06-07-001
    Asst. Prof. Dragan Laušević, Institut za zdravje Crne Gore, Podgorica, Serbia and Montenegro
    Asst. Prof. Miran Mozetič
14. Large Scale Synthesis and Dispersions of Metal Oxide Nanowires
    BI-US/06-07-002
    Dr. Mahendra Sunkara, University of Louisville, Department of Chemical Engineering, Louisville, Kentucky KY, USA
    Asst. Prof. Miran Mozetič
15. Microscopic Characterization of Field Emission Sites on Nanostructured Carbon Films
    BI-US/06-07-023
    Prof. Robert Nemanich, North Carolina State University (NCSU), Department of Physics, Raleigh, NC, USA
    Dr. Vincenc Nemanič

R & D GRANTS AND CONTRACTS

1. Study of thin organic films and nanostructured materials by synchrotron radiation
   Dr. Janez Kovač
2. Fusion relevant research and plasma surface interaction
   Prof. Miran Čerček
3. Research of gas arrester follow current selfextinguishing characteristics
   Dr. Vincenc Nemanič
4. Highly reactive plasma for treatment of advanced composites
   Asst. Prof. Miran Mozetič
5. Plasma sterilization and funcitoanlization of biocompatible materials
   Asst. Prof. Miran Mozetič
6. Electron beam writer with nanometric resolution
   Dr. Vincenc Nemanič
7. Local and systemic effects of articulation of metal components from total hip replacement
   Dr. Ingrid Milošev
8. Industrial intelectual rights as an instrument for economy development
   Dr. Uroš Cvelbar
9. Self cleaning photocatalytic paints and coatings
   Dr. Urška Lavrenčič
10. Smart functional coatings for improvement of structures and components used in defensive purpose
    Dr. Peter Panjan
11. Nanoelectronics and devices for nanotechnology
    Dr. Vincenc Nemanič
12. Development and characterisation of advanced soft magnetic and getter materials
    Dr. Vincenc Nemanič

RESEARCH PROGRAMS

1. Vacuum technique and materials for electronics
   Dr. Vincenc Nemanič
2. Thin film structures and plasma surface engineering
   Prof. Anton Zalar

VISITORS FROM ABROAD

1. Dr. Slobodan Milošević, Nino Čutić, Nikša Krstulović, Institute of Physics, Zagreb, Croatia, several times in the year
2. Dr. Primož Eiselt, Plasmait, Lebring, Austria, several times in the year
3. Zoran Vratnica and Danijela Vujošević, Institute for health of Montenegro, Podgorica, Montenegro, several times in the year
4. Dr. Marek Rubel, dr. Arkadij Kreter, dr. Sebastian Brezinšek, Forschungszentrum Jülich, Germany, 14 February 2006
5. Prof. R. J. Nemanich, North Carolina State University, Raleigh, USA, 28 May – 31 May 2006
6. Prof. Giorgos A. Evangelakis in dr. Elizabeth Symiakaki, University of Ioannina, Greece, 30 July – 5 August 2006
7. Prof. Lian-Mao Peng, Key Laboratory for the Physics and Chemistry of Nanodevices and Department of Electronics, Beijing University, Beijing, China, 16 – 23 August 2006
8. Eugene Brian, North Carolina State University, Raleigh, USA, 14–23 September 2006

9. Prof. Francisco Tabares, Laboratorio National de Fusion, CIEMAT, Madrid, Spain, several times in the year
10. Dr. Sabastian Brezinšek, Institut für Plasma Physic, Forschungszentrum Jülich, Jülich, Germany, several times in the year
11. Dr. Miklos Manyhard , Research Institute for Technical Physics and Materials Science, Budapest, Hungary, 5–7 December 2006
12. Dr. Andre Ricard in dr. Cristina Canal, CPAT, Univerze Paul Sabatier, Toulouse, France, 10–20 December 2006

STAFF

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2. Asst. Prof. Miran Mozetič
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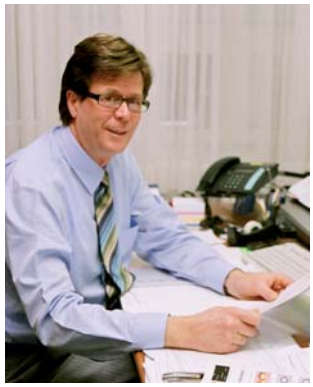
15. Janez Trtnik

** Part-time faculty member

DEPARTMENT OF SOLID STATE PHYSICS F-5

Our research program is focused on studying the structure and dynamics of disordered and partially ordered condensed matter at the atomic and molecular levels with a special emphasis on phase transitions. The purpose of these investigations is to discover the basic laws of physics governing the behaviour of these systems, which represent the link between perfectly ordered crystals, on one hand, and amorphous matter, soft condensed matter and living systems, on the other. Such knowledge provides the key to our understanding of the macroscopic properties of these systems and is an important condition for the discovery and development of new multifunctional materials and nanomaterials for new applications. An important part of the research program is devoted to the development of new experimental methods and techniques in the field of magnetic resonance, magnetic resonance imaging, scanning tunnelling, electronic and atomic force microscopy, as well as dielectric relaxation spectroscopy and dynamic specific-heat measurements.



Head:
Prof. Igor Muševič

The experimental techniques used are as follows:

- one (1D) and two (2D) dimensional nuclear magnetic resonance (NMR) and relaxation, as well as quadrupole (NQR) resonance and relaxation,
- multi-frequency NMR in superconducting magnets of 2T, 6T and 9T, as well as the dispersion of the spin–lattice relaxation time, T_1, via field cycling,
- nuclear double resonance and quadrupole double resonance, such as ^{17}O–H and ^{14}N-H,
- frequency-dependent electron paramagnetic resonance (EPR) and 1D and 2D pulsed EPR and EPR relaxation
- MR imaging and micro-imaging,
- linear and non-linear dielectric spectroscopy in the range 10^{-2} Hz to 10^{9} Hz,
- electron microscopy and scanning tunnelling microscopy,
- atomic force microscopy and force spectroscopy,
- dynamic specific-heat measurements.

The research program of the Department of Solid State Physics at the Jožef Stefan Institute is performed in close collaboration with the Department of Physics at the Faculty of Mathematics and Physics of the University of Ljubljana. In 2006, the research activity was performed within three research programs:

- NMR and Dielectric Spectroscopy of Condensed Matter: Smart New Materials and Translational Symmetry Breaking
- Physics of Soft Matter, Surfaces and Nanostructures
- Experimental Biophysics of Complex Systems

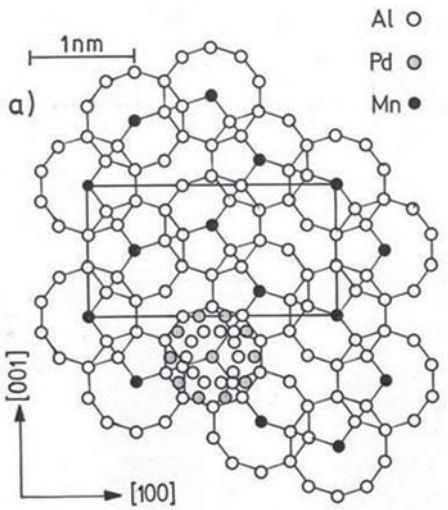


Figure 1: Structure of the complex metallic "epsilon" phase in the system Al–Pd–(Mn,Fe,Co,Rh) (J. Dolinšek)

The program of the research group **NMR and Dielectric Spectroscopy of Condensed Matter:** Smart New Materials and Translational Symmetry Breaking was focused on investigations of the basic laws of physics of partially ordered condensed matter, as well as on the relation between the microscopic structure and the dynamics of these systems, and the macroscopic properties of matter with broken translational symmetry. The investigations were focused on materials such as quasicrystals and complex metallic alloys, relaxors and disordered ferroelectrics, magnetoelectric materials and multiferroics fullerenes, carbon nanofoams and TiO_2 nanotubes. New methods of nuclear quadrupole resonance (NQR) have been developed for the detection of small amounts of explosives such as TNT.

In the field of quasicrystals and complex metallic alloys with a gigantic unit cell we have discovered new metallic phases of ε-Al-Pd-(Mn, Fe, Co, Rh), that show a "smart" combination of good electrical conductivity and low thermal conductivity. This is an outstanding combination of transport properties, as it is common for most materials that are good electric conductors to also be good conductors of heat. We have also shown that NMR can reveal the hidden "forbidden" symmetries of quasicrystals.

An outstanding achievement is our discovery that in the vicinity of the critical point of ferroelectric relaxors the electric polarization can be rotated with small energy requirements. The discovery is of great importance for the engineering of new materials with enhanced electromechanical properties and applications in robotics, medicine and telecommunications.

A very important achievement in the field of relaxors and disordered ferroelectrics was our discovery that an external electric field, applied to the system PMN-PT in the vicinity of the morphotropic boundary, induces a line of critical points, above which the difference between the paraelectric and ferroelectric phase vanishes. This means that the energy barriers between different orientations of electric polarization become vanishingly small, whereas the corresponding electromechanic response of the system becomes gigantic. This discovery enables the synthesis of a new class of relaxor materials with a gigantic piezoelectric effect. This work was published in Nature. Another very important achievement is our discovery in the field of polymer composite materials, where the particles of electrically conducting anyline are added to the relaxor polymer matrix. We have shown that in the vicinity of the corresponding percolation point, the dielectric response becomes extremely large. In cooperation with the Department for Electronic Ceramics we have developed the first percolative ceramic composites, i.e., solid solutions of isolating and conductive perovskite ceramics, which in the vicinity of the percolation point show a very large dielectric response.

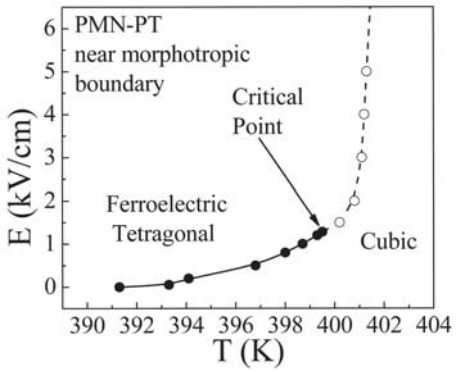


Figure 2: Critical point in the electric field-temperature phase diagram of ferroelectric relaxors (Z. Kutnjak).

In the field of magnetoelectric materials we have discovered the magnetoelectric effect in the vicinity of the phase transition from the paraelectric to the ferroelectric phase in PFN. We have also investigated the system PFN-PMW, which seems to be the first magnetoelectric relaxor. Magnetoelectric systems, where the magnetic properties can be controlled by an electric field and vice versa, are very important new materials for spintronic components, magnetoelectric capacitors, as well as memory elements, where an electric readout of magnetically stored information could be realized. The bilinear magnetoelectric effect is allowed in time- and space-asymmetric systems, with no time-reversal symmetry and no inversion symmetry.

We have successfully developed a new method of NQR that allows for the detection of small amounts (15 gram) of TNT explosive in a single-shot RF pulse experiment, lasting approximately 20 seconds. In comparison, the classical method of TNT detection using NQR requires more than 5 hours of signal averaging and is not suitable for practical applications. The new approach is based on spin pre-polarized NQR of ^{14}N using a specially designed multipulse excitation method that allows for the averaging of more than 100 spin-echoes within a single excitation sequence. We see an important application of this novel NQR method in the analysis and control of pharmaceutical materials. Our investigations have shown that the ^{14}N NQR method could be used efficiently for the analysis of the polymorphism of pharmaceutically active substances that determine the mechanical properties of tablets. The method could be used for an online, real-time analysis of tablet production. The method could also be used for determining the chemical composition of active substances in the solid state, which is not possible using standard methods of analysis, such as high-resolution NMR.

We have also been successful in the field of electronic paramagnetic resonance (EPR) methods and applications. Using this method we have determined the magnetic properties of carbon nanofoams. This material has by far the smallest known density among known materials and has an extremely large surface area. It is also characteristic for its interesting magnetic properties, which originate from defect centres at the edges of layers. Magnetic correlations, which develop at lower temperature, are reminiscent of spin glasses. Due to its gigantic surface area, the carbon nanofoam is a highly interesting material for hydrogen storage. We have discovered that polymer composites based on TiO_2 nanotubes exhibit highly interesting mechanical properties and are also potentially interesting for the storage of Li in Li-ion batteries. Doped TiO_2 nanotubes are potentially interesting for spintronics applications.

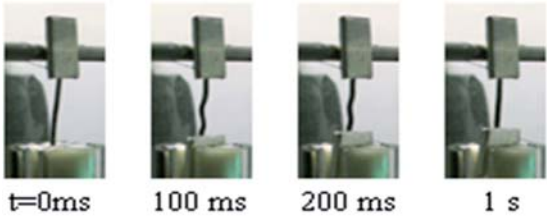


Figure 3: Termo-electromechanical actuation of a liquid crystalline elastomer reprocessed with carbon nanoparticles (B.Zalar).

Our research on liquid crystalline elastomeres and their composites with carbon nanoparticles has been performed in close collaboration with the "Physics of Soft Matter, Surfaces and Nanostructures" research program. The investigations have been focused on the development of new methods for the deposition of thin, electrically conductive carbon layers on the surface of elastomeric material, as well as the actuation of the elastomers by resistive heating of the material. Using resistive heating we are able to achieve 100-ms response times for a 150% elongation of the sample, using several mW of electric power. This new technology could potentially be used in micro-actuators.

Our results have been published in 35 scientific papers in 2006, among them we had one paper published in Nature and two papers were published in Physical Review Letters. A total of 63 papers were presented at international conferences, and 3 contributions were published in international monographs. Two patents have been granted, one of them a European patent. We had a close collaboration with the Gorenje company, that also resulted in a project entitled "Development of Super-Hard PA foils with Titanium Dioxide Nanotubes". Within the framework of the EU's Network of Excellence "Complex Metallic Alloys", we have organized the "1st European School in Materials Science", that took place in Hotel Mons, Ljubljana, 21–28 May 2006.

The investigations of the research group **"Physics of Soft Matter, Surfaces and Nanostructures"** were focused on novel, soft-condensed matter systems and surfaces with novel and specific functional properties. Among them, we have investigated liquid crystalline elastomeres and dendrimeres as novel multifunctional materials, molecular motors, soft-matter photonic crystals and novel synthetic or self-assembled micro- and nanostructures. The aim of the program is to understand the structural and dynamical properties of these systems, their interactions, their function at the molecular level, self-assembly mechanisms in soft matter, as well as possible applications of novel phenomena. The underlying idea is that it is possible to understand complex mechanisms, such as self-assembly, on a macroscopic level, using a simplified physical picture and model systems. In this sense, the program combines experimental and theoretical investigations, modelling and simulations.

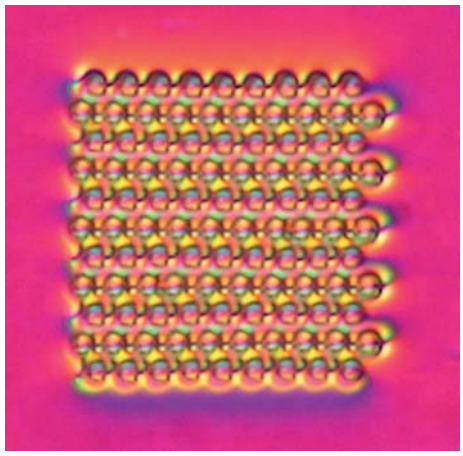


Figure 4: 2D colloidal crystal assembled from micrometer silica spheres in a nematic liquid crystal (M.Škarabot).

In the field of liquid crystalline colloids we have used laser tweezers and time-resolved optical microscopy to report the first observation of stable 2D nematic colloidal crystals in a very thin layer of a nematic liquid crystal. This work was published in Science. 2D nematic colloidal crystals are thermodynamically extremely stable, with the colloidal binding energy being ten thousand times larger than traditional water-based colloids. Such a strong binding opens up real possibilities for producing photonic crystals in 2D and even 3D. We have successfully modelled the stability of 2D nematic colloidal crystals of dipolar and quadrupolar symmetry. We have discovered novel colloidal interactions between colloidal inclusions in the nematic liquid crystals, which originate from entangled and distributed topological defects. We have modelled the stability of 2D colloidal structures, bound by delocalized and entangled topological defect lines and we have predicted novel 2D structures. We have also investigated colloidal interactions inside a capillary filled with nematic liquid crystal.

We were the first to assemble highly stable 2D photonic crystals using dispersions of silica colloidal particles in a nematic liquid crystal. The discovery represents a novel concept of self-assembly and is of great importance for photonic materials (Science18, 954-958 (2006)).

Using the NQR relaxometry method in combination with X-ray scattering we have studied liquid crystalline dendrimeres and have shown that the microsegregation of specific parts of these complex molecules occurs in the smectic phases. As a result, bilayer smectic phases are formed with a very high smectic order and a small molecular tilt in the smecti C phase. Proton NMR relaxometry has revealed three distinct rotational modes of motion of dendrimere branches. Due to microsegregation, a strong undulation motion of the smectic layers is observed in dendrimere smectic phases compared to the traditional smectic phases of rod-like molecules.

We have investigated the annihilation of nematic point defects in cylindrical capillary and forces between objects in liquid crystals. We were the first to investigate and explain the pre- and post-collision regime of defect annihilation in nematics. We have investigated theoretically the nature of the Casimir force in free-standing smectic films. We have investigated the influence of aerosil on the nature of the phase transition between the smectic A and C phases, which is important for the universality of our understanding of the influence of random disorder to the systems with broken symmetry and the physics of networks. We have investigated theoretically the influence of random field on the phase separation and have shown that spontaneous orientational order favours phase separation, whereas a random field acts in the opposite direction.

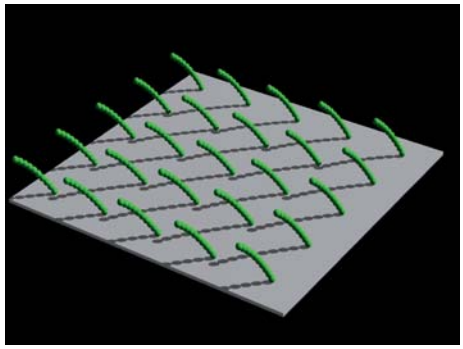


Figure 5: Computer simulation of artificial cilia, composed of magnetic colloidal particles (A.Vilfan).

We have investigated active systems, which are driving molecular motors. A simplified model has been developed that enabled theoretical studies of the hydrodynamic coupling on the functional properties of biological cilia. We have shown that hydrodynamic coupling can induce synchronization of biological cilia and the emergence of phase waves, which are actually observed in the respiratory epithelia of some micro-organisms. In cooperation with the Soft-Matter Group at the Faculty of Mathematics and Physics of the University of Ljubljana we have developed a new concept of biomimetic microfluidic pumps based on magnetic colloidal particles.

In the field of applications of liquid crystals we have performed extensive modelling of the optical properties of twisted nematic phases with birefringent compensation layers. A new concept of LCD eye-protecting shutters has been developed, which was successfully implemented in our spin-off company Balder d. o. o. We have also investigated the influence of ionic contamination of a liquid crystal on the electro-optic properties of LCDs, and have developed a conceptually new method of the alignment of liquid crystals on isotropic inorganic surfaces.

We have synthesized a series of WO_{3-x}, which are very rare in nature, and were used as a starting material for the synthesis of WS_2 nanotubes. We have performed the first synthesis of WS_2 fullerenes using a diffusion process. Much effort has been devoted to safety studies in nanotechnology, in cooperation with the Department for Surface Engineering and Optoelectronics (F4), the Department for Experimental Particle Physics (F9), and the company Cosylab d.o.o. we have developed a prototype of a nanoparticle detector, based on a conceptually new approach.

We have studied STM manipulation of individual CO molecules on Cu(111) and Cu(211) surfaces at temperatures below 7K using our newly constructed low-temperature STM in ultra-high vacuum. We have also investigated the electronic properties of UAsSe and ThAsSe.

In 2006 we published 24 papers in international SCI journals, one paper was published in Science and two papers in Physical Review Letters. We have published 4 contributions in international monographs and have been granted 2 international patents. Members of the program group have delivered 2 plenary lectures and 9 invited lectures at international conferences. In cooperation with the Slovenian Army we have developed a dedicated system for the storage of explosive materials. In cooperation with foreign partners from the "Ettore Majorana Centre for Scientific Culture", we have organized a very successful international workshop "13th Workshop: Colloids, Interfaces and Liquid Crystals", within the International School of Liquid Crystals, Erice, 19–25 July 2006.

Figure 6: Conformation space of bacteriophage membrane protein M13 (orange) and spin label (red) (J.Štrancar).

Within the program **"Experimental Biophysics of Complex Systems"** we have explored the processes and structures of various complex systems (from model systems to the structures in living cells, tissues and even small animals) including the effects of various bioactive molecules on these systems. To improve the understanding of cell signalling and signal transduction in biomembranes, biomembrane structural heterogeneity, membrane domains and their interactions with other cell structures under different conditions were investigated. In-vivo oxymetry techniques for the optimization of medical treatment in tumour therapies were developed, as well as magnetic resonance imaging techniques and mathematical modelling of thrombolysis, magnetic resonance microscopy for applications in forestry and wood science, constrained diffusion and food processing.

In the study of biomembrane structure we found that domain structure together with the membrane fluidity of malignant breast-cancer cells affects the cell adhesion and consequently the breast-cancer malignancy (accepted in ABB 2006). A novel simulation approach has been developed to simulate spin labels rotation conformational spaces in membrane proteins. When these techniques are coupled to site-directed spin labelling EPR techniques, they can represent the basis for a new methodology for membrane-protein structure determination where classical high-resolution methods are less applicable or successful.

The role of nanomaterials has been investigated for applications in the maintenance of clean surfaces with the photocatalysis. Our studies involving titanate nanotubes showed the significant potential of these nanomaterials in antimicrobial surfaces. Due to the large interacting surfaces the effect of these materials could easily exceed the effect of materials available on the market. However, the main problem addressed in the last months of 2006 was to prevent aggregation while using this material in suspension and under surface coverage.

Within the research of the efficiency of topical application of various drugs, the transport of the drugs through the skin and skin oxidation it was very important to detect the influence of anaesthetics on the oxidation and to show that this effect can be quite significant and consequently an important factor in various therapies. On the other hand, drug transport was shown to be affected by the variation of liposome contents – the best effect on the drug transport through the mucous membrane has been achieved by using MLV from hydrogenated soya lecithin with 30 mol% of cholesterol.

We developed a new mathematical model of thrombolysis that accounts for the effect of the boundary layer formed after a sudden constriction of the flow in stenotic vessels.

^{31}P-NMR spectroscopy was applied to study the effect of radiation on biological systems. Metabolic changes in mice exposed to different radiation doses were determined. In addition, NMR spectroscopy was employed to study paradontotic tissues removed during surgery.

A new MRI method of diffusion-weighted imaging that enables direct imaging of diffusion spectra was developed. Studies were also made in food processing, where T2/T1-weighted imaging as well as diffusion-weighted imaging was employed to study gelatinization in corn meal during thermal treatment.

The above research has been supported by a number of international projects financed by the EU's 5 and 6FP as well as NATO. It was also supported within the bilateral Slovenian–USA, Slovenian–German and Slovenian–Greek and other scientific cooperations. International cooperation with the following:

- The high magnetic field centers in Grenoble, France, and Nijmegen, The Netherlands
- The high magnetic field center at the University Florida, Tallahassee, Florida, USA
- The ETH, Zürich, Switzerland
- The Ioffe Institute in St. Petersburg, Russia

- The University of Duisburg, the University of Mainz and the University of Saarbrucken in Germany
- The University of California, the University of Utah and the Liquid Crystal Institute, Kent, Ohio, USA,
- National Institute for Research in Inorganic Materials, Tsukuba, Japan
- NCSR Demokritos, Greece
- The Institute for Biophysics and X-Ray Structure Research of the Academy of Sciences, Graz, Austria
- The Max Delbruck Center for Molecular medicine in Berlin, Germany
- The Dartmouth Medical School, Hanover, NH, USA
- The Mayo Clinic, Rochester, USA

made the above studies possible.

Some outstanding publications in 2006

1. Zdravko Kutnjak, Jan Petzelt, and Robert Blinc, The giant electromechanical response in ferroelectric relaxors as a critical phenomenon, Nature (Lond.) 441, 956–959 (2006).
2. G. Papavassiliou, M. Pissas, G. Diamantopoulos, M. Belesi, M. Fardis, D. Stamopoulos, A. G. Kontos, M. Hennion, J. Dolinšek, J.-Ph. Ansermet, C. Dimitropoulos, Low temperature charge and orbital textures in $La_{0.875}Sr_{0.125}MnO_3$, Phys. Rev. Lett. 96, 097201 (2006).
3. Wolfgang Kleemann, Jan Dec, Vladimir V Shvartsman, Zdravko Kutnjak, and Thomas Braun, Two-dimensional ising model criticallity in a three-dimensional uniaxial relaxor ferroelectric with frozen polar nanoregions, Phys. Rev. Lett. 97, 065702-1-065702-4 (2006).
4. A.Vilfan, F. Julicher. Hydrodynamic flow patterns and synchronization of beating cilia, Phys. Rev. Lett. 96, 058102 (2006)
5. I. Muševič, M. Škarabot, U. Tkalec, M. Ravnik, S. Žumer, Two-dimensional nematic colloidal crystals self-assembled by topological defects, Science 18, 954-958 (2006).
6. P. Kossyrev, M. Ravnik, S. Žumer, Branching of colloidal chains inside supramicrometer capillaries, Phys. Rev. Lett. 96, 048301 (2006).
7. David Stopar, Janez Štrancar, Ruud B. Spruijt, Marcus A. Hemminga Motional restrictions of membrane proteins: a site-directed spin labeling study. Biophys. J. 91, 3341-3348(2006).

Some outstanding publications in 2005

1. M. Remškar, A. Mrzel, A. Jesih, J. Kovač, New composite MoS2C60 crystals, Adv. mater, 17 (2005), 911-914
2. R. Blinc, B. Zalar, V. V. Laguta, M. Itoh , Order-disorder component in the phase transition mechanism of O-18 enriched strontium titanate, Phys. Rev. Letters 94 (2005), 147601
3. B. Zalar, A. Lebar, J. Seliger, R. Blinc, V. V. Laguta, M. Itoh, NMR study of disorder in BaTiO3 and SrTiO3, Phys. Rev. B 71 (2005), 064107
4. A. Lebar, Z. Kutnjak, S. Žumer, H. Finkelmann, A. Sanchez-Ferrer, B. Zalar, Evidence of supercritical behavior in liquid single crystal elastomers, Phys. Rev. Lett. 94 (2005), 197801
5. A. Lebar, Z. Kutnjak, S. Žumer, H. Finkelmann, A. Sanchez-Ferrer, B. Zalar, Evidence of supercritical behavior in liquid single crystal elastomers, Phys. Rev. Lett. 94, 197801 (2005).
6. T. Apih, V. Bobnar, J. Dolinšek, L. Jastrow, D. Zander, U. Koster, Influence of the hydroghen content on hydrogen diffusion in the Zr69.5Cu12Ni11Al7.5 metallic glass, Solid State Communications, 134 (2005), 337–341
7. M. Škarabot, I. Muševič, B. Helgee, L. Komitov, Direct evidence of the molecular switching in electrically commanded surfaces for liquid-crystal displays, J. Appl. Physi. 98 (2005), 046109-1-046109-3
8. D. Stopar, J. Štrancar, R. B. Spruijt, M. A. Hemminga, Exploring the local conformational space of a membrane protein by site-directed spin labeling, J. Chem. Inf. Comput. Sci. 45 (2005), 1621–1627.
9. B. Blanc, D. Svenšek, S. Žumer, M.Nobili, Dynamics of nematic liquid crystal disclinations: the role of the backflow, Phys. Rev. Lett. 95, 097802 (2005)

Some outstanding publications in 2004

1. Muševič, M. Škarabot, D. Babič, N. Osterman, I. Poberaj, V. Nazarenko, A. Nych, Laser trapping of small colloidal particles in a nematic liquid crystal: Clouds and ghosts, Physical Review Letters, 93 (2004), 87801
2. M. Conradi, M. Čepič, M. Čopič, I. Muševič, Structures and phase transitions in thin free standing films of an antiferroelectric liquid crystal. Phys. Rev. Lett. 93 (2004), 227802
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1. Janez Pirš, Matej Bažec, Bojan Marin, Silvija Pirš, Andrej Vrečko
   High contrast, wide viewing angle LCD light-switching element: EP patent No. 1625445
   München, European Patent Attorneys, 2006.
2. Janez Pirš, Silvija Pirš, Bojan Marin, Robert Blinc, Martin Čopič, Rok Petkovšek
   Process for the manufacturing of the polymer compensation layer for LCD optical light shutter and the construction thereof: EP-patent No. 1192499
   München, European Patent Attorneys, 2006.
3. Janez Seliger, Robert Blinc, Tomaž Apih, Gojmir Lahajnar
   Triple resonance enhanced nuclear quadrupole resonance detection of TNT and other explosives, patent No. 21715
   Slovenian Intellectual Property Office, Ljubljana, 2006.
4. Janez Pirš, Andrej Vrečko, Silvija Pirš, Bojan Marin
   High contrast, wide viewing angle LCD light-switching filter: patent No. WO O2006122679
   München, European Patent Attorneys, 2006.

Awards and appointments

1. Robert Blinc: elected for a foreign corresponding member of the Macedonian Academy of Science and Arts, 10 May 2006
2. Robert Blinc: re-appointed as associate professor of the University of Utah, Department of Physics, Salt Lake City, U.S.A., 21 February 2006
3. Robert Blinc: elected as a honorary member of the Bureau AMPERE, 18 July 2006
4. Robert Blinc: appointed as the president for the panel "Condensed matter in physics and chemistry European Research Foundation", Brussels, Belgium, 27 September 2006
5. Zdravko Kutnjak: Zois Prize for important scientific achievements, 27 September 2006
6. Polona Umek: awarded a two-month fellowship of the Government of France for research at the Université Paris Sud, 2006
7. Andrej Zorko: FUTURUM Fundation Prize for 2006 for best Ph.D. work in the field of natural medical and technical sciences

Organization of conferences, congresses and meetings

1. 5th Symposium of Science and Technology of Nanomaterials in Slovenia, Organic, Inorganic and Biomolecular Nanostructures: From Fundamental Science to Appolications – SLONANO 06, 20–21 September 2006, J. Stefan Institute, Ljubljana, (Dr. Denis Arčon)
2. Advanced techniques for the detection of plastic and liquid explosives, Workshop on "Security Technologies for the 21st Century", Hotel Bernardin, Portorož, Slovenia, 9–11 November 2006, (Professor Robert Blinc)
3. European School in Materials Science, Hotel Mons, Ljubljana, Slovenia, 22–27 May 2006 (Prof. Janez Dolinšek)
4. 5th Conference of Physicists in Basic Research, Gozd Martuljek, Slovenia 10 November 2006 (Prof. Igor Muševič)

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2. Gorazd Planinšič
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3. Sandra Kure, Marjeta Šentjurc, Miha Črnigoj, Nataša Poklar Ulrih, Veronika Abram
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4. Maks Merela, Urška Mikac, Igor Serša, Primož Oven
   3D MD imaging of diffuse porous and ring porous wood
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5. Aleš Mohorič
   Experiences in building a small "Vacuum bazooka: extended
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6. Igor Muševič, Miha Škarabot, Miha Ravnik, Igor Poberaj, Dušan Babič, Natan Osterman, Andriy Nych, U. Ognysta, Vassili Nazarenko, Slobodan Žumer
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   In: Liquid crystals X: 13-15 August, 2006, San Diego, California, USA(Proceedings of SPIE, vol. 6332), Iam-Choon Khoo, ed., Bellingham, SPIE, cop. 2006, 9 p.
7. Ana Nemec, Zlatko Pavlica, Milan Petelin, Marjanca Nemec, Marjeta Šentjurc
   Study of the systemic response to aspiration of gram negative pathogens: detection of organ nitric oxide levels
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8. Janez Pirš, Mirko Kokole, Andrej Vrečko, Barbara Malič, Marija Kosec, Dušan Ponikvar
   New non contact alignement technique for LCDs
   In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 245-250.
9. Janez Pirš, B. Schmitz, Bojan Marin, B. Taheri
   Auto-darkering welding filters - state of-the-art and perspectives
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10. Gorazd Planinšič, Miha Kos
    Collaboration between the science center and university department: opportunities and challenges
    In: Informal learning and public understanding of physics: selected contributions, Gorazd Planinšič, ed., Aleš Mohorič, ed., Ljubljana, Faculty of Mathematics and Physics, 2006, pp. 103-107.
11. Robert Repnik, Marjan Krašna, Samo Kralj
    Teaching and learning the physics of liquid crystals
    In: Conference proceedings, 17th International Conference on Information and Intelligent Systems, September 20-22, 2006, Varaždin, Croatia, Boris Aurer, ed., Miroslav Bača, ed., Varaždin, Faculty of Organisation and Informatics, FOI, cop. 2006, pp. 477-481.
12. Andrej Vrečko, Janez Pirš, Silvija Pirš, Dušan Ponikvar
    Active LCD light intensity and color modulators
    In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 239-244.
13. Shihai Zhang, Vid Bobnar, Adrijan Levstik, (9 avtorjev)
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RESEARCH MONOGRAPH

1. Samo Kralj, Milan Ambrožič, Said Bešlagić, Robert Repnik, Vladimir Grubelnik, ed.
   Knjiga fizikalnih šal, anekdot in stripov
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TEXTBOOKS AND LECTURE NOTES

1. Milan Ambrožič, Gorazd Planinšič, Erik Karič, Samo Kralj, Mitja Slavinec, Aleksander Zidanšek
   Fizika, narava, življenje, Učbenik za pouk fizike v 8. razredu devetletne osnovne šole (Raziskovalec 8), 1. izd., Ljubljana, DZS, 2000.
2. Zdravko Kutnjak
   Dielectric and thermal properties of nanostructured materials: laboratory work and seminars: laboratory work and seminar supporting materials related to the course of Dielectric and Thermal Properties of Nanostructured Materials given at the Jožef Stefan International Postgraduate School
   Ljubljana, Jožef Stefan International Postgraduate School, [2006].
3. Zdravko Kutnjak
   Dielectric and thermal properties of nanostructured materials: selected lectures given at the Jožef Stefan International Postgraduate School within the course of Dielectric and Thermal Properties of Nanostructured Materials
   Ljubljana, Jožef Stefan International Postgraduate School, [2006].
4. Zdravko Kutnjak
   Selected chapters from physics of materials: lectures given at the Jožef Stefan International Postgraduate School within the course of Physics of Materials
   Ljubljana, Jožef Stefan International Postgraduate School, [2006].

PATENT APPLICATIONS

1. Stanislav Gobec, Andreja Kovač, Alja Brajić, Slavko Pečar, Julieanne Bostock, Ian Chopra, Roman Lenaršič, Sergeja Bombek, Marijan Kočevar, Slovenko Polanc
   Diazendikarboksiamidi kot inhibitorji D-alanil-D-alanin ligaze: patentna prijava No. P-200600186
   Ljubljana, Urad Republike Slovenije za intelektualno lastnino, 18.08.2006.
2. Aleš Obreza, Rok Frlan, Nina Vobovnik, Andreja Kovač, Didier Blanot, Slavko Pečar, Stanislav Gobec
   Novi arilsulfonoidrazidni inhibitorji encimov MurC in MurD: patentna prijava No. P-200600094
   Ljubljana, Urad Republike Slovenije za intelektualno lastnino, 25.07.2006.

THESES

Ph. D. Theses

1. Vladimir Boštjan Bregar: Characterization of ferromagnetic composite materials in microwave frequency range (Janez Seliger)
2. Andrija Lebar: NMR investigation of monodomain liquid crystal elastomer (Boštjan Zalar)

M. Sc. Thesis

1. Klara Vidmar: Overview and analysis of nature protection on Slovenian coastal area (komentor Aleksander Zidanšek)

B. Sc. Theses

1. Matej Cvetko: Stability of the planar nematic structure in the eccentric cylindrical geometry (Samo Kralj)
2. Boštjan Drolc: Study of magnetic properties of iron-oxide nanoribbons (Denis Arčon, comentor Polona Umek)
3. Marjan Grilj: Adhesion of TiA1N thin ceramic films on tool steels (Janez Dolinšek)
4. Sandra Kure: Phenolic compounds and cell membrane fluidity (comentor Marjeta Šentjurc)
5. Mojca Maver: Synthesis of hydroxyethylamine mimetics as transitionstate inhibitors of Mur ligases (Slavko Pečar)
6. Tomaž Peterman: Simulation of multilayer nitride coatings deposition by magnetron sputtering (Janez Dolinšek)
7. Urška Šuštaršič: Influence of penetration enhancers on the stability of benzyl nicotinate colloidal carriers and skin oxigenation (comentor Marjeta Šentjurc)
8. Zoran Trifunović: Nuclear quadrupole double resonance measurement of N-14 NQR frequencies in nicotinic acid N-oxide (Janez Seliger)
9. Erik Zupanič: Scanning tunneling microscopy of copper surfaces (comentor Albert Prodan)

INTERNATIONAL PROJECTS

1. Multifunctional Ceramic Layers with High Electromagnetoelastic Coupling in Complex Geometries
   MULTICERAL
   6. FP
   NMP3-CT-2006-032616
   EC; Prof. Andrei Kholkin, University of Aveiro, Dept. of Ceramics & Glass Engineering, Aveiro, Portugal
   Prof. Robert Blinc, Prof. Marija Kosec, Dr. Janez Holc, Prof. Raša Pirc
2. Synthesis and Characterization of Electromechanically Active Composites of Mesogenic Elastomers and Electrically Active Nanoparticles
   ELACEM
   6. FP
   MEIF-CT-2006-039643
   EC
   Asst. Prof. Boštjan Zalar
3. Reliable, Tuneable and INexpensive Antennas by collective fabrication processes
   RETINA
   6. FP
   AST4-CT-2005-516121
   EC; Dr. Volker Ziegler, EADS Deutschland GmbH, Corporate Research Centre, Dept. LG-ME, München, Germany
   Dr. Vid Bobnar, Prof. Marija Kosec, Asst. Prof. Barbara Malič
4. Complex Metallic Alloys
   CMA
   6. FP, Network of Excellence
   NMP3-CT-2005-500140
   EC; Centre National de la Recherche Scientifique, Paris, France
   Prof. Janez Dolinšek, Dr. Peter Panjan, Prof. Spomenka Kobe
5. Safe Production and Use of Nanomaterials
   NANOSAFE2
   6. FP
   NMP2-CT-2005-515843
   EC; Frederic Schuster, Commissariat a l"Energie Atomique, Grenoble, France
   Asst. Prof. Maja Remškar, Marko Žumer, B. Sc., Andrej Detela, B. Sc., Prof. Boris Turk
6. Fullerene-based Opportunities for Robust Engineering: Making Optimised Surfaces for Tribology
   FOREMOST
   6. FP
   515840-2
   EC; Alberto Alberdi, Fundacion Tekniker, Eibar, Spain
   Asst. Prof. Maja Remškar, Marko Žumer, B. Sc.
7. Improving the Understanding of the Impact of Nanoparticles on Human Health and the Environment
   IMPART
   6. FP
   013968
   EC; Mark Pullinger, Chalex Research Ltd., Torquay, Great Britain
   Asst. Prof. Maja Remškar
8. Applications of Liquid Crystals for Advanced Nanoscale Devices and Optics
   ALCANDO
   5. FP
   G5MA-CT-2002-04023
   EC
   Prof. Igor Muševič, Prof. Robert Blinc
9. Functional Liquid Crystal Elastomers
   FULCE
   5. FP
   HPRN-CT-2002-00169
   EC; Heino Finkelmann, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany
   Prof. Slobodan Žumer
10. A Quadrupole Resonance Instrument for the Clearance of Abandoned Minefields
    NATO SfP - Minefield Detection
    NATO SfP – 978007
    3311-05-837009
    NATO Scientific Affairs Division; Prof. J. A. S. Smith, King's College London, Chemistry Department Strand, London, Great Britain
    Dr. Tomaž Apih
11. Protein - Lipid Interactions Biophysical Characterization of Structural and Functional Properties of Membrane Domains (Rafts)
    COST D22, WG 002/01
    EC; Prof. John Findlay, University of Leeds, School of Biochemistry and Molecular Biology, Leeds, Great Britain; Antoinette Killian, Department of Biochemistry of Membranes, Center for Biomembranes and Lipid Enzymology, Ultrecht University, Ultrecht, The Netherlands
    Prof. Milan Schara
12. Advanced Paramagnetic Resonance Methods in Molecular Biophysics
    COST P15
    EC
    Dr. Janez Štrancar
13. Origin of Live and Early Evolution; Preparation and Properties of Functional Vesicles as Proto Sell Models
    COST D-27
    EC
    Dr. Marjeta Šentjurc
14. Novel Soft Matter with Unusual Optical and Physical Properties: Nanostructured Liquid-crystal Microemulsions and Elastomers
    BI-GR/04-06-015
    Prof. George Nounesis, Molecular Biophysics Group, Institute of Radioisotopes and Radiodiagnostic Products, NCSR "Demokritos", Agia Paraskevi, Athens, Greece
    Asst. Prof. Zdravko Kutnjak
15. Novel Solid-state Intermetallic Materials for Hydrogen Storage and Advanced Characterizations
    BI-GR/04-06-018
    Dr. Sofoklis S. Makridis, Institute of Nuclear Technology and Radiation Protection, NCSR "Demokritos", Agia Paraskevi, Athens, Greece
    Prof. Albert Prodan
16. Uporaba naprednih pulznih EPR tehnik v raziskavah novih fulerenskih materialov: strukturne lastnosti Li4C60
    BI-HR/06-07-005
    Prof. Boris Rakvin, Rudjer Boskovic Institute, Zagreb, Croatia
    Dr. Denis Arčon
17. Software za detekciju i obradu signala na Varianovem EPR spektrometru i kalibracija magnetskog polja
    Prof. Boris Rakvin, Rudjer Boskovic Institute, Zagreb, Croatia
    Dr. Pavel Cevc
18. Regulator magnetskog polja za Varianov magnet
    UZ-171-2006
    Prof. Boris Rakvin, Rudjer Boskovic Institute, Zagreb, Croatia
    Dr. Pavel Cevc
19. Uloga znanosti za održivi razvoj
    BI-HR/05-06-029
    Prof. Ivo Šlaus, Rudjer Boskovic Institute, Zagreb, Croatia
    Prof. Robert Blinc
20. Interaction of Liposomes with Aminoacids and Peptides for Targeted Delivery into the Organism as Studied by ESR
    BI-HR/05-06-032
    Dr. Vesna Noethig-Laslo, Rudjer Boskovic Institute, Zagreb, Croatia
    Dr. Marjeta Šentjurc
21. Ispitavanje novih kompleksnih metalnih spojeva i kvazikristala
    BI-HR/05-06-027
    Dr. Ana Smontara, Institut za fiziku, Zagreb, Croatia
    Prof. Janez Dolinšek
22. Phase Behaviour of Pressurized and Perturbed Complex Fluids
    BI-PL/05-07-002
    Prof. Rzoska Sylwester Janusz, Institute of Physics, Silesian University, Katowice, Poland
    Prof. Samo Kralj
23. NMR Study of Collective Orientational Fluctuations in the Smectic Phases
    BI-PT/06-07-003
    Prof. Pedro Sebastiao, Centro de Fisica da Matéria Condensada da Universidade de Lisboa, Lisbon, Portugal
    Prof. Marija Jamšek Vilfan
24. Field-cycling NMR Study of Complex Liquid Cryxtalline Systems
    BI-PT-04-06-002
    Prof. Pedro Sebastiao, Centro de Fisica da Materia Condensada da Universidade de Lisboa, Lisbon, Portugal
    Prof. Marija Jamšek Vilfan
25. Influence of Disorder on Critical Phase Behavior
    BI-RO/05-06/002
    Prof. Popa-Nita Vlad, Faculty of Physics, University of Bucharest, Bucharest, Romania
    Prof. Samo Kralj
26. Transtition Metals Dichalcogenide Nanotubes: Theoretical and Experimental Investigations of Mechanical and Electro-optical Properties
    BI-CS/06-07-007
    Prof. Milan Danmjanovič, Fizicki fakultet, Univerzitet u Beogradu, Beograd, Serbia and Montenegro
    Asst. Prof. Maja Remškar
27. EPR Investigation of Surface Active Antidepressant Drug - Membrane Interactions
    BI-TR/05-08-001
    Prof. Maral Sünnetçiodlu, Hacettepe University, Department of Physics Engineering, Beytepe-Ankara, Turkey
    Dr. Marjeta Šentjurc
28. Insight in the Physical Phenomena behind the Light-induced Anchoring
    BI-UA/05-06-006

Dr. Nazarenko Vassili, Institute of Physics National Academy of Science of Ukraine, Kyiv, Ukraine
Prof. Igor Muševič

29. Applications of MoS2 and WS2 Nanotubes
BI-US/06-07-016
Seabaugh Alan, University of Notre Dame, Electrical Engineering, Notre Dame, IN, USA
Asst. Prof. Maja Remškar
30. Magneto-resonance Study of New Porous Materials for Electrodes in Li-based Batteries
BI-US/06-07-037
Brunel Louis Claude, National High Magnetic Field Laboratory, Tallahasse, FL, USA
Dr. Andrej Zorko
31. Vloga EPR oksimetrije in vivo pri študiju vpliva topikalne aplikacije vazodilatorja na učinkovitost obsevanja v radioterapiji tumorjev
BI-US/04-05/021
MD, Prof. Harold Swartz, Dartmouth Medical School, Hanover, NH, USA
Dr. Marjeta Šentjurc
32. Improved Visibility of the OCB Mode Device
444268-P050801
Carol Toncar, Kent State University, Research & Graduate Studies, Kent, Ohio, USA
Dr. Janez Pirš

R & D GRANTS AND CONTRACTS

1. Study of magnetism in new complex materials
Asst. Prof. Denis Arčon
Specificity of interaction of some cytolytic proteins with membrane lipid domains
Dr. Marjeta Šentjurc
2. Extremophiles as a source of novel bioactive substances
Dr. Marjeta Šentjurc
3. Biophyiical processes studied with optical tweezers
Dr. Andrej Vilfan
4. Study of one- and two-dimensional antiferromagnets with a spin gap
Asst. Prof. Denis Arčon
Spectroscopic imaging of mechanical stress fields in mesomorphic elastomers with magnetic resonance
Dr. Boštjan Zalar
5. Colloidal particles in 2D free standing ferroelectric smectic films
Prof. Igor Muševič
6. Biosignal transduction and membrane domain structure
Dr. Janez Štrancar
7. Transport dielectric and thermodynamic properties of nanostructured and novel materials
Asst. Prof. Zdravko Kutnjak
8. Dielectric spectroscopy of electroactive polymer composites
Dr. Vid Bobnar
9. MRI research of wood as a material and as a live tissue
Dr. Mojca Urška Mikac
10. Layered ceramic nanostructures and 2D nanoparticles arrays
Dr. Albert Prodan
11. Analysis and optimization on thrombolysis by magnetic resonance microscopy
Asst. Prof. Igor Serša
12. Quasicrystals as new materials for hydrogen storage
Prof. Janez Dolinšek, Dr. Martin Klanjšek
13. UHV cryostat for a low-temperature scanning tunneling microscope
Dr. Albert Prodan
14. New nanomaterials as a support for ecotechnological optimization
Dr. Polona Umek, Prof. Robert Blinc
15. Termically stable antioxidants and food stability
Dr. Marjeta Šentjurc
16. Nuclear quadrupole resonance - a selective method for explosives detection
Dr. Tomaž Apih
17. Development of photoelectrochemical cells of Groetzel type
Prof. Igor Muševič
18. Analysis, computer modeling and optimization of the storage of explosives
Dr. Janez Pirš
19. Selfcleaning materials for antimicrobial protection of surface of vechicles and equipment
Dr. Janez Štrancar
20. Biodosimetry by magnetic resonance methods
Dr. Marjeta Šentjurc
21. Development of super-hard PA composites
Asst. Prof. Denis Arčon
22. Observation of aging of nitrocellulose engine fuel
Prof. Igor Muševič
23. Smart functional hard coatings for increased durability of defence-related equipment
Prof. Janez Dolinšek
24. Computer based electronic system for controlling the storage of explosives
Dr. Janez Pirš
25. Complex materials for new technologies: from soft matter to hard coatings
Prof. Slobodan Žumer
26. Hybrid materials and structures
Dr. Vid Bobnar
27. Synthesis of 1D inorganic nanostrucutres, bionanostructures and preparation of composites
Dr. Umek Polona, Dr. Maja Remškar
28. Nanostructured surfaces and interfaces
Prof. Igor Muševič

RESEARCH PROGRAMS

1. Experimental biophysics of complex systems
Prof. Milan Valter Schara
2. Physics soft matter, surfaces and nanostructures
Prof. Slobodan Žumer
3. NMR and dielectric spectroscopy condensed matter: smart new materials and translational symmetry breaking
Prof. Robert Blinc

NEW CONTRACT

1. NQR detector for nanodestructive detection of landmines and IED (improvised explosive devices
Iskra Feriti d. o. o.
Dr. Tomaž Apih

VISITORS FROM ABROAD

1. Dr. George Cordoyiannis, National Center for Scientific Research "Demokritos", Institute of Material Science, Aghia Paraskevi Attikis, Greece, 1 January – 31 August 2006, 25 September – 28 September 2006
2. Aleh Kavalenka, Belarusian State University Work, Systems Analysis Department, Minsk, Belarus, 1 January – 1 November 2006
3. Dr. Fani Milia, National Center for Scientific Research "Demokritos", Institute of Material Science, Aghia Paraskevi Attikis, Greece, 10 January – 25 January 2006, 9–11 November 2006
4. Dr. Valentina Domenici, Dipartimento di Chimica e Chimica Industriale, Universita di Pisa, Pisa, Italy, 9–11 January 2006, 6–20 May 2006
5. Sergiy Lazarenko, Radboud University of Nijmegen, IMM Institute, Nijemegen, The Netherlands, 15–31 January 2006
6. Dr. Vesna Noethig- Laslo, Institute Rudjer Boškovič, Zagreb, Croatia, 31 January – 3 February 2006; 10–12 May 2006; 1–2 June 2006
7. Prof. Dr. Horst Beige, Martin- Luther Universitaet, Halle, Germany, 20–25 February 2006
8. Dr. Alexandra Ioannidou, University of Western Macedonia, Kozani, Greece, 24 February – 5 March 2006; 5–12 June 2006, 22–27 September 2006
9. Dr. Reiner Zeizig, Max- Delbruck Center for Molecular Medicine, Berlin, Germany, 27 February – 1 March 2006
10. Dr. Theo Rasing, Faculty of Science, Radboud University of Nijmegen, Nijemegen, The Netherlands, 1–3 March 2006
11. Prof. Dr. Maral Sunnetcioglu, Hacettepe University, Department of Physics Engineering, Ankara, Turkey, 26 March – 2 April 2006
12. Prof. Dr. Ivo Šlaus, Institute Rudjer Boškovič, Zagreb, Croatia, 6 April 2006; 13 April 2006; 21–22 May 2006; 7–8 June 2006, 22–23 October 2006, 19–21 November 2006, 17–18 December 2006
13. Prof. Dr. Milan Damnjanovič, University of Belgrade, Belgrade, Serbia and Montenegro, 2–7 May 2006
14. Prof. Dr. Ivanka Milošević, University of Belgrade, Belgrade, Serbia and Montenegro, 2–7 May 2006
15. Prof. Dr. Vlad Popa – Nita, Faculty of Physics, University of Bucurest, Bucurest, Romania, 8–19 May 2006
16. Krunoslav Mirosavljević, Institute Rudjer Boškovič, Zagreb, Croatia, 10–12 May 2006
17. Dr. Bernhard Schimtz, DIN Certco (TUV), 23 May 2006
18. Dr. Uichiro Mizutani, Toyota Physical & Chemical Research Institute, Nagakute, Aichi, Japan, 24 May 2006
19. Dr. Hae Jin Kim, Frontier Research Laboratory, Energy Nanomaterial Team, Korea Basic Science Institute, South Korea, 26 May – 2 June 2006, 17–22 September 2006
20. Prof. Dr. Mikhail A. Anisimov, Department of Chemical and Biomolecular Engineering, A. James Clark School of Engineering and Chemical Physics Program, Institute for Physical Science and Technology, University of Maryland, College Park, U.S.A., 28 May – 1 June 2006
21. Prof. Dr. Henry Connor, Kentucky Wesleyan Colleague, Department of Chemistry, Owensboro, KY, U. S. A., 5–7 June 2006
22. Prof. Dr. Mark Warner, Cavendish Laboratory, University of Cambridge, Great Britain, 5–6 June 2006

23. Prof. Dr. Mitsuru Itoh, Materials and Structures Laboratory, Tokyo Institute of Technology, Nagatsuta, Midori, Yokohama, Japan, 10– 13 June 2006
24. Prof. Dr. Daniele Finotello, Kent State University, Kent, Ohio, U.S.A., 12–17 June 2006
25. Dr. Natasha Shah, Beckman Laser Institute, University of California, Irvine, U.S.A., 17–20 June 2006
26. Prof. Dr. Heino Finkelmann, Institute for Macromolecular Physics, University of Freiburg, Freiburg, Germany, 20 June 2006
27. Prof. Dr. Koval Sergio Fabian, University of Rosario, Rosario, Argentina, 21–22 June 2006
28. Dr. Nuray Horasan, Adnan Menderes Universitesi, Fen-Edebiyat Fakultesi, Aydyn, Turkey, 26 June –22 September 2006
29. Prof. Dr. Qiming Zhang, Materials Research Institute, The Pennsylvania State University, PA, U. S. A., 6–10 July 2006
30. Dr. Andriy Nych, Institute of Physics, National Academy of Sciencs (NAS) of Ukraine, Kyiv, Ukrajina, 3 September 2006 – 31 March 2007
31. Ulyana Ognysta, M. Sc., Institute of Physics, National Acedemy of Sciences (NAS) of Ukraine, Kyiv, Ukraine, 3 September – 1 October 2006
32. Dr. Tetsui Asaji, Department of Chemistry, College of Humanities and Sciences, Nihon University Sakurajosui, Setagaya-ku, Tokyo, Japan, 18 August – 18 Septemeber 2006
33. Prof. Dr. Yoshihiro Ishibashi, Faculty of Business, Aichi Shukutoku University, Nagakute-cho, Japan, 10–27 September 2006
34. Prof. Dr. Yishay Manassen, University of Ben Gurion, Beer Sheve, Israel, 12 October 2006
35. Prof. Dr. Tadeusz Walczak, EPR Center for Vable Systems, Dartmout College of Medicine, Hanover, NH, U.S.A., 20–23 September 2006
36. Prof. A. Bussmann-Holder, Max-Planck-Institut für Festkőrperforschung, Stuttgart, Germany, 23–26 September 2006
37. Prof. Dr. Victor Aksenov, Joint Institute for Nuclea rResearch, Dubna, Russia, 9–21 October 2006
38. Prof. Dr. Pedro Sebastiao, Technical University of Lisbon, Lisbon, Portugal, 9–21 October 2006
39. Daniel Ferreira, Technical University of Lisbon, Lisbon, Portugal, 9–21 October 2006
40. Horst Böhm, University of Mainz, Mainz, Germany, 13–23 October 2006
41. Daniel Corbett, Univerza of Cambridge, Cambridge, Great Britain, 20–21 November 2006.
42. Prof. Valentin Laguta, Institute for Problems of Material Science, Ukrainian Academy of Sciences, Kiev, Ukraine, 1–31 November 2006
43. Prof. Dr. Valentin S. Vikhnin, A. F. Ioffe Physical Technical Institut, St. Petersburg, Russia, 3–10 December 2006
44. Dr. Oksana Zaharko, ETHZ & PSI, Villigen, Switzerland, 4 December 2006
45. Ruža Frkanec, Imunološki zavod, Zagreb, Croatia, 19–20 December 2006
46. Lidija Habjanec, Imunološki zavod, Zagreb, Croatia, 19–20 December 2006
47. Marija Brglez, Imunološki zavod, Zagreb, Croatia, 19–20 December 2006

STAFF

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4. Asst. Prof. Vid Bobnar
5. Dr. Pavel Cevc
6. Prof. Janez Dolinšek
7. Dr. Valentina Domenici*
8. Dr. Cene Filipič
9. Prof. Nenad Funduk***
10. Prof. Marija Jamšek Vilfan
11. Prof. Anton Jeglič*
12. Dr. Klemen Kočevar***
13. Prof. Samo Kralj*
14. Asst. Prof. Zdravko Kutnjak**
15. Prof. Gojmir Lahajnar**
16. Prof. Adrijan Levstik
17. Dr. Mojca Urška Mikac
18. Prof. Igor Muševič*
19. Prof. Slavko Pečar*
20. Dr. Janez Pirš
21. Prof. Albert Prodan**
22. Asst. Prof. Maja Remškar**

*23. Prof. Milan Valter Schara**, retired 1. 8. 2006*

24. Prof. Janez Seliger*
25. Asst. Prof. Igor Serša**
26. Prof. Janez Stepišnik*
27. Dr. Marjeta Šentjurc
28. Dr. Miha Škarabot**
29. Asst. Prof. Janez Štrancar**
30. Dr. Polona Umek**
31. Dr. Herman Josef Petrus Van Midden***
32. Dr. Andrej Vilfan
33. Prof. Boštjan Zalar**
34. Prof. Aleksander Zidanšek**
35. Prof. Slobodan Žumer*

Postdoctoral associates

36. Dr. Zoran Arsov,
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38. Dr. Alan Gregorovič
39. Dr. Peter Jeglič**
40. Dr. Martin Klanjšek**
41. Dr. Tilen Koklič
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43. Dr. Maja Mrak
44. Dr. Andrej Zorko**

Postgraduates

45. Zrinka Abramović, M. Sc.
46. Iztok Dogša, B. Sc.
47. Matej Pregelj, B. Sc.
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52. Andrej Vrečko, B. Sc.
53. Stanislav Vrtnik, B. Sc.
54. Blaž Zupančič, B. Sc.
55. Rok Žitko, B. Sc.

Technical officers

56. Dr. Orest Jarh***
57. Ivan Kvasić, B. Sc.
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63. Marta Vidrih, B. Sc.
64. Erik Von Zupanič, B. Sc.

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65. Andreja Berglez, B. Sc.

66. Rebeka Blagus, left 1. 6. 2006

67. Dražen Ivanov
68. Mirko Kokole
69. Davorin Kotnik
70. Silvano Mendizza
71. Marjanca Nemec
72. Iztok Ograjenšek
73. Silvija Pirš
74. Ana Sepe
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DEPARTMENT FOR COMPLEX MATTER F-7

The research within the Department for Complex Matter encompasses a variety of research fields, ranging from the synthesis of new materials to fundamental investigations of elementary excitations in complex systems. These include anything from nano-biosystems and biomolecules to superconductors and nanowires. The experimental methods used are suitably diverse, from synthetic chemistry to biomedicine and femtosecond laser spectroscopy and magnetometry. Last year's research achievements are, as a result, quite wide ranging.

Head:
Prof. Dragan D. Mihailović

The activities in the department can be grouped together into a number of thematically inter-related research areas:

Ultrafast studies of electron dynamics in different systems

The field of relaxation processes of photo-excited electrons in strongly correlated electron systems remains one of the main topics of our research. Several experimental studies of carrier-relaxation phenomena in strongly correlated electron systems have been performed using femtosecond time-resolved techniques. The aim of the ongoing research is to gain additional information about the nature of the low-lying excitations in these materials, and to explore the nature and strength of the interactions of electrons with other low-lying excitations.

As an important contribution to understanding the nature of high-temperature superconductivity we should point out our study of relaxation processes in the cuprate superconductor $La_{2-x}Sr_xCuO_4$. We have focused our research on nonlinear effects in a high-perturbation regime utilizing high-energy pulses from a Ti:sapphire amplifier. In the high-excitation density limit the pulse energy is high enough to completely destroy the superconductivity, enabling us to determine the upper bound of the condensation energy. Moreover, it is particularly interesting that at excitation levels as high as 100 times the condensation energy the pseudogap remains unperturbed. This can be explained only in the case that phonons take part in a pairing mechanism. The paper is currently being reviewed by Nature Physics.

With high-intensity ultra-short laser-pulse excitation we have shown that we can controllably destroy the superconducting condensate in the cuprate superconductor $La_{2-x}Sr_xCuO_4$. The measurements also allow us to determine an upper limit to the condensation energy in the transition to the superconducting state. A particularly unusual observation is that at excitation levels as high as 100 times the condensation energy, the pseudogap remains unperturbed. This can be explained only if we assume that phonons absorb most of the energy released during the pairing of quasiparticles.

We have performed temperature- and excitation-intensity-dependence measurements of carrier-relaxation processes in the heavy fermion system $YbAgCu_4$ and the Kondo insulator SmB_6. In addition, we have studied carrier-relaxation dynamics in several other heavy fermion compounds ($YbCdCu_4$, $Yb_2Rh_3Gd_9$, and $CeCoIn_5$). The results show close agreement with the prediction of the Rothwarf-Taylor model, implying that the carrier-relaxation dynamics in this large class of compounds is governed by the presence of a weakly temperature-dependent hybridization gap. This work has been published in Physical Review Letters and as an invited review in J.Phys.:Condens. Matter.

We have studied nonequilibrium carrier and structural dynamics related to the structural phase transition at 274 K in a quasi-one-dimensional semiconductor $(NbSe_4)_3I$. The photo-induced reflectivity transient is the sum of the picosecond electronic response and several damped oscillatory components, whose frequencies correspond to the optical phonon modes. A comparison with the Raman data points to the superiority of time-resolved optical spectroscopy, since low-frequency modes have been observed, which are inaccessible to conventional Raman. Moreover, several modes present only in the low-temperature phase show a pronounced softening near the structural phase transition. However, an analysis of the data using the Landau-Khalatnikov equation, and equations of motion for coupled phonons, suggest that the order parameter is electronic in origin. This work has been published in Physical Review B 74, 085211 (2006).

Utilizing femtosecond optical spectroscopy we have performed temperature-dependent measurements of photo-excited carrier dynamics in $GdVO_3$, the system that undergoes an orbital ordering phase transition at 199K. Below T_N =118 K the system is antiferromagnetic, with several reports suggesting the presence of a phase separation. Measurements of photo-induced reflectivity in the temperature range between 5 and 300 K have been performed,

where dramatic changes in the dynamics are observed in the vicinity of the Neel temperature. In order to determine the nature of the anomalous temperature dependence of the carrier-relaxation dynamics near T_N we are going to perform comparative studies on YVO_3, where no phase separation has been observed below T_N.

During 2006 we have upgraded our experimental setup to allow us to make time-resolved magneto-optical Kerr rotation (TRMOKE) measurements. The first system that was investigated was (Pr,Ca)MnO_3 thin films, where we investigated TRMOKE as a function of Ca doping, temperature and magnetic field. The experiments were performed in collaboration with the EU Comephs project on samples from Caen.

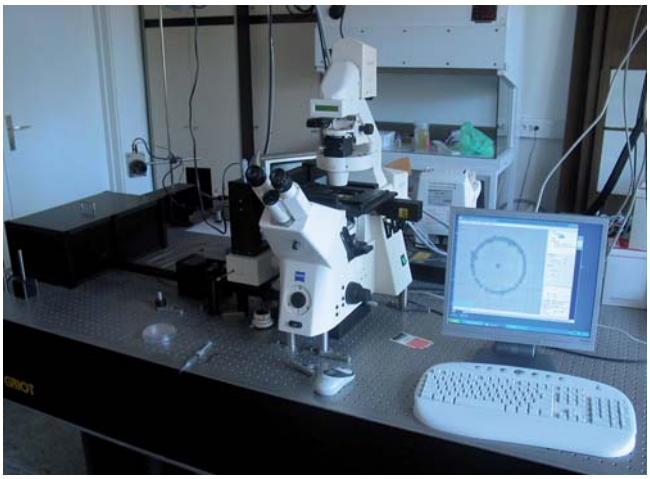

Figure 1: Laser tweezers setup. Micron-sized colloidal beads trapped in a circular laser trap are visible on a computer screen.

Theoretical studies on the nanoscale

We continued with investigations of the lattice-gas model with competing anisotropic Jahn-Teller and isotropic Coulomb interactions by means of Monte-Carlo simulations. The emphasis was on the single-particle density of states.

A major effort was also directed to the application of the previously developed theoretical concepts to the analysis of the resistivity and magnetisation in the region where phase separation is well established. The best candidates for the analysis appear to be ferromagnetic oxides. On the basis of our theory of the conductivity of a composite system and the model of phase separation we proposed an explanation of the phase coexistence and described the magnetization and resistivity of manganites near the ferromagnetic phase transition in the framework of the current carrier density collapse. The quantitative description of the resistivity is obtained without any fitting parameters, by using the experimental resistivities far away from the transition and experimental magnetization, making it essentially model-independent. The results were published in Phys. Rev. Letters.

Nanotubes and nanomaterials

A lot of effort was devoted to the study of the physical properties of $Mo_6S_{9-x}I_x$ nanowires and their potential applications. Extensive experiments were performed on their dispersion characteristics, which is the basis of all potential applications in nanotechnology. It was found that nanowires can be controllably dispersed, where the diameter is determined solely by the concentration of the nanowires. Thus one can prepare nanowire bundles of a desired diameter simply by adjusting the concentration. The results were published in Chem.Phys. Letters. Electron transport experiments were performed on single nanowires and on networks (published in Applied Physics Letters). With the aim of improving the transport properties of the material by high-temperature annealing, experiments were performed which showed that the conductivity can be improved by many orders of magnitude. We have also shown that nanowire networks can be used as gas sensors. The measurement of single-nanowire properties required the extensive development of nanolithography techniques, which enabled us to measure the resistance of a 7-nm-diameter nanowire at various points along its length using a conductance atomic-force microscope (CAFM). The results showed classical ohmic behaviour, which suggests that in spite of the strong one-dimensional character of the MoSI nanowires, the transport cannot be described in terms of Luttinger liquid behaviour, but appears to be dominated by the scattering of electrons on imperfections within the nanowire. On the other hand, the temperature dependence of the nanowire's resistivity was found to exhibit a peculiar power-law behaviour with a systematic dependence of the power exponent on the nanowire's diameter. These results are strongly suggestive of Luttinger liquid behaviour, but cannot be reconciled with the CAFM experiments. The results of the single-nanowire measurements were published in Nanotechnology.

Conductivity measurements on single $Mo_6S_{9-x}I_x$ nanowires have shown that in spite of their very strong one-dimensional character, they do not exhibit Luttinger liquid behaviour on length scales of tens of nanometres. Instead, they appear to exhibit classical ohmic behaviour.

The modelling of the nanowire's structure and mechanical properties has led to some interesting predictions of non-linear mechanical and electronic properties, which may lead to potential nanoscale applications. In particular, calculations have shown that the conductivity is predicted to be strongly dependent on the elongation of the nanowires, which leads to possible applications as nanoscale strain gauges and transducers. This work was published in Physical Review B.

A large part of the activity in the area of nanowire research was devoted to possible applications with advanced composites for tribological applications, in sensing and in field-emission devices. The work is partially in the commercial domain, closely linked to the synthesis of nanowire materials at the start-up company Mo6 d.o.o.

We have shown the fast and efficient preparation of peapods of SWNT filled with an exohedrally functionalized fullerene derivative at low temperatures using refluxing hexane solutions. The mobility and reactivity of the functionalized fullerenes with pyrrolidine (C_{60}-C_3NH_7) incorporated in single-wall carbon nanotubes were examined by high-resolution transmission electron microscopy. An individual functional group attached to each fullerene cage is unambiguously visualized. This provides direct evidence for the functionalized structure on a single-molecular basis. A rotational motion of the incorporated molecules tends to occur during the observation and, consequently, each fullerene molecule is likely to stand facing its functionalized group towards the nanotube wall. A fine-structure analysis of electron-energy-loss spectra for the nitrogen K(1s) edge shows a considerable change in the nitrogen's chemical state and suggests a strong tube-fullerene interaction. This research was published in Physical Review Letters.

Electron dynamics in biological macromolecules

In 2006 we started with the synthesis of M-DNA, a new form of DNA where divalent metal cations are incorporated into the DNA structure by replacing one of the hydrogens from the hydrogen bonds in the interior of the double helix. The aim of our work was to investigate how the intercalation of metal ions into the DNA double helix alters the DNA's electronic structure and how this is reflected in its optical absorption spectrum. In our experiment we have used Zn^{2+} cations that readily form a complex with DNA in alkaline buffers (pH 9). The level of DNA saturation with Zn^{2+} was controlled by an ethidium bromide (EB) fluorescence assay, i.e., when intercalated into DNA, EB fluoresces about 25 times more strongly than when free in solution. The insertion of Zn^{2+} into the DNA structure precludes the EB intercalation, thus making the EB fluorescence a direct measure of the percentage of (un)occupied intercalation sites. By measuring the optical absorption spectra of the Zn-DNA in a solution and in a dry form and comparing them with the corresponding spectra of pristine DNA we have found that the HOMO-LUMO gap decreases by ~0.1 eV. This HOMO-LUMO gap decrease is presumably caused by structural changes in the M-DNA double helix induced by an intercalated metal cation. Those structural changes promote the π - π overlap between molecular orbitals of neighbouring nucleobases and consequently increase the energy bandwidths. We suggest that the energy band broadening is smaller than predicted because of sequence randomness in the native CT DNA, were only certain fragments of uniform base-pair sequences exhibit an effective increase of the $\pi - \pi$ stacking.

In the **Light and Matter** research group we continued our interdisciplinary studies of the interaction of light and matter and its use in research and applications in different fields.

Soft Matter

We continued the research on liquid-crystal colloids. Magneto-optical tweezers were used to study the interactions between super-paramagnetic beads, which are long ranged due to the elastic deformations in the liquid crystal. We measured the spatial dependence of the force between two micrometer-sized particles and determined the effective drag coefficient. The results were published in Phys. Rev. Letters.

We expanded our research to the colloids in an isotropic medium (in this case water), where we managed to create the locomotion of two particles (known as "swimmers") in a thin cell with a changing magnetic field. Super-paramagnetic beads were also used for creating longer chains. Preliminary experiments show that a nanolithographically treated surface covered with such chains can be used as a model for studying the hydrodynamics of beating cilia.

In cooperation with the Nonlinear Physics Group from the Faculty of Physics, University of Vienna, we continued our investigations of the diffraction properties of holographic polymer-dispersed liquid crystals (H-PDLCs). The light-scattering properties of the gratings with a strong overmodulation of the diffraction efficiency were studied. We also analyzed the effect of light scattering on the two-beam-coupling effect in this material. Measurements of the diffractive properties of cold neutrons (SANS, research center GKSS, Gesthacht, Germany) showed that HPDLCs exhibit a photoneutron effect much larger than any holographic material analyzed so far. The results were published in Phys. Rev. Letters.

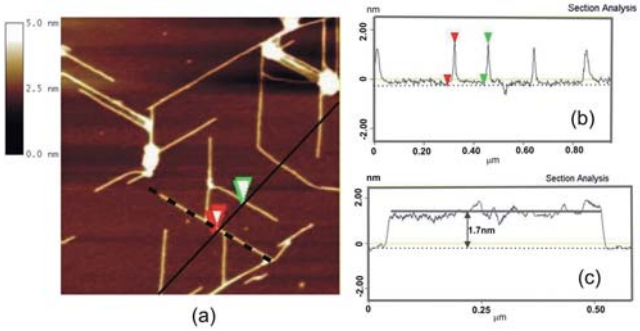

Figure 2: AFM image of G4-nanowires of guanosine 5'-monophosphate assembled on a mica surface. The size of the region shown in (a) is 0.001 mm x 0.001 mm. Figures (b) and (c) show a cross-section perpendicular to the wire direction and along the wire direction, respectively.

In cooperation with Brown University (Providence, USA) we investigated the structural and dynamic properties of photonic crystals and quasicrystals made from polymer-liquid-crystal composites. Dynamic light-scattering measurements revealed that the dispersion relation of the thermal orientational fluctuations of the nematic LC phase embedded in the periodic or quasiperiodic polymer matrices exhibit a band structure analogous to the phonon and electronic bands in crystals.

The investigation of the diffraction properties of photonic materials fabricated by the holographic patterning of mixtures of polymers and liquid crystals showed that these composite media have a large anisotropy of the optical refractive index and offer the possibility to tune their diffractive properties with external fields. We have shown that they also possess an extremely high contrast in their refractive index for neutrons, as a result of which they are very promising for the fabrication of neutron-optical devices, such as neutron interferometers.

Surface optical second-harmonic generation (S-SHG) was used to study the switching characteristics of the thin films of ferroelectric liquid-crystal polymers (FLCP). These films (also called electrically commanded surfaces) represent a promising novel switching concept in LCD technology; however, their fundamental properties are still far from being fully resolved. We analyzed the effect of an external electric field on the magnitude of the SHG signal and the dynamic response to switching of the field. The research took place in cooperation with the Gothenburg University from Sweden.

We continued our research work on the self-assembling properties of guanosine derivatives, especially guanosine 5'monophosphate (GMP), deposited onto mica and silicon substrates. The analysis of surface adsorbates was performed by atomic force microscopy (AFM). It was found that under appropriate deposition conditions, GMP on mica forms G4-nanowires, which can be several micrometers long and exhibit a profound directional growth along the crystallographic axes of the substrate.

In cooperation with the Institute of Physics, National Academy of Sciences of the Ukraine we investigated the dynamical properties of suspensions of ferroelectric nanoparticles in nematic liquid crystals. Some liquid-crystal suspensions of ferroelectric nanoparticles show a surprisingly large increase in the nematic-isotropic transition temperature, which can exceed 10 K. We have studied by dynamic light scattering the viscoelastic properties of suspensions of $Sn_2P_2S_6$ and $BaTiO_3$ particles in a nematic mixture. The bend diffusivity $D=K/\eta$ of the suspensions is higher than in a pure liquid crystal, while the twist diffusivity is slightly smaller. A new mode was observed, which we attributed to the "optic mode", where the spontaneous polarization and nematic director fluctuate in counter phase.

Nonlinear optics

In the Nonlinear Optics Laboratory we study new materials and their interaction with laser light. We are especially interested in new materials that promise new applications in the following highly competitive fields: optical data storage, and optical processing and telecommunications, especially in the form of integrated optics. We are also interested in compact laser sources in the eye-safe wavelength region of 1550 nm. In 2006 we cooperated with Fotona, a company from Ljubljana, and with the National Institute for Materials Science in Tsukuba, Japan, studying the optical properties of domain-engineered $LiTaO_3$ crystals with Mg doping and various degrees of stoichiometry. These crystals are especially suited for optical parametric conversion from the Nd:YAG wavelength to the eye-safe region.

Biomedical optics

We have investigated the potential of pulsed photo-thermal radiometry (PPTR) for the non-contact characterization of vascular lesions and the tomography of structures in human skin. We have developed an original numerical algorithm for the reconstruction of axial temperature profiles from measured radiometric transients to solve the involved inverse problem. Using the algorithm, which includes automated adaptive regularization, we have performed a numerical study of the procedure, to determine the influence of experimental parameters (e.g., IR detector technology, acquisition spectral band, and effective absorption coefficient value) on the accuracy of the results.

In collaboration with the Beckman Laser Institute, University of California at Irvine, we have tested the system performance in systematic experimental tests involving optical coherence tomography and the histology of dedicated vitro tissue models.

In collaboration with Clinical Center Ljubljana (Department for Plastic Surgery and Burns) and Fotona, d.d., we have continued with clinical trials of laser therapy for some dermatologic lesions - primarily port-wine-stain birthmarks and keloid scars – also involving a prototype dual-wavelength laser system fitted with a dynamic cryogen cooling device. To support the study, which could help improve the understanding and efficacy of dermatologic laser therapy, we have developed a PC program for the acquisition, archiving, analysis and visualization of objective measurements of skin colour with a tri-stimulus colorimeter.

Biological systems

We continued our research on biological samples and expanded them to biomimetic systems. Using magneto-optical tweezers we performed preliminary micro-rheological experiments on cytoskeletal proteins and determined the parameters of the cross-linked networks. Biomimetic directed motion was successfully generated in thin samples

of isotropic liquids. Combining nanolithographic methods and magnetic tweezers we created a surface with attached super-paramagnetic bead chains, which is a very good model for studying hydrodynamics in the vicinity of cell flagella.

Some outstanding publications in 2006

1. B. Berčič, U. Pirnat, P. Kušar, D. Dvoršek, D. Mihailovic, D. Vengust, B. Podobnik, Transport properties of $Mo_6S_3I_6$ nanowire networks, Appl. phys. lett., vol. 88 (2006), 173103-1-173103-3
2. Z. Liu, M. Koshino, K. Suenaga, A. Mrzel, H. Katura, S. Iijima, Transmission electron microscopy imaging of indicidual functional groups of fullerene derivatives, Phys. rev. lett., vol. 96 (2006), 88304-1-88304-4
3. A.S. Alexandrov, A.M. Bratkovsky,V. Kabanov, Phase coexistence and resistivity near the ferromagnetic transition of manganites, Phys. rev. lett., vol. 96 (2006), 117003-1-117003-4
4. J. Kotar, M. Vilfan, N. Osterman, D. Babič, M. Čopič, I. Poberaj, Interparticle potential and drag coefficient in nematic colloids, Phys. rev. lett., vol. 96 (2006), 207801-1-207801-4
5. M. Fally, I. Drevenšek Olenik, M. A. Ellabban, P. K. Pranzas, J. Vollbrandt, Colossal light-induced refractive-index modulation for neutrons in holographicpolymer-dispersed liquid crystals, Phys. rev. lett., 97 (2006), 167803-1–167803-4
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2. Janez Pirš, Silvija Pirš, Bojan Marin, Robert Blinc, Martin Čopič, Rok Petkovšek: Process for the manufacturing of the polymer compensation layer for LCD optical light shutter and the construction thereof: EP-patent no. 1192499. 2006; Munich: European Patent Attorneys.

Awards and appointments

1. Asst. Prof. Jure Demšar: Sofja Kovalevskaja reward, Alexander von Humboldt Foundation, rewarded November, 1, 2006, Berlin, Germany

Organization of conferences, congresses and meetings

1. ESF Exploratory Workshop Self-assembly of guanosine derivates from quadruplex DNA to biomolecular devices, Bled, Slovenia, 13–15 November 2006
2. SLONANO 2006: Organic, inorganic and bio-molecular nanostructures: From fundamental science to applications, Ljubljana, Slovenia, 20–21 September 2006

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3. Aleš Omerzu, Madoka Tokumoto
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1. Martin Čopič, Mojca Vilfan
Liquid crystal-surface interactions studied by light scattering
In: Proceedings of the 5th International Meeting on Information Display and the 5th International Display Manufacturing Conference: August 22-25, 2006, Daegu Exhibition and Convention Center, Korea(Digest of technical papers), Seoul, Korean Information Sisplay Society, 2006, pp. 1711-1714.
2. Dragan Mihailović
MoSIx nanowires: a user-friendly new nano-materials for nanosensors and NEMS
In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 19-20.

Regular Paper

1. Damjan Dvoršek, Dragan Mihailović
Femtosecond-timescale structure dynamics in complex materials: the case of $(NbSe_4)_3I$
In: Topology in ordered phases: proceedings of the 1st International Symposium on TOP, 2005: Sapporo, Japan, 7-10 March 2005: with CD-ROM, New Jersey [etc.], World Scientific, cop. 2006, pp. 95-102.

THESES

Ph. D. Thesis

1. Matija Avsec: Dynamic properties of nematic liquid crystal dispersions (Martin Čopič)

B. Sc. Theses

1. Brina Črnko: Effect of added ions on self-assembly of guanosine derivatives (Irena Drevenšek Olenik, co-mentor Lea Spindler)
2. Miha Devetak: Measurements of resistivity changes of a Mo6S3I6 nanowire circuit due to different concentrations of Methanol (Dragan Mihailović)
3. Martin Gorjan: Measurements of life-time of photoexcited states in DNA (Dragan Mihailović, co-mentor Aleš Omerzu)
4. Koncilija Jure: Optical second-harmonic generation in thin films of a ferroelectric liquid crystal polymer (Irena Drevenšek Olenik)
5. Mathieu Lu-dac: Rasistive behaviors in superconductors: The phase slip phenomena (Viktor Kabanov)
6. Miha Pelko: Measurements of the optical absorption anisotropy in oriented DNA (Dragan Mihailović, co-mentor Aleš Omerzu)
7. Mojca Rangus: Study of magnetical properties of nanoparticles of superconductors Mo6S6I2 (Dragan Mihailović, co-mentor Aleš Mrzel)
8. Tomaž Stritih: Coherent effects in multiple scattering of light (Irena Drevenšek Olenik, co-mentor Alenka Mertelj)
9. Jure Strle: Measurements of longitudinal conductivity of Mo6S3I6 nanowires by using atomic force microscope (Dragan Mihailović)

PATENT APPLICATION

1. Alessandro Lukan
Naprava za merjenje pretoka hitrosti kapljevin ali plinov z več okni : patentna prijava 200600125
Ljubljana, Urad RS za intelektualno lastnino, 2006

INTERNATIONAL PROJECTS

1. Electronic Response of Molybdenum-based Nanowires
   EREMON
   6. FP
   MEIF-CT-2006-040958
   EC
   Prof. Dragan Mihailović
2. Controlling Mesoscopic Phase Separation
   COMEPHS
   6. FP
   NMP4-CT-2005-517039
   EC; Prof. E. Liarokapis, National Technical University of Athens, Zografou, Athens, Greece
   Prof. Dragan Mihailović
3. Design, Synthesis and Growth of Nanotubes for Industrial Technology
   DESYGN-IT
   6. FP
   NMP4-CT-2004-505626
   Grace Dempsey, The Provost Fellows and Scholars of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin, Dublin, Ireland
   Prof. Dragan Mihailović
4. Template Grown Molecular Nanomaterials
   NANOTEMP
   5. FP
   HPRN-CT-2002-00192
   EC; Dr. Karl S. Coleman, University of Oxford, Inorganic Chemistry Laboratory, Oxford, Great Britain
   Prof. Dragan Mihailović
5. Ultrafast Processes in Low-Dimensional Nanomaterials
   NATO Reintegration Grant
   PDD (CD)-(EAP.RIG 981425)
   Dr. F. Pedrazzini, NATO, Public Diplomacy Division, Collaborative Programmes Section, Brussels, Belgium
   Asst. Prof. Jure Demšar
6. Processes in Biophysical Matter Studied with Optical Tweezers
   NATO Reintegration Grant
   PDD (CD)-(EAP.RIG 981424)
   Dr. F. Pedrazzini, NATO, Public Diplomacy Division, Collaborative Programmes Section, Brussels, Belgium
   Dr. Mojca Vilfan
7. Dinamika lokaliziranih stanja u niskodimenzionalnim sistemima - od pikosekunde do sata
   BI-HR/05-06-019
   Dr. Damir Starešinić, Institut za fiziku, Zagreb, Croatia
   Asst. Prof. Jure Demšar
8. Surface Structure of Guanosine Derivatives on Solid Substrates
   BI-IT/05-08-008
   Prof. Paolo Mariani, Facoltà di Scienze, Università Politecnica delle Marche, Ancona, Italy
   Prof. Irena Drevenšek Olenik
9. Inhomogeneous State and Conductivity of Complex Compounds
   BI-RU/05-07-001
   Dr. Rinat Mamin, E.K. Zavoisky Physical-Technical Institute, Kazan Scientific Center of Russian Academy of Science, Russia
   Asst. Prof. Viktor Kabanov
10. Photoexcited Electron Dynamics in Heavy Electron Systems
    BI-US/05-06-023
    Dr. Antoinette J. Taylor, Center for Integrated Nanotechnology MST-CINT Mail Stop K756, Los Alamos National Laboratory, Los Alamos, NM, USA
    Asst. Prof. Jure Demšar
11. Development of Photothermal Technique for Characterization of Dermatologic Vascular Lesions
    BI-US/05-06-022
    J. Stuart Nelson, M. D. Ph. D., Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA
    Asst. Prof. Boris Majaron

R & D GRANTS AND CONTRACTS

1. Biophysical processes studied with optical tweezers
   Prof. Martin Čopič
2. Polymeric nanocomposites
   Prof. Majda Žigon
3. Development of novel laser therapies for dermatologic vascular lesion
   Dr. Boris Majaron
4. Synthesis of 1D Anorganic Nanostructures, Bionanostructures and Preparation of Composites
   Dr. Aleš Mrzel
5. Nanoelectronics and Nanotechnology
   Prof. Dragan D. Mihailović

RESEARCH PROGRAMS

1. Dynamics of Complex Systems
   Prof. Dragan D. Mihailović
2. Light and Matter
   Prof. Martin Čopič

NEW CONTRACT

1. Cooperation agreement
   Chamber of Craft of Slovenia
   Prof. Dragan D. Mihailović

VISITORS FROM ABROAD

1. Prof. Martin Fally, Nonlinear physics group, Faculty of Physics, Vienna University, Vienna, Austria, 5–19 February 2006.
2. Dr. Mostafa Ellaban, Nonlinear physics group, Faculty of Physics, Vienna University, Vienna, Austria, 20–28 February 2006.
3. Dr. Alexander Kotlyar, Department of Biochemistry, The George S. Wise Faculty of Life Science, Tel Aviv University, Tel Aviv, Israel, 1–5 April 2006.
4. Prof. Karlheinz Schwarz, Institut für Materialchemie, Technische Universität Wien, Vienna, Austria, 4–6 April 2006.
5. Dr. Francesco Federiconi, Facolta di Scienza, Universita delle Marche, Ancona, Italy, 3 May – 3 June 2006.
6. Prof. Hans Kuzmany, University of Vienna, Institut für Naterialphysik, Vienna, Austria, 8–10 May 2006.
7. Dr. Yuri Reznikov, Institute of Physics, Kiev, Ukraine, 14–17 May 2006.
8. Prof. Sasha Alexandrov, Department of Physics, Loughborough University, Loughborough, Great Britain, 14–18 May 2006.
9. Prof. Steven Conradson, Los Alamos National Laboratory, Materials Science and Technology Division, Los Alamos, New Mexico, USA, 18–28 May 2006.
10. Dr. Liu Lerwen, Zyvex Corporation, USA, 5 June 2006.
11. Dr. Rinat Mamin, Laboratory of Novel Materials, Kazan Physical-Technical Inst. RAS, Kazan, Russian federation, 21 June – 21 July 2006.
12. Dr. Damir Starešinić, Institute of physics Zagreb, Croatia, 17–28 July 2006.
13. Dr. Alexander Kotlyar, Department of Biochemistry, Tel Aviv University, Israel, 11–12 September 2006.
14. Dr. Danny Porath, Hebrew University of Jerusalem, Israel, 11–12 September. 2006.
15. Dr. Paolo Mariani, Università politecnica delle Marche, Ancona, Italy, 10–12 September 2006.
16. Dr. Damir Dominko, Institute of physics Zagreb, Croatia, 12–15 September 2006.
17. Dr. Christopher Gadermaier, National Laboratory of Ultrafast Science, Dipartimento di Fisica, Politecnico di Milano, Milan, Italy, 1–31 October 2006.
18. Dr. Hans Sawade, Fraunhofer Institut für angewandte Polymerforschung, Potsdam, 25–29 October 2006.

STAFF

Researchers

1. Prof. Martin Čopič*
2. Asst. Prof. Jure Demšar**
3. Prof. Irena Drevenšek Olenik*
4. Dr. Christoph Gadermaier
5. Asst. Prof. Viktor Kabanov**
6. Dr. Matjaž Lukač***
7. Asst. Prof. Boris Majaron
8. Asst. Prof. Alenka Mertelj**
9. Asst. Prof. Tomaž Mertelj*
10. **Prof. Dragan Dragoljub Mihailović**, Head**
11. Dr. Aleš Mrzel
12. Dr. Aleš Omerzu
13. Asst. Prof. Lea Spindler*
14. Dr. Mojca Vilfan**
15. Prof. Marko Zgonik*

Postdoctoral associates

16. Dr. Damjan Dvoršek
17. Dr. Marko Marinček***
18. Dr. Boštjan Podobnik***
19. Dr. Roman Yusupov

Postgraduates

20. Matija Avsec, B. Sc., left 01. 08. 2006
21. Miha Devetak, B. Sc.
22. Klemen Kunstelj, B. Sc.
23. Primož Kušar, B. Sc.
24. Matija Milanič, B. Sc.
25. Jure Strle, B. Sc.
26. Andrej Tomeljak, B. Sc.
27. Marko Uplaznik, B. Sc.

Technical officers

28. Boštjan Berčič, B. Sc.
29. Martina Knavs, B. Sc.
30. Alessandro Lukan, B. Sc.
31. Tamara Matevc, B. Sc.
32. Nika Simčič, B. Sc., left 06. 10. 2006
33. Damjan Vengust, B. Sc.

Technical and administrative staff

34. Smiljana Golja, left 15. 09. 2006
35. Marko Koren

Ph. D. Students from Abroad

36. Mihaela Ploscaru, B. Sc., Romania
37. Joaquin Gabriel Miranda Mena, M. Sc., Mexico
38. Mathieu Lu-dac, B. Sc., France

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF REACTOR PHYSICS F-8

During the past year we have been working mainly on:

- ***theoretical, experimental and applied reactor physics,***
- ***plasma physics,***
- ***ion fragmentation,***
- ***neutron dosimetry,***
- ***neutron radiography,***
- ***semiconductor physics,***
- ***new methods for planning radiation treatment.***

Head:
Prof. Bogdan Glumac

Our research in **reactor physics** was focused mainly on new methods for power and research reactor calculations, where special attention was given to the calibration and benchmarking of nuclear data, and to computational methods. We have linked theoretical and practical reactor physics by participating in a project for evaluating older critical safety experiments, which is hosted by the Idaho National Laboratory. With the use of advanced Monte Carlo techniques we evaluated the criticality and uncertainties of an exotic experimental reactor in which fuel in the form of a plutonium-uranyl nitrate solution was used. We have focused attention on Monte Carlo neutron, photon and electron transport, and nuclear data processing for transport calculations, and on advanced nodal methods aimed at detailed power-distribution reconstruction. The results of this basic research have been published in a number of papers, both in scientific journals and conference proceedings. We continued with the implementation and verification of our new, two-dimensional program package for the TRIGA research reactor burn-up calculations. We have completed the work on an expert opinion connected with the introduction of the 'BEACON' core-monitoring system. We have entered the field of new neutron sources in collaboration with the Institute for Transuranium Elements, where we study neutron production in ultra-fast pulsed-laser interactions with matter. This year we initiated, in collaboration with the Department for Nanostructured Materials, the development and irradiation of SiC-fibre-based low-activation composite materials for the first wall of a future fusion reactor. The activation of candidate materials was experimentally determined by irradiation in a reactor neutron beam followed by gamma spectroscopy. For better interpretation of the results a calculation of the differences between the activation characteristics in a fission and in a fusion neutron beam was performed.

In the area of **plasma physics** we continued our studies of the plasma potential formation in front of a negative electrode that emits electrons. Using a fluid model we analyzed the current-carrying electrode bias to an arbitrary negative potential and immersed in a two electron temperature plasma. We studied the dependence of the electrode bias where the transition between temperature-limited and space-charge-limited emission occurs on the density and temperature of the hot electron population. We also started investigations of the potential formation in plasmas with negative ions and in plasmas with several groups of positive ions. For a floating electrode we investigated the dependence of the critical emission coefficient on the density and temperature of the hot electron population. In collaboration with the Ion Physics Institute at the University of Innsbruck, Austria, and with the Faculty of Physics, University of Iasi, Romania, we continued our investigations of fire-ball dynamics. In the framework of the Slovenian Fusion Association, we have participated in the Upgrade of the Gamma-Ray Cameras for JET – the Joint European Torus, the world's largest fusion reactor. Our task was to calculate the neutron attenuation in the planned shields for the γ cameras and the neutron field around the cameras. On the basis of these calculations, decisions about the future development of the diagnostic-system upgrade will be taken.

In the **nuclear track field** we have evaluated detectors that were exposed in Antarctica by co-workers of the F8 department on their missions in 2004 and 2005. The coincidence fast neutron dosimeters, developed in the F8 department for the measurements of low neutron fluences in remote regions have been exposed to cosmic rays for different time intervals. The work was performed in the frame of the ozone-hole enlargement analyses in collaboration with the Taras Shevchenko University, Kiev, Ukraine. In the field of **ion fragmentation** the work was continued with the determination of fragmentation cross-sections of the radioactive carbon isotopes with the help of the FRANG program, developed in the F8 department.

Neutron radiography and **neutron activation analisys** were used for the study of objects of cultural heritage. Non-destructive examinations and elemental analyses of excavated archaeological objects were performed in collaboration with the National Museum of Slovenia. Neutron radiography was also used for the study of the transport mechanism of liquids in building materials, the emphasis being given to the study of moisture rise in concrete. This research was carried out in collaboration with the University of Maribor.

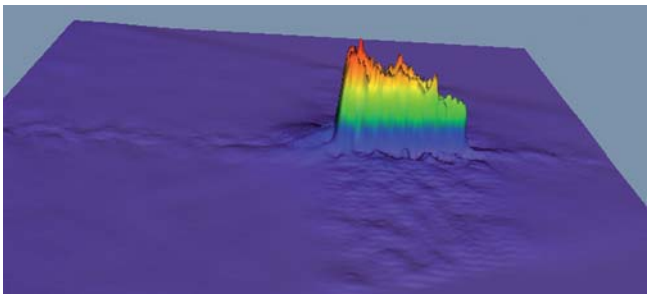

Figure 1: Calculated neutron flux behind the vacuum door and below the γ cameras on a fusion reactor

In the investigation of the electrical characteristics of **organic semiconductor devices** the differential capacitance of such bilayer organic structures was derived, its validity was verified on the basis of the number in the published literature data, establishing thus the foundation for the capacitance spectroscopy of organic semiconductor devices. Using an in-house constructed facility based on the ionized cluster beam deposition method, for thin-film growth, the unipolar, bilayer Al/PTCDA(800 nm)/CuPc(1200 nm)/ITO organic semiconductor structures, characterized by hole electric current only, were fabricated, their electrical characteristics studied and for the first time the possibility of their use as possible capacitive sensors for ionization radiation was investigated. In particular, the response of the above-mentioned organic structure to the a beam of the ^{241}Am radioactive source warrants that the investigation be continued.

In the field of **medicine (oncology – new methods for planning radiation treatment)** we studied the effect of statistical uncertainty on inverse treatment planning based on the Monte Carlo method dose calculation.

Members of the department are also involved in the management of the **Research Unit of the Slovenian Fusion Association.** The work programme of the association in 2006 included nine projects from four departments of the Jožef Stefan Institute with collaborators from the University in Nova Gorica and from the Faculty for Electrical Engineering of the University of Ljubljana. The Research Unit also includes the Faculty of Mechanical Engineering of the University of Ljubljana, with three projects.

Some outstanding publications in 2006

1. Cvikl, B., Koželj, M., Korošak, D., Jecl, R., Energy band shape of monolayer meta/organic/metal structures as determined by the capacitance-voltage method, J. Appl. Phys. 99 /2006), 023704-1–023704-11.
2. Rant, J., Milić, Z., Istenič, J., Knific, T., Lengar, I., Rant, A., Neutron radiography examination of objects belonging to the cultural heritage, Appl. Radiat. Isotopes, vol 64, 7–12, 2006.
3. Snoj, L., Ravnik, M., Effect of packing fraction variations on the multiplication factor in pebble-bed nuclear reactor, Kerntechnik (1987), vol. 71, 208–213, 2006.
4. Ballegeer, E. A., Forrest, L. J., Jeraj, R., Mackie, T. R., Nickles, R. J., PET/CT following intensity-modulated radiation therapy for primary lung tumor in a dog, Vet. Radiol. Ultrasound, 47(2), 228–233, 2006.
5. Bosswell, S., Tome, W., Jeraj, R., Jadarat, H., Mackie, T.R., Automatic registration of megavoltage to kilovoltage CT images in helical tomography: an evaluation of the setup verification process for the special case of a rigid head phantom, Med. Phys. 33(11), 4395–4404, 2006.

Organization of conferences, congresses and meetings

1. Organization of the "International Conference Nuclear Energy for New Europe 2006", Portorož, 18–20 September 2006
2. Organization and realization of the "5th General Meeting of EU Task Force on Plasma-Wall Interaction", Slovenian Fusion Association, Ljubljana, at the "Milan Čopič Nuclear Training Centre", 13–15 November 2006

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1. Bruno Cvikl, Matjaž Koželj, Dean Korošak, Renata Jecl
   Energy band shape of monolayer metal/organic/metal structures as determined by the capacitance-voltage method
   In: J. appl. phys., Vol. 99, 11 p., 2006.
2. Jože Rant, Zoran Milić, Janka Istenič, Timotej Knific, Igor Lengar, Andrej Rant
   Neutron radiography examination of objects belonging to the cultural heritage
   In: Appl. radiat. isotopes, Vol. 64, pp. 7-12, 2006.
3. Luka Snoj, Matjaž Ravnik
   Effect of packing fraction variations on the multiplication factor in pebble-bed nuclear reactors
   In: Kerntechnik (1987), Vol. 71, pp. 208-213, 2006.

REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Igor Lengar, Milan Tomazin, Matjaž Ravnik, Luka Snoj
   Water-reflected plutonium-uranyl nitrate solution containing boron and gadolinium
   In: International handbook of evaluated criticality safety Benchmark experiments. Vol. 6(NEA/NSC/DOC, (95)03), Idaho Falls, 2006.
2. Joseph Magill, J. Galy, Tomaž Žagar
   Laser transmutation of nuclear materials
   In: Lasers and nuclei: applications of ultrahigh intensity lasers in nuclear science(Lecture notes in physics, 694), Heinrich Schwoerer, ed., Joseph Magill, ed., Burgard Beleites, ed., Berlin, Heidelberg, New York, Springer, cop. 2006, pp. 131-146, 2006.
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   Pulsed neutron sources with tabletop laser-accelerated protons
   In: Lasers and nuclei: applications of ultrahigh intensity lasers in nuclear science(Lecture notes in physics, 694), Heinrich Schwoerer, ed., Joseph Magill, ed., Burgard Beleites, ed., Berlin, Heidelberg, New York, Springer, cop. 2006, pp. 109-127.

PUBLISHED CONFERENCE PAPERS

Regular Papers

1. G. Aliberti, G, Palmiotti, M. Salvatores, T.K. Kim, T.A. Taiwo, M. Anitescu, Ivan Aleksander Kodeli, E. Sartori, J.C. Bosq, J. Tommasi
   Nuclear data sensitivity, uncertainty and target accuracy assessment for future nuclear systems
   In: Ann. nucl. energy, Vol. 33, pp. 700-733, 2006.
2. A. Bidaud, Ivan Aleksander Kodeli, G. Chiba
   Impact of the treatment procedure of recently available nuclear data covariance matrices on nuclear reactor uncertainty analysis
   In: Proceedings, PHYSOR-2006, ANS Topical Meeting on Reactor Physics, 10-14, September 2006, Vancouver, Vancouver, Canadian Nuclear Society, 2006.
3. Bruno Cvikl, Matjaž Koželj, Dean Korošak, Renata Jecl
   Interface charge and trap density dependence on C - U line shape of monolayer Al/PTCDA/ITO structure
   In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 71-76.
4. Milan Čerček, Tomaž Gyergyek
   Properties of multiple layers in negative ion plasma with a bi-maxwellian electron population
   In: Contributed papers(Europhysics conference abstracts, vol. 301), 33rd European Physical Society Conference on Plasma Physics, Roma, June 19-23, 2006, [Mulhouse Cedex], European Physical Society, cop. 2006, 4 p.
5. Milan Čerček, Tomaž Gyergyek, M. Contulov, M. Kršak
   Potential formation in the plasma with two positive ion species
   In: Proceedings, 13th International Congress on Plasma Physics, Kiev, May 22-26, 2006, Kiev, National Academy of Sciences of Ukraine, 2006, pp. 1-4.
6. Tomaž Gyergyek, Milan Čerček
   Multiple floating potentials of an electron emitting electrode immersed in a two-electron temperature plasma with critical electron emission
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7. Tomaž Gyergyek, Milan Čerček, Borut Jurčič-Zlobec
   Potential formation in a bounded two-electron temperature plasma system - numerical solutions and PIC simulation
   In: Contributed papers(Europhysics conference abstracts, vol. 301), 33rd European Physical Society Conference on Plasma Physics, Roma, June 19-23, 2006, [Mulhouse Cedex], European Physical Society, cop. 2006, 4 p.
8. Tomaž Gyergyek, Milan Čerček, Borut Jurčič-Zlobec
   Potential formation in a plasma diode containing two=electron temperature plasma: comparison of analytical and numerical solutions and PIC simulations
   In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006, 8 p.
9. Tomaž Gyergyek, Milan Čerček, Borut Jurčič-Zlobec
   Current-voltage characteristics of an electron emitting electrode that limits a bounded plasma system containing hot electrons
   In: , pp. B733-B739.
10. Tomaž Gyergyek, Milan Čerček, Borut Jurčič-Zlobec
    Primerjava analitičnih in numeričnih rešitev enodimenzionalnega kinetičnega modela plazemske diode
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11. Ivan Aleksander Kodeli
    Deterministic 3D transport, sensitivity and uncertainty analysis of TPR and reaction rate measurements in HCPB breeder blanket mock-up Benchmark
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
12. Ivan Aleksander Kodeli, E. Sartori, B.L. Kirk
    Status and future plans for the international radiations shielding and dosimetry experiments (SINBAD) database
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13. Matjaž Koželj, Bruno Cvikl, Dean Korošak
    Properties of organic Schottky junctions under the influence of ionizing radiation
    In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 77-82.
14. Matjaž Koželj, Bruno Cvikl, Dean Korošak
    Application of organic semiconductors for the detection of ionizing radiations
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
15. Marjan Kromar, Bojan Kurinčič
    Impact of replaced fuel rods on the nuclear parameters of the NPP Krško fuel
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16. Marjan Kromar, Bojan Kurinčič
    Impact of possible control rod misalignment on the NPP Krško core instrumentation
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
17. Saša Novak, Milan Čerček
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    In: SLOTRIB '06: zbornik predavanj Posvetovanja o pogonskih in alternativnih gorivih, tribologiji in ekologiji, Posvetovanje o pogonskih in alternativnih gorivih, tribologiji in ekologiji, Ljubljana, Slovenija, 14. november 2006 = Conference on Fuels, Tribology and Ecology, Ljubljana, Slovenia, 2006, Jože Vižintin, ed., Janez Bedenk, ed., Mitjan Kalin, ed., Ljubljana, Slovensko društvo za tribologijo, 2006, pp. 19-30.
18. R.A. Price, Gianfranco Gualdrini, S. Agosteo, S. Menard, J.L. Chartier, B. Grosswendt, Ivan Aleksander Kodeli, G.P. Leuthold, B.R.L. Siebert, H. Tagziria, R.J. Tanner, M. Terrissol, M. Zankl
    Pitfalls and modelling incosistencies in computational radiation dosimetry: lessons learnt from the QUADOS intercomparison. Part II: Photons, electrons and protons
    In: Radiat. prot. dosim., Vol. 118, pp. 155-166, 2006.
19. M. Samec, Dean Korošak, Bruno Cvikl
    Complex network model of porous matter conductivity
    In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 83-88.
20. Luka Snoj, Matjaž Ravnik
    Calculation of power density with MCNP in TRIGA reactor
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
21. Luka Snoj, Matjaž Ravnik
    Power peakings in mixed Triga cores
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
22. Andrej Trkov, R. Capote-Noy
    Validation of 232Th evaluated nuclear data trough Benchmark experiments
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
23. Tomaž Žagar, Slavko Slavič, Bojan Žefran, Luka Snoj, Matjaž Ravnik
    TRIGLAV-W a Windows computer program package with graphical users interface for TRIGA reactor core management calculations
    In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006, 2006.

TEXTBOOKS AND LECTURE NOTES

1. Tomaž Gyergyek, Veronika Kralj-Iglič, Aleš Iglič, Miha Fošnarič
   Vaje iz fizike I
   4. popravljena in dopolnjena izd., Ljubljana, Fakulteta za elektrotehniko, cop. 2006.

B. SC. THESIS

1. Andrej Rakuša: Fragmentation reaction crossections of radioactive carbon beams in graphite target (Bogdan Glumac)

INTERNATIONAL PROJECTS

1. Upgrade of Gamma-Ray Cameras: Neutron Attenuators
   EFDA Task Agreeement Code: JW6-TA-EP2-GRC-01, Contract No.: JW6-OEP-MHST-01
   EURATOM – MHST
   6. FP, Fusion Association, EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Dr. Igor Lengar
2. Upgrade of Gamma-Ray Cameras: Neutron Attenuators
   EFDA Task Agreeement Code: JW6-TA-EP2-GRC-01, Contract No.: JW6-NEP-MHST-01
   EURATOM – MHST
   6. FP, Fusion Association, EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Dr. Igor Lengar
3. RU Administration and Services
   EURATOM – MHST
   6. FP, Slovenian Fusion Association – EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Prof. Milan Čerček
4. Nuclear Data: Benchmark Experiments to Validate EFF/EAF Data TW5-TTMN-002
   EURATOM – MHST
   6. FP, Slovenian Fusion Association – EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Dr. Igor Lengar
5. Collaboration in DEMO Working Group
   EURATOM – MHST
   6. FP, Slovenian Fusion Association – EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Prof. Matjaž Ravnik
6. Interaction of Vibrationally Excited Hydrogen with Fusion Relevant Materials
   EURATOM – MHST
   6. FP, Slovenian Fusion Association – EURATOM
   FU06-CT-2004-00083, 3211-05-000017
   EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
   Prof. Milan Čerček, Dr. Iztok Čadež
7. Transport Processes of Light and Heavy Ions in Matter and their Application in Medicine, Intercontinental and Space Flights and Nuclear Waste
   BI-RU/05-07-011
   Alexander Golovchenko, Joint Institute for Nuclear Research, Dubna, Moscow Region, Russia
   Dr. Marko Giacomelli
8. The Use of Nuclear Methods in Geophysical Investigations in Different Regions of Earth
   BI-UA/05-06-005
   Dr. Volodymyr Pyvlovych, Institute for Nuclear Research, Kyiv, Ukraine
   Prof. Radomir Ilić

R & D GRANTS AND CONTRACTS

1. High energy ion interactions in tissue-like materials and metals
   Dr. Igor Lengar
2. Interfacial amorphization and Fermi level pinning
   Prof. Igor Jenčič, Prof. Bruno Cvikl
3. Investigation of fusion relevant phenomena in plasma-wall interaction
   Prof. Milan Čerček
4. Radiation field characterization for diagnostic and therapeutic use of radioactive isotopes
   Asst. Prof. Robert Jeraj
5. Fusion relevant research of plasma interaction with surfaces
   Prof. Milan Čerček
6. Long-lived activation in fission and fusion reactor shields
   Prof. Bogdan Glumac, Dr. Tomaž Žagar
7. On the use of benchmark experiments for improved utilisation of nuclear facilities
   Asst. Prof. Andrej Trkov
8. Prevention and reduction of the consequences of the terrorist attack on TRIGA research reactor
   Prof. Matjaž Ravnik
9. Biodosimetry by magnetic resonance methods
   Asst. Prof. Robert Jeraj
10. Climate changes and national security in Slovenia
    Prof. Matjaž Ravnik
11. Thorium / Uranium Data Evaluation Assessment
    Asst. Prof. Andrej Trkov

RESEARCH PROGRAM

1. Reactor Physics
   Prof. Bogdan Glumac

NEW CONTRACT

1. NEK Core Design Report
   Krško Nuclear Power Plant
   Dr. Marjan Kromar

VISITORS FROM ABROAD

1. Mirela Contulov, Virginia Dinca and Mihaela Hasan, University in Constanca, Constanca, Romania, 20 March –30 April 2006
2. Martin Kršňak, University Comenius, Bratislava, Republic of Slovakia, 6 February – 31 May 2006
3. Georges Mortier, Serge Evrard, European Commission, Brussels, Belgium, 17–18 May 2006
4. Dr. Barry Green, Yvan Capuet, Francesca Siniscalchi, European Commission, Brussels, Belgium, 7 July 2006
5. Dr. Thomas Schwarz – Selinger, Max Planck Institut, Garching, Germany, 4–9 September 2006
6. Dr. Luigi Tomassino, Laboratorio di Misure, ENEA – DISP, Rome, Italy, 18–20 September 2006
7. Dr. Maurizio Gasparotto, EFDA Associate Leader for Technology, Garching, Germany, 18–20 September 2006
8. Dr. Ulrich Fischer, Forschungszentrum Karlsruhe, Karlsruhe, Germany, 18–20 September 2006
9. Prof. Vladimir M. Pavlovych, Institute for Nuclear Research, Odessa, Ukraine, 26 October 2006
10. Prof. Vitaly Rusov, Odessa National Polytechnical University, Odessa, Ukraine, 26 October 2006
11. Dr. Sebastian Brezinsek, Forschungszentrum Jülich, Jülich, Germany, 16–17 November 2006
12. Prof. Roman Schrittwieser in dr. Codrina Ionita-Schrittwieser, Institute for Ion Phyisics, University of Innsbruck, Innsbruck, Austria, 3–16 December 2006
13. Dr. Daniel Lopez Aldama, Centro de Gestion de la Informacion y Desarollo de la Energia, Havana, Cuba, 16–30 December 2006

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1. Prof. Bruno Cvikl*
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3. **Prof. Bogdan Glumac**, Head**
4. Asst. Prof. Tomaž Gyergyek*
5. *Prof. Radomir Ilić*, died 3. 1. 2006*
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18. Dr. Marjan Kromar
19. Alberto Milocco, M. Sc.
20. Slavko Slavič, B. Sc.
21. *Milan Tomazin, B.Sc., left 1. 3. 2006*
22. Uršula Turšič

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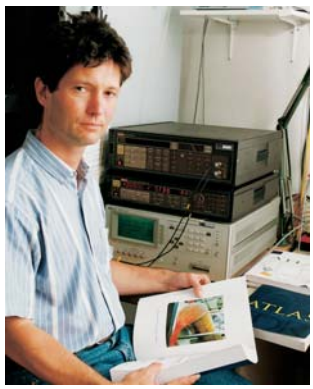
23. Dušan Rudman
24. Darinka Stich
25. Bojan Žefran

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF EXPERIMENTAL PARTICLE PHYSICS F-9

The research in the Department of Experimental Particle Physics is devoted to experimental studies of elementary particles, revealing the ultimate building blocks of matter and the nature of the interactions between them. Experiments are carried out within large collaborative programmes at international centres for particle physics at CERN, near Geneva, at DESY, in Hamburg, and at KEK, in Tsukuba. The department is also engaged in developing and applying the technologically advanced particle detectors that are demanded by such measurements. Astro-particle physics is an emerging field that applies the experimental techniques of particle physics to solve astrophysical problems. Slovenian researchers are participating in the construction of the Pierre Auger observatory and in the first measurements of ultra-high-energy cosmic rays with the apparatus spread over 3000 km² near Malargue in Argentina.



Head:
Prof. Marko Mikuž

In order to reveal the ultimate secrets of nature in the world of elementary particles, accelerators with higher and higher energies are needed. Their cost, both in terms of money and human resources, has grown to the level where they are affordable only as joint international enterprises. Thus, future accelerators will be unique facilities of their kind, the first being the Large Hadron Collider (LHC), under construction at the European Organization for Nuclear Research (CERN), near Geneva. Researchers will exploit this facility to perform experiments in what are presently inaccessible regions of energy, which, though being pushed higher and higher, still remain minute compared to that of the vast blast of the Big Bang that led to the creation of the Universe.

Together with colleagues from the Physics Department of the Faculty of Mathematics and Physics and the Faculty of Electrical Engineering of the University of Ljubljana, and from the Faculty of Chemistry and Chemical Technology of the University of Maribor, we are performing measurements at CERN, the German centre, DESY, in Hamburg, and the Japanese centre, KEK, in Tsukuba. We are taking part in three experiments, each conducted as an international collaboration:

- ATLAS at the Large Hadron Collider (LHC) at CERN (1900 researchers, 150 institutions),
- Belle at the asymmetric electron-positron collider (KEK-B) at KEK (400 researchers, 56 institutions),
- HERA-B at the HERA electron-proton collider at DESY (310 researchers, 33 institutions).

In the field of astro-particle physics we are part of the Pierre Auger collaboration (200 researchers, 55 institutions), which is constructing a giant scale (3000 km²) observatory near Malargue in Argentina for the detection of ultra-high-energy cosmic rays. This endeavour is carried out in collaboration with colleagues from the University of Nova Gorica.

A detailed report on the activities of 2006 follows, focused on the contributions of our researchers:

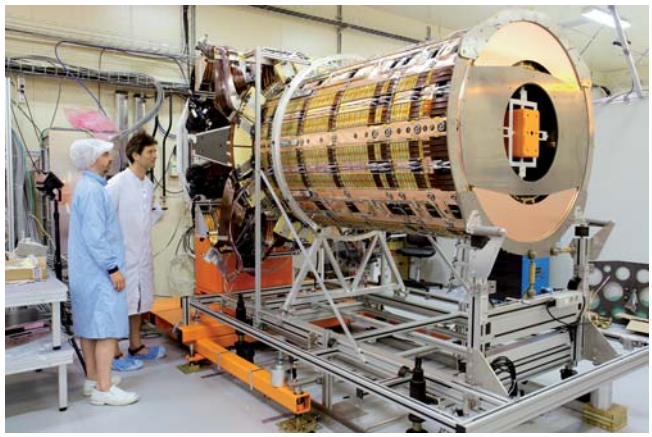


Figure 1: One of the two fully assembled ATLAS SemiConductor Tracker (SCT) end-caps ready for insertion into the Transition Radiation Tracker. On the cylinder's surface, flexible large-scale power tapes can be seen, which fan out from the detector in the rear. The tapes were produced in Slovenia as part of our contribution to the ATLAS construction.

ATLAS

- The intensive installation of huge detector parts is taking place in an experimental cavern 100 metres underground, with the aim to have the complete detector operational for the first LHC collisions in autumn 2007.
- Integration of the over 4000 silicon tracker (SCT) modules into the barrel and two end-caps (Fig. 1) was completed, followed by their insertion into the respective transition radiation tracker parts to form the ATLAS Inner Detector (ID). The ID barrel was lowered into the ATLAS cavern, installed in the centre of the ATLAS detector and connected to power, cooling and read-out services.
- Detector modules with diamond sensors for the beam-conditions monitoring system were finalized and installed on the pixel-beam pipe-support system.
- Large-scale flexible heater pads with dimensions up to 1.9 x 0.4 m² on copper-Kapton laminates were produced for the SCT thermal enclosure.
- The generation of phase-space in proton collisions at 14 TeV was studied.

- The background to the Higgs boson searches in the Standard model and MSSM was simulated in detail.
- The simulation of top-quark production in proton-proton collisions was studied and a simulation programme written.
- The contribution of quantum chromodynamics phenomena to the precise determination of the top quark's mass was studied.

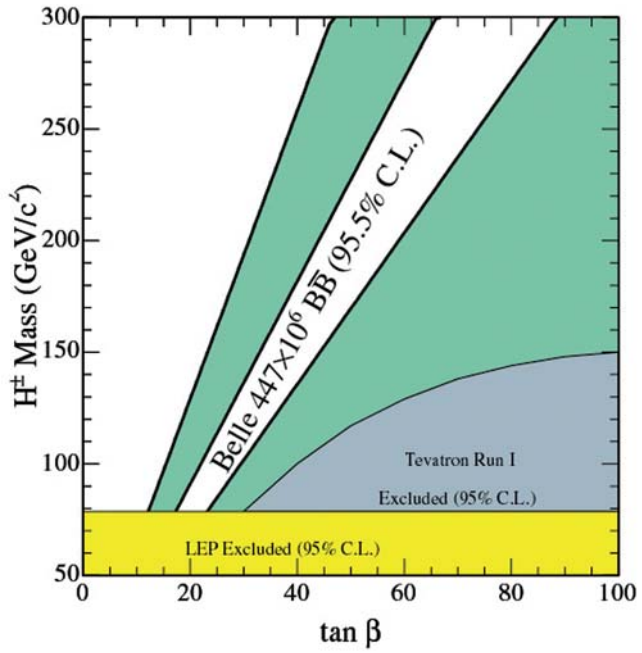


Figure 2: Allowed interval (in white) for the mass of a hypothetical charged Higgs particle as a function of tanβ, the parameter of the supersymmetric version of the Standard Model, after the measurement of the $B^- \to \tau \nu_\tau$ branching fraction with the Belle detector

- The grid infrastructure on the SiGNET computer cluster was constantly upgraded and large amounts of simulated data were produced in the scope of the "ATLAS Computing System Commissioning" on Nordugrid and gLite middleware platforms.

BELLE

- First observation of the leptonic decay $B \to \tau \nu$, and measurement of the corresponding branching fraction (Fig. 2).
- Evaluation of the first measurements of the process $e^+e^- \to \Upsilon(5S)$, which allows us to study the properties of B_s mesons.
- Determination of the production probability of B_s mesons in $\Upsilon(5S)$ decays, determination of the masses of the B_s and B_s^* mesons, and the first setting of the upper limits for several rare decays of B_s.
- Evaluation of the measurement of CP symmetry-violation in $B \to D^+D^-$.
- Publication of an improved upper limit for the parameters of mixing in the D^0 system.
- Preparation of a measurement of the D^0 mixing in $D^0 \to K^+K^-$ and $D^0 \to K_S\pi^+\pi$ decays.
- Observation of new baryons, Ξ_c, composed of u(d), s and c quarks.
- Determination of the form factors for the $D^0 \to K(\pi)\, l\, \nu$ decays, and a precise measurement of their probability.
- First direct proof for the spin-dependent quark fragmentation in e^+e^- annihilations (Collins effect).
- Measurement of the CP symmetry-violation in B decays to the final state $\eta' K_S$.
- Continuation of the development of a novel type of Čerenkov ring imaging counter with aerogel as a radiator; tests in a test beam at KEK.

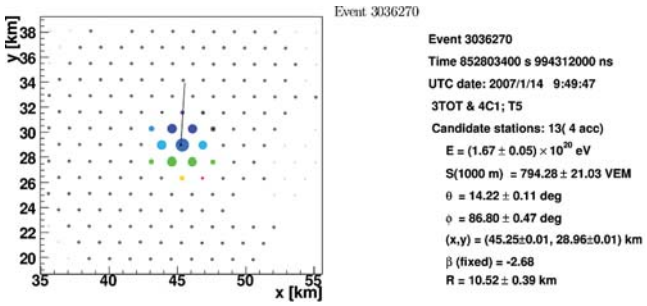


Figure 3: Detection of a cosmic particle with a reconstructed energy of 1.6 x 10^{20} eV by the surface-detector array of the Pierre Auger Observatory. Signals in the individual detectors of the array are denoted by circle diameters (left). Reconstructed cosmic-ray parameters (right) are pointing to an ultra-high-energy particle impinging nearly perpendicularly on the Earth's atmosphere.

HERA-B

- Finalization of the measurements of cross-sections for the production of hyperons as well as scalar and vector D mesons.

PIERRE AUGER

- The fourth fluorescence detector at Loma Amarilla was equipped with light-collection telescopes.
- Lidar stations for monitoring atmospheric conditions were re-calibrated and software for the online light-attenuation monitoring were improved.
- Continuous installation of ground detectors, now covering 75% of the planned surface, was taking place.
- More than 15 cosmic rays with energies in excess of 10^{19} eV were detected. At least one of them had an energy exceeding 10^{20} eV (Fig. 3).
- The arrival direction-anisotropy of cosmic rays was studied.
- An analysis of the space-time structure of the atmospheric shower front was performed.

Detector development

- In collaboration with CERN, the University of Valencia, the University of Michigan, Ann Arbor and Ohio State University, work on the Compton camera was continued.
- The collimator geometry for a brachytherapy source locator was optimized.
- A multiwire proportional chamber was built as the coincidence detector for an aerogel Cherenkov detector for ^{90}Sr beta rays and parameters of the detector of ^{90}Sr in environmental samples optimized by Monte Carlo simulations.

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TEXTBOOKS AND LECTURE NOTES

1. Aleš Stanovnik
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Fizika I, Zapiski predavanj
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PH. D. THESIS

1. Boštjan Maček: Measurement of Br ($D^+_s \to \Phi l^+\nu_l$) Branching Fraction with Belle Detector (Supervisor: Boštjan Golob)

INTERNATIONAL PROJECTS

1. Enabling Grids for E-sciencE-II
EGEE-II
EGEE-NA1, EGEE-NA2, EGEE-NA3, EGEE-NA4
6. FP; 031688
EC; Dr. Bob Jones, CERN IT-EGE, Geneve, Switzerland
Prof. Marko Mikuž
2. Safe Production and Use of Nanomaterials
NANOSAFE2
6. FP; NMP2-CT-2005-515843

EC; Commissariat a l'Energie Atomique, Grenoble, France
Andrej Detela, B. Sc., Asst. Prof. Maja Remškar, Marko Žumer, B. Sc., Prof. Boris Turk
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Dr. Jan Timmermans, CERN, Geneve, Switzerland
Asst. Prof. Borut Paul Kerševan
4. Collaboration HERA-B
Dr. Mike Medinnis, Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany
Prof. Peter Križan
5. Collaboration ATLAS
Prof. Peter Jenni, CERN, Geneve, Switzerland
Prof. Marko Mikuž
6. Collaboration CERN RD-39
Dr. Jaako Haarkonen, HIP, Finland
Dr. Zheng Li, BNL, USA
Prof. Marko Mikuž
7. Collaboration CERN RD-42
Prof. Peter Weilhammer, CERN, Geneve, Switzerland
Prof. Marko Mikuž
8. Collaboration CERN RD-50
Prof. Mara Bruzzi, University of Florence, Florence, Italy
Dr. Michael Moll, CERN, Geneve, Switzerland
Prof. Marko Mikuž
9. Collaboration Belle
Prof. Masanori Yamauchi, KEK, Tsukuba, Japan
Prof. Peter Križan
10. Collaboration CIMA
Cameras for Imaging in Medical Applications
Prof. Peter Weilhammer, CERN, Geneve, Switzerland
Prof. Marko Mikuž
11. Study of Top Events produced at the LHC for the Commissioning of the ATLAS Detector
BI-IT/05-08-003
Dr. Marina Cobal, Universitŕ di Udine, Udine, Italy
Asst. Prof. Borut Paul Kerševan
12. New Methods for Measurements of D Meson Mixing
SLO-JPN
Prof. Fumihiko Takasaki, KEK, Institute of Particle and Nuclear Studies, Tsukuba-shi, Ibaraki-ken, Japan
Asst. Prof. Marko Starič
13. Development of Readout System for the Belle Proximity Focusing Ring Imaging Cherenkov Detector
SLO-JPN
Prof. Fumihiko Takasaki, KEK, Institute of Particle and Nuclear Studies, Tsukuba-shi, Ibaraki-ken, Japan
Dr. Rok Pestotnik

R & D GRANTS AND CONTRACTS

1. Measurements of Rare Decays of B and D Mesons
Asst. Prof. Samo Korpar
2. Search for Exotic Hadronic Bound States
Asst. Prof. Tomi Živko
3. Data Analysis Tools and Environment for Physics Research with the ATLAS Detector
Asst. Prof. Borut Paul Kerševan
4. Semiconductor Detectors for Medical and High Radiation Fields Applications
Dr. Dejan Žontar
5. Novel Direct Electric Drives
Andrej Detela, B. Sc.
6. SiGNET - Development and Implementation of Grid Technologies with the European Project EGEE Including the Transfer into the Slovenian Environment
Prof. Marko Mikuž
7. NIDAR - Optical Laser System for 3D Scanning
Asst. Prof. Marko Zavrtanik
8. Fast Detection of the Radioactive Strontium-90
Asst. Prof. Samo Korpar

RESEARCH PROGRAMS

1. Astroparticle Physics
Asst. Prof.Marko Zavrtanik
2. Experimental Particle Physics
Prof. Marko Mikuž

VISITORS FROM ABROAD

1. Segev Benzi, Columbia University, Cosmic Ray Group, New York, USA, 14–19 May 2006
2. Prof. Dr. Harris Kagan, Ohio State University, Columbus, USA, 6–9 April 2006
3. Dr. Oleksiy Lytochenko, Dr. Vladir Khomenkov, Istituto Nazionale di Fisica Nucleare, Padova, Italy, 14–16 March 2006
4. Dr. Norman Manna, Universitŕ degli Studi di Bari, Bari, Italy, 14–16 March 2006
5. Dr. Ulrich Parzefal, Albert-Ludwigs-Universität Freiburg, Germany, 2– 4 September 2006
6. Dr. Heinz Pernegger, CERN, Geneva, Switzerland, 6–9 April 2006
7. Prof. Dr. Bogdan Povh, Max-Planck-Institut für Kernphysik, Heidelberg, Germany, 10–11 April 2006
8. Prof. Dr. William Trischuk, University of Toronto, Toronto, Canada, 6–9 April 2006

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3. Prof. Boštjan Golob*
4. Asst. Prof. Borut Paul Kerševan*
5. Asst. Prof. Samo Korpar*
6. Dr. Gregor Kramberger**
7. Prof. Peter Križan*
8. Asst. Prof. Igor Mandić**
9. **Prof. Marko Mikuž*, Head**
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12. Prof. Marko Starič**
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22. Dr. Andrej Studen**
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32. Jan Jona Javoršek***, B. Sc.

Technical and administrative staff
33. Jure Eržen
34. Majda Kelbelj
35. Dejan Lesjak
36. Erik Margan

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF INORGANIC CHEMISTRY AND TECHNOLOGY K-1

The Department of Inorganic Chemistry and Technology is one of the leading groups in the world in the field of synthesizing new inorganic compounds containing fluorine. The main research fields are as follows: reactions in superacids, the chemistry of noble gases, the chemistry of the elements of the main groups, and the synthesis of new inorganic materials with special properties. A great deal of the activity of the group has been devoted to technological and ecological problems in Slovenia. The group has been cooperating closely with Slovenian industry for more than 30 years. The group is also active in the field of educating teachers of chemistry and promoting natural sciences among students at colleges and elementary schools.

Head:
Dr. Tomaž Skapin

In the field of new inorganic compounds containing fluorine, new coordination compounds of the type $[M^{x+}(L)_n](AF_6)_x$ (M is a metal, e.g., Mg, Ca, Sr, Ba, Cd or a lanthanide element; A is P, As, Sb, Bi, Ta, Ru; L is a ligand, e.g., XeF_2, AsF_3, HF; and x is the oxidation number of the central atom) have been synthesized. The results for $Cd/SbF_5/XeF_2$ deserve special attention. We prepared six compounds with different molar ratios between Cd and XeF_2: $[Cd(XeF_2)_8](SbF_6)_2$, $[Cd_2(XeF_2)_{10}](SbF_6)_4$, $[Cd_2(XeF_2)_6](SbF_6)_4$, $[Cd_2(XeF_2)_5](SbF_6)_4$, $[Cd_3(XeF_2)_4](SbF_6)_6$, and $[Cd_4(XeF_2)_3](SbF_6)_8$. Single-crystal structures of $[Cu(XeF_2)_6](SbF_6)_2$ and $[Zn(XeF_2)_6](SbF_6)_2$ were determined. Compounds with RuF_6^- as the anions are also worthy of note: $[Ba(XeF_2)_5](RuF_6)_2$ and $XeF_2{\cdot}Xe_2F_3RuF_6$.

The investigations of the fluorides/Lewis acids systems (AsF_5, SbF_5, BF_3, etc.) were continued. The compounds ASb_2F_{11} (A = K, Rb, Cs, Tl), $CsSb_3F_{16}$, IF_6AsF_6, $Cd(AuF_6)_2$, $KAuF_6$, and $Mg(HF)AuF_4AuF_6$ were synthesized and their structures determined. $Mg(HF)AuF_4AuF_6$ is the first example of a mixed-valence Au^{III}/Au^{V} ternary fluoride. We also prepared and characterized a series of metal(II) heptafluortantalates(V) ($MTaF_7$; M = Ca, Sr, Ba, Pb). Two structures of our new compounds – $Mg(HF)AuF_4AuF_6$ and $Ba(H_3F_4)_2$ – were selected for the covers of the journal Solid State Sciences: (Vol. 8, No. 6 and Vol. 8, No. 8).

Prof. dr. B. Žemva is one of the few European researchers who has received a prominent American Chemical Society Award For Creative Work in Fluorine Chemistry.

Together with researchers from Colorado State University, USA, and Moscow State University, Russia, we have continued to study the selective fluorination of fullerenes. PrF_4 was used for the fluorination of fullerenes for the first time; it exhibits remarkably strong oxidizing fluorinating properties, yielding hyperfluorinated species, $C_{60}F_n$ ($60 < n < 100$).

The volatile fluorofullerene products of high-temperature reactions of C_{60} with the ternary manganese fluorides were monitored as a function of reaction temperature, reaction time, and stoichiometric ratio by in-situ Knudsen-cell mass spectrometry. An optimized set of conditions was found that yielded the greatest amount of $C_{60}F_8$. Two isomers of $C_{60}F_8$ were purified, one of which has not been previously reported.

With the Aichi Institute of Technology, Nagoya, Japan, we studied the surface structure and the electrochemical characteristics of natural graphite fluorinated by ClF_3 at 200°C and 300°C. The x-ray photoelectron spectra of surface-fluorinated samples showed that the surface fluorine concentration increased with an increase in the particle size of graphite and the reaction temperature.

With the aim of preparing a water-and-soil repellent material, cotton and polyester fabrics were exposed to radio-frequency plasmas of the gases SF_6, C_2F_6, C_6F_{14} and C_6F_6. AFM images revealed topographic changes and the formation of microstructures in fabric exposed to the plasma; this inhibited water droplets from spreading over the surface. There is also an additional effect resulting from the composition of the surface of the material. The strongest hydrophobic effect was observed for samples exposed to a radio-frequency plasma of C_6F_{14} gas.

In 2006 the research within the European project FUNFLUOS was extended from the preparation of AlF_3 with a high surface area by oxidative decomposition of hydrazinium(2+) fluoroaluminate, $N_2H_6AlF_5$, with

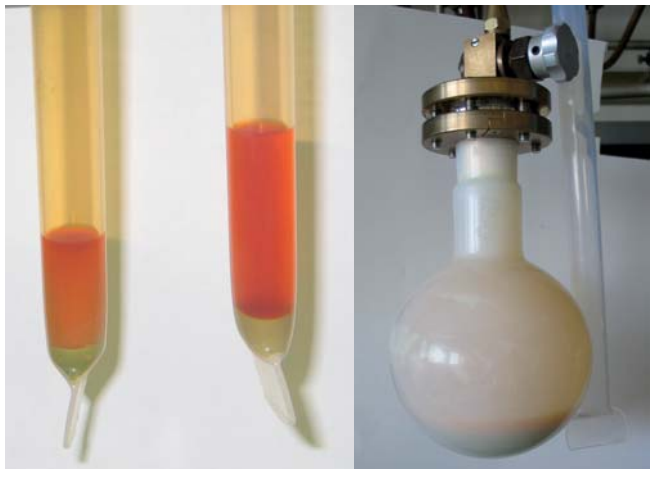

Figure 1: Preparation of CrF_3 with a high surface area in liquid anhydrous HF on a smaller (left) and a larger scale (right)

A systematic investigation of the reaction products between SbF_5 and AF (A = Li-Cs, Tl) with or without solvents (SO_2, HF) was completed.

elemental fluorine to similar reactions with iron and chromium compounds like $N_2H_6CrF_5H_2O$ and $N_2H_6FeF_5$. Reactions in liquid anhydrous hydrogen fluoride (aHF) gave amorphous CrF_3 with an unusually high surface area (200–300 m^2g^{-1}), a high Lewis acidity and a high catalytic activity. The repeatability of the synthesis in liquid aHF is good. There are small quantities of $CrOF_3$ present in the final product. The reactions were successfully carried out using larger quantities. In the case of the iron compound the surface area of the product was much lower (~30 m^2g^{-1}). The sol-gel route to high-surface-area AlF_3 was modified by adding HF in gaseous form to alcohol solutions of aluminium alkoxides. The method gave excellent results.

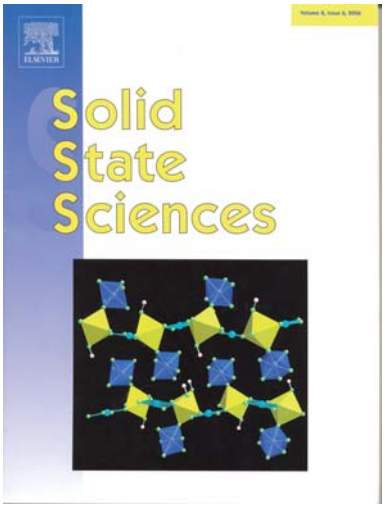

Figure 2: Cover of the journal Solid State Sciences, structure of $Mg(HF)AuF_4AuF_6$

In the analytical laboratory a method for determining the total fluoride content in organic matter and in food was developed. The method makes it possible to determine the total daily intake of fluorine as a result of consuming food. In addition, the elemental composition of some compounds synthesized in this laboratory was conducted.

In 2006 Prof. Boris Žemva received the American Chemical Society (ACS) Award for Creative Work in Fluorine Chemistry. On this occasion a special issue of the Journal of Fluorine Chemistry (vol. 127, No. 10), with 24 papers from his colleagues and friends, was dedicated to him.

Research on the enthalpies of formation of some aqueous polynuclear oxyanions was conducted.

A computer program combining physical and chemical models of absorption for the computation of fluid dynamics in a flue-gas scrubber is under development. The program will be useful for the dimensional and efficiency optimization of the scrubber. A method for the integral assessment of the suitability of technology optimization alternatives was developed for the flue-gas desulphurization example, quantitatively considering impacts on performance, economy and reliability of the proposed alternatives under consideration.

As part of the EU's 6FP CA project SHAPE RISK (http://shaperisk.jrc.it) we were engaged in the preparation of the final work package: Radical changes, breakthrough and prospective. The results of the project were, and will be, presented to related scientific, technical and policy-making audiences. The results will also be used in the preparation of priorities for the 7FP and for potential revisions, and for the implementation of legislation and directives at the EU level: directives 96/82/EC (Seveso II), 96/61/EC (IPPC), and 89/391/EEC (Atex).

For 15 years, the School of Experimental Chemistry has been engaged in the popularisation of natural sciences among the young from elementary schools and colleges.

With regard to major accident hazards we were engaged by the industrial companies Petrol d.d., Istrabenz plini d.o.o. and Plinarna Maribor d.d. in the preparation of four safety reports used in the licensing process, risk management and for emergency preparedness, also involving consulting services for drawing up formal safety-management systems at company levels.

Figure 3: Celebration of the 15th anniversary of the School of Experimental Chemistry, attractive demonstration: "nitrogen fountain".

In the frame of development research organized by the Slovenian environmental cluster, led by Esotech, we have been cooperating in three projects: (1) Development of thermal treatment of wastes in fluidized beds acting as a catalyst and/or reagent; (2) Continuation of the development of low-cost FGD and (3) The development of the additives for the enhancement of the efficiency of the wet calcite FGD process. With the project "Thermal use of waste" we were also engaged in the work of the Centre of Excellence for Environmental Technologies (CEET). With CEET we were involved in the establishment of the Slovenian technological platform for water.

Basic engineering was prepared for the design of three industrial plants that started operating successfully in 2006: (1) Chemical water preparation and clarification in Cinkarna Celje, (2) Reconstruction of the FGD plant and the lead smelter in MPI TAB Mežica and (3) Reconstruction of the chemical purification and clarification of waste waters in the Acroni steelworks in Jesenice.

We have successfully performed conditioning of radioactive waste resulting from past activities of IJS in cooperation with SVPIS in hot cell facility.

In 2006 we celebrated the 15th anniversary of the School of Experimental Chemistry. On this occasion we were presented with the awards of Prometeus of Science and Excellent Partnership by the Slovenian Scientific Foundation. Last year we performed 31 one-week courses of physical and chemical experiments for the students of elementary schools and colleges. We took part in the Festival of Science in Ljubljana and in the frame of the European project Wonders we were also involved in the international festivals of science in Madrid and Helsinki.

Some outstanding publications in 2006

1. P. Benkič, H. D. B. Jenkins, M. Ponikvar, Z. Mazej, Synthesis and characterisation of alkali metal and thallium polyfluoroantimonates, $ASb_nF_{(5n+1)}$ (n=2, 3), Eur. J. Inorg. Chem., (2006), 1084–1092
2. T. Bunič, G. Tavčar, M. Tramšek, B. Žemva, Coordination of XeF_2 to calcium and cadmium hexafluorophosphates(V), Inorg. Chem., 45 (2006) 1038–1042
3. D. Kontić, B. Kontić, M. Gerbec, How powerful is ARAMIS methodology in solving land-use issues associated with industry based environmental and health risks?, J. Hazard. Mater., 130 (2006), 271–275
4. K. Matsumoto, R. Hagiwara, Z. Mazej, E. Goreshnik, B. Žemva, Anomalously large formula unit volume and its effect on the thermal behavior of $LiBF_4$, J. Phys. Chem. B, 110 (2006), 2138–2141
5. M. Ponikvar, J.F. Liebman, Paradoxes and paradigms : observations on pyrohydrolytic decomposition of fluorine-containing materials and accompanying thermochemistry, Struct. Chem., 17 (2006), 75–78

Patent granted

1. Andrej Stergaršek
   Process for flue gas desulphurization with integrated equipment: patent No. 21956
   Ljubljana, Slovenian Intellectual Property Office, 2006.

Awards and appointments

1. Boris Žemva: American Chemical Society Award for Creative Work in Fluorine Chemistry, Atlanta, USA, ACS, 2006
2. Slovenian Scientific Foundation and Experimental School of Chemistry: Best Science Event, Winners of Science Communication Activity Exchange: Slovenia to Madrid, WONDERS European Science Festival, Madrid, Spain, April 2006
3. Experimental School of Chemistry: Excellent Partnership, Slovenian Scientific Foundation, Ljubljana, 21 November 2006
4. Experimental School of Chemistry: Prometeus of Science, Slovenian Scientific Foundation, Ljubljana, 11 December 2006

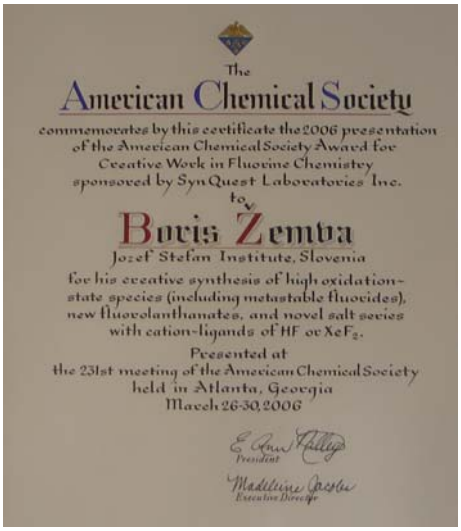
The
American Chemical Society
commemorates by this certificate the 2006 presentation of the American Chemical Society Award for Creative Work in Fluorine Chemistry sponsored by SynQuest Laboratories Inc.
to
Boris Žemva
Jozef Stefan Institute, Slovenia
for his creative synthesis of high oxidation-state species (including metastable fluorides), new fluorolanthanates, and novel salt series with cation-ligands of HF or XeF_2.
Presented at
the 231st meeting of the American Chemical Society
held in Atlanta, Georgia
March 26-30, 2006

Figure 4: Award of the American Chemical Society

Organization of conferences, congresses and meetings

1. Innovation and technical progress: benefit without risk?, Ljubljana 11–13 September 2006
2. Fifth International Conference on Inorganic Materials, Ljubljana, 23–26 September 2006

BIBLIOGRAPHY

ORIGINAL ARTICLES

1. Primož Benkič, H. Donald Brooke Jenkins, Maja Ponikvar, Zoran Mazej
   Synthesis and characterisation of alkali metal and thallium polyfluoroantimonates, Asb_nF_{5n+1} (n=2, 3)
   In: European Journal of Inorganic Chemistry, pp. 1084-1092, 2006.
2. Tina Bunič, Gašper Tavčar, Melita Tramšek, Boris Žemva
   Coordination of XeF_2 to calcium and cadmium hexafluorophosphates(V)
   In: Inorg. chem., Vol. 45, pp. 1038-1042, 2006.
3. Tina Bunič, Melita Tramšek, Evgeny Goreshnik, Boris Žemva
   Barium trihydrogen tetrafluoride of the composition $Ba(H_3F_4)_2$: the first example of homoleptic HF metal environment
   In: Solid state sci., Vol. 8, pp. 927-931, 2006.
4. Alexey A. Goryunkov, Zoran Mazej, Boris Žemva, (17 avtorjev)
   Reaction of C_{60} with $KMnF_4$ isolation and characterization of a new isomer of $C_{60}F_8$ and re-evaluation of the structures of $C_{60}F_7(CF_3)$ and the known isomer of $C_{60}F_8$
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INTERNATIONAL PROJECTS

1. Form-It "Take Part in Research"
Form-It
6. FP; SAS6, 042938
EC; Markus Meissner, Austrian Institute for Applied Ecology, Vienna, Austria
Tomaž Ogrin, M. Sc.
2. Functionalised Metal Fluorides
FUNFLUOS
6. FP; NMP3-CT-2004-505575
EC; Humboldt-Universität zu Berlin, Berlin, Germany
Dr. Tomaž Skapin
3. Sharing Experience on Risk Management (Health, Safety, Environment) to prepare Future Industrial Systems
SHAPE-RISK
6. FP; NMP2-CT-2003-505555
EC; Institut National de l'environnement industriel et des risques, Verneuil en Halatte, France
Asst. Prof. Marko Gerbec, Asst. Prof. Branko Kontič
4. Worldwide Remediation of Mercury Hazards through Biotechnology
BIOMERCURY
6. FP; NMP2-CT-2004-505561
EC; Gesellschaft für Biotechnologische Forschung MBH, Braunschweig, Germany
Dr. Andrej Stergaršek, Prof. Milena Horvat

5. Plasma Polymers and Related Materials
   COST 527
   EC
   Dr. Adolf Jesih
6. Problem-based Learning in Vocational Science - Designing Activities that develop the Skills used by Scientists in the Workplace for Integration into Vocational Science Courses
   PROBASE
   Leonardo da Vinci Programme
   HU/06/B/F/PP-170027
   Lévayné Szalay Luca, Bertalan Zsolt, Petrik Lajos Két Tanítási Nyelvű Vegyipari, Környezetvédelmi és Informatikai Szakközépiskola, Budapest, Hungary
   Tomaž Ogrin, M. Sc.
7. Experimental and Quantum Theoretical Studies of Inorganic Materials and Processes related to Catalysis
   BI-MK/05-06-001
   Dr. Ljupčo Pejov, Institute of Chemistry, Faculty of Science, Skopje, Macedonia
   Dr. Tomaž Skapin
8. Development of Low Cost Flue Gas Desulphirization (FGD) Technology
   BI-RO/05-06/005
   Boita Corina, Institute for Studies & Power Engineering (ISPE), Bucharest, Romania
   Dr. Andrej Stergaršek
9. Study of Polymerization Process in RF Plasmas
   BI-CS/06-07-022
   Prof. Zoran Petrović, Institut za fiziku Beograda, Zemun, Belgrade, Serbia
   Dr. Adolf Jesih

R & D GRANTS AND CONTRACTS

1. Development of the methods for determination of fluoride in food, organic mateter and soil
   Prof. Boris Žemva, Dr. Maja Ponikvar
2. Metal fluorides with specific surface properties
   Prof. Boris Žemva, Dr. Gašper Tavčar
3. Development and preparation of the Graetzl type photoelectrochemical cells
   Prof. Boris Žemva
4. Development of an ammunition categorisation system with implementation into the Quality Manager and Warehouse Management system
   Assist. Prof. Robert Kocjančič
5. Smart functional coatings for improvement of structures and components used in defensive purpose
   Dr. Adolf Jesih
6. Syntheses of 1D inorganic nanostructures, bionanostructures and the preparation of composites
   Dr. Adolf Jesih
7. Recycling and reuse of wastes
   Dr. Andrej Stergaršek
8. Biological methods of waste water treatment
   Dr. Andrej Stergaršek

RESEARCH PROGRAM

1. Inorganic chemistry and technology
   Prof. Boris Žemva

NEW CONTRACTS

1. Consulting for the preparation of the security plan
   Istrabenz Plini d.o.o.
   Asst. Prof. Marko Gerbec
2. Experimental school of chemistry
   Ministry of Education and Sport
   Tomaž Ogrin, M. Sc.
3. Developmnet of technologies for waste water management in power sector
   Esotech, d. d., Velenje
   Dr. Andrej Stergaršek

VISITORS FROM ABROAD

1. Prof. Zoran Lj. Petrović, Institut za fiziku, Belgrade, Serbia, 6–10 November 2006
2. Dr. Maja Radetić, Tehnološko-metalurška fakulteta, Belgrade, Serbia, 6–10 November 2006

STAFF

Researchers
1. Asst. Prof. Marko Gerbec
2. Dr. Yevheniy Horyeshnik
3. Dr. Adolf Jesih
4. Asst. Prof. Robert Kocjančič
5. Dr. Zoran Mazej
6. **Dr. Tomaž Skapin, Head**
7. Dr. Andrej Stergaršek
8. Dr. Melita Tramšek
9. **Prof. Boris Žemva**, Head until 1. 3. 2006**

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11. Dr. Gašper Tavčar

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13. Peter Frkal, B. Sc.
14. Tomaž Ogrin***, M. Sc.

Technical and administrative staff
15. Neda Hanc
16. Pero Kolobarić
17. Robert Moravec
18. Marija Toplak
19. Mira Zupančič

** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF PHYSICAL AND ORGANIC CHEMISTRY K-3

The basic research of the Department of Physical and Organic Chemistry is focused on experimental and theoretical studies of various physico-chemical processes at surfaces and in atmospheric chemistry. In the field of organic chemistry we investigate halogenated, and in particular fluorinated, organic molecules.

Head:
Dr. Ingrid Milošev

The experimental research in the field of electrochemistry was devoted to materials that are important in biomedical and technological applications. We studied various copper-based alloys in chloride solutions in terms of the effect of the alloy composition on the corrosion resistance and the composition of the passive layer. The *in-vitro* electrochemical behaviour of AISI 316L stainless steel was tested in simulated physiological solutions containing complexing agents that simulate the role of proteins. In the field of corrosion protection we introduced the method of the electrochemical quartz-crystal nanobalance (EQCN), which is a powerful technique for obtaining *in-situ* information on corrosion inhibition and its mechanism (Figure 1).

The experimental studies of biomedical materials were focused on total hip replacements, and these were carried out in collaboration with the Valdoltra Orthopaedic Hospital and the Faculty of Medicine, University of Ljubljana. The survival rate of a large group of Sikomet metal/metal total hip replacements was studied for a mean period of seven years. We found that aseptic loosening remains the major reason for failure. The histological findings and the prevalence of osteolysis suggest the possibility of a hypersensitivity-like immunological response to wear particles. The long-term survival of a cemented Ti_6Al_4V alloy straight-stem femoral component was studied as a function of the material of the femoral head and the quality of the cement mantle. We continued with our studies of the effect of the femoral head material on the release of submicron wear-debris particles.

The electrochemical quartz-crystal nanobalance (EQCN) is a powerful technique for obtaining information on corrosion inhibition and its mechanism.

Our theoretical physico-chemical investigations were oriented on studies of the mechanism of radical reactions in atmospheric chemistry. For the CH_3O_2 + NO reaction we showed that it proceeds through two independent reaction channels with the main products $CH_3O + NO_2$. Methylperoxy nitrite is an important reaction intermediate, which can isomeize to the nitrate. In summary, the calculations provide a quantitative mechanism that explains the detection of trace quantities of methyl nitrate in the atmosphere. The barriers determined for each step are entirely consistent with the values used in parametric schemes employed for the successful modelling of nitrate yields.

A theoretical examination of the $BrONO_2 \rightarrow BrOONO$ isomerization indicated that the process of formation of two BrOONO isomers from BrO + NO_2 is likely, but both conformers can isomerize easily to the relatively more stable $BrONO_2$. Furthermore, we showed that the participation of NO_2 plays a substantial role in the $XONO \rightarrow XNO_2$ (X = Cl, Br) isomerization (Figure 2). This bimolecular isomerization is much more likely with respect to the corresponding unimolecular isomerization and its presence in the X + NO_2 system is capable of explaining the preferential product formation in recent experiments. We elucidated the mechanism of the ClCO + NO_2 reaction, and the main conclusion is that NO_2, the ubiquitous atmospheric pollutant, can act as a sink for the chloroformyl radicals, which are themselves generated in the upper atmosphere.

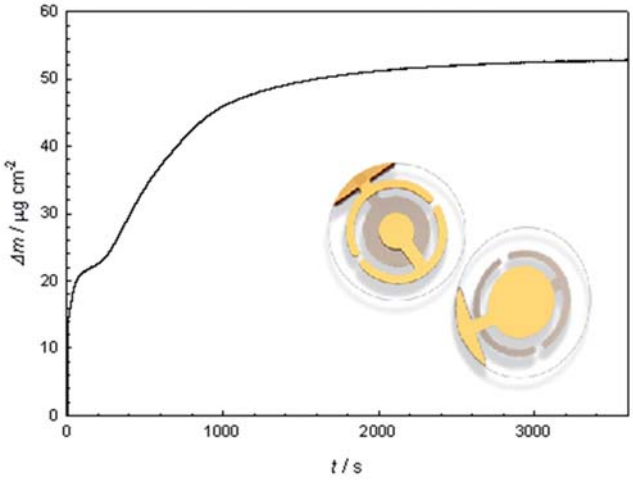

Figure 1: Change in mass on a copper electrode in 3% NaCl solution due to the adsorption of a benzotriazole inhibitor. Inset shows a scheme of a quartz crystal with a gold electrode

We have started to investigate, by means of density-functional-theory (DFT) electronic structure calculations, two compounds from a new class of potential Li-cathode materials, Li_2MnSiO_4 and Li_2FeSiO_4. In particular, the former compound has been recently identified as one of the first cathode battery materials that, at least in principle, could exchange more than one lithium ion per formula unit. However, experiments have not confirmed these expectations, presumably due to the poor electronic conductivity of the compound. Using computer simulations we showed instead that

Li_2MnSiO_4 is structurally unstable upon delithiation. Based on the insights gained from the computer simulations, we proposed that a stable material with a reversible exchange of more than one Li ion per formula unit could be obtained by using an appropriate Mn/Fe mixture (solid solution) with the general formula $Li_2Mn_xFe_{1-x}SiO_4$.

The isomerization of XONO → XNO_2 (X = Cl, Br) in the presence of NO_2 is capable of explaining the preferential product formation in recent X+NO_2 experiments.

We have continued with the DFT computer simulations of elementary processes on transition-metal surfaces, where we investigated the dehydrogenation of methane. One of the many problems in the catalytic conversion of methane to, for example, methanol is that heterogeneous catalysts cleave all the CH bonds, because the reaction barrier for the first step of the dehydrogenation, $CH_4 \rightarrow CH_3+H$, is usually the largest. Eventually, graphite is formed on the surface, which inactivates the catalysts. We showed that a combination of very active reaction centres, such as Rh, with more inert substrates, such as Cu, can hinder the second dehydrogenation step with respect to the first, thus resulting in the reverse of the natural order of the heights of the two barriers.

In the field of organic and bioorganic chemistry we continued our interest in the application of green reaction conditions to the selective and efficient halogenation of organic compounds. We developed a method for the bromination of 1,3-diketones and β-ketoesters using NBS under solvent-free conditions, while only water was used for the isolation of the products. In the case of aromatic ketones, regioselectivity could be directed by the reaction conditions: under solvent-free conditions α-bromination was the exclusive process, while in water, ring functionalisation was observed to occur. Water was used as the reaction media and the H_2O_2/HBr system or NBS illuminated by a 40-W incandescent light bulb as the reagent for the benzylic bromination of the derivatives of toluene. In the case of NBS the ring bromination of electron-rich toluenes occurred. A combination of elemental iodine and 30% aqueous H_2O_2 was used as a reagent for the selective and effective iodination of methoxy-substituted benzenes in water media. The role of the nature of the oxidant, the reaction conditions and the structure of the substrates on the course of the transformation of the derivatives of anisole were investigated. Two types of transformation, oxidation or iodination, were established as a function of these reaction parameters, while the ionic or ion-radical nature of the reaction route was postulated, depending on the amount of iodine consumed. The effect of water on the functionalisation of the phenyl ring in methyl-substituted benzene derivatives with F-TEDA-BF_4 was elaborated, the kinetic and activation parameters of these reactions were measured and the reaction route was postulated.

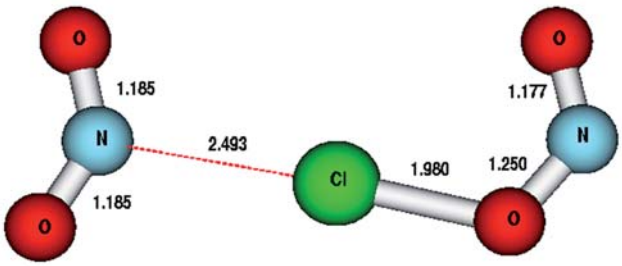

Figure 2: Transition state for ClONO→ $ClNO_2$ isomerization in the presence of NO_2

A simulation showed that it might be possible to obtain a stable Li-cathode material by using an appropriate Mn/Fe mixture (solid solution) with the general formula $Li_2Mn_xFe_{1-x}SiO_4$.

We applied our synthetic method by using fluorinated alcohols as solvents and activators for hydrogen peroxide for the synthesis of various cyclic tetraoksanes from ketones by oxidation with 30% aqueous H_2O_2 and determined their antimalaric activities towards plasmodium falciparum. Some of the compounds showed a high bioactivity. We discovered that molecular iodine could be used as a catalyst for the direct oxidation of ketones to dihydroperoxides using 30% H_2O_2 (Figure 3).

Iodine was also shown to be an efficient catalyst for the transformations of alcohols. Tertiary alcohols were, under solvent-free conditions in the presence of 5% of iodine, dehydrated to alkenes, while secondary or primary alcohols under these conditions gave the corresponding ethers.

On the basis of our invitation we prepared an extensive review article for "Advances in Organic Synthesis" Vol 2 "Modern Organofluorine Chemistry" on the chemistry and applications of derivatives of N-fluoro-1,4-diazoniabicyclo(2.2.2) salts.

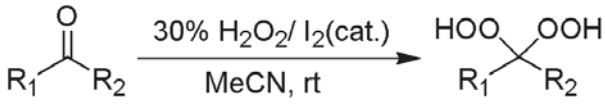

Figure 3: New method for the synthesis of dihydroperoxides

Some outstanding publications in the past three years

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2. A. Lesar, M. Hodošček, E. Drougas and A. M. Kosmas Quantum mechanical investigation of the atmospheric reaction CH_3O_2 + NO,J. Phys. Chem. A 110 (2006), 7898–7903
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Awards and appointments

1. Matjaž Finšgar: Prešern award for chemistry, Ljubljana, 6 December 2006, University of Ljubljana, B.Sc. thesis "Study of corrosion inhibition of copper using electrochemical techniques and quartz nanobalance "
2. Tadeja Kosec and Ingrid Milošev: Best poster award at the EUROCORR 2006, Maastricht, Netherlands, 23–29 September 2006 for the contribution "The application of BTA inhibitor in corrosion protection of brass in chloride solution"

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2. Jernej Iskra
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A theoretical examination of the isomerization of $BrONO_2$ to BrOONO
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REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Jernej Iskra
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PUBLISHED CONFERENCE PAPERS

Invited Paper

1. Ingrid Milošev
Kovinski materiali za bioaplikacije
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Regular Paper

1. Agnie M. Kosmas, Evangelos Drougas, Antonija Lesar, Milan Hodošček
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THESES

B. Sc. Theses

1. Edita Blaževič: Corrosion resistance of dental alloys based on nickel (Prof. Stane Pejovnik, Dr. Ingrid Milošev)
2. Matjaž Finšgar: Study of corrosion inhibition of copper using electrochemical techniques and quartz nanobalance (Prof. Boris Pihlar, Dr. Ingrid Milošev)

INTERNATIONAL PROJECTS

1. New Fluorous Media and Processes for Cleaner and Safer Chemistry
COST D29 (Working Group 0011-03)
EC
Dr. Jernej Iskra
2. Psi-K: Towards Atomistic Materials Design
ESF, Strasbourg Cedex, France
Dr. Anton Kokalj
3. Physicochemical Behaviour of the Atmospheric Pollutants: Reaction of Plain and Chlorinated Metoxy and Methilperoxy Radicals with Nitrogen Oxide
BI-GR/04-06-004
Dr. Agnie M. Kosmas, University of Ioannina, Department of Chemistry, Ioannina, Greece
Dr. Antonija Lesar
4. Theoretical Study of Bioactive Molecules with Property of Nitric Oxide (NO) Release: N-nitrosohydroxylamine and its N- and O-alkyl Derivatives
BI-HR/06-07-022
Dr. Mirjana Eckert-Maksić, Rudjer Boškovic Institute, Zagreb, Croatia
Dr. Antonija Lesar
5. Chemistry at Silver Surfaces: Understanding Ethylene Epoxidation and Other Peculiar Reactions on Silver based Catalysts
BI-IT/05-08-004
Dr. Mario Rocca, Department of Physics, University of Genova, Genova, Italy
Dr. Anton Kokalj
6. PVD Coatings for Protection of Aluminium-based Substrates for Aircraft Applications
Micael Pawlik, PPG Industries, Inc., One PPG Place, Pittsburg, Pennsylvania; Rosanna Drive, Allison Park, PA, USA
Dr. Ingrid Milošev, Dr. Peter Panjan

R & D GRANTS AND CONTRACTS

1. Local and systemic effects of articulation of metal components from total hip replacements
Dr. Ingrid Milošev
2. Smart functional coatings for improvement of structures and componens used in defensive purposes
Dr. Ingrid Milošev
3. Nanomaterials in electrochemical systems
Dr. Ingrid Milošev

RESEARCH PROGRAMS

1. Bioanorganic and bioorganic chemistry
Dr. Stojan Stavber
2. Micro- and nanostructured functional materials: development, physical and chemical characterization and simulation of processes
Dr. Ingrid Milošev

NEW CONTRACT

1. Research on the area of surface active materials
Ecot, d.o.o., Ljubljana
Dr. Stojan Stavber

VISITORS FROM ABROAD

1. Prof. Agnie Mylona Kosmas and Zoi Salta, B.Sc., University of Ionnina, Greece, 4–8 April 2006
2. Prof. Mirjana E. Maksić, Ruđer Bošković Institute, Zagreb, Croatia, 28 June – 1 July 2006
3. Malgorzata Figurska, B.Sc. Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland, 7 August – 15 September, and 27 November – 20 December 2006
4. Dr. Paolo Umari, Democritos – Elettra Theory Group, Basovizza, Italy, 12 October 2006
5. Zoi Salta, B.Sc., University of Ionnina, Greece, 3 November – 3 December 2006

STAFF

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1. Dr. Jernej Iskra
2. Dr. Anton Kokalj
3. Dr. Antonija Lesar
4. **Dr. Ingrid Milošev**, Head**
5. Dr. Stojan Stavber
6. Prof. Marko-Andrej Zupan*

Postdoctoral associate
7. Dr. Lea Županc Mežnar***

Postgraduates
8. Matjaž Finšgar, B.Sc.
9. Tadeja Kosec Mikić, M. Sc.
10. Saša Kovačič, B. Sc.
11. *Petra Kralj, M. Sc., left April 4, 2006*
12. Jasminka Pavlinac, B. Sc.
13. Ajda Podgoršek, B. Sc.
14. Katja Žmitek, B. Sc.

Technical officers
15. Edita Blaževič, B. Sc.

* Full-time faculty member
** Part-time member of other organisation
*** Member of industrial or other organisation

ELECTRONIC CERAMICS DEPARTMENT

K-5

The Electronic Ceramics Department is active in the fields of synthesis, properties and applications of materials for electronics – mainly complex multifunctional materials and structures. The materials of interest include ceramic piezoelectrics, ferroelectrics, relaxors, 'conductive' oxides and materials for solid-oxide fuel cells (SOFCs). The emphasis is on the creation of properties through the synthesis and the structure on the nano-, micro- and macro-levels.

Head:
Prof. Marija Kosec

New materials: lead-free piezoelectrics and relaxors. We continued our research on the synthesis of alkaline niobates, i.e., the 'model' system, Na_2CO_3/ K_2CO_3/Nb_2O_5, using diffusion couples. The first reaction product at the interface between the equimolar mixture of alkaline carbonates and Nb_2O_5 is a phase that is isostructural with $Na_2Nb_4O_{11}$ and contains both alkali ions. The (K,Na)NbO_3 forms during the reaction of the polyniobate phase and the alkaline species. The parabolic rate constant k_p for the ternary system K_2CO_3/Na_2CO_3/Nb_2O_5 is of the same order of magnitude as for the system K_2CO_3/Nb_2O_5, i.e., about 10^{-15} m^2/s, and about 10^{-14} m^2/s for the Na_2CO_3/Nb_2O_5. The rate of the diffusion-controlled reaction in the ternary system is determined by the diffusion of the slower species; in this case the potassium ions (Figure 1).

We began research on $K_{0.5}Na_{0.5}NbO_3$ (KNN) thick films.

The research on the solid-state crystal growth (SSCG) of $(K_{0.5}Na_{0.5})NbO_3$ (KNN) was continued. We succeeded in growing approximately 700-μm-thick $K_{0.5}Na_{0.5}NbO_3$ and 100-μm-thick $(K_{1-x-y}Na_xLi_y)(Nb_{1-z}Ta_z)O_3$ crystals on (110)- or (001)-oriented $KTaO_3$ seeds. The orientation and the chemical composition of the crystal are identical to that of the seed and of the ceramic matrix, respectively. This research is part of the EU 6FP project IMMEDIATE.

The synthesis of nanoparticles of multicomponent oxides in solution. We systematically studied the synthesis of nanoparticles with the aim of controlling the morphology and attaining high chemical homogeneity. The research of the **sol-gel synthesis of nanoparticles** was focused on $La_2Zr_2O_7$ from an alkoxide-nitrate precursor and $Pb(Zr_{0.5}Ti_{0.5})O_3$ from an alkoxide-acetate precursor.

High-energy milling or mechanochemical synthesis is a promising particle-synthesis route. There is only scarce literature data on the pathway of reactions triggered by high-energy impacts in a mill. One of the key reasons is the non-equilibrium, complex and localized nature of the processes occurring during high-energy milling. We focused on the mechanism of the reaction between Na_2CO_3 and Nb_2O_5 that yields $NaNbO_3$. During the starting phase of milling the Na_2CO_3–Nb_2O_5 mixture, the long-range order in Na_2CO_3 is completely destroyed, which is not the case if the Na_2CO_3 is milled separately. We determined by infrared spectroscopy that one of the characteristic absorption bands of the CO_3^{2-} group at 1445 cm^{-1} splits, and at the same time the band at 1055 cm^{-1} is activated (Figure 2). This latter band is characteristic for the symmetrical C-O vibration in the CO_3^{2-} group and it is not IR-active in the Na_2CO_3. Based on experiments and literature data we concluded that a carbonato complex forms in the first phase of milling, which represents an intermediate step in the mechano-synthesis of $NaNbO_3$.

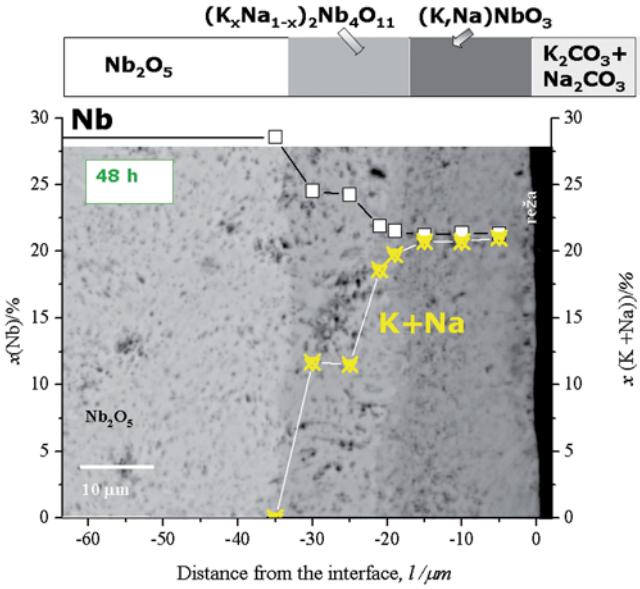

Figure 1: SEM/BEI micrograph and SEM/EDS analysis of the diffusion couple $(K_2CO_3+Na_2CO_3)/Nb_2O_5$, heated for 48 hours at 600°C, and a schematic representation of the phases present in the diffusion couple. The concentrations are given in atomic percent Nb and (K + Na).

The research on **chemical solution deposition of ferroelectric thin films** based on lead zirconate titanate focused on the processing of thicker films with thicknesses of about 1 μm. Strongly (100)-oriented PZT films crystallize on the $PbTiO_3$ nucleation layer on Pt/Si after annealing at 500°C and consist of 100–200-nm-wide columnar grains. The 800-nm-thick PZT films exhibit the values of P_r = 29 μC/cm^2, E_c = 140 kV/cm, ε = 520 and tan δ = 0.096. The research is conducted in collaboration with the Laboratory for Microsensor Structures and Electronics, Faculty for Electronics, University of Ljubljana and HIPOT-RR within a project funded by the ARRS. The aim is to study and develop microsensor systems based on piezoelectric micro-electro-mechanical systems (MEMS).

We have begun research on lead-free ferroelectric thin films based on $K_{0.5}Na_{0.5}NbO_3$.

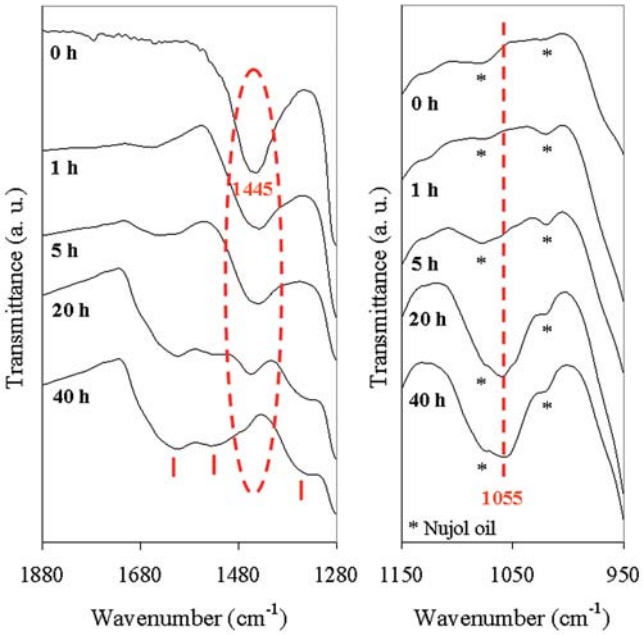

Figure 2: Infrared spectra of the Na_2CO_3–Nb_2O_5 mixture after 0, 1, 5, 20 and 40 hours of high-energy milling.

Prof. Marija Kosec, department head, received the Zois award for the top scientific achievements in 2006. We organized the Fourth European Microelectronics and Packaging Symposium EMPS 2006 with a satellite Workshop on Ferroelectric Thin- & Thick-Films Processing and Their Applications in MEMS on 21–24 May 2006 at Terme Čatež, Slovenia. In the frame of research on lead-free piezoelectrics we performed a diffusion-couples study of the reaction between alkaline carbonates and niobium oxide. The $(K,Na)NbO_3$ solid solution is formed after heating at 600°C via a diffusion reaction, controlled by the rate of diffusion of potassium ions.

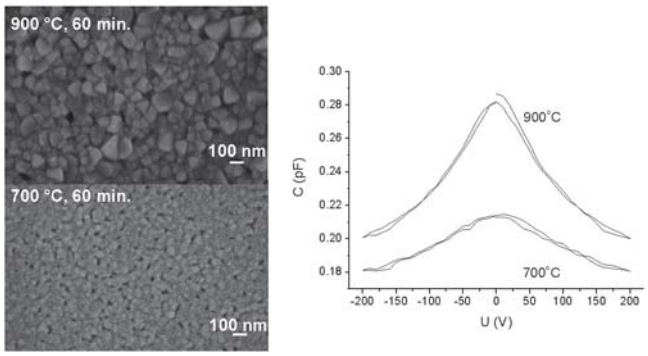

Figure 3: $Ba_{0.3}Sr_{0.7}TiO_3$ thin films on alumina substrates: the grain size and tunability of the capacitance with the applied electric field increase with increasing the annealing temperature from 700°C to 900°C. (The capacitance was measured at 1 MHz on ferro-capacitors with an 8.5 ± 1 μm gap between the Cr/Au electrodes. (Collaboration with HYB, Šentjernej, Slovenia, and EPFL, Switzerland)

We prepared thin-film ferro-capacitors based on $Ba_{0.3}Sr_{0.7}TiO_3$ (BST) on ceramic alumina substrates. By increasing the annealing temperature from 700°C to 900°C the grain size increases from 40 to 80 nm. The dielectric permittivity and tunability ($\varepsilon_{0V}/\varepsilon_{200V}$) of BST films, measured at 1 MHz, strongly depend on the grain size, exhibiting values of 345 and 1.47, and 722 and 1.93 for the films with 40-nm- and 80-nm-sized grains. The gap between the electrodes was 8.5 μm (Figure 3). BST films display a non-linear dependence of the dielectric permittivity under conditions representative of those required by tunable applications. The research of high-frequency phase shifters (10–14 GHz), which contain these ferro-capacitors, takes place in collaboration with HYB, Šentjernej, Slovenia, and EPFL, Switzerland, in the frame of the EU 6FP project RETINA.

We have initiated research on processing methods and the processing of structures of micrometer dimensions. By screen-printing we prepared $0.65Pb(Mg_{1/3}Nb_{2/3})O_3$–$0.35PbTiO_3$ (PMN-PT) thick films on alumina substrates sintered at low temperatures, i.e., 950°C. The powder for the thick-film processing was prepared by high-energy milling. We also investigated the electrophoretic deposition (EPD) of layers with thicknesses of a few tens of micrometers.

Phase relations in the RuO_2–ZnO–SiO_2 system were investigated. This system is relevant for lead-free glasses in resistor compositions, i.e., the ZnO replaces the PbO. The conductive RuO_2-based phase is compatible with the ZnO-containing glassy phase.

In the area of **thick-film technology, materials and sensors** we investigated the properties of piezoelectric $(Pb(Zr,Ti)O_3$ (PZT) materials on LTCC (low-temperature co-fired ceramic) substrates. These structures are used as sensors for mechanical quantities and as actuators (Figure 4). The electrical properties of the films on the glassy LTCC substrates are decreased relative to those on inert alumina substrates, which is a consequence of the interaction between the glassy phase of the LTCC and the active ferroelectric layer, as was confirmed by SEM/EDS analysis. Based on measurements of the mechanical and piezoelectric properties and confirmed by numerical modelling, we concluded that the moduli of the elasticity as well as the piezoelectric coefficients of the thick films are up to 50% lower than in bulk ceramics. We simulated many designs, and designed and fabricated optimized sensor and actuator structures. By optimising the materials and processing, these products were prepared by conventional thick-film technology.

Thick-film temperature sensors based on resistors with positive and negative temperature coefficients – PTC and NTC – incorporated into LTCC structures, exhibit a sufficient electrical output; however, the mechanical properties need to be improved.

In collaboration with an industrial partner, Hyb d.o.o., Slovenia, we continued our research on **new, environment-friendly materials** for hybrid thick-film circuits, with the emphasis on reliability, in agreement with RoHS (Restriction of use of Hazardous Substances).

The collaboration with the company ETI d.d. Izlake, Slovenia, is in the field of alumina porcelains. The aim is to improve the thermal-shock resistance of porcelain, which is crucial for the vital ceramic parts of fuses, by changing the chemical and phase composition of the electro-porcelain by adding lithium compounds.

The research was conducted in the frame of the research program, four ARRS projects, two of which are co-financed by Slovenian industry, one project financed by Slovenian industry and nine EU projects.

Some outstanding publications in 2006

1. Marko Hrovat, T. Maeder, C. Jacq, Janez Holc, Janez Bernard, Subsolidus phase equilibria in the PbO-poor part of the TiO_2-PbO-SiO_2 system and its application in low-temperature thick-film dielectrics. J. Mater. Res., 21[12], 2006, 3210–3214.
2. Danjela Kuščer, Anton Meden, Janez Holc, Marija Kosec, The mechano-synthesis of lead-magnesium-niobate ceramics, J. Am. Ceram. Soc, 89[10], 2006, 3081–3088.
3. Barbara Malič, Iztok Arčon, Alojz Kodre, Marija Kosec, Homogeneity of Pb(Zr, Ti)O_3 thin films by chemical solution deposition : extended X-ray absorption fine structure spectroscopy study of zirconium local environment. J. Appl. Phys., 2006, 100, 051612–051612-8.
4. Tadej Rojac, Marija Kosec, Barbara Malič, Janez Holc, The application of a milling map in the mechanochemical synthesis of ceramic oxides, J. Eur. Ceram. Soc., 2006, 26, 3711–3716.

Awards and appointments

1. Marija Kosec: Zois award for top-level science and research achievements in the field of ceramic materials, Ministry of Higher Education, Science and Technology, Ljubljana

Organization of conferences, congresses and meetings

1. PIEZO 2006, Øyer (Lillehamer), Norway, 5–8 March 2006
2. Workshop on Ferroelectric Thin- &Thick-Films Processing and Their Applications in MEMS, Terme Čatež, 21 May 2006
3. European Microelectronics and Packaging Symposium (EMPS 2006), Terme Čatež, Slovenia, 21–24 May 2006
4. ELECTROCERAMICS X, Toledo, Spain, 17–22 June 2006
5. Slovenian Chemical Days, Maribor, Slovenia, 10–12 September 2006
6. 42nd International Conference on Microelectronics, Devices and Materials and the Workshop on MEMS and NEMS (MIDEM), Strunjan, Slovenia, 13–15 September 2006
7. 14th Conference on Materials and Technology, Portorož, Slovenia, 16–18 September 2006

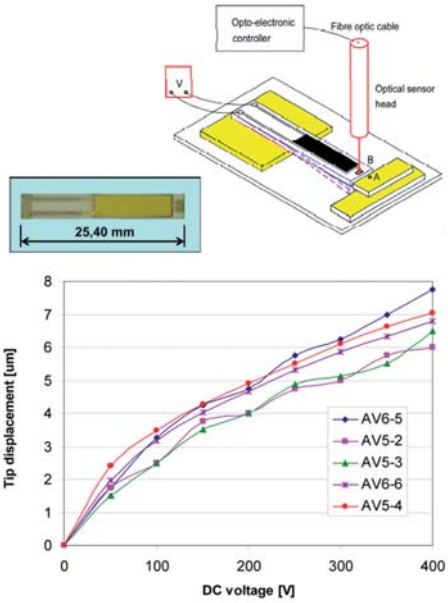

Figure 4 : Piezoelectric actuator, fabricated from a Pb(Zr,Ti)O_3 thick film on an alumina substrate. Scheme of the setup for the measurement of the displacement vs electric field (top), photo of an actuator (middle) and measurement result (bottom).

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2. Darko Belavič, Dubravka Ročak, Marko Hrovat, Janeta Fajfar Plut, Janez Ivan Pavlič, Srečo Maček, Zdzislaw Drozd, Ian McGill, Krystyna Bukat
   Substitution of ecologically hazardous substances in thick-film ceramic interconnection modules
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    The application of a milling map in the mechanochemical synthesis of ceramic oxides
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16. Tadej Rojac, Marija Kosec, Primož Šegedin, Barbara Malič, Janez Holc
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18. Miguel Angel de la Rubia Lopez, M. Peiteado, J. F. Fernandez, A. C. Caballero, Janez Holc, Silvo Drnovšek, Danjela Kuščer, Srečo Maček, Marija Kosec
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PUBLISHED CONFERENCE PAPERS

Invited Paper

1. Darko Belavič, Marina Santo-Zarnik, Marko Hrovat, Janez Holc, Marija Kosec, Srečo Maček, Mitja Jerlah, Janez Bernard, Marko Pavlin, Hana Uršič
An investigation of thick-film technology for sensors and actuators in C-MEMS
In: Proceedings, XXX International Conference of IMAPS Poland Chapter, Kraków, 24-27 September, 2006, Wiesław Zaraska, ed., Andrzej Cichocki, ed., Dorota Szawagierczak, ed., Kraków, Institute of Electron Technology, Cracow Division, 2006, pp. 21-28.

Regular Papers

1. Uroš Aljančič, Barbara Malič, Mira Mandeljc, Mišo Vukadinović, Danilo Vrtačnik, Drago Resnik, Matej Možek, Marija Kosec, Slavko Amon
Cantilever as testing structure for characterization of PZT thin films on Pt/Si substrates
In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 271-276.
2. Darko Belavič, Dubravka Ročak, Janeta Fajfar Plut, Marko Hrovat, Janez Ivan Pavlič, Zdzislaw Drozd, Srečo Maček, Ian McGill, Krystyna Bukat
An introduction of RoHS legislation in SMD thick-film hybrid technology: a case study
In: Proceedings, ESTC 2006, 1st Electronics Systemintegration Technology Conference, September 5th-7th, 2006, Dresden, Germany, [S. l.], IEEE, 2006, pp. 690-695.
3. Darko Belavič, Dubravka Ročak, Marko Hrovat, Srečo Maček, Janeta Fajfar Plut, Janez Ivan Pavlič, Zdzislaw Drozd, Krystyna Bukat
An investigation of thick-film hybrid interconnections with "ecologically friendly" materials
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4. Darko Belavič, Marina Santo-Zarnik, Janez Holc, Marko Hrovat, Marija Kosec, Silvo Drnovšek, Jena Cilenšek, Srečo Maček
An investigation of the piezoelectric properties of thick-film PZT actuators on ceramic substrates
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5. Darko Belavič, Marina Santo-Zarnik, Marko Hrovat, Janez Holc, Marija Kosec, Srečo Maček, Hana Uršič
Study of piezoelectrical actuators for use in micro- and mezo-electro-mechanical system applications
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6. Darko Belavič, Marina Santo-Zarnik, Marko Hrovat, Janez Holc, Marija Kosec, Barbara Malič, Silvo Drnovšek, Jena Cilenšek
A comparative study of the technology and architecture for actuators realized with PZT layers in LTCC structures
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7. Janez Bernard, Darko Belavič, Marina Santo-Zarnik, Marko Hrovat, Marija Kosec
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8. V. Blechertas, R. Bansevicius, Marina Santo-Zarnik
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9. Laila Čakare-Samardžija, Barbara Malič, Marija Kosec
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10. Jerneja Godnjavec, Andreja Benčan, Barbara Malič, Marija Kosec
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11. Janez Holc, Marija Kosec, Marko Hrovat, Barbara Malič, Danjela Kuščer, Silvo Drnovšek
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12. Marko Hrovat, Darko Belavič, Jena Cilenšek
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13. Marko Hrovat, Darko Belavič, Janez Holc, Jena Cilenšek
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14. Marko Hrovat, Janez Holc, Darko Belavič, Jena Cilenšek
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23. Hana Uršič, Marko Hrovat, Darko Belavič, Jena Cilenšek, Silvo Drnovšek, Janez Holc, Marina Santo-Zarnik, Marija Kosec
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25. Mišo Vukadinović, Barbara Malič, Mira Mandeljc, Marija Kosec, Vladimir Sherman, Tomoaki Yamada, Nava Setter
Uncertainty of $Ba_{0.3}Sr_{0.7}TiO_3$ thin films permittivity extracted from measurements of planar capacitors
In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 157-162.
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Studies of local induced polarization in modified ferroelectric thin films / ... [et al.]. In: The Eleventh International Meeting on Ferroelectricity (IMF-11) / guest editors Ricardo L. Migoni, Marcelo G. Stachiotti. - Philadelphia : Taylor & Francis, 2006. Ferroelectrics, vol. 335, pp. 269-274, 2006

THESES

Ph. D. Theses

1. Saša Javorič: (La,Sr)CoO_3 Electrodes in Pb(Zr,Ti)CoO_3 Ferroelectric Capacitors (Prof. Slavko Amon, Prof. Marija Kosec)
2. Darja Jenko: Synthesis of (K,Na)NbO_3 Ceramics (Prof. Marija Kosec, Asst. Prof. Barbara Malič)
3. Mira Mandeljc: Study of Crystallization of Pb(Zr,Ti)O_3 (Prof. Marija Kosec)

B. Sc. Thesis

1. Ana Drmota: Thermoplastic Composites Based on Ceramic Hexaferrites (Prof. Marija Kosec, Dr. Andrej Žnidaršič)

PATENT APPLICATIONS

1. Patent application No. : P-200600254
Lead based perovskite thick film structures on reactive ceramic
Janez Holc, Silvo Drnovšek, Marija Kosec, JSI
2. Patent application No. : P-200600253
Preparation of dense ceramics based on alkaline niobate and niobate-tantalate
Janez Holc, Janez Bernard, Barbara Malič, Marija Kosec, JSI

INTERNATIONAL PROJECTS

1. Monolithic above IC Ultra High Value Capacitors for Mobile and Wireless Communication Systems
CAMELIA
6. FP; NMP3-CT-2006-033103
EC; Cliodhna Horan, Tyndall National Institute, Lee Maltings, Cork; University College Cork, National University of Ireland, Cork, Ireland
Asst. Prof. Barbara Malič
2. Multifunctional Ceramic Layers with High Electromagnetoelastic Coupling in Complex Geometries
MULTICERAL
6. FP; NMP3-CT-2006-032616
EC; Prof. Andrei Kholkin, University of Aveiro, Dept. of Ceramics & Glass Engineering, Aveiro, Portugal
Prof. Marija Kosec, Dr. Janez Holc, Prof. Robert Blinc, Prof. Raša Pirc
3. Multicomponent Oxides for Flexible and Transparent Electronics
MULTIFLEXIOXIDES
6. FP; NMP3-CT-2006-032231
EC; Prof. Rodrigo Ferrao de Paiva Martins, UNINOVA - Instituto de Desenvolivimento de Novas Technologias, Monte de Caparica, Portugal
Dr. Danjela Kuščer Hrovatin
4. REliable, Tuneable and INexpensive Antennas by collective fabrication processes
RETINA
6. FP; AST4-CT-2005-516121
EC; Dr. Volker Ziegler, EADS Deutschland GmbH, Corporate Research Centre, Dept. LG-ME, München, Germany
Prof. Marija Kosec, Asst. Prof. Barbara Malič, Dr. Vid Bobnar
5. Inexpensive, high-perforMance, lead-free piezoelectric crystals and their applications in transducers for ultrasonic Medical DIAgnostic and industrial Tools and Equipments
IMMEDIATE
6. FP; COOP-CT-2005-017569
EC; Dr. Dragan Damjanovic, Ecole Polytechnique Federale de Lausanne, Swiss Federal Institute of Technology - EPFL, Ceramics Laboratory - LC, Materials Institute - IMX, Faculty of Engineering - STI, Lausanne, Switzerland
Prof. Marija Kosec, Dr. Andreja Benčan Golob
6. Multifunctional & Integrated Piezoelectric Devices
MIND
6. FP; NMP3-CT-2005-515757
EC; Wanda Wolny, Ferroperm Piezoceramics A/S, Kvistgård, Denmark
Prof. Marija Kosec, Asst. Prof. Barbara Malič
7. Fuel Cell Application in a New Configurated Aircraft
CELINA
6. FP; AST4-CT-2005-516126
EC; Wolfgang Dressel, Airbus Deutschland GmbH, Hamburg, Germany
Prof. Marija Kosec, Dr. Danjela Kuščer Hrovatin
8. Removal of Hazardous Substances in Electronics: Processes and Techniques for SMEs
GREENROSE
6. FP; COLL-CT-2004-500225
EC; Knut Aune, Abelia, Oslo, Norway
Prof. Marija Kosec
9. Miniaturised Ultrasonic, Engineered-Structures and LTCC-Based Devices for Acoustics, Fluidics, Optics and Robotics
MINUET
6. FP; NMP2-CT-2004-505657
EC; Wanda W. Wolny, Ferroperm Piezoceramics A/S, Kvistgård, Denmark
Prof. Marija Kosec, Dr. Janez Holc
10. Innovative Ceramic Processing
CERAMOS, Marie Curie Training Site
CERAMOS
5. FP; HPMT-CT-2001-00372
EC
Prof. Marija Kosec, Dr. Andreja Benčan Golob, Prof. Tomaž Kosmač
11. Centre for Advanced Processing, Technologies and Materials for Ceramic Electro and Electromechanical Devices
SICER
5. FP; G1MA-CT-2002-04029
EC
Prof. Marija Kosec, Asst. Prof. Barbara Malič
12. Polar Electroceramics
POLECER
5. FP; G5RT-CT-2001-05024
EC; Wanda W. Wolny, Ferroperm Piezoceramics A/S, KvistgÍrd, Denmark
Prof. Marija Kosec, Asst. Prof. Barbara Malič
13. Electroceramics from Nanopowders produced by Innovative Methods
ELENA
COST 539
EC
Asst. Prof. Barbara Malič
14. Processing and Microstructure Control of Electronic Ceramics
BI-CN/05-07/001
Dr. Hong Wang, Electronic Materials Research Laboratory, Key Lab of Ministry of Education of China, Xi'an Jiatong University, Xi'an, China
Prof. Marija Kosec

R & D GRANTS AND CONTRACTS

1. Hybrid Micro Electromechanical Systems
Dr. Marko Hrovat
2. Capacitive Ceramics: Pressure Sensors
Dr. Marko Hrovat
3. Fuel cell systems as an auxiliary energy sources for autonomous millitary vehicles
Dr. Danjela Kuščer
4. Research and development of piezoelectric micro-electromechanical systems based on Pb(Zr,Ti)O 3 thin films on Si for detection of movement
Asst. Prof. Barbara Malič
5. Hybrid Materials and Structures
Dr. Janez Holc
6. Nano-Structured Surfaces and Interfaces
Asst. Prof. Barbara Malič

RESEARCH PROGRAM

1. Electronic Ceramics , Nano, 2D in 3D Structures
Prof. Marija Kosec

NEW CONTRACT

1. Capacitive Ceramics: Pressure Sensors
HIPOT-RR, d.o.o., Šentjernej
Dr. Marko Hrovat

VISITORS FROM ABROAD

1. Prof. Angus Kingon, North Carolina State University, Raleigh, North Carolina, USA, 8–16 January 2006
2. Fabien Remondiere, B.Sc., SPCTS (Science des Procedes Ceramiques et de Traitements de Surface), Limoges, France, 10–20 January 2006
3. Prof. Rainer Waser, RWTH Aachen University and Research Center Jülich, Germany, 12–15 January 2006
4. Dr. Pierre Marechal, Laboratorie d'Ultrasons Signaux et Instrumentation, Francois-Rabelais University, Tours, France, 8–16 February 2006
5. Dr. Erwan Filoux, Laboratorie d'Ultrasons Signaux et Instrumentation, Francois-Rabelais University, Tours, France, 8–16 February 2006
6. Dr. Jim Drehle, IMAPS, USA, 19 May 2006
7. Bruce Romenesko, The Johns Hopkins University, USA, 19 May 2006
8. Reda Jasoniene, Concern Achema Group, Lithuania, 6 June 2006
9. Eimutis Juzeliunas, Institute of Chemistry, Lithuania, 6 June 2006
10. Bonifacas Vengalis, Semiconductor Physics Institute, Lithuania, 6 June 2006
11. Prof. Hisao Suzuki, Department of Materials Science and Technology, Shizuoka University, Hamamatsu, Japan, 12–16 June 2006
12. Prof. Božena Hilczer, Institute of Molecular Physics, Polish Academy of Sciences, Poland, 19–27 September 2006
13. Dr. Iza Szafraniak, Institute of Molecular Physics, Polish Academy of Sciences, Poland, 19–27 September 2006
14. Dr. Marzia Paderi, Centro Richerche FIAT, Italy, 2–6 October 2006
15. Abel Santos Rosel, Instituto de Ciencia de Materiales de Madrid, Spain, 8–27 October 2006

Long Term Visitors

1. Laila Čakare Samardžija, B.Sc., Institute of Solid State Physics – ISSP, University of Latvia, Riga, Latvia, 31 July 2000 – 31 August 2007
2. Elena Daniela Ion, M.Sc., National Institute for Materials Physics, Magurele, Romania, 18 March 2004 – 30 September 2007
3. Dr. Iulian Boerasu, National Institute for Materials Physics, Magurele, Romania, 1 November 2004 – 20 April 2006
4. Joanna Skrzypek, B.Sc., University of Silesia, Faculty of Informatics and Materials Science, Sosnowiec, Poland, 1 July 2005 – 31 January 2006

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3. Dr. Janez Holc
4. Dr. Marko Hrovat
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11. Dr. Jenny Julie Angeline Tellier
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20. Silvo Drnovšek, B.Sc.
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22. Srečo Maček

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ENGINEERING CERAMICS DEPARTMENT K-6

The Engineering Ceramics Department is the leading group in the field of structural ceramics and ceramic technologies in Slovenia. The research programme comprises phenomena relevant to materials synthesis and component fabrication as well as mechanisms leading to the degradation of engineering ceramic structures under operating conditions. The applied research work is focused on new applications of engineering ceramics, the development of novel, high-strength, wear-, corrosion- and/or heat-resistant materials and the development of alternative, cost-effective and environmentally friendly ceramic technologies.

Head:
Prof. Tomaž Kosmač

In our research on layered ceramic composites with ribbon-like microstructures, prepared by the repeated rolling and folding of laminates made from paraffin pastes and subsequent sintering, we focused mainly on the synthesis and characterization of the aluminium titanate/alumina composites with a 2:1 ratio of the respective components. After the transition from flat-layered to wavy ribbon-like microstructures the strength of the composite was higher than the strength of a particulate composite with a similar composition by 50%. Furthermore, when indented by a Vickers prism the material exhibits pseudo-plastic behaviour and a large degree of isotropy, as well as an isotropic thermal expansion coefficient. An extensive paper relating to this research was sent to J. Ceram. Soc. Jpn., with a review of the theoretical background related to the fabrication of such composites and practical examples that reveal the applicability of the fabrication process and the final products.

Within the study of the reactivity of AlN powder with water the research on powder protection by the adsorption of aluminium dihydrogen phosphate was continued in 2006. The procedure that proved to be very successful for the protection of micrometer particles was extended to nanometre powders of AlN. It was shown that it is possible to protect AlN powder with a particle size of about 100 nm against hydrolysis, without a significant increase in the amount of oxygen on the surface of the particles.

In 2006 the company Interdent from Celje started to trade with dental posts based on zirconia (Figure 1) that were developed in the Engineering Ceramics Department, while a researcher from the Engineering Ceramics Department founded a company in Tolmin that produces such dental posts.

Applicative research on composites made from carbon fibres was continued. We studied the use of various polymer ceramic precursors for the preparation of such materials: the precursors are based on phenol pitches, polysylazanes and polycarboxylanes, with the addition of various active and passive fillers. We found that the properties of the matrix phase and the corresponding mechanical and thermal properties of the composites can be controlled by the addition of these fillers. These composites can be used for the fabrication of brake discs. We continued investigations of the compatibility and wear of sintered brake pads, which are used in combination with brake discs based on C/C-SiC composites. We showed that after the pad and disc are heated to 1000°C during braking, a very thin friction layer of mixed oxides is formed from the metals in the pad on the surface of the brake pad. Furthermore, we explained the mechanism of oxide formation and the influence of the number of brakings on the morphology of the oxide layers.

In the area of new, super-hard composite materials based on the compound $AlMgB_{14-x}TiB_2$ ($x = 0.05–0.3$) we studied, in cooperation with the K9 department and the private researcher V Kevorkijan, the possibilities of sintering these materials at normal pressure, with various additives for sintering facilitation. The results of the research are encouraging since they indicate the possibility of preparing new, super-hard materials at a lower cost.

In the area of bio-ceramics we mostly investigated the preparation of bio-active materials with the mechanical properties necessary for load-bearing bone implants. For this purpose the surfaces of ceramics based on Al_2O_3 or ZrO_2 were coated with a thin layer of bio-active hydroxi-apathite (HA) material. A biomimetic method of precipitating from a super-saturated solution of calcium and phosphate ions was used. The ceramics coated in this way are bio-active, which was proved with in-vitro tests in a simulated body fluid (SBF). Encouraged by good results we investigated more closely the mechanism of the precipitation and growth of HA crystallites on Al_2O_3 and ZrO_2 ceramics. In addition to the preparation of a bio-active coating on the ceramic material with high strength we started to investigate the possibility of preparing bio-active composite material that is composed of a strong matrix based on Al_2O_3 or ZrO_2 and a bio-active secondary phase $CaTi_4(PO_4)_6$ (CTP). We found that the preparation of particulate composites is not possible due to reactions between the matrix and the CTP during sintering; however,

these reactions cause the appearance of a transitional liquid phase that accelerates the matrix densification. Therefore, future research of this kind will be redirected towards a study of the reactive sintering of Al_2O_3 and/or ZrO_2 with small additions of CTP.

Figure 1: Dental posts based on ZrO_2 from serial production

We investigated theoretically the bend strength of flat, multilayered particulate composites. The strength depends on the mechanical and thermal properties of individual layers as well as on their widths. The results indicate that by using an optimal composition (the mass fractions of the components in each layer), microstructure, width and arrangement of the layers it is possible to significantly increase the composite strength in comparison to a monolithic particulate composite, and this strength enhancement is a consequence of the residual thermal stresses in the material. Many experimental and theoretical investigations of the various mechanical properties of multilayered composites were already made; however, they were almost exclusively limited to the cases of either symmetrical composites with a few layers or composites with alternating layers. Our aim was a systematic optimization of the composite structure to achieve the maximal bending strength, including both symmetrical and asymmetrical composites with the optimal number of layers. Alumina-zirconia composites were considered as a model system, since we have already synthesized these composites as a promising material for hip-prosthesis prototypes.

We studied the Weibull statistics of the mechanical properties of brittle construction materials in civil engineering. Repeated measurements of some mechanical quantities such as the bend strength and fracture toughness can be described well by 2-parameter Weibull statistics. This result is important since by using the results of only a limited number of testing measurements it is possible to predict quite accurately the statistical parameters of the products from serial production. As an example of the application of Weibull statistics we analyzed statistically some mechanical properties of corrugated roofing sheets made of fibre-cement composites that are manufactured and regularly tested by the company Esal d.o.o. from Anhovo.

Investigations of dental ceramics based on tetragonal ZrO_2 were going in some different directions in 2006. In addition to the pre-clinical tests on prototype dental posts with a core for affixing the prosthetic crown, which were developed in cooperation with stomatologists from the Medical Faculty in Ljubljana, we focused our attention on the mechanisms and kinetics of accelerated ageing in an aqueous medium and fatigue in artificial saliva of Y-TZP ceramics. In addition, some work was done on developing partially porous Y-TZP ceramics with a high strength and a low Young's modulus. Zirconia is very stiff in comparison to natural dentin, and as a consequence, large elastic stresses appear at the contact between the natural and synthetic materials, which may result in a gap at the contact, leading to secondary caries. We attempted to solve this problem by reducing the Young's modulus of the ceramics, which can be achieved by partial sintering, while on the other hand, we tried to alleviate the negative influence of porosity on the ceramics' strength by controlling the average size and size distribution of the pores.

We also investigated the formation of nanostructural oxide ceramic coatings on a substrate of tetragonal dental Y-TZP ceramic, with the goal to improve the adhesion of dental cement to the surface of the Y-TZP (Figure 2). We succeeded in synthesising thin homogeneous layers of amorphous aluminium hydroxide (AlOOH), with thicknesses up to 100 nm and with a high specific area, so that after the thermal treatment this material transforms into aluminium oxide without a change of morphology. In collaboration with the stomatologists from the Medical Faculty in Ljubljana we measured the adhesion of dental cement to Y-TZP substrates coated in this way, and we obtained up to five times larger values for the adhesion in comparison to Y-TZP substrates without coatings.

In the frame of the research on multilayered composites for antiballistic protection based on SiC the preparation of ceramic powder suspensions for the formation of ceramic pre-shapes, the pyrolysis of an organic medium and the infiltration of silicon into porous moulds were investigated. We showed that the choice of the dispersive medium is the most important parameter in the preparation of these composites, in which a volume fraction of SiC in the composites of more than 80% is required. However, since it is impossible to prepare the suspensions with such a high volume fraction of powders, it is necessary to obtain this fraction of SiC by the reaction of carbon that is formed during the pyrolysis of the dispersive medium with the silicon during the filtration. An appropriate composition of the dispersive medium was obtained by the rarification of polymeric precursors with organic solvents. The model protection plates were fabricated by pouring the suspensions into a metal mould. After the shaping, netting and pyrolysis we obtained the pre-shapes, which made possible the formation of an appropriate composite microstructure after the infiltration of silicon. The prepared samples' dimensions changed very little during the whole process, which confirms the assumption that any additional machining of the infiltrated products is unnecessary. This procedure was also used for the fabrication of samples with more layers. Repeated casting of the

suspension into the mould enables the use of suspensions that differ in terms of the composition (silicon carbide and/or boron carbide), the size of the particles and the use of graphite and/or silicon carbide cloth between the individual layers. We determined the conditions and the compositions of the suspensions that do not lead to the separation of layers during subsequent processes, e.g., drying, fixing and the pyrolysis of pre-forms.

Besides the research work, the staff of the Engineering Ceramics Department conducted several R&D projects for industrial partners and other end-users of bio- and engineering ceramics. In the frame of our long-lasting cooperation with the AET d.o.o. factory from Tolmin the research support of technological processes, with the emphasis on improving the quality and lowering the costs, was continued. We developed a method of direct mixing of ceramic powders into a paraffin suspension, which brings a significant cost efficiency to the existing technology for the preparation of material for injection. For this purpose it was necessary to change the composition of the powders for the suspensions in such a way as not to alter the subsequent process (shaping, removal of binders and sintering). Using the new method of suspension preparation an improvement in the mechanical properties of sintered ceramics as well as better dimensional control of the sintered products and better repeatability of the process were achieved. Furthermore, in cooperation with the researchers from AET d.o.o. we developed a new mixture for the fabrication of ceramics with a high alumina weight content (96%) by adding a mixture of manganese and titanium oxide as a secondary phase, with the aim of achieving better wear resistance. Owing to the formation of a transient liquid phase with a low melting point the sintering of such a composite ceramic material takes place at 300°C to 400°C lower temperatures than those for "standard" ceramics with a high alumina content and with additions of silicates. The goal of this research is to determine the optimal composition of the liquid phase and the appropriate sintering conditions to obtain a small-grain-size microstructure and improved mechanical properties and wear resistance of sintered ceramics.

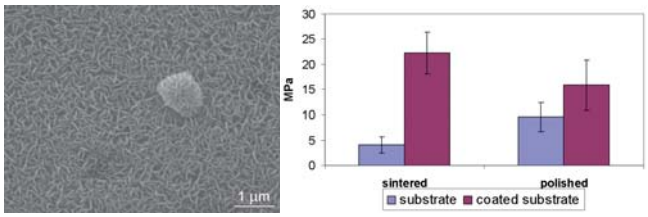

Figure 2: Nanostructural ceramic coating from aluminium oxide on the substrate of tetragonal dental Y-TZP ceramics and its influence on the adhesion of dental cement to the surface of Y-TZP

In the frame of a project that was also financed by the company AET d.o.o., we studied the densification, phase composition, microstructure, mechanical and electrical properties of reaction-sintered non-oxide ceramic materials with dispersed TiN particles. The matrix phase of the composite material was a ceramic based on Si_3N_4, SiAlON and AlN/SiC/Si_3N_4 composites, to which TiO_2 was added. We found that TiO_2 transforms into a conducting TiN or TiCN during reaction sintering, irrespective of the matrix phase used. The ceramic composites made in this way are electrically conducting, mechanically strong and corrosion resistant, thus they are suitable candidates for the production of various ignition and heating elements, e.g., glow-plugs for diesel engines, furnace igniters and other ceramic heaters. This research is also financed by the Iskra ISD company from Kranj.

The cooperation with the company MS Production from Bled in the area of the research and development of C/C-SiC composites with a double matrix for the production of brake disks was continued, and the composites exhibit good mechanical and friction properties and a good oxidation resistance. The cooperation with the same partner was extended to include research on multilayered composites for antiballistic protection based on SiC. This research was also supported by the Ministry of Defence.

Some outstanding publications in the past three years

1. Kristoffer Krnel, Tomaž Kosmač. The role of chemisorbed anions in the aqueous processing of AlN powder: dedicated to professor dr. Fritz Aldinger on the occasion of his 65th birthday. Z. Met. Kd., 2006, vol. 97, p. 645–648.
2. Aleš Dakskobler, Tomaž Kosmač. Preparation and properties of aluminium titanate-alumina composites with a corrugated microstructure. J. Mater. Res., 2006, vol. 21, p. 448–454.
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B. SC. THESES

1. Lovro Gorjan: "Preparation of the suspensions for the fabrication of alumina products by injection moulding", defence, (T. Kosmač, S. Pejovnik)
2. Aljoša Maglica: "Si_3N_4 ceramic composites with dispersed TiN particles", (T. Kosmač, S. Pejovnik)

INTERNATIONAL PROJECTS

1. Network for Nanostructured Materials of ACC
   NENAMAT
   6. FP; INCO-CT-2003-510363
   EC
   Prof. Jan Dusza, Institute of Materials Research - Slovak Academy of Sciences, Kosice, Slovakia
   Prof. Tomaž Kosmač
2. Innovative Ceramic Processing
   CERAMOS, Marie Curie Training Site
   5. FP; HPMT-CT-2001-00372
   EC
   Prof. Tomaž Kosmač, Prof. Marija Kosec, Dr. Barbara Malič
3. Low Pressure Injection Molding of Near-Net Shaped Piezoelectric Ceramics
   U3-MM/K6-06-028
   Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials Group, Changwon, Korea
   Prof. Tomaž Kosmač, Asst. Prof. Miran Čeh
4. Design and Development of Functionally Graded SiAlON Ceramics
   BI-TR/04-07-007
   Prof. Hasan Mandal, Anadolu University, Faculty of Engineering and Architecture, Department of Materials and Engineering, Eskişehir, Turkey
   Prof. Tomaž Kosmač

R & D GRANTS AND CONTRACTS

1. Development of light, superhard composite materials based on AlMgB14-xTiB2
   Dr. Kristoffer Krnel
2. Research of C/C-SiC ceramic matrix composites for braking systems
   Dr. Kristoffer Krnel
3. Development of multifunctional B4C-Al and B4CMg composite materials for new products
   Prof. Tomaž Kosmač
4. Multilayered composites based on SiC for ballistic protection
   Dr. Aleš Dakskobler
5. Synthesis of nanoparticles and nanocomposites
   Prof. Tomaž Kosmač

RESEARCH PROGRAM

1. Engineering and bio-ceramics
   Prof. Tomaž Kosmač

NEW CONTRACTS

1. Development of wear-resistant ceramics
   AET, d.o.o., Tolmin
   Prof. Tomaž Kosmač
2. Development of a fabrication method for C/C-SiC composites with ceramic matrix for braking systems
   MS PRODUCTION, Miklavž Zornik, s.p., Bled, Slovenia
   Prof. Tomaž Kosmač
3. Development of a ceramic heater
   HIDRIA AET, d.o.o., Tolmin
   Prof. Tomaž Kosmač
4. Development of a ceramic heater
   Iskra ISD, d.d., Kranj - Industry of constituent parts
   Prof. Tomaž Kosmač

VISITORS FROM ABROAD

1. Ayse Kalemtas, Nurcan Calis-Acikbas, Anadolu University, Faculty of Engineering and Architecture, Department of Materials Science and Engineering, Eskişehir, Turkey, 13–25 March 2006
2. Prof. Hasan Mandal, Anadolu University, Faculty of Engineering and Architecture, Department of Materials Science and Engineering, Eskişehir, Turkey, 22–25 March 2006
3. Prof. Hasan Mandal and Dr. Ferhat Kar, Anadolu University, Faculty of Engineering and Architecture, Department of Materials Science and Engineering, Eskişehir, Turkey, 23–26 July 2006
4. Dr. Jae-Ho Jeon, Ceramic Materials Team, Korea Institute of Machinery and Materials, Sangnam-Dong, Chwangwon, Korea, 7–16 December 2006
5. Dr. Hans-W. Gundlach, DG Dental e.k., Bremen, Germany, 11 December 2006

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DEPARTMENT FOR NANOSTRUCTURED MATERIALS K-7

The basic and applied research in the Department for Nanostructured Materials includes ceramic materials, intermetallic alloys and minerals. Our research encompasses conventional processing as well as the development of new technologies and methods for preparing new materials with novel properties. It includes experimental and theoretical investigations of structures, analyses of chemical compositions at the atomic level, and measurements and calculations of physical properties, all of which help us to improve the properties of micro- and nanostructured materials.

Head:
Prof. Spomenka Kobe

In the frame of the European Network of Excellence called CMA (Complex Metallic Alloys) we studied materials with the potential for **hydrogen storage** in the systems $Ti_{40}Zr_{40}Ni_{20}$, $Ti_{45}Zr_{35}Ni_{17}Cu_3$, $Ti_{40}Hf_{40}Ni_{20}$, $Ti_{45}Hf_{35}Ni_{17}Cu_3$. Elemental powders were mixed in the proper ratios and mechanically alloyed in a planetary ball-mill in an argon atmosphere. After different alloying times (0, 20, 40, 60, 80 and 100 hours) we analysed the samples using x-ray diffraction, vibrating-sample magnetometry and differential scanning calorimetry. The last of these provided us with crystallization temperatures, enthalpies and activation energies of the various samples. We also did the amorphisation of the $Ti_{40}Zr_{40}Ni_{20}$ material in a hydrogen atmosphere, but this material remained partially crystalline and very reactive to the air because the surfaces of the nanoparticles were very clean. We published an article in the Journal of Alloys and Compounds and presented our results at the 14th Conference on Materials and Technologies in Portorož, Slovenia. We completed the installation of our external laboratory and a device for high-pressure hydrogen absorption. Hydrided Ni–Ti–Zr/Hf samples (amorphous and crystalline) were sent to Korea for deuterization; these samples were subsequently analysed by ^{2}HMNR at the F5 department.

We analysed the atomic-scale structure and chemistry of (111) twins in $MgAl_2O_4$ spinel crystals from the Pinpyit locality near Mogok (Myanmar) using the complementary methods of high-resolution transmission electron microscopy (HRTEM).

We continued our research on **thin films of intermetallic alloys** of rare earths and transition metals prepared by pulsed-laser deposition and characterized using SQUID magnetometry, scanning electron microscopy (SEM), x-ray photoelectron spectroscopy (XPS) and atomic-force/magnetic-force microscopy.

We started research in the field of magnetocaloric materials for use in magnetic coolers. This work is focused on the $Gd_5(Si_xGe_{1-x})_4$ system. Samples with different compositions were produced using two methods, arc-melting and mechanical alloying, both with subsequent homogenization. The samples were then characterized with powder x-ray diffraction (XRD), SEM and transmission electron microscopy (TEM). The final goal is to process a **material with a large magnetocaloric effect** that will be cheaper than the existing Ga, the material which is currently used for this application.

We investigated technologically interesting materials using calculations within the framework of the density-functional theory. Research was focused on the **magnetism of monatomic nanowires** and on the influence of nonmagnetic substrates on their properties, as well as on the simulation of the nuclear-magnetic resonance (NMR) spectra of complex metallic alloys.

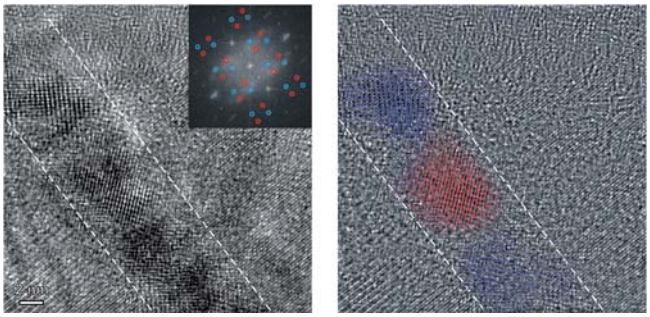

Figure 1: Nanotwins of ilmenite between (301) twinned rutile

In the field of **ZnO ceramics**, grain-growth studies indicated that inversion boundaries (IBs) are growth faults that control the growth of ZnO grains. Low-temperature experiments have shown that in the ZnO–SnO_2 system IBs form before the Zn_2SnO_4 spinel phase and grains with IBs grow exaggeratedly at the expense of the normal ZnO grains until they completely dominate the microstructure. Depending on the oxidation state of the IB-forming dopant we have identified two competing mechanisms of IB nucleation: (i) internal diffusion, and (ii) surface nucleation and growth. The first mechanism is typical for III+ dopants and is controlled by Zn-vacancy diffusion, whereas the second mechanism holds for all IB-forming dopants and is controlled by the chemisorption of the dopants on Zn-deficient (0001) surfaces. In both cases the driving force for the inversion is the preservation of the local charge balance.

We continued our research within the European fusion programme EURATOM/Fusion. The development of a **SiC/SiC composite for the first-wall blanket of a future fusion reactor** was largely focused on densification studies of SiC-based matrix material. By using the complementary techniques of high-resolution TEM and XPS we

studied (in collaboration with the F4 department) the surface composition of SiC powders and its effect on densification. We developed techniques for modifying SiC powder with a thin coating of aluminium or magnesium hydroxide. The results show that a 2–3-nm-thick AlOOH layer makes the powder behave in an alumina-like way. The colloidal behaviour of suspensions and the properties of SiC fibres were also investigated with the aim to effectively infiltrate SiC-fibre woven using vacuum slip infiltration or electrophoretic deposition (EPD). We studied the wettability of the hydrophobic SiC fibres with two different silicones, polymer and surface-active agents and different coatings on the SiC fibres (carbon, CrN). The microhardnesses of both the components of the SiC/SiC composite prepared using infiltration were measured, and the propagation of the obtained cracks was observed.

Research was focused on the magnetism of monatomic nanowires and on the influence of the nonmagnetic substrate on their properties, as well as on the simulation of the nuclear-magnetic resonance (NMR) spectra of complex metallic alloys.

The basic research on **EPD** was focused on the deposition of alumina powder from ethanol-based suspensions, where we used submicrometer and nanometre powder. We studied the colloidal properties of alumina-ethanol suspensions and on the basis of the obtained results we prepared suitable suspensions for EPD. The microstructures of the EPD compacts were characterized by SEM. Since the nanometre alumina powder is highly agglomerated, which has a negative effect on the final density of the sintered compacts, we tried to find a suitable de-agglomeration technique.

The research on the tribological behaviour of ceramic materials was continued in collaboration with the Faculty for Mechanical Engineering, University of Ljubljana. Functionally graded composites of Al_2O_3–ZTA–Al_2O_3, developed in the frame of the EU's 5FP Biograd were investigated, and it has been shown that due to residual compressive stresses in the alumina surface layer, the wear resistance of the composite is higher than that for monolithic alumina. Furthermore, **a new concept for the boundary lubrication of ceramics** based on water using surface-charge adjustment was published.

In the frame of a new EU 6FP Integrated Project we began a collaboration with an international team with the aim to develop **a new generation of bone implants** with improved integration. Within the project, a coating that should improve the implant's integration with bone tissue and prevent early inflammation will be developed. By engineering the substrate and coating the macro- and microstructure, natural bone will be imitated. Accordingly, the research is supported by a study of the self-organization of natural skeletons. We also began research in the field of bone-tissue engineering. Commonly used bone implants that are usually made of titanium alloys often lead to stress shielding of the bone and can cause bacterial infections, which requires another operation. For this reason the aim of our work was to modify the implant's surface to obtain a structural similarity between the bone and the implant and thus enable osseointegration (the integration of the bone and the host tissue). At the same time, with the deposition of biocompatible and bioactive coatings, like bioglasses and calcium phosphate, we want to improve the bioactivity that will stimulate osseointegration and prevent the formation of a biofilm on the implant surface that can cause inflammation after surgery.

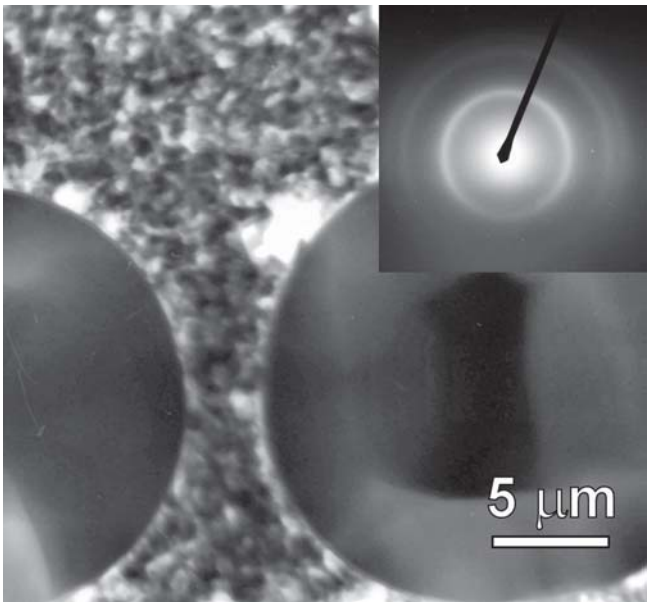

Figure 2: TEM (transmission electron microscopy) micrograph of the cross-section of amorphous SiC fibres embeded in fine-grained SiC matrix.

The synthesis of **perovskite nanowires** based on template-assisted processing via sol-gel EPD was studied. As a starting material for the fabrication of perovskite nanowires $SrTiO_3$-, $BaTiO_3$- and $CaTiO_3$-based ceramics were implemented. In this study we are promoting a new synthesis procedure, which enables the structuring of the perovskite in the form of nanowires with a high aspect ratio. The development of the fabrication of such perovskite nanowires promises various interesting industrial applications in the field of nanotechnology.

As a result of extensive research on the whereabouts of minerals in Slovenia we have prepared **a book entitled 'Mineral localities of Slovenia'**. In this book we have documented the most important mineralogical treasures of Slovenia. Compared to other similar works in this field we have specifically focused on the relations between individual mineral occurrences and their geological setting and tectonics. The book describes the basic principles of rock formation, their recrystallization during tectonic processes and the setting up of the conditions for crystal nucleation and growth. The book has 384 pages and describes 43 of the most important surface mineral localities in Slovenia.

In the field of analytical electron microscopy our studies were focused on the development and **implementation of** high-resolution high-angle annular dark-field scanning-transmission electron microscopy **(HAADF-STEM) (Z-contrast)**, which enables a quantitative determination of the chemical composition on an atomic scale by using HAADF-STEM imaging. The algorithm is based on a quantitative correlation between simulated and experimental HAADF-STEM images. The final result of the HAADF-STEM analysis is a corresponding atomic model with an optimized chemical composition of the individual atomic columns. In the case of $Ba_2NaNb_5O_{10}$, with a complex tunsgten bronze-type structure, we showed that the local lattice distortions significantly influence the experimentally determined intensities of the atomic columns. A quantitative interpretation of the intensities, i.e., the determination of the chemical composition, is only possible if the exact crystal structure and the value of the Debye-Waller factor are known. Only then can the intensities of the atomic columns in simulated images correspond to the true values and be succesfully compared with the intensities in simulated images. HAADF-STEM was also used to determine the thickness and deformation of the crystal lattice of individual GaN and GaAlN layers in a GaN/GaAlN superstructure, which was composed of 200 consecutive GaN and GaAlN layers.

We analyzed the atomic-scale structure and chemistry of **(111) twins in $MgAl_2O_4$ spinel crystals** from the Pinpyit locality near Mogok, Myanmar, using complementary method of high-resolution transmission electron microscopy (HRTEM). The (111) twins in spinel can be crystallographically described by a 180° rotation of the oxygen sublattice normal to the twin composition plane. This operation generates a local hcp stacking in an otherwise ccp lattice and maintains the regular sequence of kagome and mixed layers. This stacking is triggered by the presence of beryllium, which replaces magnesium cations in the twin-boundary tetrahedral sites. The Be-rich twin-boundary structure is closely related to the $BeAl_2O_4$ (chrysoberyl) and taaffeite group of intermediate polytypic minerals. Based on this we conclude that the formation of (111) twins in spinel is a preparatory stage of polytype formation (taaffeite) and is a result of the thermodynamically favourable formation of hcp stacking due to Be incorporation in the {111} planes of the spinel structure in the nucleation stage of crystal growth. In addition to spinel twins we also clarified the mechanism for the formation of (301) rutile twins from Diamantina (Brazil). HRTEM analyses revealed that these twins contain ilmenite lamella (up to a few nanometres thick) between the rutile domains in the orientation relationship $(301),[010]_R \mid (10.0),[00.1]_I \mid (301),[010]_R$. The ilmenite lamella is additionally twinned, which suggests its mechanism of formation from primary hydroxides. The contact (301) rutile twins grow from hydrothermal solutions in which grains with a tivanite-type structure (rutile-goethite intergrowths) form at the beginning. These grains are already twinned because of the mechanism of their formation. On monoclinic tivanite platelets, which are additionally twinned, rutile is able to crystallise in two twinned orientations on both sides of the grain. The tivanite lamella is transformed to ilmenite in a subsequent process of recrystallisation.

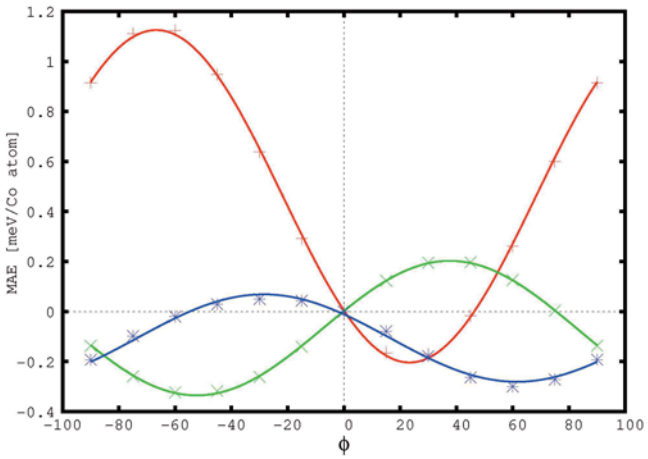

Figure 3: The calculated magnetic-anisotropy energy for a Pt-supported Co nanowire as a function of the magnetization direction in the plane perpendicular to the wire by taking into account the spin-orbit coupling for all atoms (red), and just the Co (green) or Pt atoms (blue).

As part of an international collaboration with Korea, piezoelectric bulk PMN-PT single crystals were studied. The microstructure, orientation and composition of PMN-PT single crystals grown from a $BaTiO_3$ single-crystal seed were studied in detail using advanced electron-probe micro-analysis wavelength-dispersive spectroscopy (EPMA-WDXS) and the electron-backscatter diffraction (EBSD) technique.

Some members of the department are, with part of the research and development program, heavily involved in managing the Center for Electron Microscopy within the frame of the national infrastructure Center for Microstructural and Surface Analysis. The implementation of various electron-microscopy analytical techniques and the possibility for researchers to access a research infrastructure for electron microscopy is of utmost importance for numerous research institutions, industrial partners as well as for graduate and post-graduate education. The analyses and expertise in the field of transmission electron microscopy, electron-probe microanalysis (SEM, energy-dispersive x-ray spectroscopy, WDXS) can be used to help industry and other research institutions, ETA-Cerkno, Comet, LEK, Belinka, EMO-Kemija, Gorenje-NO, Kemijski Inštitut, Donit-Tesnit, BIA-Separations, Faculty of Natural Sciences, University of Ljubljana, as well as other departments from the Jožef Stefan Institute (F3, K3, F4, F7 and F5).

Dr. Nina Daneu, a member of the Department for Nanostructured Materials, was one of the three recipients of the Jozef Stefan Golden Emblem Prize for the most outstanding contributions to science in PhD dissertations in the field of natural sciences in Slovenia.

Awards and appointments

1. Dr. Nina Daneu: Jožef Stefan Golden Emblem Prize for the most outstanding contributions to science in PhD dissertations in the field of natural sciences in Slovenia, Ljubljana, Jožef Stefan Institute, 24 March 2006
2. Andraž Kocjan: "Ti-Zr(Hf)-Ni Quasicrystals for Hydrogen Storage". Winning contribution in the young scientists' lecture competition at the 14th Conference on Materials and Technologies, Portorož, 16–18 October 2006

Organization of conferences, congresses and meetings

1. 14th Conference on Materials and Technology, Portorož, 16–18 October 2006 (co-organisation)
2. European School in Materials Science, Ljubljana, 22–27 May 2006 (co-organisation)
3. Nineteenth International Workshop on Rare Earth Permanent Magnets and Their Application (REPM'06), Beijing, China, 26 August – 1 September 2006 (members of the International Scientific Advisory Committee)
4. 16th International Microscopy Congress (IMC16), Sapporo, Japan, 3–8 September 2006 (members of the International Scientific Advisory Committee)

Some outstanding publications in 2006

1. M. Komelj, Influence of the substrate on the magnetic anisotropy of monatomic nanowires, Phys. Rev. B 73 (2006), 134428.
2. M. Kalin, S. Novak, J. Vižintin, Surface charge as a new concept for boundary lubrication of ceramics with water, J. phys., D, Appl. Phys., 39 (2006), 3138-3149.
3. M. Shiojiri, M. Čeh, S. Šturm, C. Chuo, J. T. Hsu, J. R. Yang, H. Saijo, Structural and compositional analyses of a strained AlGan/GaN superlattice. J. Appl. Physcs., 100 (2006), 03110-1-03110-7.

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2. Janez Dolinšek, Paul J. McGuiness, Martin Klanjšek, I. Smiljanić, Ana Smontara, E. S. Zijlstra, S. K. Bose, I. R. Fisher, M. J. Kramer, P. C. Canfield
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4. Mitjan Kalin, Goran Dražić, Saša Novak, Jože Vižintin
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5. Mitjan Kalin, Saša Novak, Jože Vižintin
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In: J. phys., D, Appl. phys., Vol. 39, pp. 3138-3149, 2006.
6. Matej Komelj, Manfred Fähnle
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7. Matej Komelj, Daniel Steiauf, Manfred Fähnle
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8. Massimiliano Liberatore, Franco Decker, Angela Šurca Vuk, Boris Orel, Goran Dražić
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9. Darja Lisjak, Paul J. McGuiness, Mihael Drofenik
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10. Darko Makovec, Zoran Samardžija, Mihael Drofenik
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11. Paul J. McGuiness, David Jezeršek, Spomenka Kobe, Boštjan Markoli, Savo Spaić
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13. Evangelia Sarantopoulou, Zoe Kollia, Alciviadis-Constantinos Cefalas, Zoran Samardžija, Spomenka Kobe
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15. Angela Šurca Vuk, Robi Ješe, Miran Gaberšček, Boris Orel, Goran Dražić
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24. Aleksander Rečnik
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2. Uroš Herlec, Bojan Režun, Aleksander Rečnik, Feliks Poljanec
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Invited Paper

1. Miran Čeh, Sašo Šturm, Hui Gu, Makoto Shiojiri
Qualitative and quantitative interpretation of atomic-resolution HAADF-STEM images
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1. Saša Novak, Milan Čerček
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2. Saša Novak, Goran Dražić, Katja Mejak
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3. Saša Novak, Katja Mejak, Goran Dražić
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4. Zoran Samardžija
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THESES

B. Sc. Theses

1. David Jezeršek, 100-µm-thick Nd–Fe–B sintered magnets for MEMS applications (Asst. Prof. Milan Bizjak, Prof. Spomenka Kobe)
2. Saša Rustja, The influence of binary phases from the BaO-Bi_2O_3 system on microstructure development of the ZnO ceramics (Prof. Stane Pejovnik, Dr. Slavko Bernik)
3. Nataša Drnovšek, Preparation of the silicon carbide based material suitable for fusion reactor applications (Prof. Stane Pejovnik, Asst. Prof. Saša Novak)

PATENT APPLICATION

1. Saša Novak, Katja Mejak, Stojana Veskovič Bukudur, Hydrophobisation of ceramic powder by organic coating in aqueous suspension: Patent application No.: 200600004, Ljubljana, Slovenian Intellectual Property Office, Ljubljana, Slovenia, 2006.

INTERNATIONAL PROJECTS

1. Multifunctional Bioresorbable Biocompatible Coatings with Biofilm Inhibition and Optimal Implant Fixation
6. FP
MEDDELCOAT
NMP3-CT-2006-026501
EC; Prof. Jozef Vleugels, Katholieke Universiteit Leuven, Research & Development, Leuven, Belgium
Asst. Prof. Saša Novak Krmpotič
2. Enabling Science and Technology through European Electron Microscopy
ESTEEM
6. FP; 026019
EC; Prof. Gustaaf Van Tendeloo, Universiteit Antwerpen, Antwerpen, Belgium
Asst. Prof. Miran Čeh
3. Complex Metallic Alloys
CMA
6. FP
NMP3-CT-2005-500140
EC; Centre National de la Recherche Scientifique, Paris, France
Prof. Spomenka Kobe, Prof. Janez Dolinšek, Dr. Peter Panjan
4. Gas Impermeable Coatings for SiC/SiC - UT1
EURATOM – MHEST
SICOAT
6. FP, EURATOM, Slovenian Fusion Association – SFA
FU06-CT-2004-00083, 3211-05-000017

EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Saša Novak Krmpotič, Asst. Prof. Goran Dražič

5. Novel Processing of SiC/SiC by Vacuum Slip-Infiltration of SiC Fibre Preforms - UT2
EURATOM – MHEST
SIC-VSI
6. FP, EURATOM, Slovenian Fusion Association – SFA
FU06-CT-2004-00083, 3211-05-000017
EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Goran Dražič, Asst. Prof. Saša Novak Krmpotič
6. Strengthening the Role of Women Scientists in Nano-Science
WOMENINNANO
6. FP
SAS6, 016754
EC; Dr. Annett Gebert, IFW Dresden, Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden E.V., Dresden, Germany
Prof. Spomenka Kobe
7. Slovenian Fusion Association, Public Information
EURATOM – MHEST
6. FP, EURATOM, Slovenian Fusion Association – SFA
FU06-CT-2004-00083, 3211-05-000017
EC; RS, Ministry of Higher Education, Science and Technology, Ljubljana, Slovenia
Asst. Prof. Saša Novak Krmpotič
8. Fuel Storage Nano-Composites Fabricated by Pulse Laser Deposition – PLD
BI-GR-04-06-019
Prof. A. C. Cefalas, National Hellenic Research Foundation, Theoretical and Physical Chemistry Institute, Athens, Greece
Prof. Spomenka Kobe
9. Hydrogen Storage in Ni-Ti-Zr-Hf Quasicrystals
BI-HR/06-07-020
Dr. Muhamed Sućeska, Dr. Maša Rajić Linarić, Brodarski Institute, Laboratory for thermical analyses, Zagreb, Croatia
Dr. Paul McGuiness
10. Precipitation of Calcium Carbonate in the Magnetic Field
BI-HR/05-06-031
Dr. Sc. Damir Kralj, Rudjer Boskovic Institute, Zagreb, Croatia
Prof. Spomenka Kobe
11. Study of Remodelling of Bone-ceramic Interface to Assess Cell Growth Kinetics as a Function of Composition and Morphological Modification of Ceramic Implant
BI-IN/06-07-009
Prof. Basu Debabrata, Central Glass & Ceramic Research Institute, Calcutta, India
Dr. Nina Daneu
12. Controlled Processing of ZnO Based Varistor Ceramics
SLO-JPN
Dr. Toshiyuki Isshiki, Kyoto Institute of Technology, Faculty of Engineering and Design, Dept. Electronics & Information Science, Matsugasaki, Sakyo-ku, Kyoto, Japan
Dr. Nina Daneu
13. IMAGE-WARP: Processing of Atomic-Resolution HAADF-STEM Images
SLO-JPN
Dr. Hiroshi Saijo, Kyoto Institute of Technology, Faculty of Engineering and Design, Dept. Electronics & Information Science, Matsugasaki, Sakyo-ku, Kyoto, Japan
Dr. Aleksander Rečnik
14. Electronic Ceramics with Interface Control of Electrical Properties
BI-CN/05-07/006
Prof. Hui Gu, Shanghai Institute of Ceramics, Shanghai, China
Asst. Prof. Miran Čeh
15. Enviromental Hydrogen-based Recycling of Nd-Fe-B Magnets
BI-CN/05-07/008
Dr. Gaolin Yan, Harbin Institute of Technology, ShenZhen Graduate School, HIT Campus of ShenZhen University Town, XiLi, ShenZhen, China
Dr. Paul McGuiness
16. Low Pressure Injection Molding of Near-Net Shaped Piezoelectric Ceramics
U3-MM/K6-06-028
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials Group, Sangnam-Dong, Changwon, Korea
Asst. Prof. Miran Čeh, Prof. Tomaž Kosmač
17. Interface Analysis of Piezoelectric Ceramic Materials
U3-MM/K7-05-015
Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials (KIMM), Ceramic Materials Group, Sangnam-Dong, Changwon, Korea
Asst. Prof. Miran Čeh
18. Novel Possibilities for the Processing of ZnO - Based Varistor Ceramics
BI-PL/04-05-009
Dr. Witold Mielcarek, Electrotechnical Institute - IEL, Wrocław, Poland
Dr. Slavko Bernik
19. Orientation Imaging Microscopy and Microanalysis Applied to Advanced Materials
BI-PL/04-05-010
Dr. Marek Faryna, Polish Academy of Sciences, Institute of Metallurgy and Materials Science, Krakow, Poland
Asst. Prof. Goran Dražič
20. Improved Materials Processing Through Tailoring the Surface Characteristics of Nano- and Micro Sized Powders
BI-PT-04-06-016
Prof. Jose Maria Fereirra, Universidade de Aveiro, Department of Ceramics and Glass Engineering, Aveiro, Portugal
Asst. Prof. Saša Novak Krmpotič
21. Development of Varistor Ceramics with Reduced Amount of Dopants and Improved Microstructural and Electrical Characteristics
BI-SCG/05-06-009
Dr. Zorica Branković, Center for Multidisclipinary Studies of the Belgrade University, Belgrade, Serbia and Montenegro
Dr. Slavko Bernik
22. Development of Single Crystalline and Electroceramic Materials by Sintering Process
BI-TR/05-08-002
Prof. Mehmet Ali Gülgün, Sabanci University, Orhanli Tuzla, Instanbul, Turkey
Asst. Prof. Miran Čeh
23. Texturing and Characterisation of ZnO-based Ceramics
BI-TR/05-08-003
Prof. Ender Suvaci, Anadolu University, Department of Materials Science and Engineering, Iki Eylus Campus, Eskisehir, Turkey
Dr. Slavko Bernik
24. A Hydrogen-storage Device for Low-cost, Environmentally Friendly Transportation
PSP
BI-GB/06-010
Prof. Ivor Rex Harris, The University of Birmingham, School of Metallurgy and Materials, Birmingham, Great Britain
Dr. Paul McGuiness, Prof. Spomenka Kobe

R & D GRANTS AND CONTRACTS

1. Layered ceramic nanostructures and 2D nanoparticles arrays
Asst. Prof. Miran Čeh
2. Fabrication of novel thin films by pulser-laser ablation with in situ ICP-MS analysis of target plumes for deposition control
Prof. Spomenka Kobe
3. Nanostructural engineering of semiconducting materials
Dr. Aleksander Rečnik
4. A development of low-activation material for the first wall in fusion reactor
Asst. Prof. Saša Novak Krmpotič
5. Nanostructural investigations of special boundaries in minerals
Dr. Nina Daneu, Prof. Tadej Dolenec
6. Qualitative Z-contrast microscopy of functional ceramics
Prof. Spomenka Kobe, Dr. Sašo Šturm
7. Hard magnetic Co-Pt thin films produced with electrodeposition
Prof. Spomenka Kobe, Dr. Kristina Žužek Rožman
8. Exploration and preservation of Slovenian mineralogical heritage
Dr. Aleksander Rečnik
9. Application of new technologies to prevent scaling in industrial flow systems
Prof. Spomenka Kobe
10. Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-hydride batteries
Dr. Paul McGuiness
11. Research of degradation mechanisms and improvement of properties of metallized film capacitors
Asst. Prof. Miran Čeh
12. Development of tissue engineered bone for use in periodontology, traumatology and orthopaedic surgery
Asst. Prof. Miran Čeh
13. Development of Graetzl-type photo-electrochemical cells
Asst. Prof. Goran Dražić
14. New generation of elements and devices for protection against transient surges (CoE Materials for electronics of next generation and other emerging technologies)
Dr. Slavko Bernik
15. Magnetic materials and intermetallic alloys (CoE Materials for electronics of next generation and other emerging technologies)
Prof. Spomenka Kobe
16. Nanostructured surfaces and interfaces (CoE Nanosciences and nanotechnologies)
Asst. Prof. Goran Dražić
17. Characterization on the nanometric scale (CoE Nanosciences and nanotechnologies)
Asst. Prof. Miran Čeh

RESEARCH PROGRAM

1. Nanostructured materials
Prof. Spomenka Kobe

NEW CONTRACTS

1. Analytical electron microscopy of metallic samples
   Faculty for Natural Sciences, University of Ljubljana
   Asst. Prof. Goran Dražić
2. Cooling systems based on magneto-caloric effect
   PROKOL d.o.o. Idrija
   Prof. Spomenka Kobe
3. Rare-earth-transition-metal alloys for high-energy permanent magnets and metal-hydride batteries
   Magneti, d. d., Ljubljana
   Dr. Paul McGuiness
4. Application of new technologies to prevent scaling in industrial flow systems
   Termoelektrarna-Toplarna, d.o.o., Ljubljana
   Prof. Spomenka Kobe
5. Dual energy varistor for impulse currents
   Varsi, d.o.o., Ljubljana
   Dr. Slavko Bernik
6. Exploration and preservation of Slovenian mineralogical heritage
   Mežica Lead and Zinc Mine, Mežica; Idrija Mercury Mine, Idrija, Slovenian Museum of National History, Ljubljana
   Dr. Aleksander Rečnik

VISITORS FROM ABROAD

1. Lorraine Neale, University of Birmingham, Birmingham, United Kingdom, 29 January – 1 February 2006
2. Werner Rechberger, M.Sc., Technische Universität Graz, Graz, Austria, 12–25 February 2006
3. Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials – KIMM, Changwon-city, Kyeongnam, South Korea, 1–4 March 2006
4. Prof. Isao Tanaka, Kyoto Institute of Technology, Kyoto, Japan, 23–25 April 2006
5. Prof. Constaninos Cefalas, National Hellenic Foundation - NHRF, Theoretical and Physical Chemistry Institute, Athens, Greece, 3–7 May 2006
6. Dr. Christina Scheu, Gert Gassner, Montanuniversität Leoben, Leoben, Austria, 8–10 May 2006
7. Prof. Hui Gu (10–17 May 2006) and Xian-Hao Wang (10 May – 6 June 2006), Shanghai Institute of Ceramics, Chinese Academy of Sciences, Shanghai, China
8. Prof. Jose Maria Ferreira, Universidade de Aveiro, Aveiro, Portugal, 23–30 June 2006
9. Dr. Goran Branković, Dr. Zorica Branković, Centar za multidisciplinarne studije, Univerzitet u Beogradu, Belgrade, Serbia, 28 June – 3 July 2006
10. Dr. Maša Rajić Linarić, Dr. Davor Linarić, Brodarski institute, Zagreb, Croatia, 3 July 2006
11. Katarina Vojisavljević, Milan Žunić (7–18 August 2006) and Katarina Djuriš, (7 August – 1 September 2006), Centar za multidisciplinarne studije, Univerzitet u Beogradu, Belgrade, Serbia
12. Jerika Suely Lamas, Falculdade de Engenharia Quimica de Lorena, São Paulo, Brazil, 6 July – 31 August 2006
13. Prof. Ivor R. Harris, University of Birmingham, Birmingham, United Kingdom, 7–10 October 2006
14. Dr. Wilfried Sigle, Rainer Höschen, Max-Planck-Institut für Metallforschung, Stuttgart, Germany, Christian Dietl, Karl Zeiss, Oberkochen, Germany, 5–8 November 2006
15. Dr. Jae-Ho Jeon, Korea Institute of Machinery and Materials – KIMM, Changwon-city, Kyeongnam, South Korea, 7–16 December 2006
16. Dr. Boriana Rashkova, Erich Schmid Institut für Materialswissenschaft, Montanuniversität Leoben, Österreichische Akademie der Wissenschaften, Leoben, Austria, 12–15 December 2006

STAFF

Researchers

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2. Asst. Prof. Miran Čeh**
3. Asst. Prof. Goran Dražić**
4. **Prof. Spomenka Kobe**, Head**
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20. Matejka Podlogar, B. Sc.
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22. Zoran Samardžija, B. Sc.
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** Part-time faculty member

DEPARTMENT FOR ADVANCED MATERIALS K-9

Research in the Advanced Materials Department is focused mainly on synthesizing and characterizing new inorganic materials. The emphasis is on investigations of high-temperature phase equlibria, the identification of new compounds, and determining their crystal structures and properties. Investigations relating to ceramics with special electrical and magnetic properties and super-hard materials and glasses are of primary importance. In recent years, nanomaterials and nanotechnologies have become an important part of the department's activities.

Head:
Prof. Danilo Suvorov

In 2006 investigations of the program group P2-0089 were focused on three important materials, i.e., magnetic nanoparticles for technological and medical applications, microwave magnetic ceramics for telecommunications, and ferroelectric materials with a high Curie temperature for high-temperature thermistors to replace lead-containing materials. The research on magnetic nanoparticles has tended to look at their functionalization. For biomedical applications, the magnetic nanoparticles should be functionalized with a surface layer of organic molecules, which makes possible the selective bonding of different bioactive molecules to their surfaces, makes them compatible with physiological fluids and prevents them from agglomerating. The bonding of different organic molecules, such as oleic acid or citric acid, has been systematically studied. Stable aqueous suspensions of maghemite magnetic nanoparticles using citric acid as a surfactant have been prepared, and this made it possible to homogeneously coat the nanoparticles with a thin layer of silica. Knowledge related to the dispersion of the magnetic nanoparticles in different media made possible the preparation of new composite materials. In cooperation with researchers from the National Institute of Chemistry in Ljubljana we prepared materials characterized by a very high content of magnetic nanoparticles, homogeneously dispersed in the polymer matrix. Such materials are interesting for applications in biomedicine as magnetic carriers, as well as for technological applications as absorbers of high-frequency electromagnetic radiation. We have continued with our research on different methods for synthesizing nanoparticles, including the sol-gel method, the sonochemical method, the hydrothermal method, and co-precipitation in reverse micelles. The adaptation of the crystal structure of the spinel ferrite nanoparticle to the nanoscale size was systematically studied. In the field of magnetic materials for telecommunications the investigations were focused on the development of materials and technology for absorbers of electromagnetic radiation and for non-reciprocal magnetic devices in the mm-wave range. In the field of microwave ceramics magnetic nanoparticles and magnetic ceramics were synthesized for applications at microwave and millimetre-wave frequencies. New information on synthesizing with various chemical routes and on the incorporation of magnetic nanoparticles in the polymer matrix was obtained. The developed absorbers for electromagnetic waves were patented (patent no. 21979).

A key characteristic of the Advanced Materials Department is an intensive cooperation with its industrial partners. In the past year cooperation with industry was enhanced with several new projects. Currently, we cooperate with ISKRA FERITI, STELEM, TRIMO, TERMO, GORENJE, IMPOL, ETA Cerkno, STEKLARNA Hrastnik, STEKLARNA Rogaška, EPCOS (Austria), Heraklith (Austria), Gama Mecanicca (Italy) and PAROC (Finland).

In 2006 we continued our research on the synthesis of $KNbO_3$ powders from a solution using the Pechini method. During the research we discovered the formation of nanostructures in the form of nanowires of pseudo-cubic $KNbO_3$. With a systematic study of the crystallization of the organic gel we discovered the mechanism for the formation of strong, anisotropic pseudo-cubic nanocrystals, i.e., template crystallization. On the subject of PTCR thermistors the research work was focused on $BaNb_2O_6$, which is believed to be appropriate for high-temperature thermistors.

With the use of the Haywang-Jonker model we designed a thermistor with an anomaly in the resistance at 250 °C By using a controlled thermal treatment of donor-doped barium-niobate in an inert atmosphere and with the subsequent reoxidation of the grain boundaries the potential barriers on the grain boundaries were formed, which induces the anomaly in the electrical resistance.

In the scope of the Program Group P2-0091 we continued our research within the Bi_2O_3–TiO_2–TeO_2 system. By synthesizing and sintering in an atmosphere with 10 bars of oxygen we succeeded in preparing $Bi_6Ti_5TeO_{22}$, $Bi_2Ti_3TeO_{12}$ and Bi_2TiTeO_8 compounds and we were also able to determine their crystal structures. It was revealed that during the synthesis Te^{4+} oxidizes to Te^{6+}, which then forms octahedra with the oxygen atoms. These octahedra

then randomly replace TiO_6 octahedra, formed by TiO_2. These synthesized compounds were then sintered to form high-density ceramics, some of which exhibit promising dielectric properties. The paraelectric $Bi_6Ti_5TeO_{22}$ compound, for example, exhibits a high dielectric constant of 350 and a Q×f value of 220GHz; however, there are problems in the application of these ceramics. These problems include TeO_2 evaporation and various decomposition processes that take place at elevated temperatures. Since W^{6+} ions possess similar ionic radii and the same charge as Te^{6+} we tried to eliminate these problems by substituting the Te^{6+} by W^{6+}. As a result we found that the isostructural compound $Bi_6Ti_5WO_{22}$ does form, and at room temperature it possesses an even higher dielectric constant. Its temperature dependence of permittivity can be further tuned by the substitution of bismuth ions by, for example, yttrium ions.

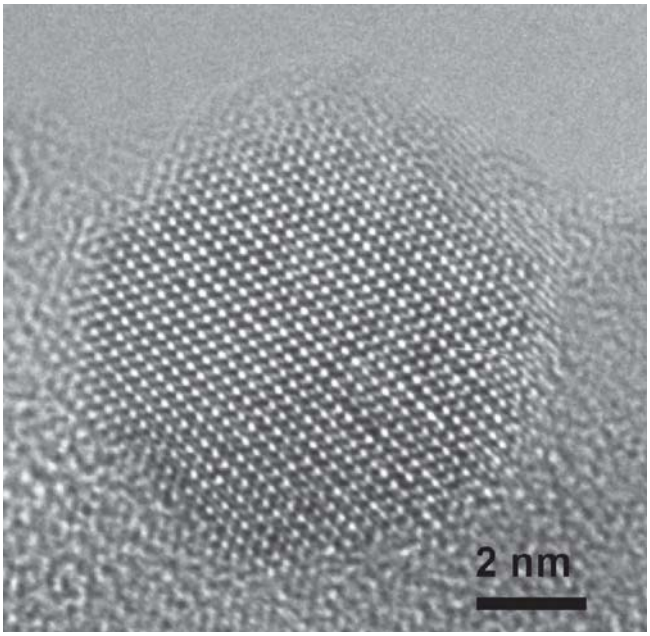

Figure 1: High-resolution TEM micrograph of magnetic nanoparticle

When analyzing the Bi_2O_3–TiO_2–WO_3 system we observed the formation of a pyrochlore. We conducted further experiments to reveal the mechanism of W^{6+} incorporation into the pyrochlore crystal lattice and determined the phase diagram of the system at 1100 °C in air.

The investigations of the synthesis and crystal structure of hexagonal perovskites within the BaO–WO_3–Nb_2O_5 ternary system revealed that the B-site cation-deficient hexagonal perovskites with the general formula $A_mB_{m-1}O_{3m}$ containing a mixed cubic/hexagonal stacking sequence of their AO_3 layers exhibit a high dielectric constant and a high quality factor in the microwave frequency region. With this in mind we investigated hexagonal perovskites in the $Ba_m(Nb,W)_{m-1}O_{3m}$ series that form within the BaO–WO_3–Nb_2O_5 ternary system. Polytypes with five, nine, twelve and twenty-seven BaO_3 layers in the unit cell have been reported to exist and resynthesized. From among all the prepared compounds the homologue with m = 5 appears to be the only stable compound within the system. The literature on this compound is modest, which encouraged us to characterize its crystal structure and prepare ceramics for microwave dielectric measurements. The phase composition and the microstructure of the sintered bodies were examined with x-ray powder diffraction and scanning electron microscopy. The x-ray diffraction patterns revealed a strong structural relationship between the $Ba_6WNb_2O_{14}$ hexagonal perovskite and α-$Ba_4Nb_2O_9$. While the crystal structure of both compounds is unknown it seemed justifiable to carry out a structural analysis, firstly on $Ba_4Nb_2O_9$, and compare it with that of $Ba_6WNb_2O_{14}$. The structural analysis was performed by a Rietveld refinement of the XRD patterns.

In the scope of the NATO Science for Peace project "Tantalum-Free Microwave Dielectric Resonators with an Enhanced Quality Factor" we investigated the influence of the deviation from stoichiometry in MNb_2O_6 (M=Mg, Zn and Co) columbites and complex perovskites with the B-site cation order $Ba(B_{1/3}Nb_{2/3})O_3$ (B= Mg, Zn and Co) on the dielectric losses in the microwave frequency range. The lowest dielectric losses (Q-values exceeding 90,000 GHz) were obtained for the Zn analogue with a slight A-site deficiency. The concentration of point defects that form as a result of the deviations from stoichiometry was studied by means of wavelength-dispersive X-ray microprobe spectroscopy (WDS) and positron-annihilation spectroscopy (PAS), which was performed in cooperation with our partners from McMaster University in Hamilton, Canada.

- **The use of co-precipitation and hydrothermal synthesis for the synthesis of monodomain particles of barium hexaferrite for the preparation of nanocomposites, i.e., absorbers of electro-magnetic radiation in the GHz range.**
- **Synthesis and functionalization of magnetic nanoparticles for applications in biomedicine.**
- **Optimisation of the preparation of magnetic ceramics for mm-wave applications.**
- **Encapsulation of maghemite nanoparticles in polymethylmetacrylate for the preparation of composites for use in technological and medical applications.**

In an investigation of the stabilization of the bismuth titanate pyrochlore with (i) Y_2O_3 and (ii) Nd_2O_3 dopants we confirmed the formation of two bismuth titanate pyrochlore solid solutions, which can be described with the following chemical formulas: (i) $Bi_{(1.6-1.08x)}Nd_xTi_2O_{(6.4-0.11x)}$ ($0.25<x<0.96$) and (ii) $Bi_{(1.6-0.8x)}Y_xTi_2O_{(6.4+0.3x)}$ ($0.04<x<2$). Further extrapolation of x to 0 in both cases of the bismuth titanate pyrochlore solid solutions indicates that the most probable formation of the stable un-doped bismuth titanate pyrochlore is in the compositional range around $Bi_{1.6}Ti_2O_{6.4}$. From the obtained results of the stabilization of the BT pyrochlore we determined the phase relations in the area of the formation of the BT-pyrochlore solid solutions. In the Bi_2O_3–TiO_2–Y_2O_3 system we additionally observed the formation of the $Bi_4Ti_3O_{12}$ solid solution, which contains up to 8 mol% Y_2O_3. In the Bi_2O_3–TiO_2–Nd_2O_3 system, two additional solid solutions are formed: $Bi_{4-x}Nd_xTi_3O_{12}$, where $0 < x < 2.6$; and $Nd_{2-x}Bi_xTi_2O_7$, where $0 < x < 0.35$.

The formation of an un-doped bismuth titanate pyrochlore was studied with samples prepared by the sol-gel method. We determined that a deficient BT pyrochlore forms in two temperature ranges: between 500°C and 650°C, and above 1150°C. The low-temperature-stable BT pyrochlore solid solution is stable up to 650°C, and above this

temperature it decomposes into the compounds $Bi_4Ti_3O_{12}$ and $Bi_2Ti_4O_{11}$. Additional heating of these two compounds to over 1150°C results in the formation of a high-temperature-stable BT pyrochlore. From the WDS analysis of this BT pyrochlore phase we determined the composition $Bi_{1.65(0.01)}Ti_{2(0.01)}O_{6.5}$. Based on the data obtained in this study of the phase relations in the binary Bi_2O_3–TiO_2 system a revised phase-equilibrium diagram of the Bi_2O_3–TiO_2 system is proposed.

In 2006 we investigated the synthesis and the kinetics of the fluorite crystal structure with modulations from the system Bi_2O_3–$(Nb_{1-x}Ta_x)_2O_5$ ($0 \leq x \leq 1$). We confirmed the existence of a high-temperature cubic phase and synthesized this kind of ceramic using a solid-state synthesis route. At lower temperatures we produced tetragonal modifications of the solid solutions and found a phase transition among the polymorphs. Furthermore, we showed that the kinetics of the cubic-to-tetragonal phase transition is prolonged with increasing x. We characterized the dielectric properties of the tetragonal and cubic Bi_2O_3–$(Nb_{1-x}Ta_x)_2O_5$ ($0 \leq x \leq 1$) samples in the microwave region. We compared the crystallographic differences of both modifications and the effect of them on the dielectric properties. With a higher concentration of Ta the permittivity (ε) decreases and the quality factor ($Q \times f$) increases. The phase transformation of the order-disorder type has its most important effect on the temperature coefficient of resonant frequency (τ_f), since by phase transformations the negative values become positive values. Furthermore, we studied the kinetics of the cubic-to-tetragonal phase transformation for x = constant at different temperatures. On the basis of these results we optimized the dielectric properties of the synthesis of this ceramic.

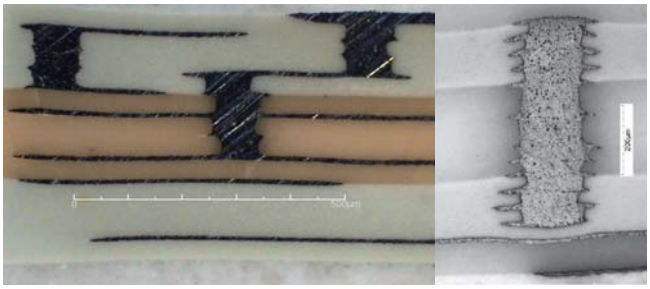

Figure 2: Development of LTCC materials Bluetooth Filter - Balun example: a.) K80–K35 test structure with Ag internal electrode, b.) Stacked via within different layers of ceramic materials

The continuing growth in mobile telecommunications has increased the need for new, low-permittivity, low-loss materials. Firstly, due to their potential use as a substrate material, and secondly, due to the expansion of the utilized frequency range from the microwave (MW) to the millimetre-wave region. Low-temperature cofired ceramic (LTCC) technology imposes the additional requirement of a low sintering temperature: lower than 970°C. Materials which can fulfil both the requirements of the very low dielectric losses and the low sintering temperature are very rare. Our investigations revealed that $P2_1/a$ $K_xBa_{1-x}Ga_{2-x}Ge_{2+x}O_8$ solid solutions are one of those materials because they exhibit $Q \times f$ values of around 100,000 GHz and can be sintered very close to the LTCC conditions. The other dielectric properties, i.e., ε=6.2–6.9 and τ_f=~-25 ppm/K, were also promising for such applications. A systematic study of $K_xBa_{1-x}Ga_{2-x}Ge_{2+x}O_8$ ceramics revealed that these solid solutions undergo a monoclinic-to-monoclinic $P2_1/a \Leftrightarrow C2/m$ phase transition, where only the $P2_1/a$ structure exhibits promising dielectric properties. The temperature of the $P2_1/a \Leftrightarrow C2/m$ phase transition is above the formation and sintering temperatures (970–990°C) of $K_xBa_{1-x}Ga_{2-x}Ge_{2+x}O_8$ ($0.67 < x \leq 1$) solid solutions, whereas the compositions at lower x (x=0.4 and 0) remain in the $P2_1/a$ modification over a wide temperature range, above the sintering temperature of 1040–1100°C. In the compositional range ($0.67 \leq x \leq 1$) only ceramics at x=0.67 can be prepared and characterized in both forms. Due to the low sintering temperature (970°C) and the high $Q \times f$ value (~100,000 GHz) $P2_1/a$ $K_{0.67}Ba_{0.33}Ga_{1.33}Ge_{2.67}O_8$ ceramics are promising candidates for microwave applications and LTCC technology.

Special emphasis was put on investigations of voltage-tuneable materials. In the $Na_{0.5}Bi_{0.5}TiO_3$–$Li_{3x}La_{(2/3-x)}TiO_3$ ($0.03 \geq x \leq 0.167$) system the homogeneity range was determined using X-ray powder diffraction and scanning electron microscopy. The synthesis mechanism of the compounds prepared by solid-state reaction was investigated as well. We found that the members of the homogeneity region first crystallize in a pseudo-cubic crystal symmetry. In order to achieve their final symmetry and homogeneity, multiple high-temperature firing is required. Such synthesis, however, resulted in a slow thermal decomposition of the $Li_{3x}La_{(2/3)-x}TiO_3$-rich compounds into TiO_2 and secondary phases, which partially evaporate or concentrate at the grain boundaries of the polycrystalline samples.

The electrical properties of the compounds from the investigated system were further determined. Attention was focused on the voltage-tuneability of the dielectric constant, which required the setting up of a proper measurement system. Samples with 5 mol% $Li_{0.12}La_{0.63}TiO_3$ and 10 mol% $Li_{0.45}La_{0.52}TiO_3$ show the highest voltage-tuneability of the dielectric constant (~50%). In addition, these two samples show low dielectric losses ($\tan\delta = 0.05$) and a low temperature dependence of the dielectric constant ($\tau_f \approx 4{,}000$ ppm/°C) in comparison with other voltage-

- **The preparation of environmentally friendly lead-free thermistors based on potassium and barium niobates with a temperature anomaly in the electrical resistance between 200 and 300°C.**
- **The preparation and characterization of tellurite glasses with special optical properties.**
- **Structural investigations of hexagonal perovskites in the system Bi_2O_3–TiO_2–WO_3, complex columbites MNb_2O_6 (M=Mg, Zn and Co) and complex perovskites $Ba(B_{1/3}Nb_{2/3})O_3$ (B=Mg, Zn and Co). Investigations of Y_2O_3- and Nd_2O_3-doped pyrochlores based on compounds in the Bi_2O_3–TiO_2 system.**
- **Investigations of materials for low-temperature co-fired ceramic (LTCC) technology.**
- **Synthesis and characterization of voltage-tuneable materials based on $Na_{0.5}Bi_{0.5}TiO_3$–$Li_{3x}La_{(2/3-x)}TiO_3$.**

tuneable materials. Our research shows that the investigated system presents a new group of voltage-tuneable materials with characteristics similar to compounds used in electronic components.

In the scope of the investigations of tuneable materials we investigated lead-free $Na_{0.5}Bi_{0.5}TiO_3$-based ferroelectric and ferroelastic materials.

It is known from the literature that the permittivity of $Na_{0.5}Bi_{0.5}TiO_3$ changes with axial pressure, $\varepsilon = \varepsilon(p)$; however, this dependence is too small to be used in applications. Therefore, we investigated and selected specific materials that would increase this pressure dependence of permittivity, for example, $NaTaO_3$, $KTaO_3$, $SrTiO_3$, and $K_{0.5}Bi_{0.5}TiO_3$. Experimentally, we synthesized materials from the whole concentration range of the (1-x) $Na_{0.5}Bi_{0.5}TiO_3$–x$NaTaO_3$ series. With x-ray powder diffraction (XRD) and scanning electron microscopy (SEM) we confirmed the existence of the solid solutions between the $Na_{0.5}Bi_{0.5}TiO_3$ and $NaTaO_3$ end-members across the whole concentration range, and specified the structural and microstructural properties of the prepared samples. We characterized the dielectric and ferroelectric properties, which confirmed our assumptions and showed some interesting features of possibly useful materials. Two of them deserve particular attention: with the addition of 5 mol% of $NaTaO_3$ the ferroelectric properties are enhanced (a higher remanent polarization and a lower coercive field); with the addition of 30 mol% of $NaTaO_3$ the temperature coefficient of permittivity (τ_ε) across a wide temperature range (-50 to +250 °C) is nearly 0.

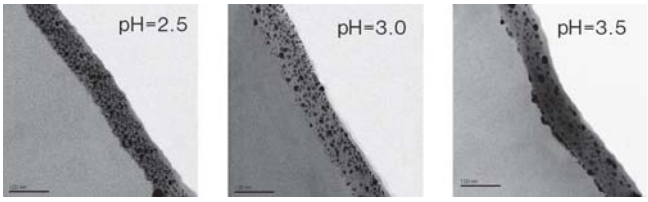

Figure 3a: In-situ synthesis of Ag nanoparticles in a polymer matrix. The concentration of Ag nanoparticles decreases with the decrease of polyelectrolyte pH

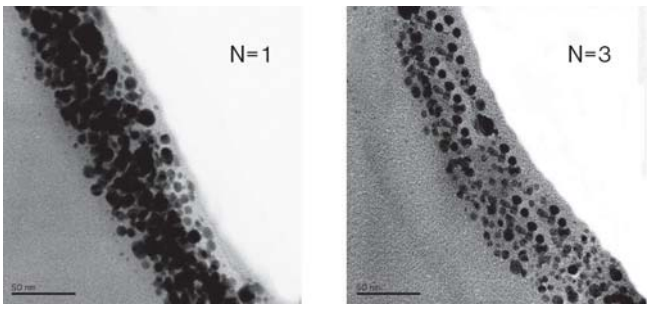

Figure 3b: In-situ synthesis of Ag nanoparticles in a polymer matrix: The influence of the number of reaction cycles on the concentration and size of Ag nanoparticles (at pH=2.5)

The investigations were focused on the preparation of a thin polyelectrolyte multilayer matrix that is used as a template for thin inorganic film synthesis by a modified sol-gel method and for the in-situ synthesis of organic-metallic composites.

The organic matrix is formed by the self-assembly of weak polyelectrolytes on a substrate by alternate dipping of a substrate into a water solution of weak polylectrolytes, positive polyallylamine (PAH) and negative polyacrylic acid (PAA) based on electrostatic interactions. The thickness of the polymeric matrix is controlled by the number of dipping cycles and the pH value of the polyelectrolyte water solutions in the 4-nm range. We prepared a thin film of TiO_2 in a polymeric matrix by the modified sol-gel reaction. On calcination, the organic matrix prevents the agglomeration of the inorganic precursor and therefore enables the synthesis of a nanocrystalline film and also exhibits a final thickness in the nanometre range.

Furthermore, silver nanoparticles were synthesized in a polyelectrolyte multilayer matrix. The polyelectrolyte multilayer matrix fabricated of weak polyelectrolytes contained some free-acid groups that act as binding sites for the silver ions. After the reduction, silver nanoparticles, homogeneously distributed within the matrix, are formed. With the in-situ synthesis of silver nanoparticles the organic matrix prevents the agglomeration of the nanoparticles and also determines their size and concentration, which are mainly dependent on the pH value of the polyelectrolyte self-assembly and on the number of reaction cycles.

The study of 1D nanostructures involved the optimization of hydrothermal-reaction parameters for the synthesis of $Mg_3[Si_2O_5](OH)_4$ nanotubes. Based on the findings the dimensions (the length and diameter) of the nanotubes can be controlled. Further research on low-dimensional structures was dedicated to utilizing hydrothermal conditions for the synthesis of nanowires with the perovskite crystal structure. The aim of this study was a controlled synthesis and characterization of nanostructures with ferroelectric and piezoelectric properties. For the preliminary experiments orthorhombic $KNbO_3$ was chosen.

In the field of investigating super-hard, light materials, a low-temperature sintering of the compound $AlMgB_{14}$ and the mixture $AlMgB_{14}$–30% TiB_2 with the addition of B_4C and infiltration of Al in an Ar atmosphere were studied. The prepared samples exhibited hardnesses (HV) from 15 to 19 GPa. In the second part of the investigation we studied phase relations in the B_4C–Al system at temperatures from 1100 to 1450°C in order to prepare new, hard composites and to avoid hot pressing and hot isostatic pressing. It was found that the phase evolution during firing depends on the starting composition and the temperature. The hardness of the prepared samples depends on the phase composition, and it is HV ≈ 16 GPa.

A simple method for the preparation of monodispersed, nanosize ZnO particles with sizes of 50 to 70 nm from an aqueous solution of $Zn(C_2O_2H_3)_2$ with the addition of a suitable amount of Na_2CO_3 was developed. The precipitated solids were hydrozincite particles ($Zn_5(OH)_6(CO_3)_2$), which easily transformed to ZnO particles during a 200 °C treatment.

The investigation of the preparation of fine $CaCO_3$ particles from $CaCl_2$ during the simultaneous addition of urea in different polyols revealed that polymorph modification and the morphology of the prepared $CaCO_3$ particles were dependent on the reaction temperature, the concentration of the reactants and the applied media.

Glass investigations were focused on the research for foreign (Heraklith, Paroc, Gamma Meccanica) and domestic (TERMO) companies. These investigations included chemical analyses of several raw materials for the production of mineral fibres, the analysis of raw materials' melting and the analysis of unmelted inclusions. The final goal of these studies was to advise our industrial partners about the proper selection of raw materials. We also determined the viscosities of glass melts and their electro-conductivity. Based on this information we prepared several bio-soluble mineral fibres on a semi-industrial scale. For the needs of the industrial partner we also investigated the influence of increased humidity and temperature on the binding of the organic pastes, which are required for the manufacturing of mineral-wool-based products.

For the Glass factory Rogaška we performed extensive studies on defects, with a special emphasis on their nature and their point of formation in the production line. This was undertaken with the purpose of enabling technologists to direct the process of glass production in a way that would prevent the appearance of inclusions. We found that most of the inclusions in the glass from the Glass factory Rogaška appear as a result of the corrosion of refractory materials, large-grained and contaminated raw material as well as unsuitable thermal conditions. However, the most frequent inclusions originate from the refractory materials at the glass contact part of the furnace, where fused cast AZS and zircon refractories are used. According to the results obtained from identifying the inclusions, special corrective actions, such as recovering the furnace temperature or replacing the damaged refractory material, were made, which prevented the occurrence of defects in the glass products.

As a part of our industrial cooperation with EPCOS OHG, from Deutschlandsberg, Austria, we launched the prototype production of a new material developed in our laboratories. In 2004, the K 80 material was successfully introduced to the production. Since then we have developed the K 35 material, which has withstood all the tests for pilot production. In addition, the new K<20 material was also developed in our laboratory.

- **Synthesis of inorganic thin films with a modified sol-gel method and in-situ synthesis of hybrid organic-inorganic composites.**
- **Study of 1D nanostructures and optimization of the hydrothermal synthesis of $Mg_3[Si_2O_5](OH)_4$ nanotubes.**
- **In the scope of investigations of super-hard, light materials low-temperature sintering of $AlMgB_{14}$ and a mixture of $AlMgB_{14}$–30%TiB_2 with the addition of B_4C and the infiltration of Al in an Ar atmosphere were investigated.**
- **Monodispersed nanoparticles of ZnO were prepared by colloidal chemistry methods.**

Some outstanding publications in the past three years

1. I. Pribošič, D. Makovec, M. Drofenik, Formation of nanoneedles and nanoplatelets of $KNbO_3$ perovskite during templated crystallization of the precursor gel. Chem. mater. 17 (2005), 2953–2958.
2. D. Lisjak, P. J. McGuiness, M. Drofenik, Thermal instability of Co-substituted barium hexaferrites with U-type structure. J. Mater. Res., 21 (2006), 420–427
3. D. Makovec, Z. Samardžija, M. Drofenik, The solid solubility of holmium in $BaTiO_3$ under reducing conditions. J. Am. Ceram. Soc., 89 (2006), 3281–3284
4. M. Udovič, M. Valant, B. Jančar, D. Suvorov, A. Meden, A. Kočevar, Phase formation and crystal-structure determination in Bi_2O_3-TiO_2-TeO_2 system prepared in an oxygen atmosphere. J. Am. Ceram. Soc., 89, (2006), 3462–3469.
5. B. Jančar, D. Suvorov, The influence of hydrothermal-reaction parameters on the formation of chrysotile nanotubes. Nanotechnology (Bristol), 17, (2006), 25–29.
6. X. Hu, D. Suvorov, Characterization of the Aurivillus phases in the vicinity of the $Bi_5AgNb_4O_{18}$ compound. J. mater. res., 21, No. 9, 2006, 2408–2414.

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1. Helmut Sommariva, Christian Hoffmann, Matjaž Valant, Danilo Suvorov
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2. Andrej Žnidaršič, Darja Lisjak, Vladimir Boštjan Bregar, Mihael Drofenik, Nevenka Rajnar
   Ceramic ferrite materials for absorption .of electromagnetic waves in frequency range from 100 MHz to 12 GHz, Patent No. 21979, Feriti d.o.o., Ljubljana
3. Andrej Žnidaršič, Vladimir Boštjan Bregar, Nevenka Rajnar
   Sheet absorbers for electromagnetic radiation with frequency range up to 12GHz.
   Patent No. 22031, Ljubljana, The Slovenian Intellectual Property Office, 2006.

Organization of conferences, congresses and meetings

1. Meeting "NATO Co-directors Annual Review Meeting", Ljubljana, Slovenia, 16–18 October 2006
2. XIV. Conference on Materials and Technologies, 16–18 October 2006, Portorož, Slovenia (co-organizers)

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In: EPJ, Appl. phys. (Print), Vol. 35, pp. 85-92, 2006.
2. Irena Ban, Mihael Drofenik, Darko Makovec
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3. G. Belous, et al. (9 avtorjev)
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6. Boštjan Berčič, Urša Pirnat, Primož Kušar, Damjan Dvoršek, Damjan Vengust, Dragan Mihailović
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7. V. Dondur, Njegomir Radić, B. Grbić, Mihael Drofenik
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8. Xing Hu, Danilo Suvorov
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9. Xing Hu, Matjaž Valant, Danilo Suvorov
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10. Boštjan Jančar, Danilo Suvorov
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14. Darja Lisjak, Mihael Drofenik
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27. Matjaž Valant, Aleš Dakskobler, Milan Ambrožič, Tomaž Kosmač
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28. Matjaž Valant, Danilo Suvorov, Robert C. Pullar, Sarma Kumaravinothan, Neil McN Alford
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Invited Paper

1. Darja Lisjak, Vladimir Boštjan Bregar, Andrej Žnidaršič, Mihael Drofenik
Microwave behaviour of ferrite composites: [presented at 6th International Balkan Workshop on Applied Physics, July 5-7,2005, Constanta, Romania]
In: J. Optoelectron. Adv. Mater., Vol. 8, pp. 60-65, 2006.

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1. Sašo Gyergyek, Miroslav Huskić, Darko Makovec, Mihael Drofenik
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3. Darja Lisjak, Andrej Žnidaršič, Vladimir Boštjan Bregar, Mihael Drofenik
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4. Matjaž Spreitzer, Boštjan Jančar, Danilo Suvorov
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TEXTBOOKS AND LECTURE NOTES

1. Andrej Žnidaršič, Ladislav Kosec
Tehnologija priprave in karakterizacija keramičnih prahov: vaje pri predmetu Metalurgija prahov
Ljubljana, Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za materiale in metalurgijo, Nanotesla Institut.

THESES

Ph. D. Theses

1. Vladimir Boštjan Bregar; Characterisation of ferromagnetic composite materials in microwave frequency range (Prof. Janez Selinger, Asst. Prof. Darja Lisjak)
2. Špela Kunej; High-temperature phase equilibriums in multicomponent oxide systems based on Bi_2O_3 (Prof. Danilo Suvorov, Dr. Srečo D. Škapin)
3. Irena Pribošič; New PTCR Materials Based on the $KNbO_3$ Ceramics (Prof. Mihael Drofenik, Asst. Prof. Darko Makovec)
4. Aljoša Košak; Synthesis and characterisation of ferrite nanoparticles and preparation of magnetic fluids (Prof. Mihael Drofenik)
5. Vuk Uskoković; The Synthesis of Nanostructured Materials within Reverse Micelles (Prof. Mihael Drofenik)

B. Sc. Thesis

1. Ines Bračko; Influence of processing parameters on dielectric properties of $Ag(Ta_xNb_{1-x}O_3)$ Ceramic (Prof. Stane Pejovnik, Dr. Boštjan Jančar)

INTERNATIONAL PROJECTS

1. Controlled Production of High Tech Multifunctional Products and their Recycling
   SAPHIR
   6. FP; NMP2-CT-2006-026666
   EC; Laurence Demoor, Christophe Goepfert, Compagne Industrielle des Lasers Cilas SA, Orleans, France
   Prof. Danilo Suvorov
2. Advanced Electronic Ceramics (Grain Boundary Engineering)
   COST 525
   EC; Prof. Robert Freer, University of Manchaster and UMIST, Manchaster Materials Science Centre, Manchaster, Great Britain
   Prof. Danilo Suvorov
   Subprojects COST 525:
   - Microstructure, Grain Boundaries and Electrical Properties of Donor/Acceptor Co-doped $BaTiO_3$-Based Ceramics
     Prof. Danilo Suvorov
   - Grain Boundary Engineering in $BaTiO_3$ Ceramics
     Asst. Prof. Darko Makovec
   - Microwave Dielectric Loss Mechanisms in New Microwave Ceramics
     Prof. Danilo Suvorov
3. Materials for Low Temperature Co-Fired Ceramics (LTCC) Applications Made by Electro Phoretic Deposition (EPD)
   EUREKA, LOFT-CFC
   E!2913, 3211-05-000128, 4302-8/2005/14
   Dr. Marjeta Maček-Kržmanc
4. Ferrite Materials and Nonreciprocal Devices for Mm-wave Applications
   EUREKA, FDMA
   E!3451, 400-76/2004-2
   Dr. Darja Lisjak
5. Tantalum-Free Microwave Dielectric Resonators with Enhanced Quality Factor
   NATO SfP 980881
   NATO Public Diplomacy Division, North Atlantic Treaty Organisation, Brussels, Belgium; Prof. Peter Mascher, McMaster University, Department of Engineering Physics, Faculty of Engineering, Hamilton, Ontario, Canada
   Dr. Boštjan Jančar
6. LTCC Materials for Multilayer LC Filters
   N0042/06
   Pavol Dudesek, EPCOS OHG, Deutschlandsberg, Austria
   Prof. Danilo Suvorov, Dr. Boštjan Jančar
7. Investigation of Materials and Processes in MLC Manufacturing
   N0083/05
   Dr. Klauss Reichmann, EPCOS OHG, Deutschlandsberg, Austria
   Prof. Danilo Suvorov, Dr. Srečo D. Škapin
8. Characterization of Bio Soluble Mineral Fibres
   N40/06
   DI Ingram Eusch, Heraklith AG, Ferndorf, Austria
   Prof. Danilo Suvorov, Dr. Marko Udovič
9. Characterization of Bio Soluble Mineral Fibres
   N0039/06
   Dr. Michael Perander, Paroc Group OY AB/R&D, Pargas; Vantaa, Finland
   Prof. Danilo Suvorov , Dr. Marko Udovič
10. Materials with improved High-frequency Magnetic Properties prepared from Silica-coated Ferrites
    BI-FR/06-PROTEUS-014
    Dr. Jeun-Lue Rehspringer, Institut de Physique et Chimie des Matériaux, Strasbourg, France
    Asst. Prof. Darko Makovec
11. Control of Grain Size and Morphologies of Nanograined Oxides by Adaptation of the Synthesis Route: Precipitation in Microemulsions and Hydrothermal Synthesis
    BI-FR/06-PROTEUS-010
    Asst. Prof. Nadine Millot, LRRS, UMR 5613, CNRS/Université de Bourgogne, Dijon Cedex, France
    Asst. Prof. Darko Makovec
12. Synthesis and Characterization of Magnetic Nanoparticles
    PROTEUS
    Prof. Jean-Luc Rehspringer, Groupe des ateriaux inorganiques, Institut de Physique et Chimie des Materiaux, Strasbourg, France
    Asst. Prof. Darko Makovec
13. New Glass Materials based on Tellurium Oxide for Non-linear Optics
    Nouveaux materiaux vitreux et cristallises a base d'oxyde de tellure pour l'optique non lineaire
    PROTEUS
    Prof. Phillipe Thomas, UMR 6638 CNRS, Faculte des Sciences, Science des Procedes Ceramiques et de Traitements de Surface, Limoges, France
    Dr. Marko Udovič
14. Characterization of the Materials for Mineral Fibres Production
    Giovanni Burini, B. Sc., Gamma Meccanica, Bibbiano, Reggio Emilia, Italy
    Prof. Danilo Suvorov , Dr. Marko Udovič
15. Non Conductive Magnetic Materials for Microwave Absorbers
    BI-IT/05-08-007
    Dr. Enzo Ferrara, Instituto Elettrotecnico Nazionale Galileo Ferraris Torino, Torino, Italy
    Dr. Darja Lisjak
16. Nanoferrites and Non-reciprocal Devices for Mm-wave Applications
    BI-HU/06-07/003
    Dr. Anna Sztaniszlav, TKI-FERRIT Development And Manufacturing Ltd., Budapest, Hungary
    Dr. Darja Lisjak

R & D GRANTS AND CONTRACTS

1. Time and position -controlled release of drug substances coated onto superparamagnetic nanoparticles
   Asst. Prof. Darko Makovec
2. Development of lightweight, super-hard composites based on AlMgB14-TiB2
   Dr. Srečo Davor Škapin
3. Development of multifunctional B4C-Al and B4C-Mg composites for new products
   Dr. Srečo Davor Škapin
4. Self-cleaninig photocatalitic paints and coatings
   Dr. Srečo Davor Škapin
5. Smart functional coatings for the increase of stability of structures and components for defensive purposes
   Dr. Srečo Davor Škapin
6. Magnetic materials and intermetallic alloys
   Prof. Mihael Drofenik
7. Synthesis of 1D inorganic nanostructures, bionanostructures and preparation of composites
   Dr. Boštjan Jančar
8. Characterisation on the nanometric scale
   Dr. Boštjan Jančar
9. Synthesis of nanoparticles and nanocompsites
   Asst. Prof. Darko Makovec

RESEARCH PROGRAMS

1. Advanced inorganic magnetic and semiconducting materials
   Prof. Mihael Drofenik
2. Contemporary inorganic materials and nanotechnologies
   Prof. Danilo Suvorov

NEW CONTRACT

1. Development of microwave ferrites
   Iskra Feriti, Ljubljana
   Prof. Drofenik Mihael

VISITORS FROM ABROAD

1. Dr. Klaus Reichmann, Dr. Hanz Florian, EPCOS OHG, Deutschlandsberg, Austria, 7 February 2006
2. Dr. Christian Hoffmann, Dr. Pavol Dudesek, EPCOS OHG, Deutschlandsberg, Austria, 16 February 2006
3. Lindberg Pontus, B. Sc., Paroc, Pargas, Finland, 25–26 April 2006
4. Sonja Embst, B. Sc., Ingram Eusch, B. Sc., Heraklith, Ferndorf, Austria, 25–26 April 2006
5. Prof. Paolo Nanni, Universita de Genova, Genova, Italy, 8 May 2006
6. Prof. Pierluigi Villa, Universita Degli Studi di L'Aquila, L' Aquila, Italy, 8 May 2006
7. Dr. Massimo Viviani, Consiglio Nazzionale delle Richere di Genova, Genova, Italy, 8 May 2006
8. Dr. Christian Hoffmann, Dr. Klaus Reichmann, Elin Solberg, B. Sc., EPCOS OHG, Deutschlandsberg, Austria, 10 May 2006
9. Elin Solberg, B. Sc., EPCOS OHG, Deutschlandsberg, Austria, 12–19 May 2006
10. Lindberg Pontus, B. Sc., Niklas Bergman, B. Sc., Paroc, Pargas, Finland, 17–18 May 2006
11. Sonja Embst, B. Sc., Markus Mente, B. Sc., Heraklith, Ferndorf, Austria, 17 May 2006
12. Dr. Jože Hafner, Termo d.d., Škofja Loka, Slovenia, 17 May 2006
13. Dr. Rick Ubic, Queen Mary University of London, London, GB, 4–9 June 2006
14. Prof. Slobodan Milonić, Prof. Dragan Uskoković, Serbia Academy of Science and Art, Beograd, Serbia and Montenegro, 1–4 September 2006
15. Pavol Dudesek, B. Sc., Dr. Christian Hoffmann, Dr. Wolfgang Statteneter, EPCOS OHG, Deutschlandsberg, Austria, 20 September 2006
16. Dr. Agnes Csanady, Mr. Gyula Kakuk, Ms. Tünde Labuda, TKI Ferrit, Budapest, Hungary, 23–30 September 2006
17. Prof. Anatolii Bilous, V.I. Vernadskii Institute of General and Inorganic Chemistry, Kiev, Ukraine, 1–30 October 2006
18. Dr. Oleksander Kramarenko, Dr. Oleg Ovchar, Institute of General and Inorganic Chemistry of Ukraine Academy of Science, Kiev, Ukraine, 1–30 October 2006
19. Dr. Emil Pollert, Institute of Physics, Prague, Czech Republic, 23–26 October 2006.
20. Dr. Sophie Le Gallet, Dr. Nadine Millot, Universite de Bourgogne, Dijon, France, 25–28 October 2006

Visiting Researchers

1. Dr. Vuk Uskoković, Institute of Technical Sciences, Serbian Academy of Science and Art, Belgrade, Serbia and Montenegro , 31 May 2004 – 6 April 2006
2. Dr. Hu Xing, Zhejiang University, Hangzhou, China, 16 December 2004 – 20 September 2006
3. Dr. Marco Peiteado Lopez, Instituto de Ceramica y Vidrio, Madrid, Spain, 1 October 2005 – 31 December 2007
4. Dr. Svetoslav Mihaylov Kolev, Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria, 1 September 2006 – 31 August 2007
5. Dr. Qin Ni, Zhejiang University, Hangzhou, China, 1 December 2006 – 1 December 2007

STAFF

Researchers

1. Prof. Mihael Drofenik*
2. Asst. Prof. Darja Lisjak
3. Asst. Prof. Darko Makovec
4. **Prof. Danilo Suvorov**, Head**
5. Dr. Srečo Davor Škapin
6. Dr. Igor Zajc
7. *Asst. Prof. Andrej Žnidaršič*** left 01.04.2006*

Postdoctoral associates

8. Asst. Prof. Irena Ban*
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10. Dr. Uroš Kunaver***
11. Dr. Špela Kunej
12. Dr. Marjeta Maček Kržmanc
13. Dr. Marko Udovič

Postgraduates

14. Jana Bezjak, B. Sc.***
15. Ines Bračko, B. Sc.
16. Stanislav Čampelj, B. Sc.
17. Urban Došler, B. Sc.
18. Sašo Gyergyek, B. Sc.
19. Jakob Koenig, B. Sc.
20. *Dr. Aljoša Košak, left 01.04.2006*
21. Manca Logar, B. Sc.
22. Urša Pirnat, B. Sc.
23. Matjaž Spreitzer, B. Sc.
24. Asja Veber, B. Sc.

Technical and administrative staff

25. Maja Šimaga Saje, B. Sc.
26. Silvo Zupančič

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF BIOCHEMISTRY AND MOLECULAR BIOLOGY B

The research activities of the members of the Department of Biochemistry and Molecular Biology are focused on investigations of the properties and structures of studied proteins, the mechanisms of their action and regulation, and genes from the structural and evolutionary viewpoint, as well as their physiological role in normal and pathological conditions.

Head:
Prof. Boris Turk

Proteolysis (Head: Prof. Vito Turk)

Proteases as primarily protein-degrading enzymes are now seen as extremely important signaling molecules involved in numerous vital processes. Their biological activities are precisely regulated, and the dysregulation of protease activity can be responsible for pathologies such as cancer, osteoporosis, rheumatoid arthritis, cardiovascular and neurological disorders. Therefore, studies on human, parasite, viral and other proteases of different origins can lead to new discoveries that are crucial for future protease-targeted drugs. The current status and perspectives in this field, with reference to some key examples, are presented in the journal Nature Reviews Drug Discovery.

We investigated the role of cysteine protease cathepsin B in the degradation of an extracellular matrix (ECM). It was demonstrated that endothelial cells degraded ECM both intracellularly and pericellularly. Intracellular cathepsin B was co-localized with the products of DQ-collagen IV degradation in the perinuclear region and in the capillary-like tubular structures. Studies with the specific epoxysuccinil inhibitor CA 074 showed that intracellular cathepsin B contributes to the neovascularization process and should be considered as a potential therapeutic target. Experimental data showed that mouse mammary tumor virus-polyoma middle T antigen (PyMT) transgenic mice deficient for cathepsin B exhibited a significantly delayed onset and reduced growth rate of mammary cancers compared with wild-type PyMT mice. The results also indicate that cathepsin B plays an important role in the tumor progression and lung metastasis of mammary cancer. In the review article we summarized the current status of the role of cysteine cathepsins, particularly the cathepsins L and S, in antigen processing and maturation of the MHC class-II molecules.

The activity of cysteine cathepsins is regulated by their protein inhibitors cystatins, thyropins and others. Among other cells, cystatins are expressed in the different cells of the immune system, although new questions are arising. The cystatin superfamily also represents a useful model for understanding the folding process and amyloid-fibril formation. Several chimeras of human stefin A and B were prepared with the emphasis on determining the folding parameters and the propensity to form amyloid fibrils. It is suggested that fibril formation is related to selected parts of the molecule, such as the ß-sheet in the case of stefin B. It was also found that stefin B is a copper-binding protein, in contrast to stefin A, which upon copper-binding inhibits amyloid-fibril formation. A book was published: 'Human Stefins and Cystatins' (E. Žerovnik and N. Kopitar Jerala, eds.; Nova Biomedical Books, New York), which contains eleven chapters and summarizes the current knowledge in the field.

Proteases as signal molecules and targets for drug design.

Although serpins typically inhibit serine-proteases it was found that serpin endopin 2C demonstrates the selected inhibition of cathepsin L. The complexed and free forms of cathepsin L were resistant to degradation by trypsin. In contrast, elastase in complex with endopin 2C was degraded by trypsin but free elastase was not degraded. These results demonstrate a conformational change in the elastase after complex formation.

Thyropins are multidomain proteins that consist of a characteristic thyroglobulin type-1 (Tg1) domain. We investigated the evolution of Tg1 domains using protein sequence data and genome databases. A phylogenetic analysis showed that Tg1 domains are highly conserved within 170 searched protein structures, whereas insertion into novel proteins is followed by rapid diversification. It can be suggested that the Tg1 domain fold is highly adoptive and comprises a well-conserved core surrounded by variable loops that account for its multiple function throughout the animal kingdom.

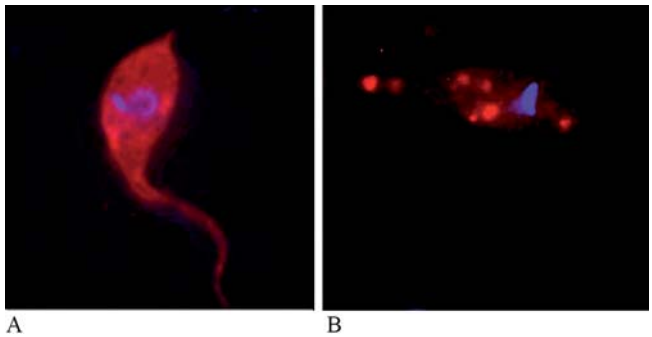

Figure 1: Immunofluorescence image revealing the intra-cellular localization of the Atg8 protein (red) of the unicellular organism Trypanosoma cruzi, in nutrient-rich conditions (A) and upon starvation (B). Nuclear and mitochondrial DNA are stained with blue.

The genome of Trypanosoma cruzi, the protozoan parasite causing Chagas disease, contains two genes, TcMCA3 and TcMCA5, with homology to those encoding metacaspases, distantly related to the cysteine proteases caspases involved in programmed cell death. The proteins encoded were expressed in E.coli, and used to prepare antibodies, which make it possible to demonstrate that TcMCA3 is expressed in all four developmental stages of the parasite, whereas TcMCA5 was expressed only in the epimastigotes form. In sera from chronic chagasic patients only the TcMCA3 protein was recognized, showing that the protein is expressed during natural infections.

Novel covalent inhibitors of cysteine proteases, O-acyl hydroxamates and their azo-peptide analogs for use as active-based probes were synthesized. An analog that showed selective inhibition of falcipain 1, a cysteine protease of the malaria-causing parasite Plasmodium falciparum, was obtained.

Our recent studies and those of others showed that apoptotic cell death involving lysosomes can be caspase-dependent or -independent. An essential event is the lysosomal membrane permeabilization and the subsequent release of cathepsins to the cytosol where cleave the pro-apoptotic Bcl-2 family member Bid, thus inducing cytochrome c release and caspase activation. Our proposed model summarizes the present knowledge about lysosome-induced apoptosis. Our results also suggest that a decrease in apoptosis activation during aging is not tissue-specific, but rather it displays a complex dependence on the species and strain of animals.

The Proteolysis Group participate in two EU projects within the EU's 6FP. We are also partners in the highly prestigious international project within the Human Science Frontiers Program (HSFP), for the first time given to a Slovenian research group, jointly with groups of the University of Tokyo, Stanford University and the Burnham Institute for Medical Research in San Diego. In addition, there are many other international collaborations that result in joint publications and the exchange of researchers. Several members of the group were invited to give lectures at international symposia and universities, and are involved in the organization of international events.

Structural biology (Head: Prof. Dušan Turk)

The installation of a pipetting robot for the preparation of crystallization screens in November 2005 has enabled the use of a modern crystallization screen, which involves over 1000 initial conditions at the same expenditure of protein content. The robot can simultaneously pipette 96 crystallization drops with 100 nl volume. The purchase of the robot (Phenix, Art Robinson design) was made possible by European structural funds through the Centers of Excellence for Nanotechnology and Environmental technology and was sponsored by Lek d.d. The purchase of a microscope (Discovery, Karl-Zeiss) enabled the automatic collection of images of crystallization drops from a single crystallization plate. With this the group has obtained sufficient equipment to make working conditions at least comparable with those in current modern laboratories. The equipment has already made possible the successful crystallization of proteins and their mutants involved in amyloid fibril formation and cathepsin complexes.

Structural biology: interaction within the immune system.

Figure 2: A new robot for the automatic replication of arranged colonies of microorganisms (yeast).

In the frame of studies of amyloid fibril formation we have followed the fibrillation of a series of stefin B mutants with DLS (dynamic light scattering) and TEM (transmission electron microscopy). We have found that a number of intermediates appear during the process. A manuscript is in preparation, and part of the studies connected with the chimeric forms of stefins was published in collaboration with scientists from the Proteolysis Group (JSI), the National Chemical Institute and the University of Sheffield, UK (Kenig et al., 2006).

The studies of the specificity of the interactions between cathepsins and the invariant chain associated with the MHC class-II molecules continue within the coordinated efforts of a Marie Curie Network. The expression of the cathepsins L,K,V and S and the inhibitory fragment of the p41 form of an invariant chain has been carried out, whereas the expression of the cathepsin F and the p31 and p41 forms of the invariant chain as well as alpha and beta chains of HLA DR molecules of larger amounts suitable for structural studies is under way. We have already tested the first series of inhibitors of cathepsins, which were, according to our design, synthesized by a group in Leiden, The Netherlands.

In the search for differences between interaction patterns of molecules involved in the endosomal pathway of the immune system response in humans and mice we have found that stefin A, which acts as a competitive inhibitor of intracellular papain-like cysteine proteases, exhibits differences against target exopeptidases. Mice stefins A and A2 both act as fast and tight inhibitors of endopeptidases papain and cathepsins L and S; however, their interaction with exopeptidases cathepsins B, C and H was several orders of magnitude weaker compared to human, porcine and bovine stefin A.

Collaborative studies within an industral project with Lek d.d. continue.

Toxins and Biomembranes (Head: Prof. Igor Križaj)

We found that ammodytoxin (Atx), a neurotoxic secreted phospholipase A_2 ($sPLA_2$) from Vipera a. ammodytes venom, induced neurotoxic effects, very similar to those in vivo, also in a murine motoneuron cell line, and confirmed it as a relevant model to study the molecular mechanism of the action of $sPLA_2$-nerotoxins. Our results demonstrated that besides hydrolytic action on the external side of the neuronal plasma membrane also the action of the $sPLA_2$-nerotoxin from the inner side of the cell is necessary for the full expression of the neurotoxicity. We developed a method that resides on the novel photo-reactive derivative of Atx and demonstrated quick internalization of the toxin into the cytosol of the model nerve cell and its association with cytosolic proteins, calmodulin and 14-3-3. We attached the nano-gold particles on Atx and using electron microscopy succeeded in confirming the internationalization of the derivative for the first time also in the motoneuron. Co-localization of the fluorescently labelled Atx with mitochondria, cellular organelles in which the still unidentified receptor for Atx resides, was clearly demonstrated in another model cell, rat neuron-like PC12 cell line. We proposed a model of action of Atx on the simplest eukaryotic cell, yeast Saccharomyces cerevisiae cell that also explains some effects of the toxin on mammalian cells. We finished the study of the role of a peroxine Pex11 with different stimuli-mediated peroxisome proliferation in yeast. Using the paleogenomic analysis and planetary-biological approach we explained why mammalian and bird genomes differ so much from the genomes of all other animals. We explained the evolutionary dynamics of the transposal elements by phylogenomic analysis and reconstruction of the ancestral conditions. Analysing neofunctionalized retro-elements we proved that in mammals introns can still be created de novo. Moreover, we studied components of the Vipera a. ammodytes venom that affect hemostasis, especially anticoagulant $sPLA_2$ and different proteases, hemorrhagic and non- hemorrhagic, and Atx-binding proteins from diverse sources. In collaboration with domestic and foreign research groups we continued immunological studies of viper's venom, developed new approaches of envenomation serotherapy, studied the role of $sPLA_2$s in mitochondria, discovered a novel type of $sPLA_2$ in sea anemone, structurally characterised cytolysins and developed new methods of analysis of DNA microarrays data. For the pharmaceutical company Lek we were performing the structural characterisation of recombinant biopharmaceuticals. In collaboration with an SME we developed a manipulator for the automatic replication of arranged colonies of micro-organisms (yeast) that will enable the further development of techniques in the field of genomics and chemical genomics (Figure 2.). This acquisition will provide us with competitiveness in the European research area in the analysis of protein toxins and low-molecular-mass biologically active compounds on the genomic level. In 2006 we succeeded, in a consortium of 20 research groups, with the application of an integrated project in the frame of EU's FP6 (CONCO).

Toxinology: new molecular tools and drugs.

Pharmaceutical Biotechnology: Man and Environment (Head: Prof. Janko Kos)

Investigations of bioactive proteins from model mushroom Clitocybe nebularis were continued. The work was focused on inhibitors of cysteine proteases (clitocypin), inhibitors of serine proteases (CNSPI), proteolytic enzymes and lectins. For a determination of the physiological function of clitocypin we used a protein array from S. cerevisiae. The results show the role of clitocypin is associated with some functions in the nucleus, such as tRNA processing and mRNA transport. The results were confirmed with the preparation of the clitocypin-GFP fusion protein and its expression in yeast. An inhibitor, homologous to clitocypin, was isolated from Macrolepiota procera. Besides the major form at Mr 17 kDa the form at Mr 21 kDa was predominant, designated as macrocypin. At the protein and nucleotide levels there is 30% of homology between the inhibitors from both mushrooms. However, the inhibitory profiles and secondary structures are very similar for both inhibitors. For the inhibitors of serine proteases two new nucleic acid sequences were determined, confirming the previously observed heterogeneity at the protein level. The final preparation of cDNA using mRNA RACE and the determination of the complete gene using PCR and a genomic library will make it possible to determine the structure and regulation of the serine protease inhibitor. In Clitocybe nebularis the presence of aspartic proteases was also studied using affinity chromatography on ConA and Pepstatin Sepharose. Their N-terminal amino acid sequences were determined. Surprisingly, the number of different inhibitors is high (seven), which has not been observed in other fungi. From Clitocybe nebularis we also isolated four lectins, distinct with regard to the molecular mass, the specificity and the amino acid sequence. For further studies of their biological properties, such as cytotoxic, immunostimulatory and antiinsecticidal action, lectins will be prepared by the methods of molecular biology. To study the response of Phaseolus vulgaris to drought we followed the activity of two serine endopeptidases and two aminopeptidases in the leaves of plants. Additionally, we followed the changes at the gene level and found 16 transcripts being significantly changed during the drought: eight being up-regulated and eight

Biotechnology: For human health and a healthy environment.

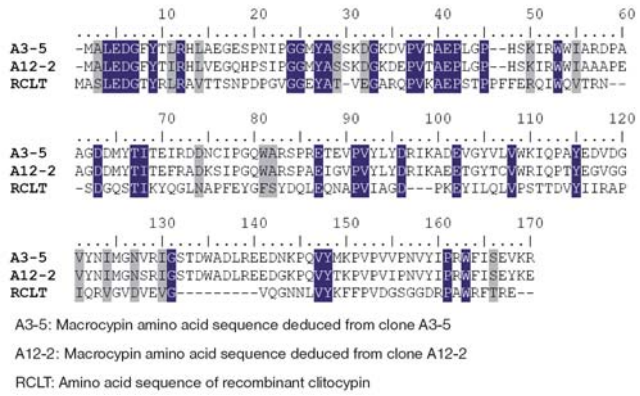

Figure 3: Comparison of amino acid sequences of clitocypin and macrocypin.

down-regulated. For five of the identified genes the association of their expression with drought has not been reported so far. In recent years we also studied the expression of sweat protein brazein in Lactococus lactis to improve the properties of food, where this bacteria is used in the production process.

Some outstanding publications in the past three years

1. Turk B. (2006) Targeting proteases: successes, failures and future prospects. Nat. Rev. Drug Discov. 5:785–799.
2. Novinec M., Kordiš D., Turk V., Lenarčič B. (2006) Diversity and evolution of the thyroglobulin type-1 domain superfamily. Mol. Biol. Evol. 23:744–755.
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Organization of conferences, congresses and meetings

1. 5th International Conference on Cysteine Proteinases and their Inhibitors: From Structure to Regulation and Biology, Portorož, Slovenia, 2–6 September 2006
2. 23rd Winter School on Proteinases and their Inhibitors, Recent Developments, Tiers, Italy, 1–5 March 2006

Awards and appointments

1. Nina Slapar, Krka Award for Ph.D. thesis
   Molecular aspect of Colorado potato beetle adaption (Leptinotarsa decemlineata Say) to plant defense response (Asst. Prof. Kristina Gruden)
2. Jernej Šribar: Maks Samec Award for the best Ph.D. thesis in the field of biochemistry
   Intracellular ammodytoxin-binding proteins and their possible role in the process of neurotoxicity (Prof. Igor Križaj)
3. Alenka Kužnik: Prešeren Award for B.Sc. Thesis
   Application of monoclonal antibodies CDI 315 for targeted delivery of nanoparticles (Prof. Janko Kos)
4. Barbara Kolarič: Student Prešeren Award for B.Sc. Thesis
   Preparation of staphylococcal protein A domain B analogs as potential cysateine protease inhibitors (Prof. Borut Štrukelj)
5. Klemen Španinger: Student Prešeren Award for B. Sc. Thesis
   The cross-talk between gene regulation of the circadian rhythm and cholesterol homeostasis (Prof. Borut Štrukelj)
6. Mateja Cegnar: Krka Award
   Development and evaluation of polymeric nanoparticles for transport of cystatin into tumour cells (Prof. Janko Kos – co-mentor)

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Ph. D. Theses

1. Katarina Cankar: Development of high throughput methods for detection of genetically modified organisms (Kristina Gruden)
2. Gregor Kosec: Expression and characterization of cysteine peptidases metacaspases and autophagins from the parasite Trypanosoma cruzi (Vito Turk)
3. Primož Meh: Expression and biochemical characterization of thyroglobulin type 1 domains of testicans and nidogens (Brigita Lenarčič)
4. Kristina Orešić: HCMV mediated retrograde transport of proteins from the endoplasmic reticulum to the cytosol (Boris Turk)
5. Sabina Rabzelj: Amyloid fibrillation and interaction with lipid membranes of human stefin B and chosen mutants in vitro (Eva Žerovnik)
6. Petra Slanc: Influence of xanthohumol, mistletoe (Viscum album L.) exctract and microcystinon gene expression in lymphatic and hepatic cell cultures (Borut Štrukelj)
7. Mateja Novak Štagoj: Heterologous expression in designed mutant strains of yeast Saccharomyces cerevisiae using the Gal 1 promoter (Borut Štrukelj)

B. Sc. Theses

1. Sanja Brus: Qualitative analysis of medicinal plants mixture composition by determination of the ITS region nucleotide sequence (Borut Štrukelj)
2. Vesna Breščak: Selection of cysteine proteinase inhibitors with phage display (Borut Štrukelj)
3. Jasmina Živa Černe: Proposal for a better integration of alkaline lysis into the production of large plasmids (Borut Štrukelj)
4. Nataša Jager: Development of a method for isolation of an exchange factor GRAB (Borut Štrukelj)
5. Adrijana Kerševan: Optimisation of the method for detection of protein phosphorylation (Metka Renko)
6. Barbara Kolarič: Preparation of staphylococcal protein A domain B analogs as potential cysateine protease inhibitors (Borut Štrukelj)
7. Mojca Krivec: Antiproliferative effect of actinonin on U937 cells (Metka Renko):
8. Alenka Kužnik: Application of monoclonal antibodies CDI 315 for targeted delivery of nanoparticles (Janko Kos)
9. Matjaž Ravnikar: Quick quantitative analysis of a herbal tea by sequencin the nuclear ribosomal DNA (Borut Štrukelj)
10. Ajda Ristič: Some properties of non-classical inclusion bodies of the recombinant protein hG-CSF (Borut Štrukelj)
11. Nives Škrlj: Preparation and partial characterization of recombinant protein SMOC-2 and identification of its interaction partners (Brigita Lenarčič)
12. Klemen Španinger: The cross-talk between gene regulation of the circadian rhythm and cholesterol homeostasis (Borut Štrukelj)

INTERNATIONAL PROJECTS

1. Chemical Genomics by Activity Monitoring of Proteases
   6. FP
   CAMP
   LSHG-CT-2006-018830
   EC; PhD. Manuel Morillas, Universitat Autonoma de Barcelona, Institut de Biotechnologia i de Biomedicina (IBB), Campus Universitari de Bellaterra, Bellaterra (Cerdanyola del Vallčs), Spain
   Prof. Boris Turk
2. High Throughput Development of Drugs for Immunotherapy of (Auto)immune Diseases
   Drugs for Therapy
   6. FP
   MRTW-CT-2004-512385
   EC; Prof. Frits Koning, Leiden University Medical Center, Leiden, The Netherlands
   Prof. Dušan Turk
3. Safe Production and Use of Nanomaterials
   NANOSAFE2
   6. FP
   NMP2-CT-2005-515843
   EC; Commissariat a l"Energie Atomique, Grenoble, France
   Prof. Boris Turk, Asst. Prof. Maja Remškar, Marko Žumer, B. Sc., Andrej Detela, B. Sc.
4. Intracellular Protease Signaling induced by Homopolymeric Amino Acid (HPAA) Tracts
   RG105, 0024/2006-C
   International Human Frontier Science Program Organisation, Strasbourg Cedex, France
   Prof. Boris Turk
5. Neurotoxic Phospholipases A2 - How They produce the Neuromuscular Blockade and How to prevent it
   NATO Programme Security through Science, Collaborative Linkage Grant
   PDD(CP)-(EAP.CLG.980899)
   NATO Public Diplomacy Division; Dr. Edward G. Rowan, University of Strathclyde, Strathclyde Institute of Biomedical Sciences, Department of Physiology & Pharmacology, Glasgow, Scotland, Great Britain
   Prof. Igor Križaj
6. Proteolytic Activities in Trypanosoma Cruzi: Cruzipain, Metacaspase, Serine Carboxypeptidase
   BI-AR/06-08-03
   Prof. Juan Jose Cazzulo, Instituto de Investigaciones Biotechnologicals, Instituto Tecnologico de Chascomus, Universidad Nacional de General San Martín- CONICET, San Martin, Provincia de Buenos Aires, Argentine
   Prof. Vito Turk
7. Izabrane tačkaste mutacije aromata u čovječijim stefinima A i B. Uticaj na stabilnost, dimerizaciju i svijanje proteina
   BI-BIH
   Prof. Selma Berbić, Medicinski fakultet, Univerza v Tuzli, Tuzla, Bosnia and Herzegovina
   Asst. Prof. Eva Žerovnik
8. Study on the Identification of the Anticoagulant Site of Phospholipases A2 by Biochemical and Crystallographic Approach
   BI-FR/06-PROTEUS-005
   Dr. Grazyna Faure, Unité d'Immunologie Structurale, Paris Cedex, France
   Prof. Igor Križaj
9. Analysis of Immunogenicity of the Long-nosed Viper (*Vipera ammodytes ammodytes*) Venom Components
   BI-HR/06-07-008
   Dr. Beata Halassy Špoljar, Institute of Immunology, Department for Research and Development, Zagreb, Croatia
   Prof. Igor Križaj
10. Struktura i dinamika biomolekula
    BI-HR/05-06-028
    Dr. Marija Luić, Institut „Ruđer Bošković", Fizička kemija, Laboratorij za kemijsku i biološku kristalizaciju, Zagreb, Croatia
    Prof. Dušan Turk
11. Mechanisms of Apoptosis and Aging as revealed by Yeast and Mammalian Cell Models
    BI-IN/06-07-011
    Prof. Roy Nilanjan, National Institute of Pharmaceutical Education and Research (NIPER), S.A.S. Nagara, Punjab, India
    Asst. Prof. Veronika Stoka

12. The Role of Secreted Phospholipases A2 in Mitochondrial Function and Disfunction
BI-IT/05-08-021
Gianfrancesco Goracci, Department of Internal Medicine, Division of Biochemistry-University of Perugia, Perugia, Italy
Prof. Igor Križaj
13. Functional Analysis of Fungal Cysteine Protease Inhibitor
PSP
BI-GB/06-002
Dr. Gary Foster, The University of Bristol, Bristol, Great Britain
Dr. Jože Brzin
14. Identification of Interactions of PEX11, The Yeast Nuclear Receptor Homologue
BI-US/05-06-007
Dr. Joseph L. DeRisi, University of California San Francisco, San Francisco, CA, USA
Asst. Prof. Uroš Petrovič

R & D GRANTS AND CONTRACTS

1. Role of cysteine proteases in inflammation
Prof. Boris Turk
2. Phospholipases in yeast Saccharomyces cerevisiae
Prof. Igor Križaj
3. Molecular basis of tolerance to abiotic stress in Phaseolus sp.
Dr. Marjetka Kidrič
4. Role of cysteine cathepsins as immunomodulators in rheumatoid arthritis
Prof. Boris Turk, Dr. Urška Repnik
5. Development of readiness plan and measures against bioterorism
Prof. Boris Turk
6. Dietary supplements for optimal nutrition in extreme environments.
Prof. Janko Kos
7. Synthesis of 1D inorganic nanostructures, bionanostructures and preparation of composites
Prof. Boris Turk
8. Nanometer scale characterization
Prof. Dušan Turk
9. Development of new drugs and biochips
Prof. Boris Turk
10. Biological methods of wastewater treatment
Prof. Dušan Turk

RESEARCH PROGRAMS

1. Structural biology
Prof. Dušan Turk
2. Proteolysis and its regulation
Prof. Vito Turk
3. Toxins and biomembranes
Prof. Igor Križaj
4. Pharmaceutical biotechnology - Man and environment
Prof. Janko Kos

NEW CONTRACTS

1. Development of ELISA -PEG 1 Essay
Lek farmacevtska družba, d. d.
Asst. Prof. Aleš Premzl
2. Determination of the crystal structure of beta lactamase inhibitors
Lek farmacevtska družba, d. d.
Prof. Dušan Turk
3. N-terminal sequence analysis of samples
Lek farmacevtska družba, d. d.
Prof. Igor Križaj

VISITORS FROM ABROAD

1. Prof. Dr. Neera Borkakoti, Medivir UK, Ltd, United Kingdom, 21–23 February 2006
2. Dr. Tim Mather, Oklahoma Medical Research Foundation, Oklahoma, USA, 25 May 2006
3. Sachin Rawaji Kadam, Pune, India, 1 January – 31 August 2006 (guest researcher - Marie Curie Actions: Research Training Network)
4. Dušana Majera, Bački Petrovac, Serbia, 15 September – 31 December 2006 (guest researcher - Marie Curie Actions: Research Training Network)
5. Christina Gabriela Pinto Droga Mazovec, Porto, Portugal, 1 January – 31 December 2006 (guest researcher)
6. Zoran Štefanić, Institut Ruđer Bošković, Fizička kemija – Laboratorij za kemijsku i biološku kristalizaciju, Zagreb, Croatia, 22– 24 May 2006
7. Monica Ferrini, Universita degli Studi di Perugia, Dipartimento di medicina interna, Sezione di Biochimica, Perugia, Italy, 15 June – 14 July 2006
8. mag. Aida Kriještorac, Univerzitet u Tuzli, Farmaceutski fakultet, Tuzla, Bosnia and Herzegovina, 3 June – 30 June 2006, 31 August – 14 October 2006
9. dr. Domenico Tortorella, Mount Sinai School of Medicine, Department of Microbiology, New York, USA, 6–9 July 2006
10. Sabrina Pfennings, Albert-Ludwigs-Universität, Institut für Molekulare Medizin und Zellforschung, Freiburg, Germany, 1 October – 18 November 2006
11. Ivan Psakhie, Siberian State Medical University, Tomsk, Russian Republic, 1 October – 23 December 2006
12. Prof. Dr. Edward G. Rowan, Strathclyde University, Glasgow, Scotland, UK, 24–26 October 2006
13. Prof. Fotis C. Kafatos, Chairman of the ERC, Imperial College London, Great Britain, 21 November 2006
14. Dr. Grazyna Faure, Institut Pasteur, Paris, France, 20–24 November 2006
15. Prof. Dr. Ramesh Singh Chouhan, Dr. MGR Deemed University, Bangalore, India, 30 November 2006
16. Dr. Beata Halassy Špoljar, Marija Brgles, Imunološki zavod, Odjel za istraživanje i razvoj, Zagreb, Croatia, 8 December 2006

STAFF

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1. Dr. Jože Brzin
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6. Asst. Prof. Dušan Kordiš**
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13. Asst. Prof. Veronika Stoka
14. Prof. Borut Štrukelj*
15. **Prof. Boris Turk**, Head**
16. Prof. Dušan Turk**
17. Prof. Vito Turk**
18. Asst. Prof. Eva Žerovnik

Postdoctoral associates

19. Dr. Sabina Anžlovar, left 31. 12. 2006
20. Dr. Marko Fonović
21. Dr. Katja Galeša, left 1. 7. 2006
22. Dr. Gregor Gunčar
23. Dr. Saša Jenko Kokalj
24. Dr. Kristina Orešić
25. Dr. Toni Petan
26. Asst. Prof. Uroš Petrovič
27. Asst. Prof. Aleš Premzl
28. Dr. Urška Repnik
29. Dr. Jerica Rozman Pungerčar
30. Dr. Nina Slapar, left 1. 9. 2006
31. Dr. Jernej Šribar
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43. Zala Jenko Pražnikar, B. Sc.
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45. Martina Klarić, B. Sc.
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47. Dr. Gregor Kosec
48. Lidija Kovačič, B. Sc.
49. Tomaž Langerholc, B. Sc.
50. Uroš Logonder, B. Sc.
51. Mojca Mattiazzi, B. Sc.
52. *Primož Meh, B. Sc., left 1. 7. 2006*
53. Marko Mihelič, B. Sc.
54. Marko Novinec, B. Sc.
55. Dr. Kristina Orešič
56. Miha Pavšič, B. Sc.
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58. Urška Požgan, B. Sc.
59. Jure Pražnikar, B. Sc.
60. Vida Puizdar, M. Sc
61. *Sabina Rabzelj, M. Sc., left 1. 7. 2006*
62. Miha Renko, B. Sc.
63. Jerica Sabotič, B. Sc.
64. Dejan Suban, B. Sc.
65. Katja Škerget, B. Sc.
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70. Ivica Štefe, B. Sc.
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** Part-time faculty member
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DEPARTMENT OF ENVIRONMENTAL SCIENCES O-2

The aim of the multidisciplinary research activities of the Department of Environmental Sciences is to investigate interactions between natural processes and human activities that induce short- and long-term changes in our environment and affect natural resources, as well as humans. Detailed studies of transport pathways and mechanisms, transformations and the fate of different natural and synthetic compounds in the environment and in biological systems has required the development of new, sensitive analytical methods for determining the concentration and speciation of elements, as well as their isotopic compositions in different matrices. The Centre of Mass Spectrometry, the Radon Centre and the Mobile Ecological Laboratory are important members of the department, which is also succesfully coordinating the Centre of Excellence "Environmental Technologies", linking scientific excellence and industry.

Head:
Prof. Milena Horvat

Environmental analytical chemistry

In the field of environmental analytical chemistry some new analytical procedures were developed and applied to different sample matrices to study the **speciation** of elements (Al, As, Cr, Hg, Ni, Sb, Sn, Zn) and processes governing their distribution. A procedure for butyl and phenyltin determination in soils by headspace solid-phase microextraction (HS-SPME) gas-chromatography pulsed-flame photometric detection (GC-PFPD) was developed. A new method for determining arsenosugars (glycerol, phosphate, sulphate and sulphonate ribose) was developed and was successfully used together with our already-optimized method for determining other arsenic (As) compounds. The new method was used to determine As compounds in Adriatic littoral algae and some commercially available Japanese seaweed products. An interdisciplinary physico-chemical approach was used for the characterization of As compounds in highly contaminated soil samples from Cornwall, UK, in the frame of a bilateral cooperation. A combination of EXAFS, XANES and sequential extractions with subsequent As speciation in the extracts confirmed that As is mostly present in a pentavalent form and is associated with amorphous aluminium and iron hydroxides. The mobility of As appears to be much greater than estimates based on crystalline structures previously assumed to be the case in the Cornish environment.

In the area of **organic analytical chemistry** and in the framework of the EU's NORMAN project, a series of analytical procedures for determining the representatives of "new, emerging contaminants", e.g., pharmaceutical and personal-care products, in different matrices (surface and waste water and sediment) were developed and validated. The developed procedures were applied to a wide series of samples from Slovenia, whose toxicity and genotoxicity were also studied.

In the field of **radiochemistry** we improved and validated the software (KAYZERO/SOLCOI® and k_0-IAEA programmes) for k_0-instrumental neutron-activation analysis (k_0-INAA) for the determination of micro- and macro-elements in environmental samples. The main advantage of the k_0 method is its ability to determine the concentrations of 68 elements in an unknown sample. A mathematical model and computational tools were developed to determine the measurement uncertainty of neutron-activation analysis (NAA), which is one of the important methods for waste characterization. By applying the developed tools, a critical survey of an IUPAC (International Union of Pure and Applied Chemistry) nuclear database was carried out and the results were successfully verified on a synthetic multi-element standard developed for testing the NAA. k_0-INAA was also used for the characterisation of some products from the pharmaceutical and oil industries.

The radiochemical neutron activation method for determining ^{129}I in environmental samples was developed and optimised. The reliability and accuracy of the method were checked by certified reference materials and the reference materials IAEA-375 Soil, NIST SRM-4357 Ocean Sediment and FC98 Seaweed (*Fucus serratus*). ^{129}I was then determined in soil and plant samples from different parts of Slovenia, sea sediments from the Adriatic and the Mediterranean Sea, and brown algae grown on rocky parts of the Adriatic coast.

A method using the 197-Hg radioactive tracer was optimized to study the mercury transformation potential (reduction and methylation) in sediments and water. The sensitivity of the method was improved by the use of the enriched stable isotope 196-Hg, which was irradiated to obtain 197-Hg with a high specific activity.

The most important event for the **Instrumental Mass Spectrometric Center (CMS)** was the purchase of a new hybrid orthogonal acceleration time-of-flight mass spectrometer (oa-ToF) Q-Tof Premier™ equipped with API (atmospheric pressure ionization) and MALDI (matrix-assisted laser-desorption ionization) sources. Equipped with various inlet systems, such as a MALDI target plate, an ultra-performance liquid chromatograph (UPLC), and a capillary column LC, this mass spectrometer is the most useful instrument for the MS and MS/MS analyses of many organic compounds. Thus, the CMS services were used in various scientific areas such as chemistry, biochemistry, pharmacy, medicinal chemistry and biology. Currently the CMS supports the research of about 30 national and international research programs, projects and some technological applications of the pharmaceutical industry in Slovenia. The research exclusivity of the CMS-IJS is shown in two main approaches: ESI studies of weakly bounded non-covalent and inclusion complexes and the support service provided to many research teams from universities and research institutes in Slovenia.

In the framework of the Slovenian metrological system, the department has the status of a reference laboratory for ensuring the traceability in chemical measurements to the mol under the coordination and management of the Metrology Institute of the Republic of Slovenia. We regularly participate in intercomparison studies organised by certification organisations such as IAEA, Austria; NIST, USA; IRMM, Belgium; BAM, Germany; APAT, Italy; Eurofins, France; and JRC, Italy.

Biological and geochemical cycling

In the field of **stable isotope geochemistry**, several research topics were tackled: (1) the accumulation and decomposition of sedimentary organic matter in aquatic sediments, (2) the stable isotope signatures of natural waters and dissolved species (bicarbonate, nitrate, sulphate, etc.) and gases (coalbed gases, soil CO_2) and their implication in hydrology, geochemistry, soil and food research, (3) the application of stable isotopes as the natural tracers of sources and transformations of substances in the environment and in technological processes.

The regeneration and burial of phosphorous were investigated in the Gulf of Trieste, and the accumulation rates and diagenesis of organic carbon and total nitrogen, as well as stable carbon and nitrogen isotope composition, in the sediments of two mountain lakes (Lake Ledvica and Lake Planina, northwest Slovenia) and in the sediment accumulations in the lakes created behind natural tufa barriers in the karstic river Krka, Croatia, were analysed. Elemental and isotopic changes of bulk sedimentary organic matter in the lakes were related to changes in the past trophic state of the lakes and their watersheds, inferred by the natural development of the lake ecosystems, anthropogenic activities, as well as earthquakes and forest fires.

The dynamics of soil carbon storage and release in forest ecosystems was studied in three different forest platforms using the analysis of the carbon isotope composition of different components. It was found that seasonal changes in bioproductivity, as well as the weathering of carbonate bedrock, critically influence the isotopic composition of soil CO_2.

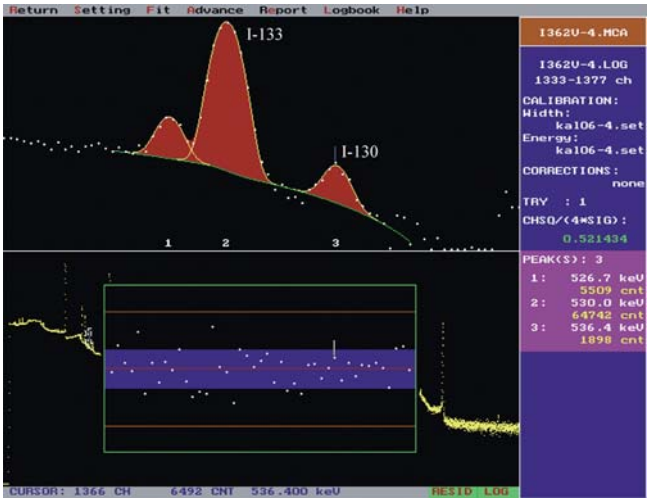

Figure 1: Gamma spectrum (Hp Ge detector) for ^{130}I, after the reaction $^{129}I(n, \gamma)^{130}I$ and irradiation with thermal neutrons in the TRIGA MARK nuclear reactor. ^{129}I was isolated from brown algae Fucus virsoides, *collected at Debeli rtič on the Slovenian coast line. ^{129}I has a very long half life; it is volatile and can easily be transported long distances, which characterises it as a global contaminant. This has been demonstrated by the steady increase of ^{129}I in the atmosphere. The main source is the processing of spent nuclear fuel.*

The stable isotopic composition of oxygen, hydrogen and tritium activity were monitored in the River Sava and in the precipitation at several continental and maritime sampling stations in Slovenia and Croatia in the scope of an IAEA research cooperation project and a Slovenian-Croatian bilateral cooperation. The study of spatial and temporal variations of precipitation and its isotope composition over this relatively small area rich in geographical and climatic diversities gave valuable information for further regional hydrological investigations and the modelling of isotope variability over the Mediterranean basin.

In cooperation with archaeologists, changes of Late Glacial and Holocene vegetation and hydrology at the Ljubljana marsh, Slovenia, have been studied using pollen, diatom, geochemical, stable isotope analyses and radiocarbon dating of the "Na mahu 1" sediment core in order to understand their impact on human society.

The focal point in investigating **radon** (^{222}Rn) transport was to identify anomalies in the Rn levels in soil gas and in thermal water, and to distinguish the anomalies caused by seismic events from those ascribed solely to the environmental parameters (temperature, barometric pressure and others). Rn has been continuously recorded in thermal springs at Bled and Hotavlje, in the air at a fault zone in the Postojna Cave (together with gaseous elementary mercury), in the air in two abysses connecting the underground flow of the Reka river with the surface, and in soil gas in 60-cm-deep boreholes in Friuli and Sicily in Italy and in Sapporo in Japan.

Radon and dissolved gaseous mercury were also analysed in seawater profiles at selected sites in the Mediterranean, with the aim of finding a relation between their levels and the active faults at the sea bottom. Machine learning programs (decision trees and neural networks) were successfully used to identify the anomalies related to seismic activity. In addition, short-term measurements of the radon concentration in soil gas have been carried out at 70 sites, covering the whole of Slovenia, in order to eventually find radon-prone areas. Radon research, conducted by the Radon Centre, was also oriented towards workplaces at these areas. The influence of the working regime and the living habits on Rn levels, and especially on the unattached fraction of Rn short-lived decay products (the crucial parameter in dosimetry), has been studied. The results obtained will contribute to an improvement in radon dosimetry methodology.

In the framework of the SARIB project, comprehensive field work was conducted from the Sava River source to the confluence with the Danube River. The main task was to characterize the sediments for organic and inorganic contaminants and other water-quality parameters for a better interpretation of the data.

In the area of mercury research in the contaminated Idrija region, an **erosion model** was further developed and validated. In addition, mercury transport between the sediments and water was studied in the deep-sea sediment obtained from the Urania cruise during the summer.

Health and nutrition

Arsenic metabolism was studied in patients with various types of blood cancer, who were experimentally treated with arsenic trioxide. Excellent success in the treatment of acute promielocyte leukemia was found; however, the results were less promising for the treatment of multiple myeloma. One of the possible reasons for the failure could be the conflicting action of arsenic trioxide, which in high concentrations kills fast-developing cancer cells with oxidative stress, and vitamin C, given simultaneously, with its antioxidative action. The involvement of stress proteins metallothioneins (MTs) responsible for cell resistance and tolerance against some drugs and metals/metalloids was particularly confirmed in glioma cells treated with cadmium or As.

In collaboration with the University of Padova, Italy, the effects of chronic exposure to aluminium (Al) chloride were studied in rats by investigating the function of the vestibulo-ocular reflex in correlation with Al concentrations in the blood and the brain.

By studying mercury–selenium (Hg–Se) interactions we tried to estimate the influence of long-term variable inorganic mercury exposure on the bioavailability of endogenous Se on the Idrija, Slovenia, population. The fate of both elements was also followed subcellulary in the gills and hepatopankreas of sea mussels *Mytilus galloprovincialis*.

In the framework of the EU's PHIME project and in collaboration with the University Clinical Centre in Ljubljana, protocols for a long-term epidemiological study were developed. The main aim is to investigate neurodevelopmental effects due to long-term, low-level exposure to MeHg and other contaminants in seafood. A survey of the total Hg, Se and polyunsaturated fatty acids (PUFA) were measured in fish, canned and fresh, commonly available in Slovenian markets, was also conducted for improved exposure assessment. The results obtained in health-related studies due to exposure to elemental Hg in Idrija miners and the inhabitants of Idrija were also evaluated, especially the role of melatonin and glutathione and other markers of neurotoxic and neftotoxic effects.

The distribution of Se species was studied in plants exposed to elevated Se concentrations during their growth. Se species were first isolated from samples by enzyme hydrolysis with Protease XIV; ion-exchange columns were used for the separation of soluble Se species and a UV-HG-AFS system was used for the final detection of Se compounds. In cooperation with the Department of Agronomy of the Biotechnical Faculty and the National Institute of Biology, Ljubljana, Slovenia, buckwheat seeds, previously soaked in solutions with different concentrations and forms of Se, were cultivated. The accumulation of Se was the highest when the seeds were soaked in a solution of selenate; this was followed by selenomethioneine, and the lowest was when selenite was used. In all cases selenoamino acid selenomethionine was identified. Polona Smrkolj received The Jesenko Award for her PhD in 2006 in the area of food science. Also, Ljerka Ožbolt received the Krka award for her master's thesis. Both awards were in the field of Se speciation in cultivated plants.

Stable isotopes were also used as tracers of the sources, origin and authenticity of various natural and processed foodstuffs, such as honey, olive oil, wine, milk and bottled water.

Monitoring/biomonitoring

Arsenic metabolism was studied in lichens as biomonitors for airborne pollution. It was found that As, deposited as a part of airborne dust particles, is modified and partially methylated. In transplanted lichens, the As accumulation and methylation occurred with a delay, probably due to the time needed for adaptation of the transplant to its new environment. In the lichen *Hypogymnia physodes*, incubated in a laboratory with arsenate, the speciation of As in the solution media and in lichen extracts was followed together with the distribution of As inside the lichen

thallus, including the possible redistribution of other micro and macroelements (P, S, K, Ca, Cl, Mn, Fe, Zn). The localisation of As inside the lichen thalli and the metabolic behaviour of exposed lichens were investigated in cooperation with the Microanalytical Centre using the micropixe method.

Polychlorinated biphenyl (PCB) and polyaromatic hydrocarbons (PAHs) have been extensively studied in numerous environmental samples (*Proteus anguinus* from a polluted area in Bela Krajina, fish from the river Idrijca and edible fish available in a Slovenian market, river water and sediments).

Researchers joined two regional projects of the International Atomic Energy Agency (IAEA) concerned with collecting internationally comparable data on air and marine pollution within the Mediterranean area. In the first phase of the project implementation work was focused on harmonizing procedures for the determination of particular pollutants and sampling environmental specimens.

Figure 2: The department installed three mass spectrometers that will enlarge the spectrum of research in the area of biogeochemical cycling of substances in the environment, environmental technologies, and environment and health research projects: (1) Q Tof Premier with EI, MALDI, LC-MS, and MS-MS modes, (2) Compound-specific stable-isotope analyzer (IR-CS-MS) and (3) Inductively Coupled Plasma Mass Spectrometer (ICP-M) hyphenated with either HPLC or GC. The equipment was co-financed by European Structural Funds.

In order to develop an effective early-warning system in the river water impacted by the past mercury mining activity, passive and active biomonitoring using peryphiton was continued throughout the year. In collaboration with the Institute of Biophysics the sensitivity and linearity of the algae response was studied, as a potential biosensor system.

The regular monitoring of radioactivity included an area around the former Uranium mine at Žirovski vrh and the nuclear power plant. Other measurements included trace elements in surface waters, particularly in the marine environment (MED POL).

Waste characterisation, treatment and management

For industrial partners, artificial soil mixtures with sewage sludge were characterised (EkoplanA, d.o.o) and the leachability of metals from the filter dusts used in asphalt composites were tested (Štore Steel, d.o.o.). The preliminary results show that the concentrations of leached hexavalent chromium do not represent any environmental hazard. Therefore, the filter dust can be used as a component in asphalt mixtures.

The leachability of zinc (Zn) and nickel (Ni) was investigated in soils that differed with respect to their mineral composition, organic matter content and cation-exchange capacity (CEC). The results indicated that the leachabilities of Zn in sewage-sludge-amended peat and clay soils were low (below 0.3% of the total Zn content) and those of Ni in sewage-sludge-amended sandy, clay and peat soil were below 1.9% of the total Ni content. In sewage-sludge-amended sandy soil the leachability of Zn was higher (11% of Zn content). The pH of the precipitation had no influence on the leachability of either metal. The treatment of sewage sludge with hydroxyapatite efficiently reduced the leachability of Zn in sewage-sludge-amended sandy soil, while in the peat soil, the soil characteristics rather than the hydroxyapatite treatment governed the Zn mobility.

In the framework of the EU's BIOMERCURY project the mass balance of mercury in an oil refinery was studied. The effectiveness of mercury removal from contaminated soils in Albania and Kazakhstan were also studied. The effectiveness of mercury removal in the Idrija waste-treatment plant was evaluated. In collaboration with Salonit Anhovo, the mercury mass balance and cycling in the process of clinker production was investigated.

In parallel, the elimination of selected pharmaceutical compounds was studied in an optimised pilot waste-water treatment plant (PWWTP) where special attention was paid to contaminant-elimination mechanisms (degradation, biodegradation, photodegradation, adsorption, etc.) and biomass adaptation to different concentration loads of pollutants in PWWTP.

Hazardous and radioactive waste-management represents an important part of sustainable development connected with environmental protection issues, industrial activities, as well as energy production. Within the EU's Leonardo da Vinci project HAZTRAIN "Hazardous waste management training programme", a tool for facilitating the process of hazardous-waste identification and classification was developed. The final product is a user-

friendly, efficient educational tool to support both hazardous-waste regulators and waste generators (small and medium-sized companies) in implementing their commitments with respect to environmental protection legislation. Radioanalytical procedures for the identification and characterization of radioactive waste were developed and/or refined, with special emphasis on technologically enhanced naturally occurring radioactive materials (TENORM). The procedures developed are being implemented for studying mobility and environmental transformations of particular radionuclides within areas contaminated by TENORM.

The Hot Cell Facility was further upgraded, and new equipment for the characterization, packing and conditioning of radioactive waste was installed within a Phare-funded project. The conditioning of a large amount of radioactive waste resulting from certain past activities was successfully carried out with the help of knowledge accrued in collaboration with the Inorganic Chemistry and Technology Department and the Radiation Protection Group.

Environmental-impact assessments and risk analysis

Accidental environmental and health-risk assessments for industries were the core work of the Group of Environmental Modelling, Risk Assessment and Environmental Impact Assessment in 2006. The assessments were made for different industries in the municipality of Koper (LPG storage facility, Port of Koper, field of gasoline and diesel reservoirs, chemical process industry). Based on these assessments, a method for the integration of risk-evaluation results into the spatial planning process is under development. The testing of the method is performed in the municipalities of Koper and Celje. A risk assessment was also made for the planned LNG terminals in the Gulf of Trieste. Results show potential cross-border impacts and the need for a comprehensive strategic environmental assessment. Such results justify the participation of the Slovenian administration in the licensing process for the sea terminal. The targeted research project is aimed at clarifying the role and contribution of the Port of Koper to the development of the coastal region. The EU project CIVITAS II – MOBILIS confirmed the expected environmental benefits of the introduction of biodiesel in public transportation in Ljubljana, while FUTURAE is aimed at discovering the future needs of the EU in the area of radioecology. SHAPE-RISK revealed the necessity for integrating the management of health, safety, and environmental issues in future industrial systems.

Some outstanding publications in 2006

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Organization of conferences, congresses and meetings

1. Branko Kontić: SRA-E - 15th Annual conference on innovation and technical progress benefit without risk, Ljubljana, 11–13 September 2006

Awards and appointments

1. Ljerka Ožbolt: Krka Award, Novo mesto, Krka d.d., M. Sc. Thesis
2. Polona Smrkolj: Jesenko Award, Biotehniška fakulteta, Ljubljana, Ph. D. Thesis
3. Dr. Polona Vreča, Forschung Austria Fellowship, Joanneum Research, Institut für WasserResourcenManagement, Graz, Austria

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REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Ljudmila Benedik
Vodovodi in podtalnice
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Padavine in suhi usedi
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PUBLISHED CONFERENCE PAPERS

Invited Papers

1. Fabio Barbone, Francesca Valent, Federica Pisa, Fulvio Daris, Vesna Fajon, Darija Gibičar, Martina Logar, Milena Horvat
Maternal fish consumption, biomarkers of mercury exposure and neurodevelopment in a cohort of Italian newborns
In: Neurotoxic metals: lead, mercury and manganese from research to prevention: a satellite meeting of 28th International ICOH Congress, June 11-16,2006, Milan, Italy: international workshop, June 17-18, 2006, Brescia, Italy, Brescia, School of Medicine, University of Brescia, 2006, 2 p.
2. Milena Horvat
Activities of the Centre of excellence for environmental technologies (CEET) and its opportunities in environmental pollution case studies
In: Slovenia and U.S. workshop on environmental science and engineering: Ljubljana, Slovenia, September 27-30, 2006: [book of abstracts], [Ljubljana, Government of the Republic of Slovenia, Ministry of higher education, science and technology, 2006], pp. 11-14.
3. Milena Horvat, Andrej Stergaršek
Activities of the Centre of excellence for environmental technologies (CEET) and its opportunities in environmental pollution case studies
In: Integration of sustainable development principles of R&D Project: sourcebook on approaches towards sustainable development in research, education and innovation, Aleksandra Kornhauser, Malcolm John Frazer, Ljubljana, Slovenian National Commission for UNESCO, ICSD-International Center for Sustainable Development, ICCS -International Centre for Chemical Studies, 2006, pp. 221-241.

Regular Papers

1. Ester Heath, Tina Kosjek, Petra Cuderman, Boris Kompare
Pharmaceuticals and personal care product residues in the environment: identification and remediation
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Optimisation of measurements procedures for determination of Beta emitters using a proportional counter
In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
9. Polona Vreča, Albrecht Leis, Zdenka Trkov, Stojan Žigon, Sabine Lindbichler
Comparison of monthly and daily isotopic composition of precipitation in South-Western Slovenia
In: 7th Austrian Stable Isotope User Group Meeting: Graz, November 24-25th, 2006(Berichte des Institutes für Erdwissenschaften der Karl-Franzens-Universitöt Graz, Österreich, 11), [S. l., s. n.], 2006, pp. 43-46.
10. Milena Horvat
Slovenska tehnološka platforma za vode - STPV
In: Vode - skrb, nadloga in izziv, Natalija Črepinšek, ed., 1. izd., Celje, Fit media, 2006, pp. 46-49.

RESEARCH MONOGRAPHS

1. Terezija Golob, Vekoslava Stibilj, Božidar Žlender, Urška Doberšek, Mojca Jamnik, Tomaž Polak, Janez Salobir, Marjeta Čandek Potokar, Jasna Bertoncelj, ed., Barbara Koroušić-Seljak, ed.
Slovenske prehranske tabele, Meso in mesni izdelki, Meat and meat products
Ljubljana, Biotehniška fakulteta, Oddelek za živilstvo, 2006.

THESES

Ph. D. Theses

1. Tjaša Kanduč: Hydrogeochemical characteristics and carbon cycling in the River Sava watershed in Slovenia (S. Lojen)
2. Blaž Kralj: Determination of high molecular mass aluminium species in biological systems (R. Milačič)
3. Nataša Nolde: Transformations and effects of mercury on the isopod (Porcellio scaber, Isopodia, Crustacea) (M. Horvat)
4. Urška Repinc: Development of procedures for determination of some trace elements via induced short-lived nuclides using neutron activation analysis (L. Benedik)

M. Sc. Thesis

1. Ljerka Ožbolt: Determination of selenium compounds in buckwheat bred in particular conditions (V. Stibilj)

B. Sc. Theses

1. Nataša Banfi: Measuring of concentration of iron ions in dietary supplements and pharmaceuticals (J. Ščančar)
2. Julija Hmeljak: Benthic transformations of mercury at the oxic-anoxic transition in the Grado Lagoon (M. Horvat)
3. Katja Kukovec: Carbon and nitrogen stable isotope fractionation in phytoplankton from the Gulf of Trieste (northern Adriatic Sea) (N. Ogrinc)
4. Marko Štrok: Optimization of measurements procedures for beta emitters with proportional counter (B. Smodiš)
5. Martina Šturm: Isotopic fractionation of sulphur in brown coals (S. Lojen)
6. Mitja Vahčič: Evaluation of mobility of selected elements from recycled industrial waste materials (R. Milačič)
7. Maša Vodovnik: Development of Biological Sensor System for Mercury Detection in Water (M. Horvat)
8. Saša Volk: Determination of selenium in fish products of the Slovenian market (V. Stibilj)
9. Antonija Zajc: Determination of mercury in different species of fresh and tinned fish of the Slovenian market (M. Horvat)
10. Petra Žvab: Radon in the Karst: reasons of elevated levels in a selected building (J. Vaupotič)

INTERNATIONAL PROJECTS

1. Public Health Impact of Long-term, Low-level Mixed Element Exposure in Susceptible Population Strata
PHIME
6. FP
016253
EC; Prof. Staffan Skerfving, Lund University Hospital, Dept. of Occupational and Environmental Health, Lund, Sweden
Prof. Milena Horvat
2. A Future for Radioecology in Europe
FUTURAE
6. FP; 036453
EC; Dr. Jean-Christophe Gariel, Institut de Radioprotéction et de Surété Nucléaire, Clamart, France
Asst. Prof. Branko Kontič
3. Network of Reference Laboratories and Related Organizations for Monitoring and Bio Monitoring of Emerging Environmental Pollutants
NORMAN
6. FP; 018486
EC; Dr. Valeria Dulio, INERIS - Direction Scientifique, Verneuil-en-Halatte, France
Dr. Ester Heath
4. Sharing Experience on Risk Management (Health, Safety, Environment) to prepare Future Industrial Systems
SHAPE-RISK
6. FP; NMP2-CT-2003-505555
EC; Institut National de l'environnement industriel et des risques, Verneuil en Halatte, France
Asst. Prof. Branko Kontič, Dr. Marko Gerbec
5. Worldwide Remediation of Mercury Hazards through Biotechnology
BIOMERCURY
6. FP; NMP2-CT-2004-505561
EC; Gesellschaft für Biotechnologische Forschung MBH, Braunschweig, Germany
Prof. Milena Horvat, Dr. Andrej Stergaršek
6. Sava River Basin: Sustainable Use, Management and Protection of Resources
SARIB
6. FP; INCO-CT-2004-509160
EC
Dr. Radmila Milačič
7. Improving the Infrastructure for Metrology in Chemistry in the Candidate New Member State
QUA-NAS
5. FP; G7-RT-CT-2002-05110
EC; Prof. Carmen Camara, Dr. Riansares Munoz Olivas, Universidad Complutense de Madrid, Madrid, Spain
Prof. Milena Horvat, Dr. Polona Vreča
8. European Virtual Institute for Speciation Analysis for Improvement of Health, Food, Industry and Environmental
EVISA
5. FP; G7RT-CT-2002-05112
EC; Dr. Wolfgang Buscher, Westfälische Wilhelms-Universität Münster, Institut für Chemo-und Biosensorik, Münster, Germany
Dr. Radmila Milačič
9. Lead Free Solder Materials
COST 531
EC
Dr. Arkadij Popovič
10. Xenobiotics in the Urban Water Cycle
COST 636
EC
Dr. Ester Heath
11. Hazardous Waste Management Training Programme
HAZTRAIN
Leonardo da Vinci

IRL-04-B/P-PP-153225
EC; Clean Technology Centre, Cork Institute of Technology, Unit 1, Cork, Ireland
Dr. Borut Smodiš

12. Measurements and Calculations of the Neutron Spectrum in Different Irradiation Channels of the TRIGA Mark II Reactor, Slovenia
13279/R1
IAEA, Vienna, Austria
Dr. Radojko Jaćimović
13. Nutritional Status and Exposure to Mercury and its Compounds in Pregnant Women and Women of Childbearing Age in Former Mercury Mining Site using Nuclear and other Techniques; Exposure to Toxic and Potentially Toxic Elements in Women of Childbearing Age in Developing Countries
13250/R1
IAEA, Vienna, Austria
Prof. Milena Horvat
14. Facility for Cyclotrone Production of Short Lived Medical Isotopes
SLO/4/004
IAEA, Vienna, Austria
Prof. Peter Stegnar
15. Chemical and Stable Isotope Investigation of the Sava and Soča Rivers in Slovenia
12642/R2
IAEA, Vienna, Austria
Dr. Nives Ogrinc
16. Potential Human Exposure to Pb, Cd, Zn, As and Hg Through Consumption of Foodstuffs Grown or Bread Near Mining Areas in Slovenia (Pb and Zn Mine Mežica and Idrija Mercury Mine)
11929/R1
IAEA, Vienna, Austria
Dr. Ingrid Falnoga
17. Training of Ms Tahereh Hosseini
IAEA Fellow, IRA/04049
IAEA, Vienna, Austria
Dr. Borut Smodiš
18. Sources and Sinks of Mercury in Freshwater Ecosystems
BI-AR/06-08/01
Prof. Ribeiro Guevara Sergio, Centro Atómico Bariloche, Comisión Nacional de Energía Atómica, Bariloche, Argentine
Dr. Milena Horvat
19. As2O3 in the Treatment of Acute Promyelocytic Leukemia
SI-AT/04-05/010
Dr. Walter Gössler, Institute of Chemistry, Analytical Chemistry, Karl-Franzens University Graz, Graz, Austria
Dr. Zdenka Šlejkovec
20. Use of Stable Isotopes Analysis in Water Resources Research
Forschung Austria Fellowship
Dr. Albrecht Leis (Mentor), Joanneum Research Forschungsgesellschaft mbH, Institut für WasserRessourcenManagement, Graz, Austria
Dr. Polona Vreča
21. Characterisation of Measurements for Trace Elements in Plastics
IRMM.B045069
Thomas Linsinger, European Commission, Joint Research Centre (JRC), Institute for Reference Materials and Measurements (IRMM), Geel, Belgium
Dr. Radojko Jaćimović
22. Određivanje uranovih radioizotopa u uzorcima okoline
BI-BIH
Dr. Stjepan Marić, Zavod za javno zdravstvo FBiH, Sarajevo, Bosnia and Herzegovina
Dr. Ljudmila Benedik
23. Radioekološka istraživanja na području Bosne i Hercegovine
BI-BIH
Dr. Marko Lalić, Institut za zaštitu zdravlja Republike Srpske, Banja Luka, Bosnia and Herzegovina
Dr. Borut Smodiš
24. Spectroscopic and Chemometric Characterization of Slovene and Cypriot Fruit Juices
Dr. Rebecca Kokkinofa-Diogenous, Ministry of Health – State General Laboratory, Acropolis, Nicosia, Cyprus;
Dr. Iztok Jože Košir, Slovenian Institute for Hop Research and Brewing, Žalec, Slovenia
Dr. Nives Ogrinc
25. Neutron Activation Analysis (NAA) of Short-lived Radionuclides for Trace Element Determinations
BI-CZ/05-06/002
Prof. Jan Kučera, Academy of Sciences of the Czech Republic, Nuclear Physic Institute, Department of Nuclear Spectroscopy, Prague, Czech Republic
Dr. Borut Smodiš
26. Les organoetains dans l'environnement
BI-FR/05-06/007
PROTEUS
Dr. Gaetane Lespes, LCABIE-UMR CNRS 5034, Universite de Pau et des Pays de l'Adour, Faculte des Sciences, Pau, France
Dr. Janez Ščančar
27. Biogeochemical Cycling of Carbon and Assessment of Shifts in Sediments in Lake Pamvotis (Greece) and Bohinj (Slovenia)
BI-GR/04-06-006
dr. Constantine Stalikas, University of Ioannina, Department of Chemistry, Laboratory for Analytical Chemistry, Ioannina, Greece
Dr. Polona Vreča
28. Formation of Recent Carbonate Sediments in Karstic Aquatic Environments
BI-HR/06-07-001
Dr. Ivan Sondi, Rudjer Boškovic Institute, Zagreb, Croatia
Asst. Prof. Sonja Lojen
29. Istraživanje utjecaja ugljikovodika na šumski ekosustav naftno-plinskog polja Žutica
Prof. Mladen Figurić, Šumarski Fakultet Sveučilišta u Zagrebu, Zagreb, Croatia
Prof. Milena Horvat
30. Geochemical Investigation of Tufa Barriers in the Krka National Park
Dr. Neven Cukrov, Rudjer Boškovic Institute, Zagreb, Croatia
Asst. Prof. Sonja Lojen
31. Sinteza organometalnih spojeva u spektrometru masa
BI-HR/05-06-002
Dr. Dunja Srzić, Rudjer Boškovic Institute, Zagreb, Croatia
Dr. Bogdan Kralj
32. Razvoj metode terenskog mjerenja alfa aktivnosti, radona i torona u zraku u tlima
BI-HR/05-06-020
Dr. Delko Barišić, Rudjer Boškovic Institute, Zagreb, Croatia
Asst. Prof. Janja Vaupotič
33. Definition of Limits and Field Applicability of the Most Widely Used Sampling Methodologies for Soil and Water
Dr. Umberto Sansone, ANPA - Agenzia Nazionele per la Protezione dell' Ambiente, Rome, Italy
Asst. Prof. Zvonka Jeran
34. Analysis of Soil Samples by Multi-elemental Instrumental Neutron Activation Analysis
INAA - SOILSAMP Project
00-31-5035
Dr. Maria Belli, APAT - Agenzia per la Protezione dell' Ambiente e per i Servizi Tecnici, Rome, Italy
Asst. Prof. Zvonka Jeran
35. Characterization of Food Products in Apulia and Slovenia by Spectroscopic and Chemometric Methods: Similarities and Differences
BI-IT/05-08-013
Prof. Antonio Sacco, Universitŕ di Bari, Dipartimento di Chimica, Bari, Italy
Dr. Nives Ogrinc
36. Mercury Emission, its Influence and its Correlation to Radon in Mount Etna Area
BI-IT/05-08-026
Dr. Salvatore Giammanco, Instituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Palermo, Italy
Dr. Jože Kotnik
37. Monitoring of Physical and Chemical Parameters Connected with Crustal Deformations in a Seismic Area: The Italy and Slovenia Border Region
BI-IT/02-05-004
Dr. Anna Riggio, Instituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy
Asst. Prof. Janja Vaupotič
38. Monitoring of Chemical and Physical Parameters at the Seismic Active Zone at the Slovenian Italian Border at the Etna Volcanic Area
BI-IT/05-08-027
Dr. Anna Riggio, Instituto Nazionale di Oceanografia e di Geofisica Sperimentale, Sgonico (Trieste), Italy
Asst. Prof. Janja Vaupotič
39. The Estimation of the Impact of Mercury Released in Environmental by a Human Activity The Behavior of Mercury Released from the Mining Area
JSPS - Grant no. 15404003
Prof. Takashi Tomiyasu, Kagoshima University, Faculty of Science, Department of Earth and Environmental Sciences, Japan
Prof. Milena Horvat
40. Relation between Radon Level in Soil Gas and Subsoil Properties
SLO-JPN
Dr. Ryoko Fujiyoshi, Hokkaido University, Graduate School of Engineering, Hokkaido, Japan
Asst. Prof. Janja Vaupotič
41. Integration of Hg Removal (RHg) in the Process of Flue Gas Desulphurization (FGD) in Thermal Power Plants
BI-CN/05-07/025
Yan Yin Jiang, Shanghai Research Institute of Environmental Industry, Shanghai Academy of Environmental Sciences, Shanghai, China
Prof. Milena Horvat
42. Elemental Composition of Minerals from The Republic of Macedonia
BI-MK/05-06-018
Dr. Trajče Stafilov, Faculty of Natural Sciences and Mathematics, Skopje, The Republic of Macedonia
Dr. Radojko Jaćimović

43. WG 25 Validation Measurements
CEN/TC 264/WG 25/338, M/360, SA/CEN/ENV/000/2005-37
Ir. Jan A. Wesseldijk, Nederlands Normalisatie-instituut, Delft, The Netherlands
Prof. Milena Horvat, Dr. Jože Kotnik
44. Radon Potential on Different Geologic Basis
BI-PL/05-07-001
Dr. Kozak Krzysztof, The Henryk Niewodniczanski, Institute of Nuclear Physics of the Polish Academy of Sciences, Department of Environmental and Radiation Transport Physics, Natural Radioactivity Laboratory, Krakow, Poland
Asst. Prof. Janja Vaupotič
45. NAA and PIXE Techniques for Microcharacterisation of Trace Elements and Their Species in Environmental Samples
BI-PT-04-06-010
Dr. Miguel Reis, Instituto Tecnologico e Nuclear (ITN), Sacavem, Portugal
Asst. Prof. Zvonka Jeran, Dr. Matjaž Kavčič
46. Training of Ms Marcia Ventura
Instituto Tecnologico e Nuclear (ITN), Sacavem, Portugal
Asst. Prof. Vekoslava Stibilj
47. Accumulation of Mercury and Methylmercury in Natural Forest Sites in Switzerland
U3-12/06
Dr. Beat Frey, Swiss Federal Research Institute WSL, Soil Sciences, Birmensdorf, Switzerland Prof. Milena Horvat
48. The Use of Nuclear Methods in Geophysical Investigations in Different Regions of Earth
BI-UA/05-06-005
Dr. Volodymyr Pyvlovych, Institute for Nuclear Research, Kyiv, Ukraine
Dr. Radojko Jaćimović, Prof. Radomir Ilić
49. Microbial Transformations and Biogeochemistry of Mercury in the Idrijca/Soča River System
BI-US/05-06-011
Dr. Mark Edward Hines, Department of Biological Sciences, University of Massachusetts Lowell, Lowell, MA, USA
Prof. Milena Horvat
50. Mineral Weathering and Crabon Transformations in Carbonate-Rich Landscapes
BI-US/05-06-003
Prof. Walter Lynnn M., University of Michigan, Geological Sciences, Ann Arbor, MI, USA
Dr. Nives Ogrinc

R & D GRANTS AND CONTRACTS

1. Stress and response to the stress in terrestrial isopode Porcellio scaber and in water leek Lemna minor: mechanistic approach
Prof. Milena Horvat
2. Biogeochemical cycling of carbon and nitrogen in eutrophic lakes
Dr. Polona Vreča
3. Identification of anomalies in radon transport caused by seismic activity
Asst. Prof. Janja Vaupotič
4. Biogeochemical cycles and pollution with organotin compounds: development and validation of analytical procedures
Dr. Janez Ščančar
5. Pathways of carbon, nutrients and pollutants through food webs in Slovenian mountain lakes
Prof. Milena Horvat
6. The impact of microbial processes on Hg biomagnification in food webs of the Gulf of Trieste (N Adriatic Sea)
Prof. Milena Horvat
7. Identification of structures, soils and deffects
Asst. Prof. Janja Vaupotič
8. As2O3 biotransformation and clinical efficacy correlations in the treatment of APL
Dr. Zdenka Šlejkovec
9. The influence and interactions of chromium and iron species in yeast cells
Asst. Prof. Radmila Milačič
10. Impact of selenium on the yield of vegetables and crop plants
Asst. Prof. Vekoslava Stibilj
11. The response of soil organic matter and natural ecosystems (primarily forests) to climate change
Dr. Polona Vreča
12. Ljubljansko barje - archaeological landscape in flux
Asst. Prof. Nives Ogrinc
13. Carbon transport processes and mechanisms in forest ecosystems
Asst. Prof. Nives Ogrinc
14. Bioremediation of mercury in contaminated sites
Prof. Milena Horvat
15. Geochemical comparison of metal fluxes in industrial and volcanic environmental
Dr. Jože Kotnik
16. Identification and remediation of pharmaceutical residues in effluent and surface waters
Asst. Prof. Ester Heath
17. Identification and remediation of pharmaceutical residues in effluent and surface waters
Asst. Prof. Ester Heath
18. Biological methods for Hg monitoring
Prof. Milena Horvat
19. Development of tools for management and analysis of the loads and influences on waters in the Sava and Soča catchments
Asst. Prof. Nives Ogrinc
20. The use of new materials from the recycled industrial products and building rubbles in civil engineering
Asst. Prof. Radmila Milačič
21. The determination of the authenticity of wine sugar using a combination of SNIF-NR, IRMS and chemometric methods
Asst. Prof. Nives Ogrinc
22. Food composition tables - meat and meat products
Asst. Prof. Vekoslava Stibilj
23. The comparision and development of new methods for determining the authenticity of oil in foodstaff
Asst. Prof. Nives Ogrinc
24. Determination of geographical and botanical origin of honey
Asst. Prof. Nives Ogrinc
25. Nutrition functionality of yeast biomass enriched with iron
Asst. Prof. Radmila Milačič
26. Monitoring of elements, biophenols and pesticides in olives and in olives oil from Slovene Istra
Asst. Prof. Vekoslava Stibilj
27. Port of Koper in the framework of sustainable development of the coastal region
Asst. Prof. Branko Kontić
28. The effect of nutrition (content of selenium and cadmium) and physical stress on the Se status of soldiers
Asst. Prof. Vekoslava Stibilj
29. Assessment of the environmental impact of military training ground Krivolak with the aim of its ecological remediation
Asst. Prof. Sonja Lojen
30. Harmonized and safety nutrition
Asst. Prof. Vekoslava Stibilj
31. Recycling and use of waste
Prof. Milena Horvat
32. Wastewater treatment by bioremediation technologies
Prof. Milena Horvat

RESEARCH PROGRAMS

1. Modelling of structure-property relationships - QSAR-QSPR
Dr. Bogdan Kralj
2. Cycling of nutrients and contaminants in the environment, mass balances and modeling of environmental processes and risk analysis
Prof. Milena Horvat
3. Modeling and environmental impact assessment of processes and energy technologies
Asst. Prof. Borut Smodiš

NEW CONTRACTS

1. Mercury cycling in the production of cement
Salonit Anhovo Joint Stock co.
Prof. Milena Horvat
2. Emission inventary of persistent organic pollutants
Ministry of the Environment and Spatial Planning
Prof. Milena Horvat, Dr. Tjaša Kanduč
3. Technical Expertise for evaluation of metal deposition
Ministry of the Environment and Spatial Planning
Asst. Prof. Zvonka Jeran
4. Cross-border impact assessment for LNG terminals in the Port of Trieste
Ministry of the Environment and Spatial Planning
Asst. Prof. Branko Kontić
5. Integration of risk assessment and spatial planning - a case study for the Municipality of Koper
Municipality of Koper
Asst. Prof. Branko Kontić
6. Changes in thermal and radiological environmental impacts due to NPP Krško after construction of HPP Brežice
Ministry of the Economy
Asst. Prof. Branko Kontić
7. Analyses of drug samples by mass spectrometry
Krka, d.d. Novo mesto
Dr. Bogdan Kralj
8. Development of Slovenian Waters' Technology Platform
ESOTECH, D.D. VELENJE
Asst. Prof. Sonja Lojen

9. The evaluation of the quality of aquatic sources
   Zavod za zdravstveno varstvo Maribor
   Asst. Prof. Nives Ogrinc
10. Monitoring of quality of marine and fresh waters 2006
    Ministry of the Environment and Spatial Planning
    Asst. Prof. Janez Ščančar
11. Ministry of Environment and Spatial Planning, Slovenian Nuclear Safety Administration
    Ministry of the Environment and Spatial Planning
    Asst. Prof. Janja Vaupotič
12. Traceability of chemical measurements to the mol (sludge, sediments, svils)
    MIRS, Ministry of Higher Education, Science and Technology
    Prof. Milena Horvat, Dr. Polona Vreča

VISITORS FROM ABROAD

1. Michael Beeston, University of Exeter, Great Britain, 1 January 2006 – 31 December 2006
2. Marcia Ventura, Portugal, Instituto tecnologico e Nuclear, Ministerio de Ciencia, Tecnologia e ensino Superior, Fundacao para a ciencia e a tecnologia, Sacaven, Lisbon 10 February – 24 August 2006
3. Ahmad Shanan, IAEA Fellowship C6/JOR/05010V, Jordan Atomic Energy Commission, Amman, Jordan, 14–29 March 2006
4. Sergio Ribeiro Guevara, Laboratorio de Analisis por Activacion Neutronica, centro Atomico Bariloche, Argentina, 3–29 April 2006
5. Tahereh Hosseini, IAEA Fellowship IRA/04049, National Radiation Protection Department, Iranian Nuclear Regulatory Authority, Tehran, Islamic Republic of Iran, 3 May – 2 July 2006
6. Kathryn Szramek, Lixin Jin, Slovenia-United States Bilateral Project, University of Michigan, Ann Arbor, 10 May – 10 June 2006
7. Melisa Haznadarević, Institut za Hidroinženiring, Sarajevo, Bosnia and Herzegovina, 29 May – 1 June 2006
8. Ivana Vukanac, Aleksandar Kandić, Laslo Nadjdjderdj, Institut za nuklearne nauke, Vinča, Serbia and Montenegro, 7–11 June 2006
9. Maria Freitas., ITN Sacavem, prof. dr. Adriano M. G. Pacheco, Sacavem, Portugal, 18–23 June 2006
10. Dr. Delko Barišić, Ivanka Lovrenčič, Institut Rudjer Bošković, Zagreb, Croatia, 25 June – 1 July 2006
11. Maria Hose Sierra, CIEMAT – Departamento de Medio Ambiente, Madrid, Spain, 5 September – 19 December 2006
12. Dr. Ryoko Fujiyoshi, Hokkaido University, Sapporo, Japan, 22–25 September 2006
13. Dr. Petre Makreski, Univerzitet Sv. Kiril i Metodij, Skopje, Macedonia, 24 September – 30 October 2006,
14. Milena Taseska, Univerzitet Sv. Kiril i Metodij, Skopje, Macedonia, 24 September – 21 December 2006
15. Dr. Salvatore Giammanco, Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Catania, Italy, 25 September – 5 October 2006
16. prof. dr. Hylke Jan Glass, University of Exeter, Camborne School of Mines, Camborne, United Kingdom, 25–26 September 2006
17. Dr. Ivan Sondi, Institut Rudjer Bošković, Zagreb, Croatia, 26 September – 2 October 2006
18. Prof. Frans de Corte, Department of Analytical Chemistry, Faculty of Sciences, Ghent University, Ghent, Belgium, 29 September – 5 October 2006
19. Dr. Takashi Tomiyasu, dr. Akito Matsuyama, National Minamata Institute, 2–12 October 2006
20. dr. Ryusuke Imura, Kagoshima University, Japan, 2–6 October 2006
21. Dr. Anna Riggio, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy and Dr. Franco Italiano, Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Italy, 2–11 October 2006
22. Prof. dr. Yurij Bondarchuk Oksana Mikhalus, Odessa National Polytechnik University, Odessa, Ukraine, 13–27 October 2006
23. Vitaliy Rusov, Volodymyr Pavlovych, Odessa National Polytechnik University, Odessa, Ukraine, 23–26 October 2006
24. Dr. Jan Kučera, 24. 10. - 29. 10. 2006, Maria Kubesova, Czech Technical University, Prague, 24 October – 10 November 2006
25. Dr. Albrecht Leis, Joanneum Research, Institut für WasserRessourcenManagement, dr. Stephan J. Köhler, Institut für Angewandte Geowissenschaften, Technische Universität Graz, Austria, 21 November 2006
26. Prof. dr. Mark Hines, University of Massachusetts, , Ms. Tamar Barkay, Mr. Isac Adato, Mr. Reging Yu, Lowell, USA, 4 April 2006 and 28 October 2006
27. Maria Angela Menezes, Centro de Desenvolvimento da Technologia Nuclear, Belo Horizonte, Brazil, 27 November – 4 December 2006
28. Darya Bairasheuskaya, Department of Environmental Monitoring, International Sakharov Environment University, Minsk, Belarus, 10 September – 10 December 2006
29. Prof. dr. Paolo Zatta, dr. Pamella Zambenedetti, University of Padova, Italy, 3 November 2006
30. Prof. Gaetane Lespes, Université de Pau et des Pays de l'Adour, Laboratoire de Chimie Analytique, Bio-Inorganique et Environnement-UMR CNRS 5034- France, 4–8 December 2006

STAFF

Researchers

Asst. Prof. Ljudmila Benedik
Dr. Ingrid Falnoga
Asst. Prof. Ester Heath
Prof. Milena Horvat, Head
5. Dr. Radojko Jaćimović
6. Asst. Prof. Zvonka Jeran
7. *Prof. Ivan Kobal, left 31.12.2006*
8. Asst. Prof. Branko Kontić**
9. Dr. Jože Kotnik
10. Dr. Bogdan Kralj
11. Asst. Prof. Sonja Lojen
12. Asst. Prof. Radmila Milačič
13. Asst. Prof. Nives Ogrinc
14. Dr. Arkadije Popovič
15. Asst. Prof. Borut Smodiš
16. Asst. Prof. Vekoslava Stibilj
17. Asst. Prof. Janez Ščančar
18. Dr. Zdenka Šlejkovec
19. Asst. Prof. Janja Vaupotič
20. Dr. Dušan Žigon

Postdoctoral associates

21. Dr. Tjaša Kanduč,
22. Dr. Darja Mazej
23. Dr. Nataša Nolde
24. Dr. Urška Repinc
25. *Dr. Polona Tavčar, left 16. 1. 2006*
26. Dr. Polona Vreča
27. Dr. Boris Zmazek***

Postgraduates

28. Tinkara Bučar, B. Sc
29. Petra Cuderman, B. Sc.
30. Marinka Gams Petrišič, B. Sc.
31. Darija Gibičar, B. Sc.
32. Rožle Jakopič, B. Sc.
33. David Kocman, B. Sc.
34. Davor Kontić, B. Sc.
35. *Dr. Blaž Kralj, left 12. 6. 2006*
36. Tadeja Milivojevič Nemanič, B. Sc.
37. Tanja Mrak, B. Sc.
38. Simona Murko, B.. Sc.
39. Andrej Osterc, B. Sc.
40. Marko Štrok, B. Sc.
41. Martina Šturm, B. Sc.
42. *Špela Uršej, B. Sc.. left 1. 7. 2006*
43. Mitja Vahčič, B. Sc.
44. Tea Zuliani, B. Sc.
45. Mladen Živčič***, M. Sc.
46. Suzana Žižek, B. Sc.

Technical officer

47. Dr. Svetozar Polič

Technical and administrative staff

48. Petra Dujmović
49. Vesna Fajon
50. Barbara Korc
51. Silva Perko
52. Janja Smrke
53. Barbara Svetek
54. Zdenka Trkov
55. Stojan Žigon

** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF AUTOMATION, BIOCYBERNETICS AND ROBOTICS E-1

Our research brings together the different fields of automatics, robotics, biocybernetics, kinesiology and environmental medicine. Most of the research topics are connected to what is called the "movement of man and machine" and its connection and interaction with the environment. The aim is to make available advanced knowledge, as well as to develop and transfer systems and technologies to our customers in the areas of industry, medicine and sport.

Head:
Dr. Leon Žlajpah

The main directions of research in the past year were humanoid robotics, the integration of mobility and manipulation in industrial and service robotics, studies of human physiology in extreme environments, the evaluation of protective equipment, the development of biomedical devices and methods, and the robotics and automation of industrial manufacturing.

The development of humanoid robotic systems is an important part of our research. In the past year we started to work on problems related to the realization of cognition in humanoid robots. This work was initiated by our participation in the EU's FP6 integrated project "Perception, Action, and Cognition through Learning of Object-Action Complexes" (PACO+). The PACO+ project aims to design a cognitive robot that is able to develop perceptual, behavioural and cognitive categories in a measurable way and communicate and share them with humans and other artificial agents. Our contribution in the first phase of the project concentrated on the development of the sensorimotor primitives needed for object exploration and for the generation of early object-action complexes. We also conducted research on coaching, where a person, acting as a coach, interactively directs humanoid behaviour to a desired outcome. In conjunction with our work in PACO+ we continued to work on learning objects using a humanoid, foveated vision system. We designed a procedure for learning complete object representations for recognition by a humanoid robot without any prior knowledge of the objects and without the manual processing of images. We also designed a draft system for human motion capture using distributed processing on a computer cluster. These studies were made in collaboration with the ATR Computational Neuroscience Laboratories, Kyoto, Japan, and were supported by the JSPS-ARRS project "Learning object-action descriptions and active object recognition by a humanoid with foveated vision" and by a bilateral project "Multiple features encoding for distributed video-based motion capture".

We have developed a new method for controlling a humanoid robot's oculomotor system, so imitating humanoid vision (higher resolution in the eye centre and lower on the edge)

In the field of the kinematics and dynamics of the human body we continued our research of the energy-efficient motion of human and robot mechanisms. We designed and built a humanoid robotic mechanism that is, in terms of its characteristics, unique in the world. It includes elastic biarticular links that makes possible the execution of fast dynamic motion. For the purposes of analysis and motion optimization we made a dynamic simulator of the vertical jump in the simulation environment Matlab/Simulink. The described robotic mechanism will enable in-depth research in the field of humanoid robotics and fast motion, e.g., running and jumping. We continued the study of human-arm motion with the emphasis on periodic motion. Here we have studied different strategies for the generation of periodic motion, especially those based on nonlinear oscillators and different learning methods. As an example we have applied the proposed strategies on a robot. The task was to operate a gyroscopic device.

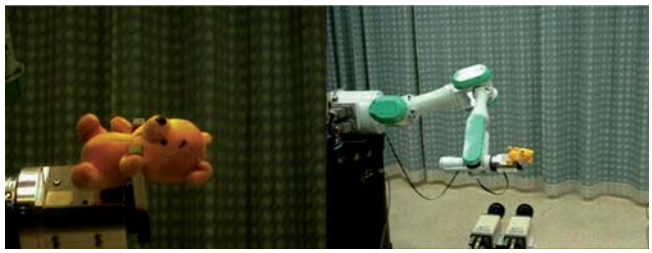

Figure 1: Object recognition with a humanoid vision system

In the field of robot control we have addressed the problem of controlling a mobile manipulator. We have developed a new type of control, which is suitable for controlling redundant systems composed of two or more subsystems, and we have integrated a different sensory system (vision, etc.). As an example of successful integration we have realized the task of pouring a drink into a glass with a robot. For this application we have combined the Mitsubishi PA10 industrial robot and the Nomad XR400 mobile robot. We have developed the kinematic and the dynamic models of the complete robot system, and realized the communications between all the systems and the supervisor control system.

Figure 2: Mobile robot arm in the role of a servant

We have been collaborating with the Alpina factory for several years. The main contribution of this R&D project is the integration of the CAD phase with the production. This approach was implemented in the shoe-manufacturing industry, but it can also be applied in other similar industries. Our approach differs from the already-existing approach using postprocessors for the NC code generation from the CAD. Namely, in the automatic code generation for industrial robots it is extremely difficult to achieve 'safe' trajectories. Safe trajectories are trajectories that ensure that the robot will not collide with the environment, will avoid a singular configuration and will not violate joint limits, velocities and accelerations. Our approach to automatically generating safe trajectories relies on the control theory of kinematically redundant robots. We also developed a new, very efficient approach, where we describe the task redundancy due to the circular shape of the work tool as a virtual mechanism. We have developed, designed and built two work cells, one for the automation of the gluing of the shoe's sole and the other for the shoe-bottom roughing and pre-roughing. With these cells we have completely eliminated the need for manual teaching. All the trajectories are generated automatically from the reference CAD model of the shoe and downloaded to the cell controller. For the generation of the 'safe' trajectories we have also developed an expert system.

A highly automated and computer-integrated production line increased the productivity and decreased the product price.

In the past year we finished the R&D phase for Droga Kolinska, a food production company, including the specification of the logical, hardware and software structure of the supervisory and control systems for the advanced tea-production and packaging plant. Together with Droga Kolinska we also implemented a fully functional production facility, which is highly automated and integrated in the manufacturing and enterprise resource planning levels. Our solution enables the concurrent production of a number of different tea blends, packaged in different container formats, while the investment costs are considerably lower than for a conventional solution with a number of separate single-product production lines. The results of this R&D project already caused an increase in the market share of the company.

Development of task-specific performance tests for the Slovenian Armed Forces ensures the optimal selection of personnel for specific tasks.

The Environmental Physiology and Ergonomics Laboratory maintains facilities for testing human performance and equipment in extreme climatic conditions. The climatic chamber simulates ambient conditions ranging from –30°C to +50°C, and can also maintain relative humidity under these conditions. It is also equipped with a vacuum pressure absorption system (VPSA) that can accurately maintain the oxygen levels inside the climatic chamber to simulate altitudes up to 15,000 m above sea level. Together with an industrial partner from the Netherlands (van Amorongen and B-Cat) we have designed and installed several such facilities for altitude training. In addition, we have installed a zero-oxygen chamber for destroying pests in furniture, for the Slovene Ethnographic Museum. The simulation of underwater environments is achieved with our hyperbaric chamber, capable of simulating depths of 70 msw. Ongoing work in the laboratory focuses on the evaluation of thermal protective clothing and clothing for NBC protections, for industrial and military partners. The evaluation of equipment is conducted with human subjects, and with thermal sweating manikins designed and constructed by our staff. The newest generation of thermal sweating manikins is the product of a collaboration with CNRS, France. These are now being marketed to several industrial partners. The range of manikins being developed includes a full manikin, a foot manikin, a torso manikin, a head manikin and a hand manikin. These will be used for the evaluation of NBC protective clothing, footwear, bullet-proof vests, helmets, and protective handwear. We continue to conduct laboratory and field evaluations of protective equipment, for the Slovenian Armed Forces, Gore & Associates, Sympatex, Armasuisse, Alpina, and Universal Customisation Systems (UCS). With colleagues from the Swedish Defence Research Establishment we continue to collaborate on studies investigating the deleterious effects of motion sickness. This year our investigations have focused on the effect of pharmacological substances used to counteract motion sickness on the

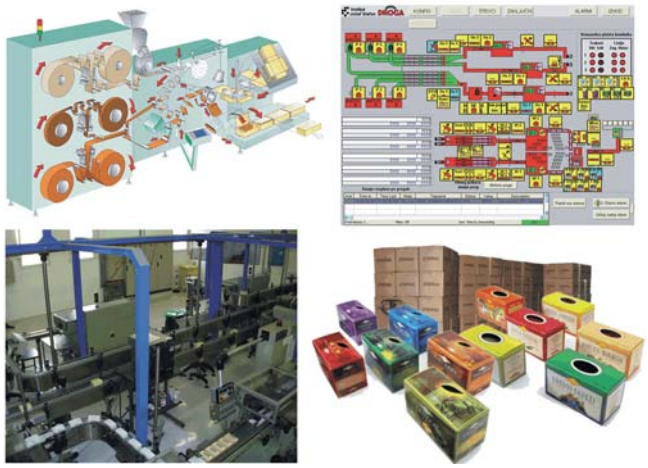

Figure 3: Control and supervisory system of the tea production line in the Droga-Kolinska factory

The testing of footwear with our sweating thermal foot manikins helped to develop new, high-quality shoes with increased wearer comfort.

thermoregulatory function. With the Institute of Naval Medicine, UK, we have established new fitness standards for military divers, which will also be implemented by the Slovenian Armed Forces. With partners from the Institute of Kinesiological Research at the University of Primorska we are developing task-specific performance standards for several branches of the Slovenian Armed Forces. With colleagues from Dalhousie University, Canada, and the Medical Faculty at the University of Maribor, we continue to investigate the possibility of harnessing the response of cold-induced vasoconstriction to prevent cold injury to the digits of the hands and feet.

In the EU project CARED (Computer Aided Rehabilitation of Respiratory Disabilities) physiotherapeutic control of expiratory muscle recruitment possibilities were examined in patients with COPD (chronic obstructive pulmonary disease). The main objective was to investigate abdominal muscles' breathing activity (EMG) during exercise testing (cycloergometry) and the effect of high-frequency electrical stimulation on muscle fatigue. The disadvantage of abdominal expiratory muscle recruitment during exercise is a diminution of venous return and therefore lower cardiac output. The consequence of the latter can be a reduced exercise tolerance. The periodic relationship between abdominal muscle breathing activity and exercise load and the phenomenon threshold were discovered. The results will be used for bio-feedback and the relaxation or blocking of abdominal muscles during breathing. The research was done in cooperation with the Clinic of Respiratory and Allergic Diseases, Golnik, Slovenia.

Figure 4: System for the evaluation of the thermal and evaporative characteristics of footwear

During the past year we studied human body movement during sports activities. The research was focused on alpine skiing. We developed a dynamic model of the skier, which has been used in simulations necessary to develop different control strategies for the robot skier. The control algorithms ensure the stable motion of the skier in different conditions (the radius of the curve, the velocity and the rough surface). In 2007 we plan to develop a robot skier. Hence, the model has been used also to evaluate the required torques of the motors. We have also developed a system that enables the robot to detect gates on the slope and an algorithm for local navigation.

Figure 5: Testing of clothing to protect against fire using the flame manikin

Some outstanding publications in the past three years

1. Babič, J., Lenarčič, J., Optimization of biarticular gastrocnemius muscle in humanoid jumping robot simulation. International journal of humanoid robotics, 3 (2006), 219–23.
2. Žlajpah, L., Robotic yo-yo : Modelling and control strategies. Robotica, 24 (2006), no. 2, 211–220.
3. Ude, A., Gaskett, C., Cheng G., Proc. IEEE International Conference on Robotics and Automation, May 2006, Orlando, Florida, USA, 3457–3462.
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1. A device providing simultaneous visibility of images within the area of 360° around itself, Jan Babič, patent no. 21898

Organization of conferences, congresses and meetings

1. Advances in robot kinematics ARK 2006, Ljubljana, 25–29 June 2006

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1. Jan Babič, Jadran Lenarčič
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2. Ola Eiken, Jacek Nowak, Tomas Jogestrand, Igor B. Mekjavić
   Effects of local arteriosclerosis on carotid baroreflex sensitivity and on heart rate and arterial pressure variability in humans
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5. Igor Potočnik, Martin Tomšič, Janez Sketelj, Fajko Bajrović
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6. Nigel A.S. Taylor, Joanne N. Caldwell, Igor B. Mekjavić
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7. Leon Žlajpah
   Modelling and control of yo-yo
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8. Leon Žlajpah
   Robotic yo-yo: modelling and control strategies
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9. Anton Ružić, Leon Žlajpah
   Avtomatizacija nekonvencionalnih nalog in proizvodnih postopkov
   In: Euroteh (Trzin), Vol. 5, No. 4, pp. 22-25, 2006.

REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Jan Babič, Damir Omrčen, Jadran Lenarčič
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2. Damir Omrčen, Leon Žlajpah, Bojan Nemec
   Combined torque and velocity control of a redundant robot system
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PUBLISHED CONFERENCE PAPERS

Invited Paper

1. Leon Žlajpah
   Simulation in robotics
   In: 5th MATHMOD: proceedings(Argesim report, no. 30), 5th Vienna Symposium on Mathematical Modeling, February 8-10, 2006, Vienna University of Technology, Inge Troch, ed., Felix Breitenecker, ed., Vienna, Argesim, 2006, pp. 5-1-5-16.

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1. Pedram Azad, Aleš Ude, Tamim Asfour, Gordon Cheng, Ruediger Dillmann
   Image-based markerless 3d human motion capture using multiple cues
   In: Proceedings, International Workshop on Vision Based Human-Robot Interaction [held in conjunction with] EUROS-2006, 18 March, 2006, Palermo, Italy, [S. l.], European Robotics Research Network, 2006, 16 p.
2. Jan Babič, Damir Omrčen
   Stability control of human inspired jumping robot
   In: RAAD 2006: proceedings, 15th International Workshop on Robotics in Alpe-Adria-Danube Region, June 15-17, 2006, Balatonfüred, Hungary, Budapest, Budapest Tech, 2006, pp. 206-211.
3. Mitja Babič, Jadran Lenarčič
   Simulacija vodenja paralelnega mehanizma ramenskega obroča
   In: Zbornik petnajste mednarodne Elektrotehniške in računalniške konference ERK 2006, 25. - 27. september 2006, Portorož, Slovenija(Zbornik ... Elektrotehniške in računalniške konference ERK ...), Baldomir Zajc, ed., Andrej Trost, ed., Ljubljana, IEEE Region 8, Slovenska sekcija IEEE, 2006, Zv. B, pp. 163-166.
4. Gordon Cheng, Sang-Ho Hyon, Jun Morimoto, Aleš Ude, Glenn Colvin, Wayco Scroggin CB: a humanoid research platform for exploring neuro science
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5. Andrej Gams, Leon Lahajnar, Leon Žlajpah, Jadran Lenarčič
   Posnemanje ritmičnega gibanja z robotom: pospeševanje rotorja žiroskopske igrače Power ball
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6. Andrej Gams, Jadran Lenarčič
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8. Nina Kocjan, Igor B. Mekjavić
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9. Bojan Nemec, Leon Žlajpah
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10. Damir Omrčen, Bojan Nemec, Andrej Kos, Leon Lahajnar, Jan Babič, Andrej Gams, Aleš Ude, Leon Žlajpah
    Integration of a redundant mobile manipulator system: a drink serving task
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11. Marcia Riley, Aleš Ude, Christopher G. Atkeson, Gordon Cheng
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13. Kai Welke, Erhan Oztop, Aleš Ude, Ruediger Dillmann, Gordon Cheng
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14. Leon Žlajpah
    Simulation of robotic manipulators
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PATENT APPLICATION

1. Leon Lahajnar, Janez Leskovec, Franci Lahajnar
   Principle and device for simultaneous viewing of pictures from different positions around the device P-2006 00112, 17. 5. 2006
   Ljubljana, Urad Republike Slovenije za intelektualno lastnino, Patentna pisarna, 2006.

INTERNATIONAL PROJECTS

1. Perception, Action & Cognition through Learning of Object-Action Complex
   PACO-PLUS
   6. FP; 027657
   EC; Universitaet Karlsruhe (TH), Karlsruhe, Germany
   Dr. Aleš Ude
2. European Robotics Network
   EURON
   6. FP; 507728

EC; Kungliga Tekniska Högskolan, Stockholm, Sweden
Prof. Jadran Lenarčič

3. Computer Aided Rehabilitation of Respiratory Disabilities
CARED
5. FP
QLG5-CT-2002-00893
EC; Prof. Adriano Demaio, Prof. Antonio Pedotti, Dipartimento di Bioingegneria, Polytechnic of Milan, Milano, Italy
Dr. Martin Tomšič
4. Innovation and New Product Development based on Inter-Region Networks
NPD-NET
INTERREG IIIC Operation
EC; Dr. Dimitris Milossis, Urban and Regional Innovation Research Unit (URENIO), Aristotle University of Thessaloniki, Thessaloniki, Greece
Dr. Anton Ružić, Prof. Peter Stegnar, Dr. Žiga Bolta
5. Manikins for Decathlon
Philippe Pieri, Centre National de la Recherche Scientifique CNRS, Centre d"Wtudes de Physiologie Appliyquee, Strasbourg Cedex, France
Dr. Leon Žlajpah
6. Goal-directed Sensorimotor Primitives for Building Object Representations on a Walking Humanoid Robot
0114061102001
Dr. Mitsuo Kawato, Advanced Telecommunications Research Institute International, Computational Neuroscience Laboratories, Department of Humanoid Robotics and Computational Neuroscience, Kyoto, Japan
Dr. Ude Aleš
7. Multiple Features Encoding for Distributed Video-based Motion Capture
Dr. Mitsuo Kawato, Toyoko Morihisa, Advanced Telecommunications Research Institute International, Computational Neuroscience Laboratories, Department of Humanoid Robotics and Computational Neuroscience, Kyoto, Japan
Dr. Ude Aleš
8. Learning Object-action Descriptions and Active Object Recognition by a Humanoid with Foveated Vision
SLO-JPN
Prof. Cheng Gordon, Advanced Telecommunications Research Institute International, Computational Neuroscience Laboratories, Department of Humanoid Robotics and Computational Neuroscience, Kyoto, Japan
Dr. Aleš Ude
9. Diving Egrometer + CE
Institute of Naval Medicine, Gosport, Great Britain
Dr. Igor Mekjavič
10. Footwear Ventilation – Part II
Mark K. Newton, W.I. Gore & Associates, Inc., Elkton, MO, USA
Borut Lenart, B. Sc.

R & D GRANTS AND CONTRACTS

1. System for automatic supervision and control of a production line for simultaneous production of different products
Dr. Aleš Ude
2. Integration of CAD systems into shoe assembly production processes
Dr. Leon Žlajpah
3. Development and optimisation of military personal protective equipment
Prof. Igor B. Mekjavič
4. Protective systems for warrior
Prof. Igor B. Mekjavič

RESEARCH PROGRAM

1. Automation, robotics and biocybernetics
Prof. Igor B. Mekjavič

NEW CONTRACT

1. The ZerOx Pest Control System
Slovene Ethnographic Museum
Dr. Leon Žlajpah

VISITORS FROM ABROAD

1. Prof. Nickos Geladas, Department of Sports Medicine & Biology of Exercise, Faculty of Physical Education and Sport Science University of Athens, Athens, Greece, one week in January 2006
2. Dr. Maria D. Koskolou, Department of Sports Medicine & Biology of Exercise Faculty of Physical Education and Sport Science, University of Athens, Athens, Greece, one week in January 2006
3. Prof. Nigel Taylor, Department of Biomedical Sciences, University of Wollongong, Wollongong, NSW, Australia, a few days in February 2006
4. Lucy E. Dorman, M. Sc.; Loughborough University (Human Thermal Environments Laboratory, Department of Human Sciences), Loughborough, United Kingdom, February 2006
5. Prof. Pietro Di Prampero, University of Udine, Italy, 7 February 2006
6. Prof. Giugliano Anotnuto, University of Udine, Italy, 7 February 2006
7. Jim House, C.N.R.S., France, 12–15 March 2006
8. Dr. Kai Welke, Department of Humanoid Robotics and Computational Neuroscinece, ATR Computational Neuroscience Laboratories, Kyoto, Japan, 16–29 March 2006
9. Dr. Gordon Cheng, Department of Humanoid Robotics and Computational Neuroscience, ATR Computational Neuroscience Laboratories, Kyoto, Japan, 16-29 March 2006
10. Agnieszka Piskuta, EMPA, Sweden, 17–20 March 2006
11. Corinne Keiser, EMPA, Sweden, 17–20 March 2006
12. David Blair, Armasuisse, Sweden, 12–13 April 2006
13. Juerg Billeter, Armasuisse, Sweden, 12–13 April 2006
14. Stefan Althaus, Armasuisse, Sweden, 12–13 April 2006
15. Prof. Mike Stanišič, University of Notre Dame, Indiana, USA, 31 March – 20 April 2006
16. Dr. Stelios Kounalakis, University of Athens, Greece, 25 February – 5 May 2006
17. Prof. Delbert Tesar, University of Texas Robotics Research Group, University of Texas, USA, 31 July 2006
18. Mihalis Keramidas, University of Athens, 20 June – 31 December 2006
19. Dr. Stelios Kounalakis, University of Athens, 24 May – 30 September 2006
20. Prof. Tomohiro Shabata, ATR Computational Neuroscience Laboratories, Kyoto, Japan, 22–23 November 2006
21. Prof. Tetsunari Inamura, ATR Computational Neuroscience Laboratories, Kyoto, Japan, 22–23 November 2006
22. Rene Luyten, Van Amerongen, The Netherlands, 13 November 2006
23. Wim van den Berg, Van Amerongen, The Netherlands, 13 November 2006
24. Janneke van den Berg, Van Amerongen, The Netherlands, 13 November 2006
25. Marcia Riley, Georgia Institute of Technology, USA, 7. 12–17 December 2006
26. Victor Candas, C.N.R.S., France, 18–20 December 2006

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9. Tadej Debevec, B. Sc.
10. Andrej Gams, B. Sc.
11. Leon Lahajnar, B. Sc.
12. Daniel Wolowske, M. Sc.

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13. Nina Kocjan, B. Sc., left 21. 07. 2006
14. Andrej Kos, B. Sc.
15. Borut Lenart, B. Sc.
16. Dr. Ladislav
17. Dr. Anton Ružić
18. Bogomir Vrhovec, B. Sc.

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20. Jožef Opeka
21. Marija Trampuž, secretary
22. Janez Zalar

DEPARTMENT OF SYSTEMS AND CONTROL E-2

The Department of Systems and Control is engaged in research, development, applications and education across various areas of control technology. Its mission is "to bridge the gap between theory and practice". Hence, the research activities are relatively application oriented, and the content of the work is closely related to the needs of production companies. The activities of the department are focused on the research of new methods and algorithms for automatic control, the development of procedures and tools to support the design and construction of control systems, the development of specific measurement and control modules, and the development and construction of complete systems for the control and supervision of machines, devices and industrial processes.

Head:
Prof. Stanislav Strmčnik

The Department of Systems and Control is engaged in research, development, applications and education across various areas of control technology.

Basic and applied research

The basic and applied research during 2006 was devoted to three sub-areas: the analysis and control of complex systems and processes, fault detection and isolation, and computer-integrated production control.

The aim of the research in the sub-area **analysis and control of complex systems and processes** was to improve the existing algorithms and also to develop new algorithms for systems or process control. A part of the activities was devoted to tuning and optimising industrial controllers, where a new tuning method was developed, with which optimal disturbance rejection can be obtained. Using this approach, a control system for stereoscopic camera synchronization was designed (Fig. 1). The second research topic was related to Gaussian processes. Here, dynamic models were developed based on Gaussian process models with a fixed structure, which were used for the design of nonlinear explicit predictive control algorithms. The third topic was related to the research of supervision algorithms for adaptive controllers. Here, new concepts were developed that enable the effective and correct adaptation also in the presence of large, fast and non-measurable disturbances. Finally, in the control of wastewater-treatment processes, feed-forward and predictive control algorithms for nitrogen control were designed and tested on a wastewater-treatment benchmark (Fig. 2).

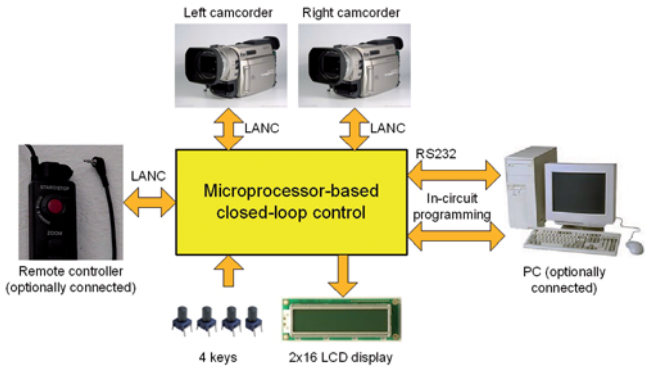

Figure 1: Block scheme of video and still cameras synchronizer (3D LANC Master).

Nowadays, continuous quality control in manufacturing as well as in the processing industries and other high-technology systems has become a standard aid to better productivity and competitiveness. Therefore, **fault detection and isolation** is currently a fast-developing sub-area of research in the Department of Systems and Control that has a growing significance for our industrial partners. In 2006, applied research in the area of fault detection and isolation was focused on two main topics. The first one can be viewed as a continuation of the research in the area of the quality assessment of electrical motors. The main idea was to use the results of an online motor assessment in order to make statistical tests that can reveal incipient changes in product quality due to changes in the assembly line (Fig. 3). In the second topic, significant progress has been achieved in the area of signal reconstruction from short time series. The research was based on the adoption of the filter-diagonalization method and its reformulation in the dynamic system framework. By using Monte Carlo analysis new results were obtained showing that the quality of reconstruction monotonically degrades with an increasing signal-to-noise ratio and a decreasing observation time.

Our research in **computer-integrated production control** is aimed at enhancing existing manufacturing information and execution systems (MES) with functions for efficient decision making. In 2006, the development of a procedural model for a selected manufacturing system was continued. The model is designed as a functional building block of MES, supporting decision making that will use parameters of technology as well as production costs to help production managers optimise

The basic and applied research during 2006 was devoted to three sub-areas: the analysis and control of complex systems and processes, fault detection and isolation, and computer-integrated production control.

It is important to note that a substantial part of our basic and applied research is closely related to work in the EU's 6FP projects PRISM, CONNECT, and PEGASE.

production (Fig. 4). Based on the model and its simplification a predictive control algorithm was designed, and its performance was investigated. The second part of the activities within this sub-area was devoted to problems of the economic evaluation of computer-integrated production control systems and the evaluation of methods for the design and implementation of human-centred technology.

It is important to note that a substantial part of our basic and applied research is closely related to work in the EU's 6FP projects PRISM, CONNECT, and PEGASE.

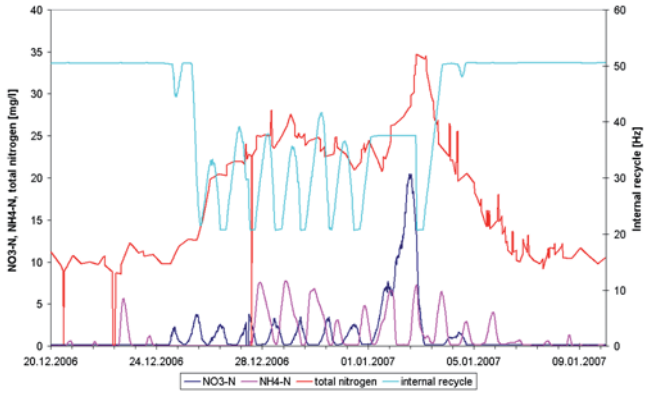

Figure 2: Control of nitrate nitrogen NO_3-N by manipulating the internal recycling at the Domžale-Kamnik wastewater-treatment pilot plant.

R&D projects for industry and other users

In 2006 our R&D activities were mainly related to projects initiated by industrial partners and co-financed by the European Regional Development Fund.

In the frame of the **Centre of Excellence for Advanced Control Technologies** (which includes 15 industrial and 4 academic partners), which is coordinated by our department, we have taken part in three R&D projects. The topics that were dealt with were mainly the following: the development of a control-loop tuning tool, the development of standardized control SW blocks, the development of specific control algorithms for wastewater treatment, the development of modules for vibro-acoustic analysis, and the conceptual design of information support for solving partially structured production management processes.

We have also played a substantial role in the coordination of a large project (26 partners) entitled **"Advanced Control Technologies for Improving Competitiveness"**. Within this project we were actively involved in various research and development sub-projects, for example, the conceptual design of additional functionalities for production management systems, the development of a prototype SW tool called LiteBatch, for batch process control, the development of a SW package for the optimal scheduling of batches in TiO_2 production, the conceptual design of methods and tools for supporting the life-cycle approach in automation projects, etc.

In 2006 our R&D activities were mainly related to projects initiated by industrial partners and co-financed by the European Regional Development Fund.

In addition to the above-mentioned large projects we have also worked on some other R&D projects.

For the companies PlasmaIt and PlasmaBull, a control system for the automatic control of a plasma-based wire-treating device was developed. The system controls and supervises all the parameters related to plasma, as well as the parameters of peripheral modules, such as temperatures, pressures, etc. For the company Domel d.d., a semi-automatic diagnostic system for the quality assessment of DOMUS-type vacuum-cleaner motors was designed and built, which was transferred to the PR of China, where a new Domel factory is established. Also, a new, completely automatic, diagnostic system for several types of motors was designed and built to increase the production capabilities at the Domel Company in Železniki. For the company GOAP a simple algorithm for calculating the room temperature set-points in buildings was developed. The algorithm changes the room-temperature set-points according to the thermal conditions in the building. In 2006, our long-term cooperation with the engineering company INEA continued. We were mainly engaged in defining a set of key performance indicators and the procedure for their calculation. The task was related to the development of the I4PROS production information system.

Figure 3: An excerpt from the system for statistical control of the manufacturing line for vacuum-cleaner motors

A part of our activities was also devoted to the development of custom-designed measuring equipment and the establishment of a development environment for microprocessor applications.

For the needs of the BRACCIA European project the Cardio&BrainSignals 12-channel measurement system was designed to measure ECG, EEG, respiratory effort, blood pressure, skin conductivity, high-resolution temperature and two auxiliary channels (Fig. 5). The system is used in research at the Royal Lancaster Infirmary, the Physics Department at Lancaster University and Ulleval Hospital, University of Oslo.

To fulfil the needs for the development of new electronic devices a development environment was established that will enable the design of

embedded control and digital signal processing systems, based on the ARM core microprocessors. The programming environment consists of the proprietary LPC2148 ARM processor-based development board, the assembler, the compiler, the debugger, the graphical interface and the FreeRTOS real-time operating system.

Some members of the department are giving lectures and practical courses at the Faculty of Electrical Engineering, University of Ljubljana, the Faculty of Logistics, University of Maribor, the University of Nova Gorica and the "Jožef Stefan" International Postgraduate School.

Education and training activities

Some members of the department are giving lectures and practical courses at the Faculty of Electrical Engineering, University of Ljubljana, the Faculty of Logistics, University of Maribor, the University of Nova Gorica and the "Jožef Stefan" International Postgraduate School. They also act as supervisors of M.Sc and Ph.D. students. Special care was given to post-qualification training for engineers from industry. In 2006, four one-week courses were organized. These courses were organized in close co-operation with the Information Technologies Knowledge Transfer Center at the Jožef Stefan Institute.

Some outstanding publications in the past three years

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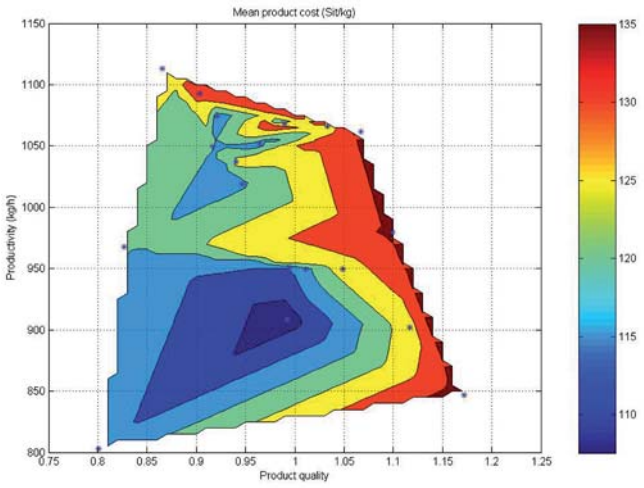

Figure 4: Production model simulation results: Estimation of the production costs in a polymerisation plant

The most important technological achievements in the past three years

1. A control system for a magneto-focused plasma annealer (Gregor Dolanc, Samo Gerkšič)
2. A series of systems for the quality control of vacuum-cleaner motors (Janko Petrovčič, Gregor Dolanc, Bojan Musizza, Đani Juričić, Dejan Tinta, Uroš Benko, Stane Černe, Janez Grom, Miro Štrubelj)

Figure 5: The Cardio&BrainSignals 12-channel measurement system, which enables the measurement of ECG, EEG, respiratory effort, blood pressure, skin conductivity, high-resolution temperature and two auxiliary channels

Patent granted

1. Miloš Ružič, Berta Kotar-Jordan, Matej Smrkolj, Samo Gerkšič, Damir Vrančić, Milena Benedik, Mira Gričar: Process for preparing clopidrogel hydrogen sulfate of form I : EP patent no. EP1693375, 2006, Rijswijk, Netherlands, European patent Office.

Organization of conferences, congresses and meetings

1. Modelling and simulation of control systems: continuing education (specialisation) course in Control Technology, Ljubljana, 30 January – 3 February 2006
2. Industrial regulation systems: continuing education (specialisation) course in Control Technology, Ljubljana, 3–7 April 2006
3. Advanced control methods: continuing education (specialisation) course in Control Technology, Ljubljana, 29 May – 2 June 2006
4. Software for process control: continuing education (specialisation) course in Control Technology, Ljubljana, 16–20 October 2006

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   Human skin microcirculation after brachial plexus block evaluated by wavelet transform of the laser doppler flowmetry signal
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THESES

Ph. D. Theses

1. Dejan Gradišar: Computer-aided modelling for production-task scheduling
2. Dejan Tinta: Fault detection in the mass production of electric motors (Đ. Juričić)

B. Sc. Theses

1. Maja Marcola: Assessing the human orientation of an air-traffic control system (Juš Kocijan)
2. Mitja Rijavec: The setting of a reference temperature profile for a reflow oven (Juš Kocijan)
3. Dean Trojer: Hands-on-experiment framework for automatic control (Juš Kocijan)

INTERNATIONAL PROJECTS

1. Design of Advanced Controllers for Economic, Robust and Safe Manufacturing Performance
CONNECT
6. FP
COOP-CT-2006, 031638
EC; Dr. Constantinos Pantelides, Process Systems Enterprise Limited, London, Great Britain
Dr. Samo Gerkšič, Dr. Vladimir Jovan
2. HelicoPter and aEronef naviGation Airborne System Experimentations
PEGASE
6. FP
AST5-CT-2006-030839
EC; Bruno Pattin, Claire Lallemand, Dassault Aviation, Paris, France
Prof. Stanko Strmčnik, Dr. Gregor Dolanc
3. Towards Knowledge - Based Processing Systems
PRISM
6. FP
MRTN-CT-2004-512233
EC; Imperial College of Science Technology and Medicine, London, Great Britain
Dr. Gregor Kandare
4. The Control System for the Plasma Cleaning Machine
Primož Eiselt, PlasmaBull GmbH, Lebring, Austria
Dr. Vladimir Jovan
5. Explicit Nonlinear Model Predictive Control based on Gaussian Process Models
Prof. Alexandra Grancharova, Institute of Control and System Research, Bulgarian Academy of Sciences, Sofia, Bulgaria
Prof. Juš Kocijan
6. Data-Driven Modelling for Decision-making Support and Process Monitoring
BI-CZ/05-06/008
Dr. Tatiana Valentine Guy, Institute for Information Theory and Automation, Department of Adaptive Control, Prague, Czech Republic
Asst. Prof. Đani Juričić
7. Analysis, Diagnosis and Control of Distributed Nonlinear Process Systems
BI-HU/06-07/006
Sc. Dr. Katalin Hangos, Computer and Automation Research Institute, Hungarian Academy of Sciences, Budapest, Hungary
Asst. Prof. Đani Juričić
8. Design of PID Controllers: Interchange of Technology and Experience - Second Part
BI-PT/06-07-005
Asst. Prof. José Paulo de Maura Oliveira, Engineering Department, University of Trás-os-Montes e Alto Douro, Vila Real, Portugal
Asst. Prof. Damir Vrančič
9. Design of PDI Controllers: Interchange of Technology and Experience
BI-PT-04-06-020
Asst. Prof. José Paulo de Maura Oliveira, Engineering Department, University of Trás-os-Montes e Alto Douro, Vila Real, Portugal
Asst. Prof. Damir Vrančič
10. Building Virtual Communities for Research and Education in Automation and Control
BI-SK/05-07-009
Prof. Mikuláš Huba, Slovak University of Technology in Bratislava, Bratislava, Slovakia
Asst. Prof. Damir Vrančič

R & D GRANTS AND CONTRACTS

1. Design of fault detection and isolation systems with application to quality assessment of electrical motors
Asst. Prof. Đani Juričić
2. An intelligent system for condition monitoring of rotating machinery
Asst. Prof. Đani Juričić
3. Optimization of HVAC systems using dynamic models
Prof. Stanko Strmčnik
4. Early diagnosis of lung cancer in subjects with occupational asbestosis
Asst. Prof. Đani Juričić
5. Development and optimisation of personal military equipment
Asst. Prof. Đani Juričić

RESEARCH PROGRAM

1. Systems and Control
Prof. Stanko Strmčnik

NEW CONTRACTS

1. Design of a module for automatic tuning of control systems
TKR d.o.o., Godovič
Asst. Prof. Đani Juričić
2. Self-adaptive actuator prototype
Danfoss Trata d.d. Ljubljana
Asst. Prof. Damir Vrančič

VISITORS FROM ABROAD

1. Dr. Carlos Alberto Mendez, Politecnica de Catalunya, Barcelona, Spain, 18 January 2006
2. Asst. Prof. Alexandra Grancharova, Bulgarian Academy of Sciences, Institute of Control and System Research, Sofia, Bulgaria, 2–15 December 2006
3. Prof. L. Felipe Blázquez, Area of Systems Engineering and Control, Dept. Electronic and Electrical Engineering, University of León, León, Spain, 6–13 May 2006
4. Prof. Dr Alfred C. Snider, University of Vermont, Burlington, USA, 9 November 2006
5. Dr. Muhidin (Dino) Lelić, United Technologies Research Center, East Hartford, USA, 18 December 2006

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20. Boštjan Pregelj, B. Sc.
21. Aljaž Stare, B. Sc.
22. Aleš Svetek, B. Sc.
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24. Sebastjan Zorzut, M. Sc.

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25. Stanislav Černe, B. Sc.
26. Giovanni Godena, B. Sc.
27. Dr. Zoran Marinšek

Technical and administrative staff

28. Janez Grom
29. Maja Janežič, B. Sc.
30. Miroslav Štrubelj

LABORATORY FOR OPEN SYSTEMS AND NETWORKS E-5

The main activities of the Laboratory for Open Systems and Networks are the R&D of next-generation networks, telecommunication technologies, components and integrated systems and information-society services and applications, especially those which ensure an efficient and pervasive life-long learning concept.

Head:
Prof. Borka Jerman Blažič

In 2006 the research group implemented the research program "Technology, Services and Business in Next Generation Networks". Research was also carried out in the EU's 6FP projects PROLEARN, DIADEM, iCamp, ALIPRO and BReATH, in the PHARE project E-VINTER, in the MAUSE project from the COST programme, and in a few national projects. The main fields of work were technology-enhanced learning, security and privacy in information systems, advanced next-generation networks, benchmarking and roadmapping of mobile communication research programs and monitoring and strategy modelling of broadband communications.

Technology-enhanced learning

"PROLERAN (Network of Excellence in Professional Learning)" is an FP6 Network of Excellence in the field of technology-enhanced professional learning. The network brings together the most important research groups in the area of professional learning and training, as well as other key organisations and industrial partners, thus bridging the currently existing gap between research and education at universities and similar organisations and training and continuous education that is provided for and within companies. In 2006 our group was involved in research relating to privacy and data protection in technology-enhanced professional learning, organizational learning and the usability of learning solutions.

The project "iCamp (Innovative, inclusive, interactive & intercultural learning campus)" from the EU's FP6 aims at providing an infrastructure – the iCamp Space – for collaboration and social networking across systems, countries and disciplines. The iCamp Space builds on existing interfaces and integrates shared community features. The interoperability amongst different open-source learning systems and tools is the key to the successful sustainability of iCamp. The main focus of our work in 2006 was on privacy, security and trust management, as well as the conceptual modelling of learning tools' data structures. Our article about iCamp won the best paper award at the AICT'06 conference.

The main goals of the E-VINTER project were: (1) the establishment of an expert centre for evaluation, standardization, and counselling for the purposes of selecting optimal e-tools for the establishment of e-learning environments, (2) the development of e-skills and competences in the framework of preparations for the national qualification in vocational training, and (3) a pilot implementation of training through the established innovative learning environments in the designated regions: the Drava Region, the Mura Region, and Carinthia. In 2006 the research work in WP1 was aimed at investigating the new generation of educational technologies. We made an evaluation of the usability and applicability of learning management systems and set up an innovative learning environment for selected target groups. An occupational standard and expert knowledge and skill standard catalogue for the "information security expert" was prepared. A part of the E-VINTER project (WP3) was based upon a pilot implementation of e-learning and training in the established innovative learning environments in designated regions: the Drava Region, the Mura Region, and Carinthia. For the e-education and training implementation of the goal groups of the three designated regions, the most appropriate tools, technologies, and e-education methods were used. In the framework of WP3 the following trainings were performed in the first half of 2006: Microcontroller Programming, E-business, and Robotics for All. The e-courses were successfully completed by 50 participants. The results were published in a scientific journal and several conference papers.

The main goal of the "MAUSE (Towards the Maturation of IT Usability Evaluation)" project is to bring more science to bear on usability evaluation methods (UEM) development, evaluation, and comparison, aiming for results that can be transferred to industry and educators, thus leading to the increased competitiveness of European industry and benefits to the public. In 2006 we developed a digital library, and in the framework of the international conference NORDICHI 2006, organized a workshop on user experience (UX).

Security and privacy in information systems

Information security and privacy is still one of the most important research fields of the laboratory. In 2006 we completed the research activities of the "DIADEM (Distributed Adaptive Security by Programmable Firewall)" project from the EU's 6FP. The final result of the research is a distributed firewall prototype, based on programmable network principles. The prototype enables dynamic and flexible detection, decisions and responses to various security threats. Its operation was tested on selected use cases in a distributed European-wide network. We have finished the focused research project "Computer Criminality in Slovenia: Analyses of the Situation and Proposed Measures" and a survey of computer criminality in Slovenia was presented and possible counter measures were proposed.

Monitoring and promoting the development of telecommunications

In 2006 we prepared an analysis of the national research projects in the field of mobile communications in the New Member States of the EU and a strategic roadmap for the alignment of the national research programmes in mobile communications with ERA. The research was linked to the EU's FP6 project "ALIPRO (Supporting the Alignment of IST Research Programmes on Mobile Communications in the New Member States)". An invited lecture was presented at the final workshop in Brussels and a contribution was made to a book published by IOS Press. In another FP6 project "BReATH (Broadband e-Services and Access for the Home)" we made an exhaustive analysis of the current status of the penetration of broadband communications in the EU's Member States, which was followed by a collection and study of best-practice models developed for a particular European region. The original research in this project resulted in a techno-economic model that provides a tool for designing and applying appropriate measures for fostering broadband communications and related e-services. A study for upgrading Telecom Slovenia's backbone network was also performed and the best technology was selected according to the model and the techno-economic tools. Several papers were presented at international conferences, and some of them are being reviewed for publication in the respective journals.

Some outstanding publications in the past three years

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Organization of conferences, congresses and meetings

1. Workshop of the BReATH project, "Development of broadband communications in Slovenia - current state, obstacles and risks", Jožef Stefan International Postgraduate School, 5 April 2006
2. Organization of PROLEARN summer school, Bled, 5–9 June 2006
3. The 15 years of Internet in Slovenia", Honouring event and roundtable, IJS, 27 November 2006

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2. Saša Mehak Rojec: Manipulation of digital signed documents from origin up to archiving them in a frame of ZEPEP management (Prof. Borka Jerman Blažič)
3. Darja Praprotnik: Data and privacy protection on Internet (Prof. Borka Jerman Blažič)
4. Kristian Nussdorfer: Impact of quality and secure information infrastructure on progress of new generation systems for e-business in marine traffic (container terminals) (Prof. Borka Jerman Blažič)

B. Sc. Thesis

1. Barbara Blatnik: Preparation of effective market communication strategies on internet (Prof. Borka Jerman Blažič)

Specialization thesis

1. Janko Šavnik: Principles, methodology and tools of computer forensic, including practical example (Prof. Borka Jerman Blažič)

INTERNATIONAL PROJECTS

1. Innovative, Inclusive, Interactive & Intercultural Learning Campus
iCAMP
6. FP; 027168
EC; Claudia Magdalena Fabian, Zentrum für Soziale Innovation, Vienna, Austria
Prof. Borka Jerman Blažič, Dr. Tomaž Klobučar
2. Broadband e-Services and Access for the Home
BReATH
6. FP; 015893
EC; Rene Kramer, Technische Univeriteit Eindhoven, Eindhoven, MB, The Netherlands
Prof. Borka Jerman Blažič
3. Supporting the ALIgnment of IST research PROgrammes on mobile communications in the new member states
ALIPRO
6. FP; 015811
EC; Jan Kaczmarek, Foundation Mobile Open Society through Wireless Technology (MOST), Warsaw, Poland
Prof. Borka Jerman Blažič
4. Network of Excellence in Professional Learning
PROLEARN
6. FP; 507310
EC; Martin Wolpers, Universität Hannover, Hannover, Germany
Prof. Borka Jerman Blažič
5. Distributed Adaptive Security by Programmable Firewall
DIADEM FIREWALL
6. FP; 002154
EC; Yannick Carlinet, France Telecom SA, Paris, France
Prof. Borka Jerman Blažič
6. Designing Advanced Interfaces for the Delivery and Administration of the Location Independent Optimised Personal Services
DIADALOS
6. FP; 506997
EC; Angela Grossmann, Riccardo Pascotto, T-Systems Nova GmbH, Berlin; Bonn, Germany
Prof. Borka Jerman Blažič
7. Creating Innovative Learning Environment, E-skills and Competences Development for Supporting the Promotion of Informal Education in Lifelong Learning
E-VINTER
SI.71-751-03 0305 0004, 05-25-U3
Phare 2003 Lifelong Learning
EC
Prof. Borka Jerman Blažič
8. Towards the Maturation of IT Usability Evaluation – MAUSE
COST 294
EC
Prof. Borka Jerman Blažič

R & D GRANTS AND CONTRACTS

1. Designing Advanced Interfaces for the Delivery and Administration of Location independent Optimized personal services
Prof. Borka Jerman Blažič
2. Techno-economic models of broadband communications development and their usage in rural areas in Slovenia
Prof. Borka Jerman Blažič
3. Cyber crime in Slovenia: analysis and suggestions
Prof. Borka Jerman Blažič
4. Modern didactical concepts, standardization development and e-learning knowledge management in Slovenian army
Tanja Arh
5. Technologies for education and development of innovative environment
Prof. Borka Jerman Blažič
6. Protocols and integration of services in NGN convergence systems
Prof. Borka Jerman Blažič

RESEARCH PROGRAM

1. Technologies and services and business in the next generation networks
Prof. Borka Jerman Blažič

VISITOR FROM ABROAD

1. Dr. Volker Zimmermann and dr. Tilman Kuechler, IMC Saarbrücken, Germany

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** Part-time faculty member

DEPARTMENT OF COMMUNICATION SYSTEMS E-6

The Department of Communication Systems is concerned mainly with the research, development and design of next-generation networks and wireless access systems, and the development of new algorithms for parallel and distributed computing and computer simulations. Other research activities include the development of software tools for the testing, modelling and simulation of communication systems, the provision of security services in communication networks, digital signal processing in medicine, the development of distributed environments for computer-supported cooperative work, teleworking, the education of young researchers, and the transfer of knowledge and new technologies to industry.

Head:
Prof. Gorazd Kandus

The research and development activities at the department are carried out by two groups: one specialising in telecommunications systems and the other in parallel and distributed systems. With the convergence of telecommunications and information systems the work in both groups is becoming increasingly interconnected, bringing about synergy effects, particularly in applied projects.

Telecommunications Systems

In 2006 most of our research activities in telecommunications systems were concentrated on terrestrial, stratospheric and satellite access networks. These wireless access networks represent the key segment of next-generation networks and will enable the end-user to access new services and applications as well as new multimedia content. We also continued with the investigation of transport network technologies and protocols, with a special emphasis on route optimisation and mobility management. We were developing advanced and innovative concepts and technologies enabling interworking, the convergence of networks and the mobility of terminals and networks. Particular emphasis was given to the solutions providing network robustness, security and quality of services.

We developed a universal radio-network planning tool that supports integration with a geographic information system (GIS) and SQL databases. The tool is intended for network operators to design, plan and maintain radio networks.

In the field of radio communications we were studying propagation in the radio channel. We continued the development of the universal radio network planning tool and transformed it from the experimental environment to the professional platform, enabling more reliable and fast operation, integration with a geographic information system (GIS) and support to SQL databases. The tool is intended for network operators to design, plan and maintain radio networks. It has been used for WiMAX radio network planning in the 3.5-GHz frequency band and for the comparison of WiMAX signal coverage in the 450-MHz and 3.5-GHz frequency bands.

We designed and analysed new adaptive modulation and coding schemes, synchronization and equalization techniques, and methods to assess the quality of the radio channel. We estimated the complexity of the communication system, the power efficiency of modulation schemes and the capacity of the radio channel. We were investigating new techniques for space-time coding and multiplexing in multiple-input multiple-output (MIMO) wireless systems. We developed low-complexity efficient iterative signal-detection methods and algorithms, applicable both in conventional single-input single-output (SISO) as well as in MIMO systems. We studied space-diversity transmission techniques, focusing on the diversity gain in terms of achievable improvement of the system reliability and availability. We commenced research work on cross-layer design and the optimisation of communication protocols in wireless communication systems, in order to improve the utilization efficiency of scarce radio resources and to support the provision of quality of service.

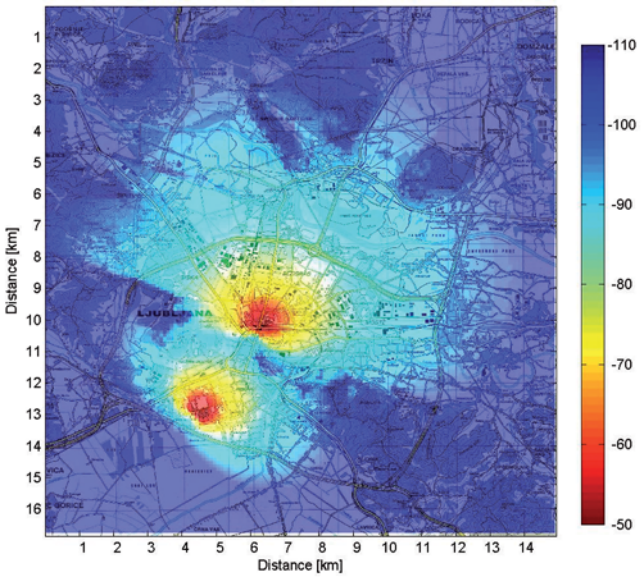

Figure 1: WiMAX radio network planning at 3.5 GHz: signal level in dBm as received from two base stations in Ljubljana

On the network layer we investigated fixed-mobile convergence and began with the development of convergence services. We focused on

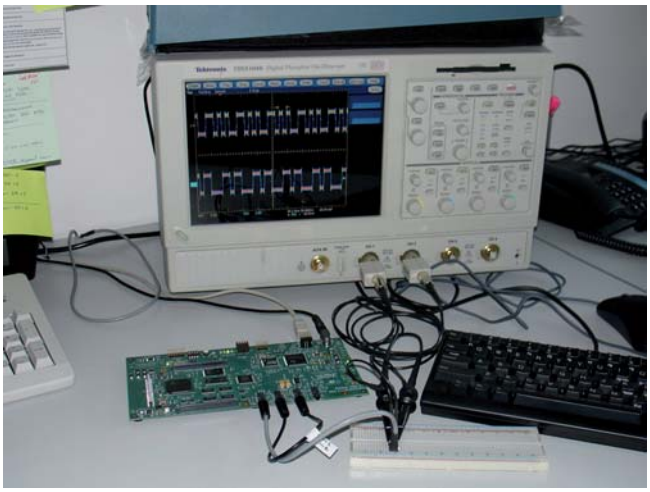

Figure 2: Implementation of adaptive coding and modulation procedures from the IEEE 802.16 standard on a digital signal processing (DSP) board TMS320C6713 DSK

Within an FP6 STREP we participated in the development of advanced techniques for radio resource management and in the investigation of the most suitable network architectures and protocols for the network of HAPs.

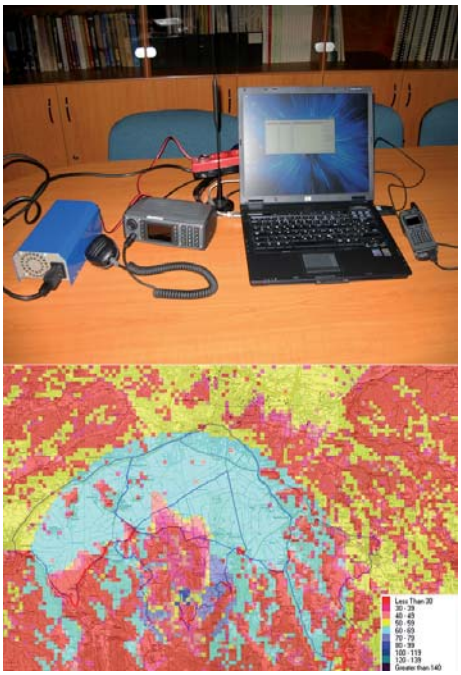

Figure 3: Measurement of TETRA signal coverage in the pilot TETRA network of the Ministry of Defence

We developed a set of new applications for TETRA networks including GIS, WAP, AVL, paging, telemetry, video and data transmission, and tested them in the pilot TETRA network of the Ministry of Defence.

mobility management in convergent networks, in particular on the vertical handover between networks based on different access technologies. We also researched modelling-policy relationships between autonomous systems in large-scale networks. We showed that disregarding the relationships leads to inaccurate simulation results. The commercial relationships with neighbouring systems prevail over the topological connectivity in determining the flow of IP traffic. We started the development of an accurate model of policy relationships to support our future work on route optimization for mobile users.

With our research work in the areas of stratospheric and satellite communication systems we also participated in the EU's FP6. Within the FP6 project SatNEx (Satellite Communications Network of Excellence) we participated in the investigation of a hybrid stratospheric satellite communication system, where the intermediate layer consisting of High Altitude Platforms (HAPs) allows the link between the GEO satellite and the user terminal to be split into two segments, i.e., from the satellite to the HAP and from the HAP to the user terminals. This solution includes the possibility of local retransmissions from HAPs, making use of a shorter link that makes it easy to implement the return channel from single-user terminals, thus supporting the implementation of advanced services such as reliable multicast content delivery. We also studied adaptive modulation procedures and methods of spherical decoding, and we applied the knowledge from radio communications to the area of free-space optical communications. In particular, we analysed standard-block and advanced iterative-encoding schemes and decoding algorithms in free-space optical systems with pulse-position modulation. We also contributed to the development of a communication system for public protection and disaster relief, integrating various local area communication technologies, such as ad-hoc networks and professional digital trunked radio, potentially deployed in remote and damaged areas, with satellites providing reliable connection in the backbone network in the case of emergency situations.

Within the FP6 STREP project CAPANINA (Communications from Aerial Platform Networks delivering Broadband Communications for All) we participated in the development of advanced techniques for radio-resource management and in the investigation of the most suitable network architectures and protocols for the network of HAPs. We extended the propagation-channel model based on digital relief and a ray-tracing approach to support the investigation of space diversity in different constellations of multiple stratospheric platforms. It was used in the investigation of achievable improvements in the system reliability and availability in the mobile operating environment and of the increased system capacity in the fixed operating environment. We designed a network architecture supporting space diversity using multiple HAPs, and developed new networking protocols for network mobility and route optimization in a multi-level mobility architecture with the handover support on the networking layer. We also studied all-optical networking in a HAP network using free-space optics, and developed a tool for the dimensioning and performance evaluation of optical transport networks.

We developed a set of new applications for TETRA networks, including GIS, WAP, AVL, paging, telemetry, video and data transmission, and tested them in the pilot TETRA network of the Ministry of Defence. We carried out a measurement campaign of TETRA signal coverage and selected the most suitable propagation-channel model for a TETRA signal to be used in the radio network planning. We also commenced with the research and development of the next generation of public alarm systems using IP over a TETRA network.

Parallel and Distributed Systems

Computer algorithms for efficient and secure implementation on parallel and distributed computers were investigated. Software tools for cluster computing were tested on a 32-processor cluster computer, which runs at our department, and on a grid, recently installed in cooperation with the Faculty of Computer and Information Science, University of Ljubljana, and

A computer-simulation program based on mesh-less spatial discretization using particles was implemented and tested. The digitalized spatial model of a human knee was finished and prepared for template medical simulations. A patent has been awarded for a new lightweight family of cryptographic protocols and the renowned publisher Springer has published our scientific monograph.

a small enterprise company, Xlab d.o.o. A computer simulation for medical applications was investigated and applied on several practical examples. New numerical methods based on mesh-less computing were developed. A doctoral dissertation was defended with important results on the accuracy and complexity of the implementation of parallel mesh-less methods. We have submitted several publications in this area that could be of great interest for the wider research community.

In the field of medical research, the spatial model of a human knee with a resolution of 1 mm was finalized in cooperation with colleagues from Clinical Centre Ljubljana (KC). We improved the simulation of the heat transfer in biological tissues, including heat transfer in the fluids that surround tissues. A parallel simulation program was finalized using advanced numerical methods (multigrid and mesh-less). Parallel programs were developed for the simulation of knee cooling after surgery or after injuries. Several contributions were published at international conferences from this area; a publication in an international journal is expected in the near future.

In cooperation with medical doctors from Clinical Centre Ljubljana a mutual interaction among respiration, heart rate and systolic pressure was investigated. The application software for the new measurement system, NevroEKG, which is able to acquire, in addition to ECG, also online signals of the respiration rate and the blood pressure, was further developed. New programs for the analysis of the baroreceptor sensitivity (BRS) were implemented. We published some contributions at specialized international conferences, and we are also expecting a new theme for an interdisciplinary doctoral dissertation from our colleagues at KC.

In the area of distributed systems security (networked information systems) we continued our work on methodologies for quantitative and qualitative modelling to support security management. In addition, we additionally focused on pure technical issues with an emphasis on cryptographic protocols. Almost every commercial application of distributed systems requires such solutions, referred to as security services. In this area, our research resulted in a patent. Furthermore, we had an invited lecturing at one international scientific event, and published two scientific papers in international journals with IF (ISI WoS). One of them was in a flagship publication of the IEEE – Computer magazine.

In the field of formal methods for discrete systems modelling and development, we conceived a generic test generation method for finite-state machines that accepts a wide class of testing strategies and always generates a test implementing the given strategy in an optimal manner. We also developed a strategy for which the method generates a test that is absolutely optimal for the given machine and its expected incorrect implementations. The method facilitates multi-criteria optimization. We also investigated enhancements of the standard specification language, E-LOTOS, and developed an operator for semantic event refinement. The operator allows the specification of multiple alternative refinements per event and also works on events shared by multiple processes, on events generating data and on urgent events.

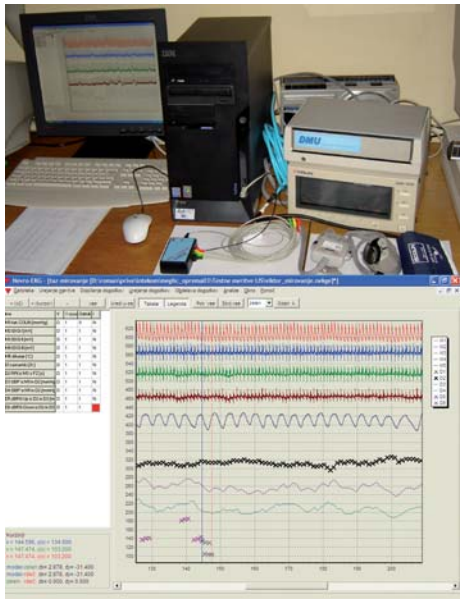

Figure 4: NeuroECG measuring device for simultaneous measurement of ECG signals, respiration frequency and blood pressure (above) with measured signals (below).

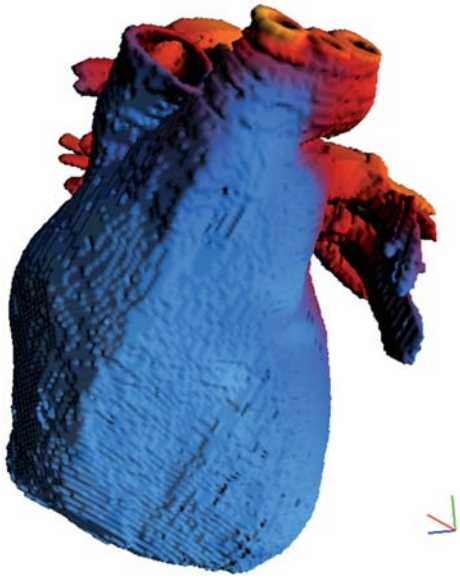

Figure 5: Surface temperature distribution, obtained from a computer simulation of cooling a human heart during surgery. Spatial heart model is composed of over one million voxels.

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2. D. Trček. Security models: refocusing on the human factor. Computer, 2006, vol. 39, no. 11, str. 103–104.
3. R. Novak, Proxy MAP for intra-domain route optimization in hierarchical mobile IP, IEICE Transactions on Communications, 2006, vol. E89-B, no. 2, pp. 472–481.
4. T. Javornik, T. Matsumoto, J. Sykora, L. Clavier, G. E. Oien, Signal processing. V: CORREIA, Luis M. (ur.). Mobile broadband multimedia networks: techniques, models and tools for 4G. 1. izd. Amsterdam ... [etc.]: Elsevier: Academic Press, 2006, str. 35–118.
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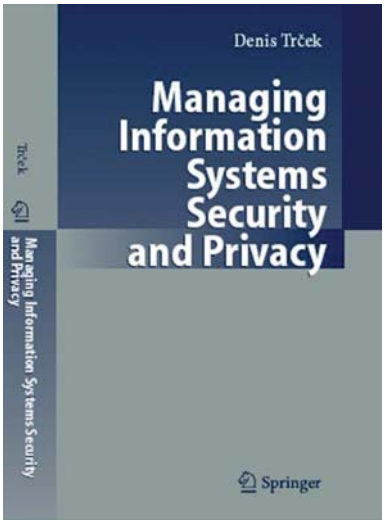

Figure 6: Scientific book published by a renowned international publisher: D. Trček, Managing Information Systems Security and Privacy, Springer, Heidelberg/New York, 2006.

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Organization of conferences, congresses and meetings

1. MORS users education for TETRA, Poljče, 29 June 2006
2. CAPANINA meeting WP1 and WP2 IST project , Ljubljana, 29–30 June 2006

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EC; Dr. Mohsine Chefki, Deutsches Zentrum für Luft- und Raumfahrt E. V. (DLR), Köln, Germany
Asst. Prof. Mihael Mohorčič
2. Satellite Communications Network of Excellence - Phase II
SatNEx- II
6. FP; 027393
EC; Prof. Erich Lutz, Deutsches Zentrum für Luft- und Raumfahrt E. V. (DLR), Weßling; German Aerospace Center, Weßling, Germany
Prof. Gorazd Kandus
3. Partner Search Support for participants in IST Priority by European network of NCP for IST under the 6th Framework Program
Idealist 34
6. FP; 511355
EC; Dr. Mohsine Chefki, Deutsches Zentrum für Luft- und Raumfahrt E. V. (DLR), Weßling, Germany
Asst. Prof. Mihael Mohorčič
4. Satellite Communications Network of Excellence
SATNEX
6. FP; 507052
EC; Prof. Erich Lutz, Deutsches Zentrum für Luft und Raumfahrt E. V. (DLR), Weßling, Germany
Prof. Gorazd Kandus
5. Communications from Aerial Platform Networks Delivering Broadband Communications for All
CAPANINA
6. FP; 506745
EC; Graham Long, University of York, York Electronics Centre, York, Great Britain
Asst. Prof. Mihael Mohorčič
6. GISAS - Geographical Information Systems (GIS) Applications for Schools
SOCRATES/MINERVA
110803-CP-1-2003-1-FI-MINERVA-M
EC; Prof. Petri Pelikka, Dr. Tino Johannsen, University of Helsinki, Department of Geography, Helsinki, Finland
Prof. Jože Rugelj
7. Pervasive Mobile & Ambient Wireless Comunications
COST 2100
EC; Prof. Roberto Verdone, DEIS- Università degli Studi di Bologna, Bologna, Italy
Dr. Tomaž Javornik
8. Quality of Service in Future Wireless Systems
COST 290

EC; Prof. Yevgeni Koucheryavy, Tampere University of Technology, Tampere, Finland
Prof. Gorazd Kandus

9. High Altitude Platforms for Communications and other Services
COST 297
HAPCOS
EC; Tim C. Tozer, University of York, York, Great Britain
Asst. Prof. Aleš Švigelj
10. Teledoctorate Project
UNESCO-ROSTE Grant
Silvano Pupolin, Universitŕ di Padova, Dipartimento di Ingegneria dell'Informazione, Padova; Dr. Paola Magri, Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT), Parma, Italy
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11. Postavljanje testne međuinstitucionalne GRID aplikacije
BI-HR/05-06-030
Prof. Karolj Skala, Ruđer Bošković Institute, 10000 Zagreb, Croatia
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R & D GRANTS AND CONTRACTS

1. Broadband wireless access networks
Prof. Gorazd Kandus
2. Computing services on GRID infrastructure
Asst. Prof. Roman Trobec
3. Computing GRID technologies for more efficient resources utilization in enterprises
Asst. Prof. Roman Trobec
4. Professional system of mobile communications for MORS
Prof. Gorazd Kandus
5. Development of advanced digital mobile system TETRA for MOD
Prof. Gorazd Kandus
6. IT development and data gathering, maintenance and management strategy
Asst. Prof. Igor Ozimek
7. Protocols and service integration in converged NGN systems
Prof. Gorazd Kandus
8. Wireless communication platforms
Asst. Prof. Igor Ozimek
9. Correctness verification of communication system functioning
Prof. Monika Kapus Kolar

RESEARCH PROGRAMS

1. Telecommunication systems
Prof. Gorazd Kandus
2. Parallel and distributed systems
Asst. Prof. Roman Trobec

NEW CONTRACTS

1. Analysis of interference of the signal in DVB-T format to DVB-S satellite services
Teletech d.o.o. Maribor
Asst. Prof. Mihael Mohorčič
2. Networked and Electronic Media
Iskratel, d. o. o.
Prof. Denis Trček

VISITORS FROM ABROAD

1. Prof. Nikola Rožić, FESB University of Split, Split, Croatia, 23–24 February 2006
2. Gideon Naveh, RAFAEL Ltd., Haifa, Israel, 11 November 2006
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4. Dr David Grace, University of York, York, Great Britain, 28–30 June 2006
5. Mr Graham Long, York Electronics Centre, University of York, York, Great Britain, 28–30 June 2006
6. Dr. Paul Mitchell, University of York, York, Great Britain, 28–30 June 2006
7. Mr. Pairoj Likitthanasate, University of York, York, Great Britain, 28–30 June 2006
8. Prof. Tien Van Do, Budapest University of Technology and Economics, Budapest, Hungary, 28–30 June 2006
9. Dr. Dung Dinh Luong, Budapest University of Technology and Economics, Budapest, Hungary, 28–30 June 2006
10. Prof. Karolj Skala, Institut Ruđer Bošković, Zagreb, Croatia, 14–15 December 2006
11. Prof. Karolj Skala, Institut Ruđer Bošković, Zagreb, Croatia, 22–23 December 2006

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7. Asst. Prof. Igor Ozimek***
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10. Prof. Denis Trček**
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15. Andrej Hrovat, B. Sc.
16. Igor Jelovčan, B. Sc.
17. Damjan Kovač, M. Sc.
18. Srečo Plevel, B. Sc.
19. Igor Rozman, B. Sc.
20. Miha Smolnikar, B. Sc.
21. *Dr. Marjan Šterk, left 01. 03. 2006*
22. Andrej Vilhar, B. Sc.

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23. Polona Anžur
24. Tomaž Krištofelc
25. *Bojan Močnik, died 29. 10. 2006*

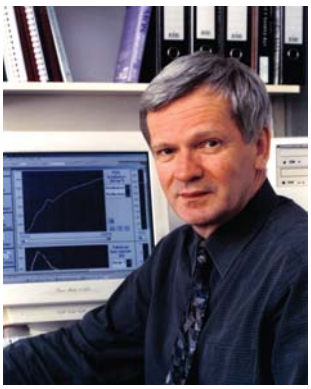
Ph. D. Students from Abroad

26. Carolina Fortuna, B. Sc., Romania

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF COMPUTER SYSTEMS E-7

The Department of Computer Systems is concerned primarily with the design automation of computing structures and systems. Within this broad area, we are concentrating on the metaheuristic approach to engineering design and logistics problems as well as system design and testing. As an integral part of our research activity, members of the department have close contacts and collaborations with scientists world-wide, through academic links and industrial contacts, thus enabling us to stay at the forefront of this rapidly developing field.



Head:
Prof. Franc Novak

In the frame of the project "A Secure Data-Storage Unit Based on New Ferroelectric Semiconductor Memory Devices" a prototype storage unit was developed as an embedded system based on the microBlaze microprocessor. The storage unit has been designed with the emphasis on data security, system availability and system reliability. A high system availability was achieved by using recent non-volatile memory technologies based on the magneto-resistive effect (MRAM) and the implementation of an error-correction-code (ECC) technique in a separate hardware core. For the purpose of system testability we explored the possibility of implementing the IEEE Std 1149.1 and IEEE Std 1500 test infrastructure. In an experimental case study we estimated the resources required for the local processing of test results within an IEEE 1500 test wrapper. Special attention was paid to the security aspects of the design. Since IEEE Std 1149.1 is known to be vulnerable to hackers, an extension of the IEEE Std 1149.1 locking mechanism was developed.

Within the EU's 6FP project ARFLEX, we investigate the possibility of using vision sensors for robot control. The objective is to radically innovate a class of products, i.e., industrial robots, where these technologies did not yet find full applications. The project aim is to increase both the flexibility and the adaptability, reduce costs and increase the field of applications on the job floor. Very precise mechanical parts should be substituted by low-cost modular units and a sophisticated control algorithm that will use sensor data, communication networks and real-time data processing. The system is based on a new generation of high-performance embedded systems for industrial robots. Our task within the project is to develop, test and integrate the vision-based embedded system for closed-loop robot control, which will make possible 3D trajectory tracking with high precision.

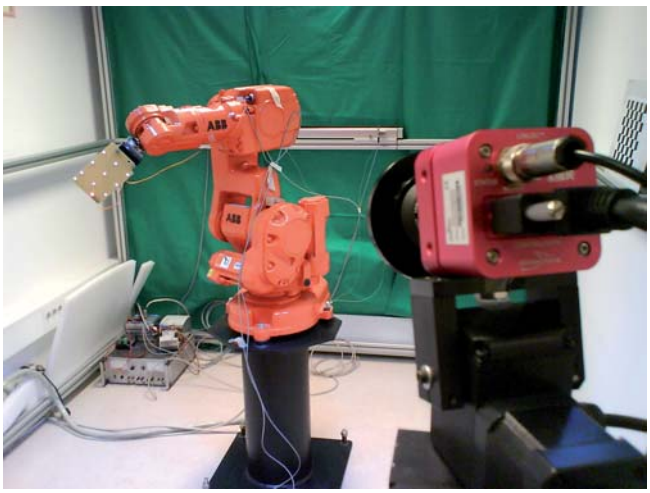


Figure 1: ARFLEX FP6 project - robot visual servoing

Within the project "Upgrade of Light Armoured Wheeled Vehicles Valuk 6x6" in the frame of the Target research programme (CRP MIR) Science for Peace and Security 2006–2010 we develop software-hardware components for the integration of different sensors and other electronic devices in a Valuk military transportation vehicle designed for CBRN detection.

In the area of real-time embedded systems we studied methods for specification, design and documentation. Special attention was given to the RT-UML and its profile for schedulability, performance and time specification, and to the applicability of the evolutionary optimization in embedded system design that is, in general, a multi-constrained and multi-objective problem.

Metaheuristic optimization algorithms are important for solving hard combinatorial and numerical problems in various domains of theoretical interest and practical applications. We were developing efficient self-setting and self-adapting evolutionary algorithms and ant-stigmergy-based optimization algorithms. The approaches were used to solve various combinatorial and, more importantly, numerical optimization problems. Evolutionary algorithms were tested on constrained numerical optimization problems. The approach with multiple ant-colonies can be successfully used to solve the mesh-partitioning problems that arise in mechanical, civil, automobile, and aerospace engineering. The multilevel ant-stigmergy approach is applied to solve discrete numerical optimization problems. Here, a novel general approach to the transformation of a multi-parameter optimization problem into the problem of finding the cheapest path is proposed. The differential ant-stigmergy approach is suitable for solving discrete as well as continuous numerical optimization problems. The multilevel and differential ant-stigmergy approaches

were used on several real-world applications, such as the minimization of the power losses of a universal electric motor, the optimization of an electro-motor casing with reduced production costs, and the optimization of the coolant flow settings for the continuous casting of steel.

We applied a web application for dietary menu planning, which we designed using linear programming and evolutionary optimization methods, for optimizing typical menus for workers, preschool and school children, students and patients that were prepared by the Ministry of Health of the Republic of Slovenia. For this very reason we modified the application so that the multi-objective and multi-constrained optimization of weekly and monthly menus for healthy people as well as people with special dietary needs can be performed. We tackled the optimization problem of menu planning by applying a multi-level approach.

In collaboration with FERI, University of Maribor, we continued our work on the hardware implementation of the progressive lossless compression of volumetric data suitable for applications in CT or MRI scanners. We also proposed a set of 2D Delaunay triangulation benchmarks for checking the correctness of algorithms and discovering possible flaws. A tool for the verification of the generated triangulation is provided.

Some outstanding publications in the past three years

1. P. Korošec, J. Šilc, B. Robič, "Solving the mesh-partitioning problem with an ant-colony algorithm", Parallel Computing, vol. 30, pp. 785–801, 2004.
2. F. Novak, M. Santo Zarnik, S. Maček, "Early warning of fault conditions of an over-current protection module in dependable communication applications", Reliability Engineering and System Safety, vol. 84, pp. 125–128, 2004
3. G. Papa, B. Koroušić Seljak, "An artificial intelligence approach to the efficiency improvement of a universal motor", Engineering Applications of Artificial Intelligence, 2005, vol. 18, pp. 47–55.
4. B. Koroušić Seljak, "Dietary menu planning using an evolutionary method", Proc. INES 2006, 10th International Conference on Intelligent Engineering Systems, June 26–28, 2006, London, pp. 108–113.
5. F. Novak, A. Biasizzo, "Security extension for IEEE Std 1149.1", Journal of Electronic Testing: Theory and Applications, vol. 22, pp. 301–303, 2006.

Patent granted

1. Test bus locking mechanism, Franc Novak, Anton Biasizzo, patent No. 21978

Organization of conferences, congresses and meetings

1. The 2nd International Conference on Bioinspired Optimization Methods and their Applications BIOMA 2006, Ljubljana, 9–10 October 2006 (Jurij Šilc, co-chair of program committee; Peter Korošec, Barbara Koroušić Seljak, Gregor Papa members of program committee; Gregor Papa chair of organization committee)
2. INFORMATION SOCIETY 2006, 9th international multiconference 9–14 October 2006 (Franc Novak, Jurij Šilc, program committee)

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2. Peter Korošec, Jurij Šilc
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1. Gregor Papa, Jurij Šilc, Barbara Koroušić-Seljak
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2. Borut Robič, Peter Korošec, Jurij Šilc
   Ant colonies and the mesh-partitioning problem
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PUBLISHED CONFERENCE PAPERS

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1. Dražigost Pokorn, Jožica Maučec Zakotnik, Mojca Močnik-Bučar, Barbara Koroušić-Seljak
   Smernice zdravega prehranjevanja za delavce v delovnih organizacijah: [XX. dnevi medicine športa Slovenije, 1.-2. december, 2006, Celje, Slovenija]
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   Evolutionary approach to deterministic test pattern generator design
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1. Jurij Šilc
   Advanced processor architectures
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2. Jurij Šilc
   Scalar and superscalar processors
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PH. D. THESIS

1. Peter Korošec: Stigmergy as an approach to metaheuristic optimization (Asst. Prof. Bogdan Filipič, co-mentor Asst. Prof. Jurij Šilc)

INTERNATIONAL PROJECTS

1. Adaptive Robots for Flexible Manufacturing Systems
   ARFLEX
   6. FP; NMP2-CT-2005-016680
   EC; Dr. Gabriella Caporaletti, EICAS Automazione S.p.A., Torino, Italy
   Dr. Drago Torkar
2. EIE-Surveyor
   SOCRATES; 225997-CP-1-2005-1-FR-ERASMUS-TNPP
   EC; Prof. Jean-Marc Thiriet, Université Joseph Fourier Grenoble, Institut Universitaire de Technologie 1 de Grenoble, Département Réseaux et Télécommunications, Saint Martin d'Hčres Cedex, France
   Prof. Franc Novak
3. Méthodes pour le test des systčmes sur puce mixtes analogique/numérique
   PROTEUS
   Prof. Florence Azais, Universite Montpellier II-LIRM, LIRMM, Montpellier, France
   Prof. Franc Novak
4. Metaheuristic Mesh Partitioning Algorithms and Parallel FEM Computations on Clusters and Grids
   BI-PL/05-07-007
   Dr. Roman Wyrzykowski, Częstochowa University of Technology, Częstochowa, Poland
   Asst. Prof. Jurij Šilc

R & D GRANTS AND CONTRACTS

1. Secure data storage unit based on new ferroelectric semiconductor memory devices
   Dr. Anton Biasizzo
2. The role of Luka Koper in logistic support of the Slovenian Armed Forces and allies
   Dr. Jurij Šilc
3. Upgrade of light armoured wheeled vehicles VALUK 6x6
   Dr. Drago Torkar
4. Nutrition for special conditions - POVIR
   Dr. Barbara Koroušič Seljak

RESEARCH PROGRAM

1. Computing structures and systems
   Prof. Franc Novak

VISITOR FROM ABROAD

1. Prof. Thiemo Krink, University of Aarhus, Denmark, 8–9 December 2006

STAFF

Researchers

1. Dr. Anton Biasizzo
2. Asst. Prof. Barbara Koroušić Seljak**
3. **Prof. Franc Novak, Head****
4. Dr. Gregor Papa
5. Asst. Prof. Jurij Šilc**

Postdoctoral associates

6. Dr. Uroš Kač***
7. Dr. Drago Torkar
8. Dr. Alenka Žužek***

Postgraduates

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10. Mariusz Wegrzyn, M. Sc.
11. Peter Mrak, B. Sc.***

Technical and administrative staff

12. Jolanda Jakofčič

** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF KNOWLEDGE TECHNOLOGIES E-8

The Department of Knowledge Technologies performs research in advanced information technologies, aimed at acquiring, storing and managing the knowledge used in the development of knowledge-based-society applications. Established areas of knowledge technologies include intelligent data analysis (machine learning, data mining, knowledge discovery and databases), text and web mining, language technologies and computational linguistics, decision support, and knowledge management. The research areas of the department also include the semantic web, virtual organizations, new media and e-science. Besides developing knowledge technologies, we also develop their applications in environmental sciences and ecology, medicine and health care, biomedicine and genetics, economy, and marketing.

Head:
Prof. Nada Lavrač

We developed various methods for intelligent data analysis, including methods for subgroup discovery and for analyzing structured and multi-relational data using background knowledge in the form of ontologies. Subgroup-discovery methods have proved useful for new data-mining tasks, i.e., contrast-set mining and emerging-pattern mining. We developed a new methodology for closed-sets mining and successfully applied it to potato micro-array data to discover the rules that best distinguish between virus-resistant and virus-sensitive transgenic potato lines.

In the EU's 6FP STREP project IQ, coordinated by our department, we have developed a number of inductive querying and constraint-based data-mining methods, most notably methods for learning predictive clustering trees (PCTs). While most predictive modelling methods focus on a single target variable, PCTs can predict several target variables simultaneously, as well as predicting structured targets (such as hierarchies or time series). We have used PCTs to analyze data in the areas of medicine, bio-informatics (functional genomics) and environmental sciences.

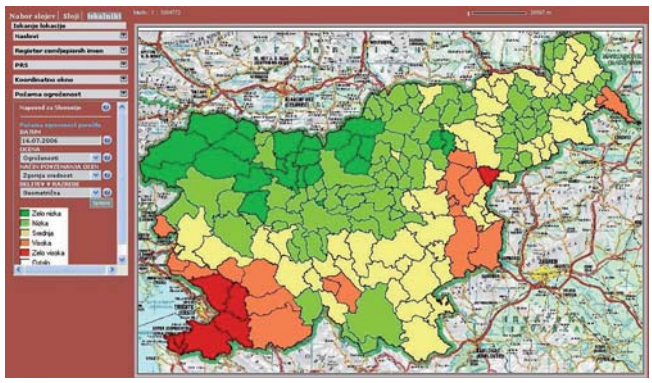

Figure 1: The probability of fire outbreaks in the natural environment, aggregated at the level of municipalities, as predicted by a model learned with machine-learning techniques.

Two national projects were concerned with the development of methods for the processing and analysis of remote-sensing data in the area of forestry. We have developed a predictive model for fire risk in the natural environment by using machine learning on data from past fires. The model predicts the probability of fire outbreaks from spatial data, multi-temporal satellite data, and meteorological forecasts. The model and its predictions have been integrated into a geographical information system for civil protection and rescue by the Ministry of Defence.

In the area of decision support, our long-term goal is to develop methods and techniques for decision modelling, implement them in object-oriented software, and integrate them with data-mining systems. In 2006 we continued to develop data-based revision methods for multi-attribute decision models, and the system proDEX for the development and use of probabilistic multi-attribute models. We focused on uncertainty-modelling mechanisms, which are essential for capturing realistic aspects of complex decision problems in ecology and agronomy. In 2006 we published a book *Decision making and modelling,* describing numerous decision-support techniques and our experience gathered in the applications of support methods.

The Department of Knowledge Technologies is a partner in 18 European projects and the coordinator of one 6FP project (IQ).

Especially successful were the use of decision-support and data-analysis methods and their transfers into practice in the scope of the ECOGEN, SIGMEA and MediNet+ projects.

In the EU's 5FP project ECOGEN and the 6FP project SIGMEA, we used decision-support and data-mining methods to analyze the ecological and economical effects of genetically modified (GM) crops on the environment. The ECOGEN project, which finished in 2006, focused on the effects at the level of individual farms, more specifically on the soil biota, with respect

The book "Decision making and modelling" (Odločanje in modeli) by Marko Bohanec was published. It describes in 300 pages numerous decision-support techniques and our experience gathered in the applications of support methods.

In the scope of the successfully concluded MediNet+ project we developed a methodology and provided analyses with GIS-supported visualization with which the Ministry of Health can model, monitor and further plan the Slovenian health-care network.

to spatial and meteorological factors, as well as the applied farming practices. In ECOGEN we developed a qualitative multi-attribute model for the assessment of soil quality, called ESQI, and implemented it as a WWW service. The SIGMEA project is concerned with regional-level effects and models, among other things, gene flow between GM and conventional crops, seed-bank decline and feral populations. In SIGMEA we developed "SMAC Advisor", a decision-support system on the co-existence of GM and conventional maize. In the MediNet+ project for the Slovenian Ministry of Health we analyzed databases about the health-care system in Slovenia using various data-mining methods combined with methods for decision-support, visualization and geographical information systems. We proposed a new methodology for monitoring various health-network indicators and carried out a number of simulations of different methods for the assessment of physicians' workload. The developed model enables the Ministry of Health to improve the planning and monitoring of the public health network in Slovenia.

In the area of text and web mining and the semantic web we successfully concluded the 6FP IP project SEKT (Semantically Enabled Knowledge Technologies), where our major contributions were in (semi)automated ontology generation. We have developed OntoGen, a data-driven interactive system for the (semi)automated construction of topic ontologies and two novel approaches that extend its functionality: an approach for semi-automated ontology generation from a social network and an approach for scalable population of ontologies with a large number of concepts and instances. We have established a close collaboration with CyC Corp., USA, which has during the past 20 years developed the largest common-sense knowledge base (ontology) in the world. We have jointly formed the European branch of the CyC Company, located in the Ljubljana Technology Park, aimed at joint research within our future 7FP projects. We are now involved in several EU 6FP projects from the semantic web area, including two STREP projects from semantic web services SWING and TAO; one which continues and extends the work undertaken in SEKT by developing lifecycle support for networked ontologies NeOn. Within NeOn we are responsible for the development of the context-sensitivity mechanisms for ontologies; to this end, we organized a tutorial on Context Sensitivity in Knowledge Rich Systems at the Intl. Semantic Web Conf. 2006 in the USA. We are closely collaborating with the UN FAO organization, which is one of the case-study partners of the project; a specific case-study goal is the development of an overfishing alert system.

OntoGen, interactive system for ontology building received the best demo award at the 3rd European Semantic Web Conference.

Our research work in the area of text and web mining in addition to existing work on the 6FP NoE PASCAL and CA KDUbiq projects continued in the direction of combining text and images in the 6FP STREP project IMAGINATION and the direction of machine translation in the 6FP STREP project SMART. We also represent the Jožef Stefan Institute at the World Wide Web Consortium (W3C), which develops and recommends future web standards. We are active

Figure 2: The book "Decision making and modelling" in 300 pages describes numerous decision-support techniques and our experience gathered in the applications of support methods.

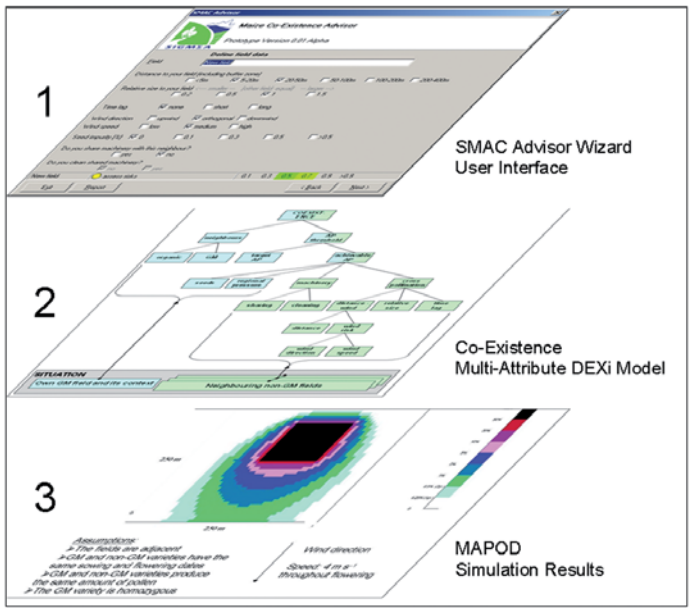

Figure 3: Three-level architecture of the decision-support system SMAC Advisor

members of the Rule Interchange Format working group. In 2006 we chaired the Organizing Committee of the 3rd European Semantic Web Conference, which was held in June 2006 in Budva, Montenegro.

In the area of knowledge management we are a partner in the 6FP IP project ECOLEAD (European collaborative networked organizations leadership initiative). We are involved in the development of a generic reference model for collaborative organizations and in the development of practical software prototypes for supporting virtual organizations. Specifically, we have developed the coFinder software tool which, based on the competencies of a virtual organization and focused web crawling, proposes potential business opportunities to the virtual organization manager. In 2007, demonstrations, trials and evaluations by actual networked organizations will be performed.

In the area of language technologies our aims are to foster the development of computational methods for processing Slovene, primarily through the creation of accessible language resources. In 2006 we successfully concluded the VoiceTRAN Speech Communicator project, led by Alpineon d.o.o., which developed a prototype speech-to-speech translator between Slovene and English. We also released the first Slovene treebank, i.e., a syntactically annotated corpus, which was included in the CoNLL-X shared task on multilingual dependency parsing. We continued the development of the WordNet-based semantic lexicon of Slovene; and significantly extended and improved the online Japanese-Slovene dictionary that we are developing in cooperation with the University of Ljubljana. The department was also involved in organizing and chairing the Fifth Slovenian and First International Conference on Language Technologies held at the JSI. Finally, we became one of the founding members of CLARIN, the European Research Infrastructure to Language Resources. Within a bilateral project completed in 2006, language resources were also developed for the Macedonian language.

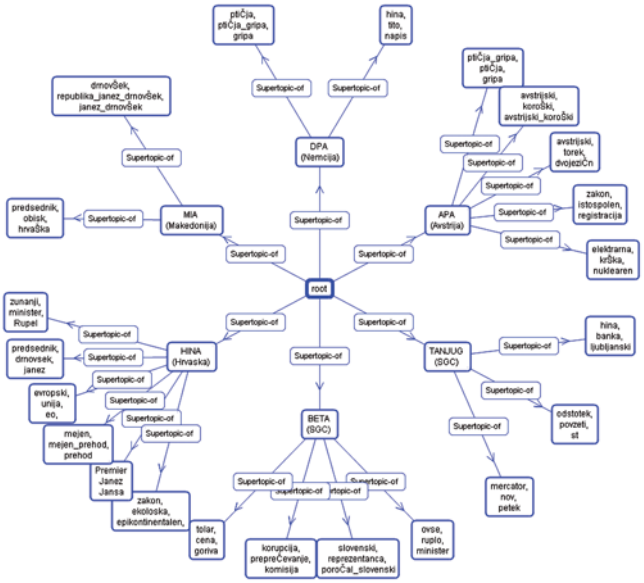

Figure 4: An analysis of foreign-press coverage of Slovenia with OntoGen.

Department members chaired the programme committee of the 9th International Conference on Discovery Science.

Some outstanding publications in the past three years

1. N. Lavrač, B. Kavšek, P. A. Flach, L. Todorovski. Subgroup discovery with CN2-SD. Journal of Machine Learning Research, vol. 5, pp. 153–188, 2004.
2. F. Železny, N. Lavrač. Propositionalization-based relational subgroup discovery with RSD. Machine Learning, vol. 62, no. 1–2, pp. 33–63, 2006.
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4. M. Bohanec. Odločanje in modeli. (Učbeniki in priročniki). Ljubljana: DMFA - založništvo, 2006. XV, 312 pp., ISBN 961-212-190-7. ISBN 978-961-212-190-7.
5. L. Todorovski, S. Džeroski. Integrated knowledge-driven and data-driven approaches to modelling. Ecological Modelling, vol. 194, pp. 3–13, 2006.
6. M. Žnidaršič, M. Bohanec, B. Zupan. proDEX - a DSS tool for environmental decision-making. Environmental Modelling & Software, 2006, 21(10), pp. 1514–1516

By the end of 2006 the 173rd Solomon seminar was given, disseminating computer science knowledge in Slovenia and abroad – video recordings of most seminars are available on the http://videolectures.net

Awards and appointments

1. Blaž Fortuna: Best Demo Award, Budva Montenegro, awarded by ESWC 2006 Conference audience.
2. Blaž Fortuna: Canonical correlation analysis and its application to multilingual text documents, Prešeren Award for best diploma, awarded by Faculty of Mathematics and Physics, University of Ljubljana.

Organization of conferences, congresses and meetings

1. Analysis of environmental data with machine learning methods, Ljubljana, Slovenia, February/March 2006.
2. KDID-2006. 5th Workshop on Knowledge Discovery in Inductive Databases, on ECML/PKDD-2006, Berlin, Germany, September, 2006.
3. Information Society 2006, organization of subconferences: SiKDD-2006 , Intelligent Systems and Language Technologies IS-LTC 2006, 9–14 October 2006
4. Workshop organization: LinkKDD-2006 - workshop on KDD-2006 Conference, Philadelphia, USA, 20–23 August 2006
5. Tutorial on "Context Sensitivity" in Knowledge Rich Systems on The 5th International Semantic Web Conference, Athens, Ga, USA, 5–9 November 2006

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46. Katerina Taškova, Panče Panov, Andrej Kobler, Sašo Džeroski, Daniela Stojanova
Predicting forest stand properties from satellite images with different data mining techniques
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49. Tanja Urbančič, Olga Štěpánková, Nada Lavrač
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TEXTBOOKS AND LECTURE NOTES

1. Marko Bohanec
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2. Nada Lavrač
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3. Nada Lavrač, Mitja Jermol, Tanja Urbančič, Dunja Mladenić
New media and knowledge management: part of "New media and e-science" programme and "Statistics" programme: 2005/06
(Postgraduate courses in new media and e-science), Ljubljana, Jožef Stefan Institute, 2006.

THESES

B. Sc. Theses

1. Miha Grčar: Empirical evaluation of algorithms for collaborative filtering (Prof. Ivan Bratko, Asst Prof. Dr. Dunja Mladenić)
2. Blaž Fortuna: Canonical correlation analysis and its application to multilingual text documents (Prof. Bor Plestenjak)

INTERNATIONAL PROJECTS

1. Stimulating Policy Debate on Women and Science Issues in Central Europe
WS DEBATE
6. FP; 036651
EC; Dr. Dora Groo, Eszter Papp, Hungarian Science and Technology Foundation; Tudomanyos es Technologiai Alapitvany, Budapest, Hungary
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
2. Statistical Multilingual Analysis for Retrieval and Translation
SMART
6. FP; 033917
EC; Nicola Cancedda, Xerox Research Centre Europe, Meylan; Xerox, Aulnay-Sous-Bois, France
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
3. Image-based Navigation in Multimedia Archives
IMAGINATION
6. FP; 034626
EC; Clemens van Dinther, Forschungszentrum Informatik an der Universitaet Karlsruhe, Karlsruhe, Germany
Asst. Prof. Dunja Mladenič, Mitja Jermol, M. Sc.
4. Extended Enterprise Management in Enlarged Europe
E4
6. FP; 027282
EC; Marialuisa Sanseverino, Centro Ricerche Fiat Societa Consortile per Azioni, Orbassano (TO), Italy
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.
5. Open Source Enterprise Resource Planning and Order Management System for Eastern European Tool and Die Making Workshop
Tool-East

6. FP; 027802
EC; Dr.-Ing. Volker Stich, Forschungsinstitut fuer Rationalisierung (FIR) and der RWTH Aachen, Research Institute for Operations Management at Aachen Univerity, Aachen, Germany
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.

6. Semantic Web Services Interoperability for Goespatial Decision Making
SWING; 6. FP; 026514
EC; David Skogan, SINTEF - Stiftelsen for Industriell OG Teknisk Forskning Ved Norges Tekniske Hoegskole, Trondheim; SINTEF ICT, Oslo, Norway
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.

7. Lifecycle Support for Networked Ontologies
NEON; 6. FP; 027595
EC; Prof. Enrico Motta, Kmi, The Open University, Milton Keynes, Great Britain
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.

8. Transitioning Applications to Ontologies
TAO; 6. FP; 026460
EC; Dr. Kalina Bontcheva, University of Sheffield, Department of Computer Science, Sheffield, Great Britain
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.

9. Inductive Queries for Mining Patterns and Models
IQ; 6. FP; 516169
EC; Prof. Sašo Džeroski, Jožef Stefan Institute, Ljubljana, Slovenia
Prof. Sašo Džeroski

10. Knowledge Base for RTD Competencies
IST-WORLD
6. FP; 015823
EC; Prof. Hans Uszkoreit, German Research Center for Artificial Intelligence GmbH (DFKI), Language Technology Lab, Saarbrücken, Germany
Marko Grobelnik, Mitja Jermol, M. Sc.

11. Central European Centre for Women and Youth in Science
CEC-WYS
6. FP; SAS6-CT-2004-003582
EC; Dr. Marcela Linková, Institute of Sociology, Academy of Sciences of the Czech Republic, Prague, Czech Republic
Asst. Prof. Dunja Mladenič, Mitja Jermol, M. Sc.

12. Semantically-Enabled Knowledge Technologies
SEKT; 6. FP; 506826
EC; John Davies, British Telecommunications plc, London, Great Britain
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Mitja Jermol, M. Sc.

13. European Collaborative networked Organizations LEADership initiative
ECOLEAD; 6. FP; 506958
EC; Martin Ollus, Technical Research Centre of Finland, Espoo, Finland
Prof. Nada Lavrač, Mitja Jermol, M. Sc.

14. Sustainable Introduction of GMOs into European Agriculture
SIGMEA; 6. FP; SSPE-CT-2004-501986
EC; Jeremy Sweet, NIAB, Cambridge, Great Britain
Prof. Sašo Džeroski

15. Superpeer Semantic Search Engine
ALVIS; 6. FP; 002068
EC; Wray Buntine, Complex Systems Computation Group at Helsinki Institute for Information Technology, Helsinki University of Technology, Espoo, Finland
Asst. Prof. Dunja Mladenič, Marko Grobelnik, Prof. Matjaž Gams

16. Pattern Analysis, Statistical Modelling and Computational Learning
PASCAL
6. FP; 506778
EC; Prof. John Shawe-Taylor, The University of Southampton, School of Electronics and Computer Science, Highfield, Southhampton, Great Britain
Asst. Prof. Dunja Mladenič, Mitja Jermol, M. Sc.

17. KD-ubiq - A Blueprint for Ubiquitous Knowledge Discovery Systems
KD-ubiq
6. FP; 021321
EC; Dr. Michael May, Stephan Kollmer, Fabian Perpeet, Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung e.V., Muenchen; Sankt Augustin, Germany
Asst. Prof. Dunja Mladenič

18. Soil Ecological and Economic Evaluation of Genetically Modified Crops
ECOGEN
5. FP; QLK5-CT-2002-01666
EC; Dr. Paul Henning Krogh, National Environmental Research Institute, Department of Terrestrial Ecology, Soil Fauna and Ecotoxicology Research Unit, Silkeborg, Denmark
Prof. Sašo Džeroski

19. Knowledge Technologies in Medicine and Healthcare
BI-CZ/06-07-021
Prof. Olga Štěpánková, Czech Technical University in Prague, Faculty of Electrical Engineering Department of Cybernetics, Prague, Czech Republic
Prof. Nada Lavrač

20. Intelligent Data Analysis
BI-FR/05-06/006
PROTEUS
Dr. Michele Sebag, Laboratoire de Rechereche en Informatique UMR 8623, Universite de Paris Sud, Orsay Cedex, France
Prof. Nada Lavrač

21. Intelligent Subgroup Discovery
BI-HR/06-07-021
Dr. Dragan Gamberger, Rudjer Boškovic Institute, Zagreb, Croatia
Prof. Nada Lavrač

22. Sustav za automatsku klasifikaciju stranica hrvatskog i slovenskog Interneta
BI-HR/05-06-003
Jasminka Dobša, M. Sc., Fakultet organizacije i informatike, Varaždin, Croatia
Asst. Prof. Dunja Mladenič

23. Gathering, Annotation and Analysis of Macedonian/Slovenian Language Resources
BI-MK/05-06-002
Dr. Katerina Zdravkova, Faculty of Natural Sciences and Mathematics Skopje, Skopje, Republic of Macedonia
Prof. Sašo Džeroski

24. Using Artificial Intelligence in Text and Web Mining
BI-SCG/05-06-019
Prof. Mirjana Ivanović, Faculty of Science, University of Novi Sad, Novi Sad, Serbia and Montenegro
Asst. Prof. Dunja Mladenič

25. Analysis of Dynamic Networks with Graph and Text Mining Methods
BI-US/06-07-032
Faloutsos Christos, Carnegie Mellon University, Pittsburgh, PA, USA
Asst. Prof. Dunja Mladenič

R & D GRANTS AND CONTRACTS

1. Processing lidar data (Development and use of algorithms for mapping and estimating forest biomass and stand structure from LIDAR data and digital multispectral images)
Prof. Sašo Džeroski
2. Digital Critical Editions of Slovene Literature
Asst. Prof. Tomaž Erjavec
3. Semantic GRID environment for ecological modelling
Dr. Ljupčo Todorovski
4. Statistical Semantic Web System
Asst. Prof. Dunja Mladenič
5. Harmonisation of technologies for following genetically modified organisms in food and feed production chain and its co-existence with conventional and ecological production chains
Prof. Nada Lavrač
6. Setting up a Slovene corpus network
Asst. Prof. Tomaž Erjavec
7. Forecasting GIS for natural environment fire hazards
Prof. Sašo Džeroski
8. VoiceTRAN II: Multilingual mobile speech communicator for 21.th century warriors
Asst. Prof. Tomaž Erjavec
9. Methodology for Producing a Digital Map of Forest Stand Height and Canopy Cover
Prof. Sašo Džeroski
10. VoiceTRAN: Multilingual mobile speech communicator for 21.th century warriors
Asst. Prof. Tomaž Erjavec

RESEARCH PROGRAM

1. Knowledge technologies
Prof. Nada Lavrač

NEW CONTRACT

1. Analysis of factors in setting up a network of health care personnel
Ministry of Health
Prof. Nada Lavrač

VISITORS FROM ABROAD

1. Stephan Bloehdorn, Karlsruhe University, Germany, 19–22 June 2006
2. Martin Stein, Karlsruhe University, Germany, 19–22 June 2006
3. Dr. Kathy Astrahantseff, Universitätsklinikum Essen, Germany, 19–25 June 2006
4. Fran Supek, Institut Rudjer Boškovic, Zagreb, Croatia, 19 June 2006
5. Giuseppe Jurman, ITC - IRST, Trento, Italy, 19–20 June 2006
6. Dr. Herwig Rollet, Know-Center, Graz, Austria, 19 June 2006
7. Prof. Bettina Berendt, Humboldt University Berlin, Institute of Information Systems, Berlin, Germany, 3–6 October 2006
8. Brigitte Joerg, DFKI, Saarbrücken, Germany, 18 April 2006
9. Prof. Rich Caruana, Cornell University, Department for Computing, Ithaca, New York, USA, 30 May – 5 June 2006
10. Ethan Dereszynski, Oregon State University, Oregon, USA, 12 May – 11 August 2006
11. Asst prof. Dr. Jasminka Dobša, Faculty for Organization and Informatics, Varaždin, Croatia, 8–10 October 2006
12. Dr. Daniel Radošević, Faculty for Organization and Informatics, Varaždin, Croatia, 8–10 October 2006
13. Dr. Joao Gama, University of Porto, Porto, Portugal, 9 November 2006
14. Dr. Rita Ribeiro, University of Porto, Porto, Portugal, 9 November 2006
15. Dr. Geoff Squire, Scottish crop research institute SCRI, Dundee, Great Britain, 31 March 2006
16. Koraljka Golub, Lund University, Lund, Sweden, 22 May 2006

STAFF

Researchers

1. Prof. Marko Bohanec**
2. Dr. Damjan Bojadžiev
3. Prof. Sašo Džeroski**
4. Asst. Prof. Tomaž Erjavec
5. Prof. Nada Lavrač**, Head
6. Asst. Prof. Dunja Mladenić
7. Prof. Tanja Urbančič*

Postdoctoral associates

8. Asst. Prof. Marko Debeljak
9. Dr. Damjan Demšar
10. *Dr. Aleks Jakulin, left 22.1.2006*
11. Dr. Branko Kavšek*
12. Asst. Prof. Ljupčo Todorovski*

Postgraduates

13. Janez Brank, M.Sc.
14. Blaž Fortuna, B.Sc.
15. Valentin Gjorgjioski, B. Sc.
16. Miha Grčar, B. Sc,
17. Mitja Jermol, M. Sc.
18. Petra Kralj, B. Sc.
19. Simon Krek***, B. Sc
20. *Peter Ljubič, B. Sc., left 1.5.2006*
21. Panče Panov, B. Sc.
22. Joel Plisson, B. Sc.
23. Dr. Miha Volovšek***
24. Miha Vuk, B. Sc.
25. Bernard Ženko, M. Sc.
26. Martin Žnidaršič, univ.dipl.inž. rač. in inf., asis. zač.

Technical officers

27. Asst. Prof. Bojan Cestnik***
28. Dr. France Dacar
29. Dr. Igor Mozetič
30. Nina Novinec, B.Sc.

Technical and administrative staff

31. Tina Anžič
32. Milica Bauer, B.Sc.
33. Marko Grobelnik

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF INTELLIGENT SYSTEMS

E-9

The Department of Intelligent Systems focuses its activities on the development of methods and techniques for intelligent computer systems, with applications in the areas of the information society, computer science and informatics, Slovene language and speech processing, and network communication systems. The main research areas are language and speech technologies, agent technologies, the semantic web, evolutionary computing, data mining, search algorithms, decision support, intelligent sensors, distributed supervisory systems, and network voice services. The department collaborates closely with the Faculty of Computer and Information Science at the University of Ljubljana on the joint research programme Artificial Intelligence and Intelligent Systems, which is led by Prof. Ivan Bratko.

Head:
Prof. Matjaž Gams

The department collaborates with the Faculty of Computer and Information Science from the University of Ljubljana on the joint research programme Artificial Intelligence and Intelligent Systems, recognized as one of the best Slovenian research programmes in 2005 by the Slovenian Research Agency in 2006. This was the first promotion of this type for any computer-science research programme. In the area of **language and speech technologies** we developed new language resources for the Slovene language, new algorithms and procedures for Slovene speech synthesis, and were engaged in syntactic parsing of Slovene texts. In cooperation with other research groups we continued the development of the syntactically annotated corpus of Slovene text called the "Slovene Dependency Treebank". Its current size is about 35,000 words. The corpus is intended to aid research in automatic syntactic parsing of Slovene text.

The department was recognized as having one of the best Slovenian research programmes.

Together with the company Amebis we developed a new version of the Slovene text-to-speech (TTS) system Govorec (Speaker). It is the first and only widely available commercial TTS system for Slovene. It can be accessed at the website govorec.amebis.si. Another good example of knowledge transfer into practice is MMC RTV Govorec (MMC RTV Speaker). This program reads the news from the RTV Slovenia teletext. It was designed **for blind and partially sighted people** as a tool for observing daily events. Users can access fresh news, updated every minute. MMC RTV Govorec is the result of a cooperation involving the Jožef Stefan Institute, Amebis and the RTV Slovenia Multimedia Centre. All three participants donated the application to the blind and partially sighted people of Slovenia, and it is available through the website www.rtvslo.si/govorec.

Figure 1: The MMC RTV Govorec (Speaker) program, which reads the RTV Slovenia teletext news on a home personal computer, was donated to the blind and partially sighted people of Slovenia by the Jožef Stefan Institute, the company Amebis, and the RTV Slovenia Multimedia Centre.

The department conducts research in the area of **agent technologies**. Agents are autonomous computer programs that simulate the behaviour of human agents. Our research includes learning, modelling and simulating intelligent agents and multiagent systems. In 2006 the emphasis was on modelling strategic multiagent behaviour without prior high-level domain knowledge. We developed a Multi-Agent Strategy Discovering Algorithm (MASDA), which is able to detect and describe a previously unknown strategy of a team of agents based only on agent trace and low-level domain knowledge. The algorithm was successfully tested on two robot football domains: the RoboCup and the 3vs2 Keepaway. This research was part of a recent doctoral dissertation from the field of multiagent system modelling.

Evolutionary computing is the study of search and optimization algorithms imitating the concepts of Darwinian evolution and genetic variation in the exploration of complex problem spaces. In this field we focused on multiobjective optimization and applications of evolutionary algorithms in process-parameter optimization in the continuous casting of steel, and marker optimization in textile production. We upgraded DEMO, an evolutionary algorithm for multiobjective optimization based on differential evolution. It is less complex than other multiobjective

In December 2006 the MMC RTV Govorec (Speaker) program was donated to the blind and partially sighted people of Slovenia. The program reads the regularly updated news from the RTV Slovenia teletext on a home personal computer. It was developed by the Jožef Stefan Institute, the company Amebis, and the RTV Slovenia Multimedia Centre. The estimated contribution of the department to the donation is € 40,000.

optimization algorithms and provides comparable, and in some cases even better results, on test problems. In 2006 the algorithm was connected with a machine learning method, with the focus on handling the classification accuracy and complexity of the induced concepts as conflicting optimization criteria.

In **data mining** the emphasis was on analyzing text data. Text categorization is usually based on content. We, however, used style-based categorization to automatically identify genres of web pages, such as personal and commercial. Our classifier will be used in the ALVIS search engine, developed as part of an EU 6FP project. We also pursued research in the automatic categorization of text documents based on character subsequences. A system for filtering malicious and spam email based on this method, which was developed at the department, received widespread recognition, and was implemented in one of the most popular spam filtering systems, CRM114.

We study **search algorithms** for game-playing, path-finding and other applications. We explained many cases of the pathological behaviour of search algorithms, i.e., achieving worse results at a greater search depth, and determined for which cases a deeper search is beneficial. We are also developing methods for the automatic selection of the optimal search depth in path-finding.

In the area of **multimedia communications and services** we successfully completed our task in the EU 6FP IST research project **WINDECT** (Wireless Local Area Network with Integration of Professional Quality DECT Telephony). The project dealt with professional-quality speech services on convergent wireless data communications in LAN/WLAN networks. Our laboratory system for automated metric testing of voice quality in VoIP/VoWLAN systems was augmented with components for VQ measurements on a WINDECT demonstrator system under the support of the local industrial partners Iskratel and Prevent Global. We successfully confirmed toll-quality speech communication on PC-emulated access points and mobile terminals. WINDECT measurement results ensure the support of professional-quality speech and video services that represent the core of convergent communications systems.

The most important publications of the department in 2006 were in the Journal of Machine Learning Research and the Artificial Intelligence journal, ranked as the first and seventh according to impact factor in the field of artificial intelligence.

For Telekom Slovenije, the national telecom operator, we realized a feasibility study for the Inteligentni dom Telekom **(Intelligent Home Telekom)** project. The study presents a complete and up-to-date state-of-the-art survey, guidelines for the functional and technical design of the intelligent-home framework, and provides a list of next-generation intelligent-home services. These services depend on ambient intelligence, as they are inherently interconnected, personalized, user-friendly, and operate in self-aware environments. Our main objective is to explore and develop new ambient-intelligence technologies that will embed intelligence properties into the next-generation intelligent-home products and services.

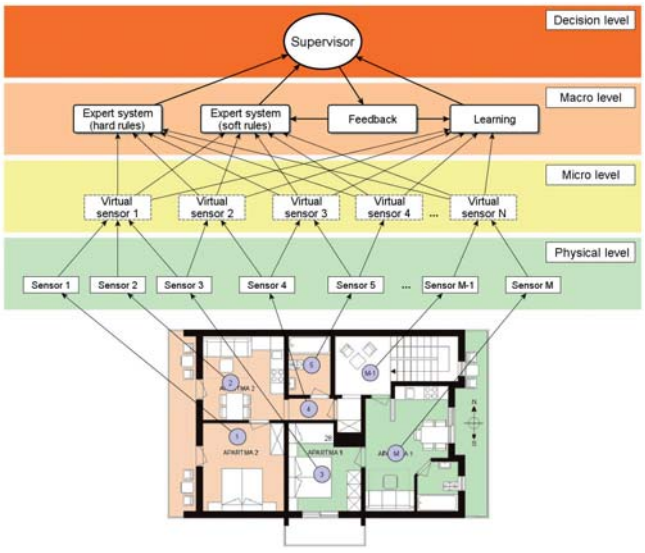

Figure 3: A scheme of the intelligent supervisory system under development for MORS (Ministry of Defence of the Republic of Slovenia)

We participated in three EU 6FP projects: ALVIS (semantic search engine), WINDECT (integration of wireless voice and data transmission services), and WeGo (implementation of e-government). Major applied projects are conducted for the Tax Administration of the Republic of Slovenia (multimedia consultation on income taxes), Telekom Slovenije (intelligent home), Špica and the Slovenian Research Agency (access control) and the Ministry of Defence of the Republic of Slovenia (intelligent supervisory systems).

We also participate in the EU 6FP project WeGo, which deals with the implementation of e-government, and carry out major national applied projects for the Tax Administration of the Republic of Slovenia (multimedia consultation on income taxes), Špica and the Slovenian Research Agency (access control) and the Ministry of Defence of the Republic of Slovenia (intelligent supervisory systems).

A traditional activity of the Department of Intelligent Systems is the organization of the International Multiconference Information Society. In October 2006 the 8th such multiconference was held in Ljubljana, and consisted of eight independent conferences.

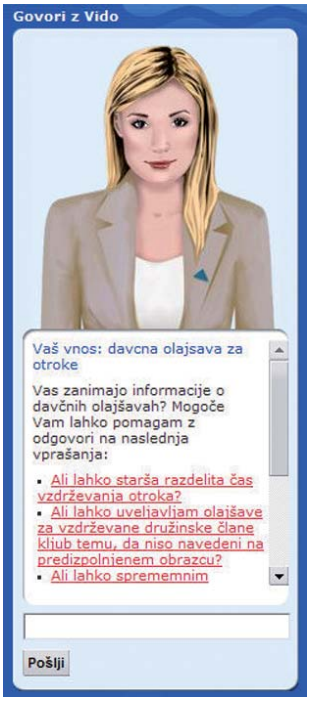

Figure 2: The department collaborates with the company Artificial Solutions in adjusting the virtual tax advisor VIDA for completing the income tax forms for DURS (Tax Administration of the Republic of Slovenia).

Some outstanding publications in the past three years

1. A. Bratko, G. V. Cormack, B. Filipič, T. R. Lynam, B. Zupan, Spam filtering using statistical data compression models, Journal of Machine Learning Research, 7 (2006), 2673–2698
2. M. Luštrek, M. Gams, I. Bratko, Is real-valued minimax pathological?, Artificial Intelligence, 170 (2006), 620–642
3. A. A. Kavalenka, B. Filipič, M. A. Hemminga, J. Štrancar, Speeding up a genetic algorithm for EPR-based spin label characterization of biosystem complexity, Journal of Chemical Information and Modeling, 45 (2005) 6, 1628–2635
4. T. Šef, M. Gams, Data mining for creating accentuation rules, Applied Artificial Intelligence, 17 (2004) 5, 395–410
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Organization of conferences, congresses and meetings

1. 9th International Multiconference Information Society IS 2006: Boderline cognitive Sciences, Cognitive Sciences, Collaboration and Information Society, Data Mining and Data Warehouses, Education in Information Society, Intelligent Systems, Language Technologies, Jožef Stefan Institute, Ljubljana, Slovenia, 9–14 October 2006
2. The Second International Conference on Bioinspired Optimization Methods and their Applications BIOMA 2006, Ljubljana, 9–10 October 2006

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PH. D. THESIS

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Avtomatsko modeliranje večagentnih sistemov: doktorska disertacija
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INTERNATIONAL PROJECTS

1. Superpeer Semantic Search Engine
ALVIS
6. FP; 002068
EC; Wray Buntine, Complex Systems Computation Group at Helsinki Institute for Information Technology, Helsinki University of Technology, Espoo, Finland
Prof. Matjaž Gams, Dr. Dunja Mladenič, Marko Grobelnik
2. Wireless Local Area Network with Integration of Professional-Quality DECT Telephony
WINDECT
6. FP; 506746
EC; Technical manager of the project: Dr. Eva Ravnikar, Ascom AG, Switzerland; Business manager of the project: Hans-Peter L. Bauer, Winfinity GmbH, Kiel, Germany
Dr. Marjan Špegel
3. Numerical Optimization of Continuous of Steel
BI-FI/04-05-009
Dr. Erkki Laitinen, Department of Mathematical Sciences, University of Oulu, Oulu, Finland
Asst. Prof. Bogdan Filipič
4. Securing and Optimising Smart Access and Personal Identification Systems with Intelligent Agents
BI-RO/05-06/016
Dr. Madalin Stefan Vlad, Politehnica University of Bucharest, Bucharest, Romania
Prof. Matjaž Gams

R & D GRANTS AND CONTRACTS

1. Integrated Multi-Media Mobile Applications in Hospitals
Prof. Matjaž Gams
2. Technology of learning in multi-agent systems
Prof. Matjaž Gams
3. Knowledge technology and decision support in medical information portals
Prof. Matjaž Gams
4. Professional System for Mobile Communications for Ministry of Defense
Dr. Marjan Špegel
5. The role of Luka Koper in logistic support of the Slovenian Armed Forces and allies
Asst. Prof. Bogdan Filipič
6. Voice TRAN II: multilingual portable speech communicator for worrior in 21st century
Prof. Matjaž Gams
7. CIVaBiS - An integrated security biometrical system
Prof. Matjaž Gams

RESEARCH PROGRAM

1. Artificial Intelligence and Inteligent Systems
Prof. Matjaž Gams

NEW CONTRACTS

1. Analyses and design of the integrated platform
Telekom Slovenije d.d.
Prof. Gams Matjaž
2. Expert councelling for the introduction of tax advisor
Tax Administration of the Republic of Slovenia
Prof. Gams Matjaž

VISITORS FROM ABROAD

1. Prof. Veljko Milutinović: Faculty of Electrical Engineering, University of Belgrade, Serbia, 16–18 Febtuary 2006
2. Prof. Erkki Laitinen, Department of Mathematical Sciences, University of Oulu, Finland, 26 February – 2 March 2006
3. Prof. Dana S. Nau, University of Maryland, College Park, USA, 3–6 October 2006
4. Prof. Günter Rudolph, Department of Computer Science, University of Dortmund, Germany, 8–10 October 2006
5. Madalin Stefan Vlad, Politehnica University of Bucharest, Romania, 28 May 2006
6. Prof. Marcin Paprzycki, dr. Maria Ganzha, Systems Research Institute, Polish Academy of Science, Warsaw, Poland, 10–12 October 2006

STAFF

Researchers

1. Prof. Ivan Bratko*, Academician
2. Asst. Prof. Bogdan Filipič**
3. **Prof. Matjaž Gams**, Head**
4. Dr. Tomaž Šef
5. Prof. Vladislav Rajkovič*
6. *Dr. Marjan Špegel, retired 31. 12. 2006*

Postdoctoral associates

7. Dr. Aleš Dobnikar***
8. Dr. Matija Drobnič***
9. Dr. Viljem Križman***
10. Dr. Aleksander Pivk***

Postgraduates

11. Andraž Bežek, M. Sc.
12. Andrej Bratko***, B. Sc.
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15. Tea Tušar, B. Sc.

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16. Robert Blatnik, B. Sc.
17. Dr. France Dacar
18. Mitja Kolbe***, B. Sc.
19. Peter Reinhardt***, B. Sc.

Technical and administrative staff

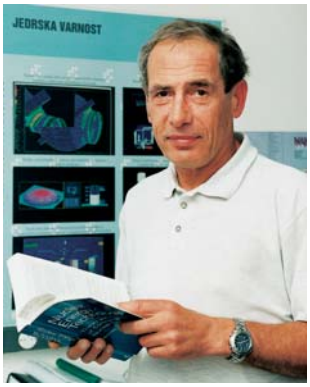
20. Mitja Lasič
21. Liljana Lasič

* Full-time faculty member
** Part-time faculty member
*** Member of industrial or other organisation

DEPARTMENT OF REACTOR ENGINEERING

R-4

The Department of Reactor Engineering is involved in basic and applied research in the fields of nuclear engineering and safety. The topics include the modelling of basic thermal-hydrodynamic phenomena, thermal-hydraulic safety analyses of design-basis and severe accidents, structural safety analyses and probabilistic safety assessment. Most of the department's research activities are part of international cooperation programs. The research results are incorporated into projects for industry and for the regulatory authorities.



Head:
Prof. Borut Mavko

Modelling of basic thermal-hydrodynamic phenomena

In the field of research on the heat transfer between structures and fluids, numerical simulations of heat transfer in a turbulent flow near a heated flat wall at a high Prandtl number were carried out. The results of our models are in excellent agreement with the results of the most accurate direct numerical simulations. These analyses have shown the negligible influence of the smallest structures on the bulk heat transfer and on the lower statistics of the turbulent thermal field. The computer codes NEPTUNE, CFX and Fluent are being used within the NURESIM project of the EU's 6FP to develop models for the inter-phase transfer of heat, mass, and momentum in a horizontally stratified flow of cold liquid and hot steam.

In the field of research on convective boiling, recent experiments from Purdue University, USA, were simulated using a model of nucleate sub-cooled boiling, which is based on the coupling of a bubble-tracking approach with an Eulerian description. In collaboration with Forschungszentrum Rossendorf, Germany, numerical simulations of convective boiling in a section of a pressurized-water reactor-fuel assembly were performed with the three-dimensional two-fluid CFX code. The influence of mixing vanes on the evolution of the two-phase flow structure and the occurrence of hot-spot locations, which may lead to a critical heat flux and damage to the fuel rods, was analysed. Activities to develop a generic two-phase wall-function model for a boiling boundary layer are also being carried out within the NURESIM project.

We performed an experiment on steam explosions with prototypic corium in the KROTOS facility at the CEA research centre in Cadarache, France.

In the field of research on pressure transients, the computer code WAHA, which was developed within the WAHALoads project of the EU's 5FP to simulate transients in piping systems, is being upgraded with a model that enables a two-way coupling between thermal-hydrodynamic phenomena in a pipe and the reactions of the flexible piping structure.

A steam explosion might occur during a hypothetical severe accident in a nuclear power plant if the molten reactor core were to pour into the water in the reactor cavity. We performed an experiment on a steam explosion with prototypic corium in the KROTOS facility at the Commissariat à l' Energie Atomique (CEA) in Cadarache, France. A number of preparatory pre-test simulations were carried out with the European code MC3D, which we appropriately improved. The simulation results were supplemented by a detailed analysis of the melt droplets' cooling and freezing, which allowed the optimal experimental parameters to be determined. With the MC3D code we simulated the molten-reactor-core discharge from the failed reactor vessel and the fuel-coolant interaction in the flooded reactor cavity. These activities are being carried out within the SARNET Network of Excellence (EU 6FP).

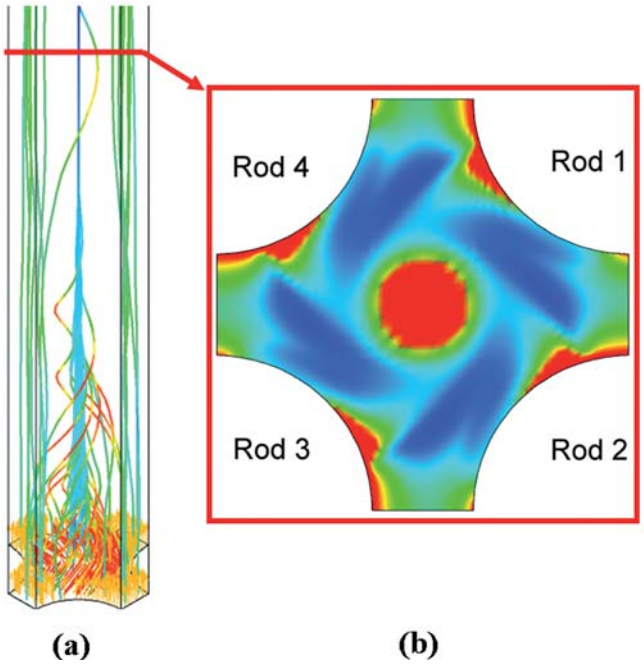


Figure1. Simulation of boiling in the channel of a pressurized water reactor's fuel assembly: influence of mixing vanes
a.) Stream lines of the vapour phase
b.) Cross-sectional distribution of the vapour volume fraction

Thermal-hydraulic safety analyses

In the field of the quantitative assessment of thermal-hydraulic code simulations, the existing fast-Fourier-transform-based method (FFTBM) was improved by signal mirroring. Thus, the edge effect between the first and the last data point of a signal, which is not physical, was eliminated in

the periodically extended time signal when performing the fast Fourier transform. Two tests were used to demonstrate the improved method, i.e., the LOFT L2-5 test (large-break loss-of-coolant accident) and the PHEBUS FPT1 test (severe accident with core melting and relocation).

With the latest available version of the RELAP5/MOD3.3 thermal-hydraulic code for the simulation of phenomena in the reactor's primary system, i.e., Patch 03, an abnormal event, which occurred at Krško Nuclear Power Plant on 10 April 2005, was analysed. A malfunction occurred during a power-reduction sequence when a regular periodic testing of the turbine valves was performed. In the input model, the control and safety systems were taken into account and operator actions were added. The results showed very good agreement between the predictions of the RELAP5/MOD3.3 Patch 03 code and actual plant data.

In the field of modelling of containment phenomena, which is also being carried out within the SARNET network, an experiment on containment sprays that was performed on the TOSQAN facility at the Institut de Radioprotection et de Sureté Nucléaire in Saclay, France, was simulated with the CFX code. The same code was also used to simulate the interaction between passive autocatalytic recombiners and the containment atmosphere, using a simplified two-dimensional model. The experiment on aerosol behaviour LACE LA4 that was performed in the LACE facility at Westinghouse Hanford Company, USA, was simulated with the European ASTEC code for severe-accident simulation.

Multiscale simulations are used to predict the propagation of short cracks in polycrystalline materials

Structural safety analyses

The main research achievements are related to the development of multiscale computational simulation tools for polycrystalline (metallic) materials. The random grain structure is represented by an incomplete random tessellation (Voronoi tessellation). The microscopic stress fields in randomly oriented and shaped grains are then obtained using the finite-element solver ABAQUS. In 2006 a successful quantification of the scatter present in the opening of short cracks was performed. We simulated the short cracks approaching and crossing the first grain boundary in their path. The development of grain-boundary-failure models to be used in simulations of intergranular cracking was initiated in cooperation with the Material Performance Centre of Manchester University, United Kingdom. A joint program of developing a procedure for obtaining large monocrystals of austenitic stainless steel was started in 2006 in cooperation with the Institute of Physics, Czech Republic. Methods and models for the assessment of the vulnerability of reinforced concrete buildings to explosions are also being developed. Other partners in the research on structural safety analyses are the EU Joint research Center, Petten, The Netherlands, Forschungszentrum Karlsruhe, Germany, and AIB-Vinçotte Nucléaire, Belgium.

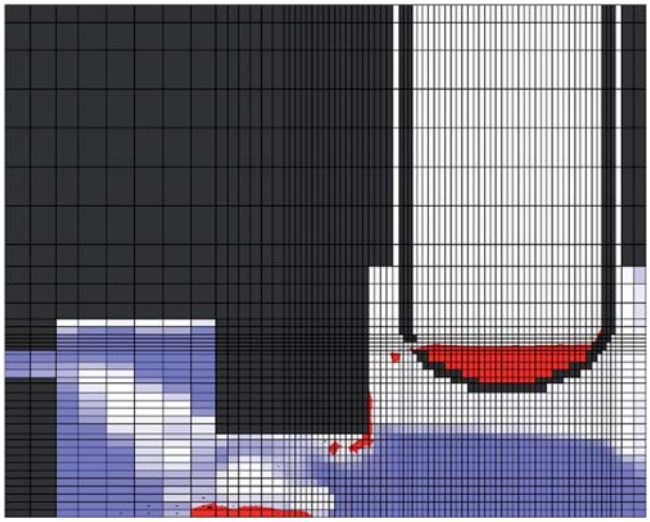


Figure 2: Simulation of the molten-reactor-core pour from a failed reactor vessel into a flooded reactor cavity with the MC3D code.

Probabilistic safety assessment

A method for analysing the inter-dependence of human actions, which are modelled as independent in probabilistic safety-assessment models, has been developed. In particular, events that may occur due to the maintenance of stand-by systems and events that are part of scenarios in the functioning of safety systems were considered.

We have been developing a method for the assessment of network reliability. The fault-tree analysis was applied in a new way, which enables an assessment of the network's reliability by considering the structure of the network and its components.

We started with the modelling of the influence of ageing in a probabilistic safety assessment. Probabilistic models that are based on constant failure rate were modified, based on models that may include the time-dependent increase of the failure rate as a consequence of ageing.

The research is being carried out in cooperation with Tsinghua University, China, the Technical University of Ostrava, Czech Republic, the Faculty of Electrical Engineering of Skopje, Macedonia, and the Polytechnic University of Valencia, Spain.

Technical cooperation, consulting services and education

In 2006 the researchers of the Reactor Engineering Department also cooperated in projects for industry and the state administration. As an authorized institution for nuclear safety assessment, the JSI participated in the verification of the TMI Action Plan Requirements in the Krško NPP. The JSI also issues permissions for recriticality

and regular operation of the Krško NPP after each regular outage. Members of the Reactor Engineering Department are also actively involved in the nuclear engineering graduate programme at the Faculty of Mathematics and Physics at the University of Ljubljana. The programme is associated with the European Nuclear Education Network (ENEN).

We cooperated in the project of human-reliability updating in the Krško Nuclear Power Plant

Some outstanding publications in the past three years

1. B. Končar, I. Kljenak, B. Mavko, Modelling of local two-phase flow parameters in upward subcooled flow boiling at low pressure, International Journal of Heat and Mass Transfer 47 (2004) 1499–1513.
2. M. Kovač, I. Simonovski, L. Cizelj, Modeling elasto-plastic behavior of polycrystalline grain structure of steels at mesoscopic level, Nuclear Engineering and Design 235 (2005) 1939–1950.
3. A. Prošek, F. d'Auria, D.J. Richards, B. Mavko, Quantitative assessment of thermal-hydraulic codes used for heavy water reactor calculations, Nuclear Engineering and Design 236 (2006) 295–308.
4. R. Bergant, I. Tiselj, On the role of the smallest scales of a passive scalar field in a near-wall turbulent flow, Heat and Mass Transfer 42 (2006) 411–426.
5. L. Cizelj, B. Končar, M. Leskovar, Vulnerability of a partially flooded PWR reactor cavity to a steam explosion, Nuclear Engineering and Design 236 (2006) 1617–1627.
6. M. Čepin, L. Cizelj, M. Leskovar, B. Mavko, Vulnerability analysis of a nuclear power plant considering detonations of explosive devices, Journal of Nuclear Science and Technology 43 (2006) 1258–1269.
7. I. Kljenak, M. Babić, B. Mavko, I. Bajsić, Modeling of containment atmosphere mixing and stratification experiment using a CFD approach, Nuclear Engineering and Design 236 (2006) 1682–1692.

Awards and appointments

1. Janez Gale: Award for young author at International Conference "Nuclear Energy for New Europe 2006", Portorož, organized by the Nuclear Society of Slovenia.

Organization of conferences, congresses and meetings

1. Meeting of European Atomic Energy Society (EAES), Ljubljana, 27–31 May 2006

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   In: Int. j. heat mass transfer, Vol. 49, pp. 1027-1038, 2006.
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Regular Papers

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2. Miroslav Babić, Ivo Kljenak, Borut Mavko
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3. Miroslav Babić, Ivo Kljenak, Borut Mavko
   Numerical study of interaction between NPP containment atmosphere and passive autocatalytic recombiners
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Projektiranje jedrskih cevovodov na (toplotno) utrujane po ASME B&PV code: seminar "Toplotno utrujanje spojev cevovodov iz nerjavnih jekel v jedrskih elektrarnah", 16.5.2006, Reaktorki center Instituta Jožef Stefan, Brinje pri Ljubljani, Ljubljana, Fakulteta za matematiko in fiziko, Oddelek za fiziko, Katedra za jedrsko tehniko, 2006.
4. Marko Čepin
Ocenjevanje verjetnosti odpovedi sistemov: seminar
Ljubljana, Institut Jožef Stefan, Odsek za reaktorsko tehniko, 2006.
5. Marko Čepin
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6. Nenad Debrecin, Tomislav Bajs, M. Glaeser, N. Fil, Andrej Prošek, Milorad Dušič, J. Stuller
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7. Igor Simonovski
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8. Igor Simonovski
Večnivojsko modeliranje nastanka in napredovanja utrujenosti razpok: seminar "Toplotno utrujanje spojev cevovodov iz nerjavnih jekel v jedrskih elektrarnah", 16.5.2006, Reaktorki center Instituta Jožef Stefan, Brinje pri Ljubljani, Ljubljana, Fakulteta za matematiko in fiziko, Oddelek za fiziko, Katedra za jedrsko tehniko, 2006.
9. Iztok Tiselj
Numerična simulacija turbulentnega mešanja: seminar "Toplotno utrujanje spojev cevovodov iz nerjavnih jekel v jedrskih elektrarnah", 16.5.2006, Reaktorki center Instituta Jožef Stefan, Brinje pri Ljubljani, Ljubljana, Fakulteta za matematiko in fiziko, Oddelek za fiziko, Katedra za jedrsko tehniko, 2006.

INTERNATIONAL PROJECTS

1. Consolidation of European Nuclear Education, Training and Knowledge Management
ENEN-II
6. FP-EURATOM
036414
EC; Dr. Peter De Regge, ENEN Association, Centre CEA de Saclay, Gif-sur-Yvette , France
Prof. Leon Cizelj
2. Sustainable Nuclear Fission Technology Platform
SNF-TP
6. FP; 036410
EC; Prof. Dan G. Cacuci, CEA Saclay, DEN/DIR, Commisariat à l'Energie Atomique (CEA), Paris, France
Prof. Borut Mavko
3. Nuclear Plant Life Prediction
NULIFE
6. FP; 036412
EC; Valton Teknillinen Tutkimuskeskus (VTT), Espoo, Finland
Prof. Leon Cizelj
4. European Platform for Nuclear Reactor Simulations
NURESIM
6. FP; 516560
EC; Maryline Rougier, CEA Saclay, DEN/DSOE, France
Asst. Prof. Iztok Tiselj, Dr. Andrej Prošek
5. Network of Excellence for Sustainable Integration of European Research on Severe Accident Phenomenology and Management
SARNET
6. FP
FI60-CT-2004-509065
EC; Institut de radioprotection et de surete nucleaire, Clamart, France
Dr. Matjaž Leskovar
6. Safety and Reliability of Industrial Products, Systems and Structures
SAFERELNET-NAS
5. FP
1/54, GIRT-CT-2001-0501
EC; Prof. Carlos Guedes-Soares, Technical University of Lisbon, Instituto Superior Téchnico, Unit of Marine Technology and Engineering, Lisbon, Portugal
Asst. Prof. Marko Čepin
7. Condensation-Induced Water Hammer in Vertical Vessels
INTAS
Ref. No.: 05-1000008-8086
EC; Prof. Francesco D'Auria, University of Pisa, Dipartimento di Ingegneria Nucleare Meccanica e della Produzione (DIMNP), Pisa, Italy
Prof. Iztok Tiselj
8. Code Applications and Maintenance Program (CAMP)
Thermal-Hydraulic Code Applications and Maintenance
International Research Project
Dr. Andrew J. Szukiewicz, Reactor and Plant Systems Branch, Division of Systems Technology, Office of Nuclear Regulatory Research;
Dr. Ashok C. Thadani, Director, Office of Nuclear Regulatory Research, United States Nuclear Regulatory Commission (US NRC), Washington, D. C., USA
Prof. Borut Mavko
9. Workplace Europe - Delivering Education & Vocational Experience by Learning on Placement Staff
WE-DEVELOP-STAFF
Leonardo da Vinci Programme
UK/05-1/EX/163315
EC; Dr. Andrej Jivkov, University of Manchester, Manchester; Keith Burnley, The North West Universities Association, Manchester, Great Britan
Prof. Leon Cizelj
10. Risk and Cost Limited Optimization of the Maintenance based on Semi-analytic Stochastic Modeling
BI-CZ/05-06/004
Dr. Radim Briš, Technical University of Ostrava (TUO), Faculty of Electrical Engineering and Computer Science (FEI), Ostrava-Poruba, Czech Republic
Asst. Prof. Marko Čepin
11. The Production of Large Monocrystals of Austenitic Stainless Steel
BI-CZ/06-07-002
Dr. Jaromír Kopeček, Institute of Physics, Academy of Sciences CR, Prague, Czech Republic
Dr. Igor Simonovski
12. PHEBUS Fission Products Agreement
SLO-F-2003-2008
Daniel Queniat, Acting Director, Institut de Radioprotection et de Surete Nucleaire (IRSN), Clamart, France
Dr. Matjaž Leskovar
13. Evaluation of Existing and Optimisation of Future Generation in Small Electric Power Systems considering Economic Analysis and Environmental Impacts
BI-MK/06-07-007
Dr. Anton Causevski, Department of Power Plants & Power Systems Faculty of Electrical Engineering, Skopje, Republic of Macedonia
Asst. Prof. Marko Čepin
14. Multidimensional Modeling of Turbulence and Bubble Dynamics in Boiling Flows
BI-US/04-05/26
Prof. Yassin A. Hassan, Texas A&M University, Department of Nuclear Engineering, Texas, USA
Dr. Boštjan Končar

R & D GRANTS AND CONTRACTS

1. Safety Margins in Nuclear Power Plants
   Dr. Andrej Prošek
2. Development of New Safety Models and Definition of Risk Criteria
   Asst. Prof. Marko Čepin
3. Simulations of Stratified and Slug Flows
   Prof. Iztok Tiselj
4. Modelling of Steam Explosions
   Dr. Matjaž Leskovar
5. Modelling of Nonhomogeneous Atmosphere in Nuclear Power Plant Containment
   Dr. Ivo Kljenak
6. Three-Dimensional Eulerian Model of Convective Boiling
   Prof. Borut Mavko, Dr. Boštjan Končar
7. Application of Methods and Techniques to Assess Ageing and Support Safe Operation of Nuclear Installations and Radiation Facilities
   Prof. Leon Cizelj
8. Improvement of Nuclear Safety with the Probabilistic Safety Assessment
   Asst. Prof. Marko Čepin
9. Multilayered Penetration Resistant Composites
   Prof. Leon Cizelj
10. Modelling of Explosion Consequences on Equipment and Structures
    Dr. Matjaž Leskovar
11. Influence of Corium Composition on Steam Explosion
    Dr. Matjaž Leskovar
12. Development and Validation of Turbulent Two-Phase Wall Functions for Subcooled Boiling Flow
    Prof. Iztok Tiselj
13. Simulation of thermal-hydraulic phenomena in the atmosphere of a nuclear power plant containment at accident conditions;
    Dr. Ivo Kljenak

RESEARCH PROGRAM

1. Nuclear Engineering
   Prof. Borut Mavko

NEW CONTRACTS

1. Assessment of Works, Corrective Actions and Tests During Krško NPP Outage
   Milan Vidmar electric power research institute, Ljubljana
   Fabjan Ljubo, M.Sc.
2. Engineering Support Activities for PSR
   Nuclear Power Plant Krsko, Krsko
   Prof. Borut Mavko

VISITORS FROM ABROAD

1. Prof. Christian Sylvain, Prof. Helios Nadal and Prof. Gérard Castello, representatives of AREVA and CERCA, Paris, France, 23 March 2006
2. Dr. Andrey Petrov Jivkov, The University of Manchester, School of Materials, Manchester, Great Britain, 2–6 October 2006
3. Asst. Prof. Anton Čauševski, University of Skopje, Macedonia, 15–29 October 2006
4. Goce Božinovski, B. Sc., University of Skopje, Macedonia, 15–29 October 2006
5. Dr. Ho Je Seong, Safety Analysis group, KOPEC, South Korea, 24 October 2006
6. Dr. Imre Ferenc Brna, KFKI Atomic Energy Research Institute, Budapest, Hungary, 25 October 2006
7. Dr. Yoshihiro Mizutani, Tokyo Institute of Technology, Japan, 15 December 2006
8. Dr. Tamotsu Jikimoto, Central Research Institute of Electric Power Industry, Japan, 15 December 2006

Visiting students from the International Association for the Exchange of Students for Technical Experience (IAESTE):
1. Kristof Mahieu, Universiteit Gent, Belgium, 1 August – 8 September 2006
2. Ricardo Torreblanca Perez, Universidad Autonoma de Nuevo Leon, Nowaday, Mexico, 21 August – 1 December 2006

STAFF

Researchers
1. Prof. Leon Cizelj**
2. Asst. Prof. Marko Tomaž Čepin**
3. *Dr. Andrej Horvat, left 1. 3. 2006*
4. Dr. Romana Jordan-Cizelj
5. Dr. Ivo Kljenak
6. Dr. Boštjan Končar
7. Dr. Matjaž Leskovar
8. **Prof. Borut Mavko**, Head**
9. Dr. Andrej Prošek
10. Dr. Igor Simonovski
11. Prof. Iztok Tiselj**

Postgraduates
12. Miroslav Babić, B. Sc.
13. Janez Gale, B. Sc.
14. Zoran Petrič, B. Sc.
15. Luka Štrubelj, B. Sc.
16. Andrija Volkanovski, M. Sc.

Technical officers
17. Ljubo Fabjan, M. Sc., 50% IJS QA Manager
18. *Dr. Iztok Parzer, died 27. 9. 2006*
19. Andrej Sušnik, B. Sc.

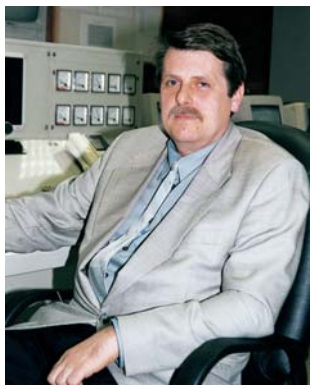
Technical and administrative staff
20. Tanja Klopčič
21. Zlata Vrhovec Mikolič

** Part-time faculty member

REACTOR INFRASTRUCTURE CENTRE RIC

The TRIGA Mark II Reactor at the Jožef Stefan Institute has been operating since 1966. It is used for neutron research, training and for producing radioactive isotopes. Besides operating and maintaining the reactor, the members of the reactor staff cooperate in other activities requiring specialists skilled in working with sources of radiation and in reactor technology, such as the servicing of industrial radioactive sources and the surveillance of the fuel management in NPP Krško.

A detailed technical description of the reactor is available at http://www.rcp.ijs.si/~ric/



Head:
Prof. Matjaž Ravnik

In 2006 the reactor operated for 216 days. A total of 1863 samples were irradiated, 838 of them in the rotary specimen rack, 595 in the pneumatic post system and 430 in the fast pneumatic post system.

The reactor mainly operated in steady-state mode. There have been no serious operational problems or events influencing nuclear or radiological safety. The reactor operators performed the regular maintenance inspections and works according to the annual plan.

The reactor was mainly used for neutron-activation analysis. The reactor operated mainly for the needs of the Jožef Stefan Institute's research departments: Environmental Science Department, Reactor Physics Department, Experimental Particle Physics Department and the Department for Nanostructured Materials. The reactor was used in the following research:

- neutronics and reactor physics
- activation analysis
- neutron dosimetry and spectrometry
- neutron radiography
- activation of materials, nuclear waste and decommissioning
- irradiation of materials for fusion reactors.

Figure 1: Ministers Zupan and Podobnik visiting the reactor on the occasion of the celebration of its fortieth anniversary

The reactor's operators support the researchers by performing the operations and services for which the researchers are not qualified and authorized, such as operating the reactor, performing irradiations and manipulations with radioactive samples. The operators were also involved in a regular re-training program and passed the examinations qualifying them for the next 5 years according to the law on nuclear safety.

The results of this research were published in approximately 20 scientific papers. Three young researchers carried out their research at the reactor.

Practical exercises for students of physics at Ljubljana University were preformed. Post-graduate students of nuclear engineering also attended some of these exercises. For these activities the reactor operated for approximately 10 days. The reactor was also used for practical exercises within the training program of the NPP Krško reactor operators. Also, some post-graduate students of nuclear engineering at the Faculty of Mathematics and Physics of the University of Ljubljana participated in the exercises. The exercises were prepared and carried out by the reactor's personnel.

Two larger groups of students from the Faculties of Electrical Engineering of Ljubljana and Zagreb Universities (40 and 60 visitors, respectively) visited the reactor, as well as approximately 300 other visitors in smaller groups.

In 2006 the reactor celebrated 40 years of operation. It started to operate on 31 May 1966 and has been operating without significant problems ever since. Several guests including ministers Janez Podobnik and Jure Zupan as well as former members of reactor's technical and scientific staff visited the reactor on the occasion of the anniversary celebration.

STAFF

Technical officers
1. Bojan Huzjan
2. Darko Kavšek
3. Bojan Oman
4. **Prof. Matjaž Ravnik, Head**
5. Marko Rosman

Administrative staff
6. Darja Stich

CENTRE FOR NETWORKING INFRASTRUCTURE CNI

The main function of the Centre for Network Infrastructure (CNI) is the management and maintenance of the Jožef Stefan Institute's computer network, including planning, development, upgrades, maintaining contact with public networks, and providing security.

Head:
Vladimir Alkalaj, M. Sc.

Upgrades to the physical network of the JSI's LAN remain the most investment-intensive task of the CNI, and are likely to remain so in the future. However, network security has become the most knowledge- and time-intensive task.

Increasing amounts of traffic invariably involves a growing number of undesirables, such as worms, viruses, break-in attempts and unsolicited commercial mail (UBE or spam). It is particularly disturbing that the incidence of viruses/worms and spam is growing faster than the amount of network traffic. Network protection, therefore, requires increasingly more powerful interfaces, firewalls and other equipment, as network traffic continues to double every 14 months.

Mail security presents an ever-increasing problem because the perpetrators of the abuse are extremely inventive; regular mail constitutes an ever-shrinking percentage of all related transactions.

The tenacity of spam perpetrators is mid-boggling. It is understandable that spam is extremely "cost efficient" given that the "advertiser" abuses the mail-transfer agent with no cost to him- or herself; therefore, any generated response constitutes pure "profit." At least, this reasoning was eminently logical just a few years ago. However, these days spam filtering has become both efficient and common – the low probability of "sneaking through" a spam message should undercut the cost of developing new strategies. Yet it does not seem to be so – which may indicate that the "advertisers" may yet be unaware of spam's low success rate, or that perpetrators are very convincing in marketing their services.

Regardless whether we will see a reduction in the level of spamming in the near future, the high rate of irregular and unsolicited e-mail messages clearly demonstrates that e-mail, as one of the first useful services available on computer networks, would have been degraded to a nuisance if it were not for the considerable efforts invested in the development of counter measures.

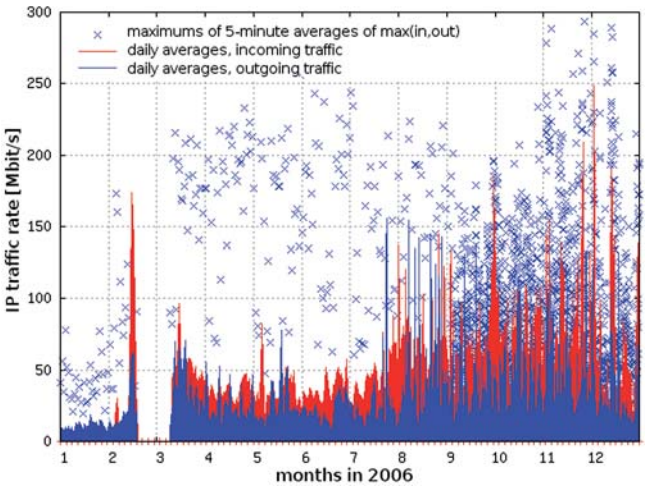


Figure 1: All 2006 outgoing/incoming traffic JSI – Arnes

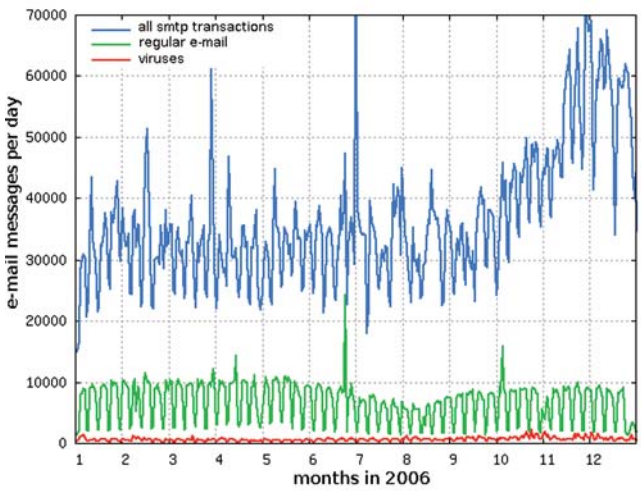


Figure 2: Illustrates the share of normal (non-spam) messages compared to all other attempts at mail delivery. The daily quantity of regular messages indicates a weekly period that remains relatively constant; however, the daily quantity of irregular delivery attempts does not show any weekly period and keeps increasing continuously. On a positive note, malware-infected messages that used to constitute a considerable portion of delivered mail a few years ago seem to have receded to a less noticeable share of the attempted mail deliveries.

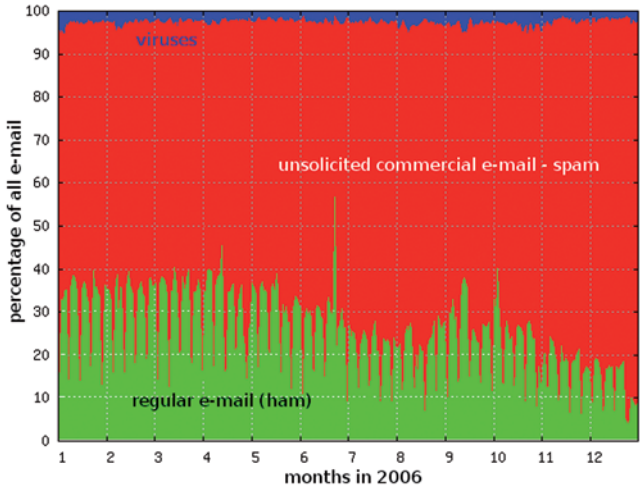


Figure 3: Illustrates the shares of the three main types of content in relation to the integral quantity of e-mail. Regular mail represents only a minor share (10–20%) of all e-mail that the mail server and filtering systems have to process to guarantee the quality separation of relevant content and garbage.

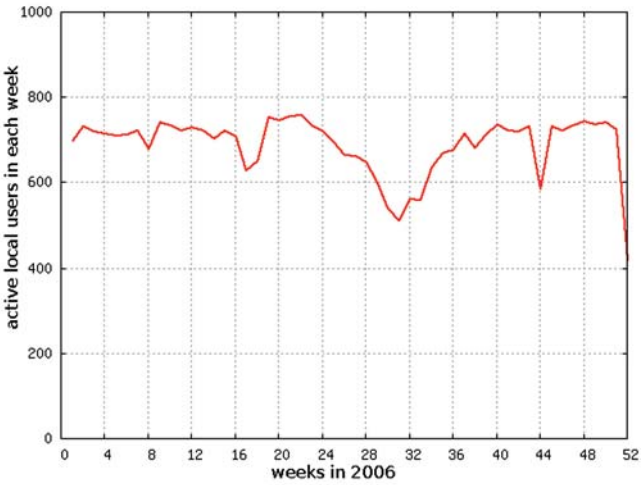


Figure 4: Illustrates how many JSI network users actually employ e-mail regularly. For each week in 2006 we have tabulated the number of different source addresses among all the e-mail messages originating from the JSI in the same week. The effect of vacations and holidays is clearly visible. The derived figure corresponds well to the total number of JSI employees and users.

STAFF

Technical officers

1. **Vladimir Alkalaj, M. Sc., Head**
2. Matjaž Levstek
3. Mark Martinec, B. Sc.
4. Matej Wedam

Technical and administrative staff

5. Ivan Ivanjko
6. Janez Srakar

SCIENCE INFORMATION CENTRE SIC

The Jožef Stefan Institute Science Information Centre is the central Slovenian physics library and one of the largest specialist libraries in Slovenia. Our main tasks are the acquisition, archiving, and loan of books and periodicals, as well as the input, update and control of the bibliographic data of the institute staff, as requested by the funding ministry.

Head:
Dr. Luka Šušteršič

Our collection covers the fields of physics, chemistry, biochemistry, electronics, information science, artificial intelligence, nuclear technology, energy management and environmental science. We are a full member of the Slovenian library cooperative, COBISS, and use their services to catalogue and loan our materials. You can check what is new in the library, browse our online catalogue, or send inter-library loan requests using our WWW site (http://library.ijs.si/).

We supplement our comprehensive print collection of core journals with electronic editions, offered through our WWW site. We subscribe to the electronic collections offered by ScienceDirect, Springer Link, Stanford HighWire Press, ACS online editions, AIP electronic editions, IoP online journals, Wiley Interscience. We provide access to the SCOPUS, Current Contents, INSPEC, Crossfire Beilstein, and Web of Science databases, and the Dialog online database services.

We manage the JSI's bibliographic database. This database contains about 80,000 records, going back to the JSI's founding in 1949. The records of last year's work are included as part of this report.

STAFF

Technical officers

1. Jasna Malalan
2. Katarina Modic, B. Sc.
3. Slavka Šmuc, B. Sc.
4. Alenka Štante, B. Sc.
5. Branka Štrancar
6. **Dr. Luka Šušteršič, Head**
7. Marjan Verč, B. Sc.
8. Saša Žnidar

Technical and administrative staff

9. Suzi Korošec
10. Jože Per
11. Nada Tratnik

ENERGY EFFICIENCY CENTRE

EEC

The basic activities of the Energy Efficiency Centre are in efficient energy use, long-term energy planning and the reduction of greenhouse-gases emissions. The centre is a focal point for the collection and transfer of energy-efficiency technologies to energy users, the state, energy-service and equipment providers, and other interested agencies. At the same time it covers the environmental effects of energy use and conversion. The most significant part of the EEC's activities is thus the cooperation with state institutions in the field of efficient energy use, energy planning, environmental taxes (e.g., CO_2 tax) and emission trading. Despite this, it still retains close contacts, because of its energy consulting role, with industrial companies and institutions. The ministry responsible for science, due to a lack of prepared programme documents in the field of research in energy and the environment, supports the above-mentioned activities only symbolically, and thus unfortunately does not promote increased research work in this field despite its crucial importance for Slovenia, the Slovenian economy and for sustainable development.

Head:
Tomaž Fatur, M. Sc.

Energy and environment

In 2006 the key activities of the Energy Efficiency Centre were centred on different professional tasks relating to energy and on reducing the impact of energy use on the environment, especially in the field of greenhouse-gases emissions. The EEC has a great deal of experience in the fields of energy, energy use, electricity production and, in recent years, in the impact of the production and use of energy on the environment. In connection with this, in 2006 the EEC prepared various strategic studies for the Ministry of the Environment and Spatial Planning and the Ministry of the Economy, necessary for the decisions of both ministries. These studies related to reducing greenhouse-gases emissions, the introduction of renewable energy sources (the preparation of the Operative Programme for Increased Wood Biomass Exploitation) and the preparation of an overview for carrying out energy policy in Slovenia.

The R&D work of Energy Efficiency Centre staff was an important contribution to the preparation of the Resolution on National Development Projects for the Period 2007–2023 for the research project "Sustainable Energy and the Hydrogen Economy", one of 34 projects for the development of Slovenia as well as the framework for economic and social reforms.

The Energy Efficiency Centre played an important role in the elaboration of the strategic basis of the Republic of Slovenia for the preparation of development projects that the government of the Republic of Slovenia presented to the public at the end of 2006. The programme, entitled Sustainable Energy and the Hydrogen Economy, was designed directly through the R&D work in the centre, and as such it plays a key role in the formation of the development priorities of Slovenia. EEC representatives have also actively participated in the preparation of programme documents for obtaining financial resources from European funds, particularly from the Cohesion Fund and the Regional Development Fund.

In 2006, the Energy Efficiency Centre cooperated in the preparation of the Operative Programme for the Reduction of Greenhouse-Gases (GHG) Emissions, accepted by the government of the Republic of Slovenia at the end of 2006, by which the ways of meeting the international obligations of Slovenia in the field of reducing greenhouse-gases emissions are determined and revised. The centre also carried out support studies and tasks for this programme, especially in terms of the preparation of a new plan for the distribution of greenhouse-gases emissions rights and environment taxes. With a good knowledge of the industrial environment, technological procedures and the necessary legislation, the centre also carried out assessments of the suitability of the applications of individual industrial enterprises as an authorized representative of the state. In 2006, printed versions were also issued, i.e., The Fourth National Communication under the United Nations Framework Convention on Climate Change, and Slovenia's report on demonstrable progress under the Kyoto Protocol, which is the cover document of the government of the Republic of Slovenia on the status of greenhouse-gases emissions. Both publications are the result of the research and professional work of the Energy Efficiency Centre and have an important role as reference documents on the situation in Slovenia in the field of greenhouse-gases emissions and the fulfilment of international obligations.

In the annual review of the Slovenian energy sector for 2005 the EEC drew attention to the fact that all energy use and supply indicators show trends that are essentially worse than expectations. This means that politically based energy mechanisms have not until now achieved the expected results. In the future, with the active

participation of the EEC, it will be necessary to focus on the execution of the mechanisms for energy-use management to improve competitiveness, reliability and the environment.

The promotion of efficient energy use and energy consulting

In this field, the Energy Efficiency Centre was concerned with cooperation in designing, monitoring and evaluating energy-efficiency programmes, the introduction of energy-efficient technologies and energy management, the informing and awareness-building of energy consumers and other target groups, as well as the promotion of energy-efficient technologies and procedures.

In 2006 the Energy Efficiency Centre carried out several consulting tasks in industry and a series of energy audits of enterprises in order to reduce energy use and costs. Seminars and workshops for industrial companies on energy management, energy-efficient technologies and energy planning were organised. The centre also prepared the programme of the largest Slovenian conference of energy managers, "Energy Managers' Days", the eighth such annual meeting of energy managers, and the participation of more than 200 energy managers confirms the quality and public profile of the EEC's professional work. The centre issues the Energy Efficiency Newsletter for the Agency for Efficient Use of Energy. Individual EEC experts published numerous articles in magazines and newspapers and took part in radio and television broadcasts.

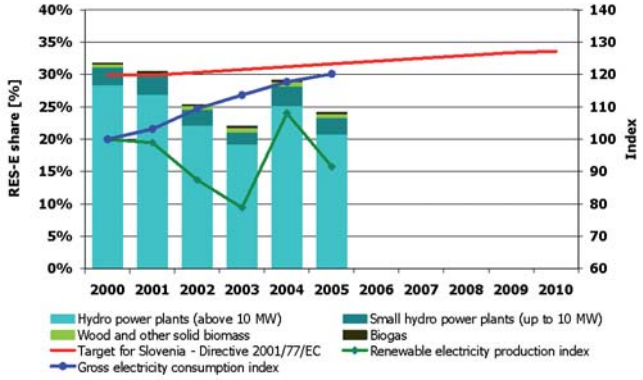


Figure 1: Share of renewable electricity production in gross electricity demand and the target addressed to Slovenia under Directive 2001/77/EC to increase demand for electricity from renewable sources to 33.6 % by 2010

International cooperation

In 2006 the EEC carried out as many as 15 international projects, financed from the European Union's resources as part of the EU's 6FP and the European Commission programme "Intelligent Energy for Europe" (formerly the SAVE and Altener programmes).

The projects cover activities in various fields including:

- new technologies and energy efficiency in EU research programmes – "Scientific Reference Systems on New Energy Technologies and Energy End-Use Efficiency and Energy RTD (SRS NET & EEE)",
- a comparison of energy indicators and energy management in small and medium-sized enterprises – "Benchmarking and Energy Management Schemes in SMEs",
- compiling and elaborating current data on the use of renewable energy sources – "EurObserv`ER Barometer",
- installing 1000 small units for the cogeneration of electricity and heat in Europe – "European Campaign for the Development and Documentation of 1000 Small Scale Cogeneration Projects in European Cities and Towns (COGEN CHALLENGE)",
- sustainable buildings – "GreenBuilding",
- carrying out the programme "MotorChallenge in Slovenia – Dissemination, Extension and Application of the Motor Challenge Programme (DEXA-MCP)".

The projects include cooperation with R&D organisations from Europe with a strong emphasis on concrete applications and the promotion of energy efficiency. In the framework of each of the 15 projects EEC staff took part in numerous foreign professional meetings and visits. For the "Intelligent Energy for Europe" projects, the EEC acquired partial co-financing from the Ministry for the Environment and Spatial Planning. Some projects were concluded in 2006, but the majority will continue until 2007 and 2008.

Some outstanding achievements in 2006

1. The Energy Efficiency Centre's staff prepared several key support documents for the government of the Republic of Slovenia, including The Operative Programme of Greenhouse Gases Emissions Reduction and design of The Operative Programme of Environment and Transport Infrastructure for obtaining financial resources from European structural funds.
2. In 2006, the Energy Efficiency Centre's staff cooperated in the preparation of The Resolution on National Development Projects for the Period 2007–2023 for the development project "Sustainable energy and the Hydrogen Economy", one of 34 development projects that form the execution of the Slovenian development strategy and the framework of economic and social reforms.
3. The Energy Efficiency Centre has 13 employees, and since 1994 the centre has participated in various international projects. In 2006 it cooperated in 15 projects in the framework of European Commission programmes (five within the EU's 6FP and ten within the Intelligent Energy for Europe programme). These

projects are in the fields of energy management, the combined production of electricity and heat, sustainable construction, external costs in energy, the exploitation of wood biomass and others.

Organization of conferences, congresses and meetings

1. Energy Managers Days 2006 – 8th meeting of Slovenian energy managers, Portorož, 3–4 April, 2006
2. Austrian Energy Days in Slovenia, Celje, 17–18 May, 2006
3. Smaller Cogeneration Units – Challenges and Opportunities, Ljubljana, 15 June, 2006
4. Introduction of Motor Challenge Programme in Slovenia, Ljubljana, 25 October, 2006
5. Introduction of GreenLight Porgramme in Slovenia, Ljubljana, 22 November, 2006

Figure 2: Execution of an energy audit

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ORIGINAL ARTICLES

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2. Evald Kranjčevič
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3. Evald Kranjčevič
   Spodbujanje energetske učinkovitosti v sistemih razsvetljave: evropski program Greenlight
   In: EGES, Energ. gospod. ekol. Slov., Št. 4, pp. 8-9, 2006.
4. Stane Merše, Andreja Urbančič
   Dražja elektrika je priložnost za soproizvodnjo
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5. Mihael Gabrijel Tomšič
   Prvi in zadnji veliki projekti v energetiki
   In: Finance, 03.11, 1 p., 2006.
6. Mihael Gabrijel Tomšič
   Plus-minus po evropsko in po domače
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7. Mihael Gabrijel Tomšič
   Iskalci in zapravljivci slovenske naravne rente
   In: Finance, Št. 160, 1 p., 2006.
8. Andreja Urbančič
   Anketa o možnostih za soproizvodnjo toplote in električne energije v Sloveniji
   In: Učin. energ., Letnik 11, 1 p., 2006.
9. Andreja Urbančič, Polona Lah
   Letni energetski pregled za leto 2005
   In: Učin. energ., Letnik 11, 1 p., 2006.

PUBLISHED CONFERENCE PAPERS

Regular Papers

1. Polona Lah, Stane Merše, Marko Pečkaj, Fouad Al-Mansour
   Vrednotenje učinkov projektov zmanjševanja emisij toplogrednih plinov in orodje 'VEM'
   In: Zbornik prispevkov, Boštjan Bibič, ed., Ljubljana, Slovensko društvo za daljinsko energetiko, 2006, pp. 75-83.
2. Stane Merše, Andreja Urbančič, Polona Lah
   Vrednotenje učinkov projektov proizvodnje električne enerhije iz obnovljivih virov na zmanjšanje emisij toplogrednih plinov in orodje "VEM"
   In: 15. mednarodno posvetovanje Komunalna energetika, 9. do 11. maj 2006, Maribor, [S.l.], United Nations Economic Commission for Europe, 2006.
3. Tomaž Fatur
   Energetska učinkovitost, IPPC dovoljenje, CO_2 taksa in prostovoljne aktivnosti podjetij
   In: [Zbornik predavanj], Barbara Petelin-Visočnik, ed., Tomaž Fatur, ed., Ljubljana, Časnik Finance, 2006, 11 p.
4. Tomaž Fatur
   Standard za energetski menedžment
   In: [Zbornik predavanj], Barbara Petelin-Visočnik, ed., Tomaž Fatur, ed., Ljubljana, Časnik Finance, 2006, 14 p.
5. Evald Kranjčevič
   Razdelitev emisijskih kuponov za drugo obdobje trgovanja z emisijami
   In: [Zbornik predavanj], Barbara Petelin-Visočnik, ed., Tomaž Fatur, ed., Ljubljana, Časnik Finance, 2006, 6 p.

INTERNATIONAL PROJECTS

1. Network for Promotion of RT Results in the Field of Eco-building Technologies, Small Polygeneration and Renewable Heating and Cooling Technologies for Buildings
   ProEcoPolyNet, PEP-Net
   6. FP; TREN/05/FP6EN/S07.54455/020114
   EC; Michael Geißler, Berliner Energieagentur GmbH (BE), Berlin, Germany
   Tomaž Fatur, M. Sc.
2. Scientific Reference System on New Energy Technologies, Energy End-use Efficiency and Energy RTD
   SRS NET & EEE
   6. FP; 006631
   EC; Dr. John Psarras, National Technical University of Athens, Zografou, Greece
   Tomaž Fatur, M. Sc.
3. Virtual Balkan Power Centre for Advance of Renewable Energy Sources in Western Balkans
   VBPC-RES
   6. FP; 509205
   EC; Dr. Andrej Gubina, University of Ljubljana, Faculty of Electrical Engineering, Ljubljana, Slovenia
   Stane Merše, M. Sc.
4. New Energy Externalities Development for Sustainability
   NEEDS
   6. FP; 502687
   EC; Adele Vendetti, Istituto di studi per l'Integrazione dei sistemi, Rome, Italy
   Dr. Mihael Gabrijel Tomšič
5. Integrated European Network for Biomass Co-firing
   NETBIOCOF
   6. FP – EURATOM; 020007
   EC; Maren Watzkat, Verein zur Förderung des Technologietransfers and der Hochschule Bremerhaven E.V., Bremerhaven, Germany
   Dr. Fouad Al-Mansour
6. Training and Network of European EnergyManagers
   EUREM.NET
   IEE Programme
   EIE/06/041/SI2.447404

EC; Dr. Robert Schmidt, Tom Ankirchner, Industrie-und Handelskammer Nürnberg für Mittelfranken Geschäftsbereich, Innovation/Umwelt, Nürnberg, Germany
Tomaž Fatur, M. Sc.

7. Evaluation and Monitoring of Energy Efficiency in the New EU Member Countries and the EU 25
   EEE-NMC
   IEE Programme
   EIE/05/005/SI2.420008
   EC; Didier Bosseboeuf, Agence De l'Environnement et de la Maitrise de l'Energie (ADEME), Angers, France
   Dr. Fouad Al-Mansour
8. The European GreenLight Programme in New Member States
   NEW GREENLIGHT
   IEE Programme
   EIE/05/192/SI2.419684
   EC; Juraj Krivošík, SEVEn, Stredisko pro efektivni vyuzivani energie, o.p.s., The Energy Efficiency Center, Prague, Czech Republic
   Evald Kranjčevič, M. Sc.
9. Strengthening the Knowledge of Local Management Agencies in the Transport Field
   COMPETENCE
   IEE Programme
   EIE/04/064/S07.38682
   EC; Odile Kubarth, Forschungsgesellschaft Mobilität – Austrian Mobility Research – GemeinnüüGmbH (FGM-AMOR), Graz, Austria
   Dr. Fouad Al-Mansour
10. European Campaign for the Development and Documentation of 1000 Small-scale Cogeneration Projects in European Cities and Towns
    COGEN CHALLENGE
    IEE Programme
    EIE/22003-138, EIE/04/138/S07.38653
    EC; Peter Löffler, The European Association for the Promotion of Cogeneration (COGEN), Brussels, Belgium
    Stane Merše, M. Sc.
11. Greenbuilding
    GREENBUILDING
    IEE Programme
    EIE/04/057/S07.38638
    EC; Laurenz Hermann, Deutsche Energie-Agentur GmbH, Berlin, Germany
    Tomaž Fatur, M. Sc., Marko Pečkaj, B. Sc.
12. Benchmarking and Energy Management Schemes in SMEs
    BESS
    IEE Programme
    EIE/04/246/S07.38678
    EC; Roelie Lambrichs-Rozendal, Boudewijn Huenges Wajer, SenterNovem, Sittard, The Netherlands
    Tomaž Fatur, M. Sc.
13. EurObserv ?ER Barometer
    EurObserv ?ER
    IEE Programme
    EIE/04/014/S07.38552
    EC; Diane Lescot, Observ ?ER – Observatoire des Energies Renouvelables, Paris, France
    Stane Merše, M. Sc., Polona Lah, B. Sc.
14. Dissemination, Extension and Application of the Motor Challenge Programme
    DEXA-MCP
    IEE Programme
    EIE/04/164/S07.38650
    EC; Geraldine Vaidie, Bruno Chretien, Agence de l'environnement et de la maîtrise de l'énergie (ADEME), Angers, France
    Tomaž Fatur, , M. Sc., Evald Kranjčevič, M. Sc.
15. "Bioenergy-Promotion" – Overcoming the Non-technical Barriers of Project-implementation for Bioenergy in Condensed Urban Environments
    BioProm
    IEE Programme
    EIE/04/100/S07.38585
    EC; Holger Haas, Stuttgart Region Economic Development Corporation (WRS), Stuttgart, Germany
    Tomaž Fatur, M. Sc., Dr. Fouad Al-Mansour
16. Austrian Energy Days in Slovenia 2006
    423WV, SLO-ENKO
    Dr. Fritz Unterpertinger, Austrian Energy Agency, Vienna, Austria
    Tomaž Fatur, M. Sc.

RESEARCH PROGRAM

1. Environment Impact - Modelling and Assessment
   Dr. Mihael Gabrijel Tomšič

NEW CONTRACTS

1. Evaluation and Monitoring of Energy Efficiency in the New EU Member Countries
   Ministry of Environment and Spatial Planning
   Dr. Fouad Al-Mansour
2. Strategic Studies for the Revision of the Emissions Reduction Programme
   Ministry of Environment and Spatial Planning
   Česen Matjaž
3. Elaboration of Tariffs for Electricity Sale to Large Consumers
   Holding of the Slovenian Power Plants
   Fatur Tomaž, M. Sc.
4. Benchmarking and Energy Management Schemes in SMEs
   Ministry of Environment and Spatial Planning
   Fatur Tomaž, M. Sc.
5. Promotion and Implementation of the Motor Challenge Programme
   Ministry of Environment and Spatial Planning
   Kranjčevič Evald, M. Sc.
6. Energy Efficient Lighting in Buildings
   Ministry of Environment and Spatial Planning
   Kranjčevič Evald, M. Sc.
7. Strategic Studies for the Elaboration of the State Plan of GHG Emissions Rights Ministry of Environment and Spatial Planning
   Allocation
   Kranjčevič Evald, M. Sc.
8. Strategic Studies for the New Legislation of the Power Plants Status
   Ministry of Economy
   Merše Stane, M. Sc.
9. Support of the Small Cogeneration
   Ministry of Environment and Spatial Planning
   Merše Stane, M. Sc.
10. Energy Audit of the Cinkarna Celje
    Cinkarna, d. d., Celje
    Pečkaj Marko
11. Increase of Investments in Renewables and Efficient Use in Non-Residential Buildings
    Ministry of Environment and Spatial Planning
    Pečkaj Marko
12. Strenghtening the Knowledge of Local Management Agencies in the Transport Field
    Ministry of Environment and Spatial Planning
    Pečkaj Marko
13. Editing of Energy Efficiency Newsletter
    Ministry of Environment and Spatial Planning
    Petelin Visočnik Barbara, M. Sc.
14. Operative Programme of Wood Biomass Energy Exploitation
    Ministry of Environment and Spatial Planning
    Urbančič Andreja, M. Sc.
15. Sustainable Energy
    Ministry of Environment and Spatial Planning
    Urbančič Andreja, M. Sc.
16. Annual Energy Review for 2005
    Ministry of Economy
    Urbančič Andreja, M. Sc.
17. Long Term Energy Balances of RS for the Period 2006 – 2026
    Ministry of Economy
    Urbančič Andreja, M. Sc.
18. Analysis of Potentials and Measures for Cogeneration Promotion
    Ministry of Economy
    Urbančič Andreja, M. Sc.

VISITORS FROM ABROAD

1. Sophie Goutalant, RAEE, Lyon, France, 24–25 April 2006
2. Andreas Koeng, IER; Stuttgart, Germany, 24–25 April 2006
3. Ludger Eltrop, IER, Stuttgart, Germany, 24–25 April 2006
4. Markus, Seiher, WRS, Stuttgart, Germany, 24–25 April 2006
5. Joah Carles Bruno, CREVER, Spain, 24–25 April 2006
6. Mubera Bičakčić, Head of Energy Department, MoFTER – Ministry of Foreign Trade and Economic Relations, Sarajevo, BIH, 8 September 2006
7. Biljana Trivanović, Senior Adviser (Electricity), MoFTER – Ministry of Foreign Trade and Economic Relations, Sarajevo, BIH, 8 September 2006
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12. Marko Košir, TASED Project Team Leader, MoFTER – Ministry of Foreign Trade and Economic Relations, Sarajevo, BIH, 8 September 2006
13. Ilias Sofronis, CRES, Atene, Greece, 12–13 October 2006
14. Anne Rialhe, AERE, Aix-les-Bains, France, 12–13 October 2006
15. Glenn Widerstrom, STEM, Eskilstuna, Sweden, 12–13 October 2006
16. Sigfrido Vignati, ENEA, Rim, Italy, 12–13 October 2006
17. Fernando Oliveira, ADENE, Amadora, Portugal, 12–13 October 2006
18. Peter Radgen, Fraunhofer ISI, Germany, 12–13 October 2006
19. Jacques – Olivier Budin, ADEME, Angers, France, 12–13 October 2006
20. Frank Hartkamp, Senter NOVEM, Sittard, The Netherlands, 12–13 October 2006
21. Michal Ramczykowski, Polish Copper Promotion Centre, Poland, 12–13 October 2006
    Francesco Buratti, ECD, Italy, 12–13 October 2006
22. Konstantin Kutlerer, Austrian Energy Agency, Vienna, Austria, 12–13 October 2006
23. Romualdas Skema, LEI, Kaunas, Litva, 12–13 October 2006
24. Edgar Blaustein, Montreuil, France, 12–13 October 2006
25. Jorg Kohl, DENA, Berlin, Germany, 12–13 October 2006

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3. Evald Kranjčevič, M. Sc.
4. Stane Merše, M. Sc.

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6. Matjaž Česen, B. Sc.
7. Polona Lah, B.Sc.
8. Marko Pečkaj, B. Sc.
9. Barbara Petelin Visočnik, M. Sc.
10. Andreja Urbančič, M. Sc.

Technical and administrative staff

11. Roza Pergarec, B. A.
12. Igor Ribič
13. Milan Simončič

CENTRE FOR ELECTRON MICROSCOPY CEM

The Centre for Electron Microscopy (CEM) has the function of a supporting infrastructure centre that comprises the equipment for electron microscopy that is necessary for the analytical and research work of the departments K5, K6, K7 and K9. Other JSI departments, research institutes, universities and industry also have access to the equipment. The users of the CEM equipment are the researchers in the field of materials science that are involved in the chemical and structural analysis of materials on the micro- and atomic scales. The major equipment of the CEM includes two scanning electron microscopes (JSM-840A and JSM-5800) and two transmission electron microscopes (JEM-2000FX and JEM-2010F).

Head:
Asst. Prof. Miran Čeh

Scanning electron microscopy (SEM) is used for morphological studies of either fractured or polished surfaces. Since both scanning electron microscopes are equipped with X-ray spectroscopy (EDXS and WDXS), qualitative and quantitative chemical analyses on a microscale are also possible. Since only a few μm^3 of the material are non-destructively analyzed, the term electron-probe microanalysis (EPMA) is used for such analytical work.

When structural features on the nanoscale are investigated, however, the various techniques of transmission electron microscopy (TEM) are used. In particular, the JEM-2010F is a state-of-the-art TEM/STEM microscope with a FEG (field-emission gun) electron source, and is one of the best microscopes in Europe. For the JEM-2010F the point-to-point resolution is below 0.19 nm, which is more than sufficient to observe the atomic columns in crystalline materials. The JEM-2010F is also equipped with an annular dark-field detector (HAADF-STEM) for so-called Z-contrast imaging, which enables chemical analyses of a single atomic column on the basis of the measured intensities. Both transmission electron microscopes are additionally equipped with analytical systems for chemical analysis (EDXS, EELS). The CEM also has the equipment for SEM and TEM specimen preparation, which is the first step for all electron-microscopy observation procedures. Of particular importance are the high- and low-energy ion-millers, which make possible the preparation of thin foils that are transparent to high-energy electrons.

The analytical work that is performed on the CEM equipment varies with respect to the investigated materials and/or the electron microscopy techniques used. While scanning electron microscopy is used mainly for microstructural characterization and the chemical analysis of polycrystalline ceramic materials (functional ceramics, engineering ceramics, bio-ceramics, and composites), magnetic materials, glasses, metals, alloys, etc., transmission electron microscopy is used for structural and chemical investigations of grain boundaries, planar faults, dislocations and

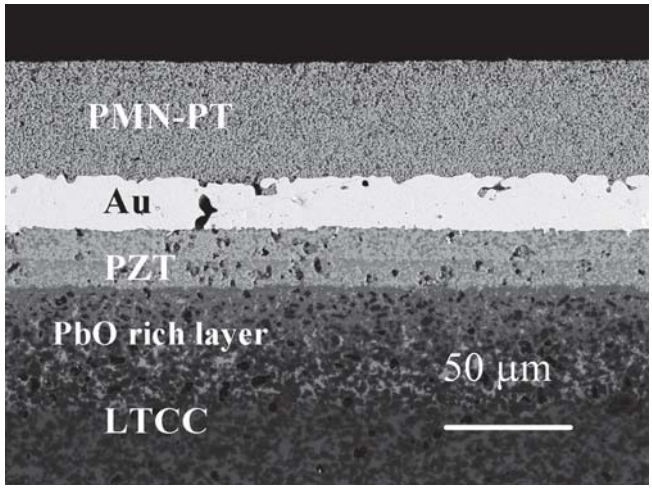

Figure 1: Cross-section of a PMN-PT thick film on an LTCC (low-temperature cofired ceramic) substrate. Screen printed and fired at 850°C for 2 h. Mag. 500x. PMN-PT – 65% $Pb(Nb_{2/3}Mg_{1/3})O_3$ + 35% $PbTiO_3$ thick-film layer, Au – thick-film gold-based electrode, PZT – $Pb(Zr,Ti)O_3$ thick-film barrier layer for reducing the interaction between the PMN-PT film and the glassy LTCC substrate, PbO-rich layer – upper part of LTCC substrate. During firing a PbO-rich phase diffused from the PZT barrier into the LTCC material, LTCC – LTCC substrate. Dept. for Electronic Ceramics: M. Hrovat.

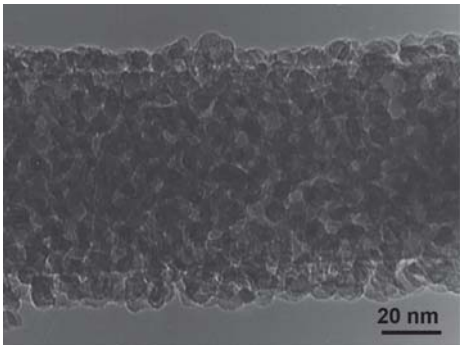

Figure 2: Si_3N_4 crystal coated with TiO_2 nanocrystals. Dept for Engineering Ceramics: I. Pribošič.

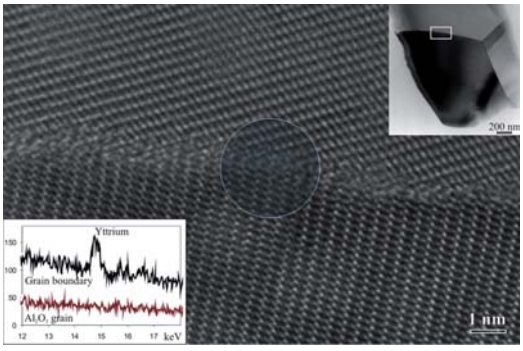

Figure 3: HRTEM image of the grain boundary between two Al_2O_3 crystal grains observed in an Al_2O_3 specimen doped with 2000 ppm of Y_2O_3. The EDXS analysis performed at the grain boundary shows the segregation of yttrium to the grain-boundary core structure. The average excess concentration of yttrium atoms (Γ_y) obtained from 18 measurements on various grain boundaries was 6.2±0.5 atom/nm². Dept for Nanostructured Materials: S. Šturm.

precipitates within the same materials. The analysis of grain boundaries is especially important since it is known that the final physical properties depend to a large extent on the structure and chemistry of grain boundaries.

In order to be able to perform electron microscopy investigations it is imperative that the equipment in the CEM is well maintained. In view of this, one of the main tasks is to achieve the maximum possible operational time of the microscopes. This complex and expensive equipment needs regular daily maintenance in addition to periodic servicing. Other activities of the CEM include the organization of training courses for operators and the implementation of new analytical methods, which is realized with the help of CEM co-workers.

Figure 4: Bright-field STEM image of ferroelectric domains in a grain of $BaTiO_3$-based PTC ceramics. Dept for Advanced Materials: B. Jančar.

CENTRE FOR KNOWLEDGE TRANSFER IN INFORMATION TECHNOLOGIES CT-3

The Centre for Knowledge Transfer in Information Technologies performs educational, promotional and infrastructural activities and enables the direct exchange of information and experience between researchers and the users of their research results.

Head:
Mitja Jermol, M. Sc.

By partnering and active engagement in different European research projects the centre successfully extends its activities to research and development. Most of the research is performed in the area of knowledge management for traditional and emerging forms of organizations, like networked and virtual organizations. The centre is currently active in eleven European projects: ECOLEAD Integrated project (European Collaborative Networked Organisation Leadership Initiative), SEKT Integrated project (Semantically Enabled Knowledge Technologies) and PASCAL Network of Excellence (Pattern Analysis, Statistical Modelling and Computational Learning), IST WORLD (Knowledge Base for RTD Competencies), TOOL-EAST (Open Source Enterprise Resource Planning and Order Management System for Eastern European Tool and Die Making Workshops), E4 (Extended Enterprise Management in Enlarged Europe), NEON (Lifecycle Support for Networked Ontologies), SWING (Semantic Web Services Interoperability for Geospatial Decision Making), IMAGINATION (Image-based Navigation in Multimedia Archives), TAO (Transitioning Applications to Ontologies), and SMART (Statistical Multilingual Analysis for Retrieval and Translation).

We develop and prepare carefully designed educational events, such as seminars, workshops, conferences and summer schools. These are targeted at experts who would like to apply the latest knowledge and achievements from intelligent data analysis, knowledge technologies, data mining, text mining and decision support to the areas of the network organizations, ecology, medicine, business decisions, finance, marketing, automation and process control. A special emphasis is put on the managers and decision makers who are aware of the strengths and benefits to the success of their businesses.

Our goal is to become an important player in knowledge transfer and the promotion of natural, technical and engineering sciences in local communities, Europe and worldwide. By combining up-to-date knowledge with various research-and-development achievements in different areas, connecting with other centres of excellence in Europe and world wide, using different methods and technologies in knowledge transfer, we wish to build a virtual learning community and thus contribute to an innovative society by supporting more efficient knowledge and ideas transfer between research and industry.

All educational events are designed to transfer basic, additional and the latest expert knowledge to the companies, research and educational organizations. In order to make the knowledge transfer efficient we are combining traditional and ICT supported training methods. For this purpose we have prepared a number of training web portals with more than 1500 hours of recorded tutorials from different domains of knowledge available at:
http://solomon.ijs.si/, http://seminars.ijs.si/ecolead/,
http://seminars.ijs.si/pascal/, http://seminars.ijs.si/sekt/,
http://seminars.ijs.si/mps .

In 2006 we prepared four seminars with approximately 50 participants from Slovenia, two workshops sponsored by different EU projects with participants from Slovenia and abroad, two kick-off meetings for EU projects, Tool-East and E4, five technical meetings for different EU projects, the 1st Jožef Stefan Institute Computer Competition with 80 participants from secondary schools in Slovenia, three international conferences, one in Slovenia, two abroad. At all these conferences there were approximately 500 participants. For the EU project ECOLEAD we organized a summer school in Finland.

We have successfully applied for the 7th International Symposium on Intelligent Data Analysis, IDA, which will take place in Ljubljana, 6–8 September 2007.

Because of our experiences in European projects we have decided to offer a service to industry and organizations for consulting, pre-evaluating and helping prepare EU project proposals as well as support for the project implementation. We have joined together experts from the institute with experience in writing project proposals, EU project coordination and operation, evaluators of project proposals for the European Commission and a number of young experts with concrete ideas.

Some outstanding publications in the past three years

1. M. Jermol, N. Lavrač, P. Ljubič, S. Bollhalter, A decision support approach to trust modeling in networked organizations, V: Collaborative networks and their breeding environments: IFIP TC5 WG 5.5, (IFIP, 186). New York: Springer, (2005), 167–174
2. M. Jermol, N. Lavrač, T. Urbančič, Managing business intelligence in a virtual enterprise: a case study and knowledge management lessons learned, Journal of intelligent & fuzzy systems, 14 (2004), 121–136
3. M. Jermol. M. Grobelnik, D. Mladenič, Towards the EU IST projects knowledge map and project partners competence directory, V: Fourth European Conference on Knowledge Management, (2003), 387–398

Organization of conferences, congresses and meetings

1. Seminar "Modelling and simulation of control systems", Ljubljana, 30 January – 3 February 2006
2. Kick-off meeting EU project E4 "Extended Enterprise Management in Enlarged Europe", Ljubljana, 2–3 February 2006
3. Kick-off meeting EU project Tool-East "Open Source Enterprise Resource Planning and Order management System for Eastern European Tool and Die Making", Ljubljana, 9–10 February 2006
4. International seminar "Analysis of environmental data with machine learning methods", Ljubljana, 27 February – 2 March 2006
5. Seminar "Industrial regulation systems", Ljubljana, 3–7 April 2006
6. 1st Jožef Stefan Institute Computer Competition, Ljubljana, 6 May 2006
7. Workshop "Equality of women and men in science and research in Slovenia", Koper, 26 May 2006
8. Seminar "Advanced control methods", Ljubljana, 29 May – 2 June 2006
9. Project meeting EU project IST World, Dubrovnik, Croatia, 7–9 June 2006
10. International conference "3rd European Semantic Web Conference – ESWC'06", Budva, Montenegro, 11–14 June 2006
11. Handover meeting EU project Tool-East "Open Source Enterprise Resource Planing and Order management System for Eastern European Tool and Die Making", Ljubljana, 26–27 June 2007
12. Project meeting "CEC-WYS", Ljubljana, 4–5 September 2006
13. International Summer School EU project ECOLEAD, Helsinki, Finland, 28–29 September 2006
14. Project meeting EU project SWING "Semantic Web Interoperability for Geospatial Decision Making", Bled, 11–13 October 2006
15. Seminar "Software for process control", Ljubljana, 16–20 October 2006
16. Technical and exploitation meeting EU project E4 "Extended Enterprise Management in Enlarged Europe", Bled, 5–6 December 2006
17. Final meeting EU project SEKT, Bled, 11–12 December 2006
18. International Management process Conference, Ljubljana, 30 November – 1 December 2006

BIBLIOGRAPHY

TEXTBOOKS AND LECTURE NOTES

1. Nada Lavrač, Mitja Jermol, Tanja Urbančič, Dunja Mladenić
   New media and knowledge management: part of "New media and e-science" programme and "Statistics" programme: 2005/06
   (Postgraduate courses in new media and e-science), Ljubljana, Jožef Stefan Institute, 2006.

INTERNATIONAL PROJECTS

1. Stimulating Policy Debate on Women and Science Issues in Central Europe
   WS DEBATE
   6. FP; 036651
   EC; Dr. Dora Groo, Eszter Papp, Hungarian Science and Technology Foundation; Tudomanyos es Technologiai Alapitvany, Budapest, Hungary
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
2. Statistical Multilingual Analysis for Retrieval and Translation
   SMART
   6. FP; 033917
   EC; Nicola Cancedda, Xerox Research Centre Europe, Meylan; Xerox, Aulnay-Sous-Bois, France
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
3. Image-based Navigation in Multimedia Archives
   IMAGINATION
   6. FP; 034626
   EC; Clemens van Dinther, Forschungszentrum Informatik an der Universitaet Karlsruhe, Karlsruhe, Germany
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič
4. Extended Enterprise Management in Enlarged Europe
   E4
   6. FP; 027282
   EC; Marialuisa Sanseverino, Centro Ricerche Fiat Societa Consortile per Azioni,

Orbassano (TO), Italy
Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik

5. Open Source Enterprise Resource Planning and Order Management System for Eastern European Tool and Die Making Workshop
   Tool-East
   6. FP; 027802
   EC; Dr.-Ing. Volker Stich, Forschungsinstitut fuer Rationalisierung (FIR) and der RWTH Aachen, Research Institute for Operations Management at Aachen Univerity, Aachen, Germany
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
6. Semantic Web Services Interoperability for Goespatial Decision Making
   SWING
   6. FP; 026514
   EC; David Skogan, SINTEF - Stiftelsen for Industriell OG Teknisk Forskning Ved Norges Tekniske Hoegskole, Trondheim; SINTEF ICT, Oslo, Norway
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
7. Lifecycle Support for Networked Ontologies
   NEON
   6. FP; 027595
   EC; Prof. Enrico Motta, KMI, The Open University, Milton Keynes, Great Britain
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
8. Transitioning Applications to Ontologies
   TAO
   6. FP; 026460
   EC; Dr. Kalina Bontcheva, University of Sheffield, Department of Computer Science, Sheffield, Great Britain
   Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
9. Knowledge Base for RTD Competencies
   IST-WORLD
   6. FP; 015823
   EC; Prof. Hans Uszkoreit, German Research Center for Artificial Intelligence GmbH (DFKI), Language Technology Lab, Saarbrücken, Germany
   Mitja Jermol, M. Sc., Marko Grobelnik
10. Central European Centre for Women and Youth in Science
    CEC-WYS
    6. FP
    SAS6-CT-2004-003582
    EC; Dr. Marcela Linková, Institute of Sociology, Academy of Sciences of the Czech Republic, Prague, Czech Republic
    Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič
11. Semantically-Enable Knowledge Technologies
    SEKT
    6. FP; 506826
    EC; John Davis, British Telecommunications plc, London, Great Britain
    Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič, Marko Grobelnik
12. European Collaborative networked Organizations LEADership initiative
    ECOLEAD
    6. FP; 506958
    EC; Martin Ollus, Technical Research Centre of Finland, Espoo, Finland
    Mitja Jermol, M. Sc., Prof. Nada Lavrač
13. Pattern Analysis, Statistical Modelling and Computational Learning
    PASCAL
    6. FP; 506778
    EC; Prof. John Shawe-Taylor, The University of Southampton, School of Electronics and Computer Science, Highfield, Southhampton, Great Britain
    Mitja Jermol, M. Sc., Asst. Prof. Dunja Mladenič

VISITORS FROM ABROAD

1. Leandro Loss, Universidade Federal de Santa Catarina, Brazil, 9 June 2005 – 31 January 2006
2. Ugo Negretto, Encima UmbH, Germany, February 2006
3. Robert C.Kahlert, Cycorp.Inc, Austin, Texas, USA, 27 January 2006

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2. **Mitja Jermol, M. Sc., Head**

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5. Tina Anžič
6. Sebastjan Mislej

MILAN ČOPIČ NUCLEAR TRAINING CENTRE ICJT

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Prof. Igor Jenčič

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We have prepared an expertise for the Krško NPP and collaborated in the preparation, design and translation of their Annual Report for 2005. We have also collaborated in the preparation of the Annual Report and some other documents of the Gen energija company.

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Figure 2: The mockup of the reactor pressure vessel is intended for specialists' training, but is also interesting for the general public

Table of training activities at Nuclear Training Centre in 2006

Date	Title	Partici-pants	Lecturers	Weeks	Participant x weeks
18. 1.	Radiation Protection for Workers at Ljubljana Airport	7	1	0.2	1.4
10. 2.	Radiation Protection for Workers at Cement Trbovlje	9	1	0.2	1.8
13.–17. 2.	IAEA Regional Workshop on Management of Regulatory Safety Assessment Activities	14	3	1.0	14.0
9. 3.	Radiation protection for industrial and other practices (unsealed sources) - Refresher Course	2	4	0.2	0.4
9. 3.	Radiation protection for industrial and other practices (sealed sources) - Refresher Course	5	3	0.2	1.0
13.–17. 3.	Introduction to the Theory of NPP	14	4	1.0	14.0
20.–24. 3.	Radiation protection RZ2 for NPP personnel	9	9	1.0	9.0
20.–31. 3.	Introduction to Systems of NPP	14	8	2.0	28.0
3.–5. 4.	Radiation protection for industrial and other practices (sealed sources)	3	3	0.6	1.8
3.–5. 4.	Radiation protection for industrial and other practices (measurement of roadway density and humidity)	1	3	0.6	0.6
10.–14. 4.	IAEA Workshop on Application of Deterministic Safety Analysis	23	4	1.0	23.0
15. 5.–9. 6.	Basics of nuclear technology, theory	17	9	4.0	68.0
8. 6.	Radiation protection for industrial and other practices (radiography) – Refresher Course	3	3	0.2	0.6
8. 6.	Radiation protection for industrial and other practices (sealed sources) - Refresher Course	1	3	0.2	0.2
8. 6.	Radiation protection for industrial and other practices (unsealed sources) - Refresher Course	1	4	0.2	0.2
8. 6.	Radiation protection for industrial and other practices (measurement of roadway density and humidity) - Refresher Course	3	3	0.2	0.6
12. 6.–7. 7.	Basics of nuclear technology, systems	21	8	4.0	84.0
3.–6. 7.	IAEA training course on Security of Radioactive sources	22	4	0.8	17.6
4.–7. 7.	Plant Life Management for Safe Operation: Systems Analysis and Human Factor in Decision-Making	13	5	0.8	10.4
6. 7. –31. 10.	Training of SNSA Expert Groups for the Emergency Response	64	18	2.0	128.0
4.–8. 9.	IAEA Regional Training Course on Foundations of Physical Protection	25	4	1.0	25.0
13.–15. 9.	Radioactivity, Radionuclides & Radiation, 8th multimedia training course with Nuclides.net	38	16	0.6	22.8
25.–29. 9.	SNSA advanced training, using simulators, on safety related NPP Krško systems	9	5	1.0	9.0
2.–6. 10.	IAEA Workshop on Safety Analysis and Technical Support for Power Uprates	19	3	1.0	19.0
9.–13. 10.	Radiation protection for medical and veterinary workers - Nuclear medicine workers	3	8	1.0	3.0
9.–11. 10.	Radiation protection for industrial and other practices (unsealed sources)	1	4	0.6	0.6
9.–11. 10.	Radiation protection for industrial and other practices (sealed sources)	10	4	0.6	6.0

Date	Title	Partici-pants	Lecturers	Weeks	Participant x weeks
16.–20. 10.	IAEA Workshop on Communicating with Stakeholders on NPP Operation and Nuclear Safety	13	6	1.0	13.0
17. 10.	Training Extension for RP Officers	5	2	0.1	0.5
8. 11.	Radiation protection for industrial and other practices (unsealed sources) - Refresher Course	7	3	0.2	1.4
8. 11.	Radiation protection for industrial and other practices (sealed sources) - Refresher Course	10	2	0.2	2.0
8. 11.	Radiation protection for industrial and other practices (measurement of roadway density and humidity) - Refresher Course	2	2	0.2	0.4
20. 11.-6. 4. 07	Power reactor theory	20	17	5.0	100.0
TOTAL		**408**	**176**	**32.9**	**607.3**

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   Energy band shape of monolayer metal/organic/metal structures as determined by the capacitance-voltage method
   In: J. appl. phys., Vol. 99, 11 p., 2006.

PUBLISHED CONFERENCE PAPERS

Regular Papers

1. Bruno Cvikl, Matjaž Koželj, Dean Korošak, Renata Jecl
   Interface charge and trap density dependence on C - U line shape of monolayer Al/ PTCDA/ITO structure
   In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 71-76.
2. Radko Istenič, Igor Jenčič
   Public opinion about nuclear energy: year 2006 poll
   In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.
3. Igor Jenčič
   The activities of Nuclear training centre Ljubljana in the area waste management
   In: WM'06 Proceedings: Global accomplishments in environmental and radioactive waste management, Tuscon, WM Simposia,Inc., 2006.
4. Matjaž Koželj, Bruno Cvikl, Dean Korošak
   Properties of organic Schottky junctions under the influence of ionizing radiation
   In: Proceedings, Danilo Vrtačnik, ed., Iztok Šorli, ed., Ljubljana, MIDEM - Society for Microelectronics, Electronic Components and Materials, cop. 2006, pp. 77-82.

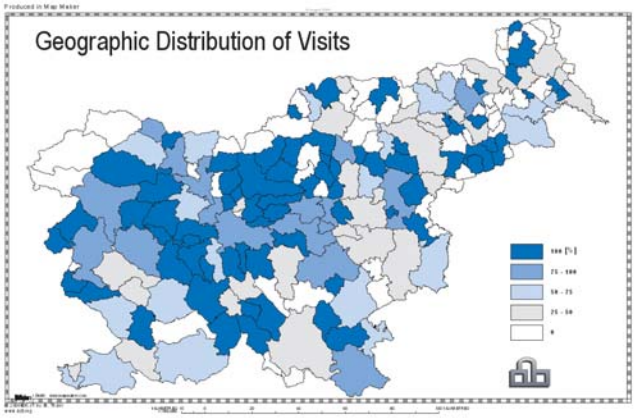

Figure 3: The visitors to the Information centre come from all over Slovenia

5. Matjaž Koželj, Bruno Cvikl, Dean Korošak
   Application of organic semiconductors for the detection of ionizing radiations
   In: Proceedings, International Conference Nuclear Energy for New Europe, Portorož, 2006, Bogdan Glumac, ed., Igor Lengar, ed., Ljubljana, Nuclear Society of Slovenia, 2006.

INTERNATIONAL PROJECTS

1. IAEA Regional Workshop on Management of Regulatory Safety Assessment Activities
   IARB06
   RER/9/084
   Lingquan Guo, IAEA, Vienna, Austria
   Tomaž Skobe, B. Sc.
2. IAEA Workshop on Application of Deterministic Safety Analysis
   IADET06
   RER/9/083
   Milorad Dušič, IAEA, Vienna, Austria
   Radko Istenič, B. Sc.
3. IAEA Training Course on Security of Radioactive Sources
   IASEC06
   RER/
   Pierre Legoux, IAEA, Vienna, Austria
   Radko Istenič, B. Sc.
4. Plant Life Management for Safe Operation: Systems Analysis and Human Factor in Decision-Making
   PLM06
   Anna Mengolini, Institute for Energy, Joint Research Centre Petten, Petten, The Netherlands
   Marjan Tkavc, M. Sc.
5. IAEA Regional Training Course on Foundations of Physical Protection
   IAFPP06
   RER/9/085
   Yuri Volodin, Dorel Popescu, IAEA, Vienna, Austria
   Melita Lenošek, B. Sc.
6. Radioactivity, Radionuclides & Radiation, 8th Multimedia Training Course with Nuclides.net
   NUCLIDES06
   Joseph Magill, EC, Joint Research Centre, Institute for Transuranium Elements, Eggenstein-Leopolshafen, Germany
   Matjaž Koželj, M. Sc.
7. IAEA Workshop on Safety Analysis and Technical Support for Power Uprates of NPPs
   IAUPR06

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Figure 1: A demonstration in the radioactivity lab is always interesting and contributes to a better understanding of radiation

Figure 2: The mockup of the reactor pressure vessel is intended for specialists' training, but is also interesting for the general public

RER/9/083
Milorad Dušič, IAEA, Vienna, Austria
Tomaž Skobe, B. Sc.

8. IAEA Workshop on Communicating with Stakeholders on NPP Operation and Nuclear Safety
IACOM06
RER/4/027
Thomas Mazour, IAEA, Vienna, Austria
Melita Lenošek, B. Sc.

NEW CONTRACTS

1. Training of NPP Krško staff in 2006
Krško Nuclear Power Plant
Prof. Igor Jenčič
2. Operation of the Nuclear Information Centre in 2006
Agency for Radwaste Management
Prof. Igor Jenčič
3. Training on the course "Power Reactor Technology"
Gen energija, Krško
Prof. Igor Jenčič
4. Co-financing of the Nuclear Information Centre
Gen energija, Krško
Prof. Igor Jenčič
5. Training of SNSA staff on simulators
Slovenian Nuclear Safety Administration
Melita Lenošek, B. Sc

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1. Prof. Igor Jenčič, Head

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2. Radko Istenič, B.Sc.
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4. Matjaž Koželj, M.Sc.
5. Melita Lenošek, B.Sc
6. Tomaž Skobe, B.Sc.
7. Marjan Tkavc, M.Sc.

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8. Saša Bobič
9. Borut Mavec

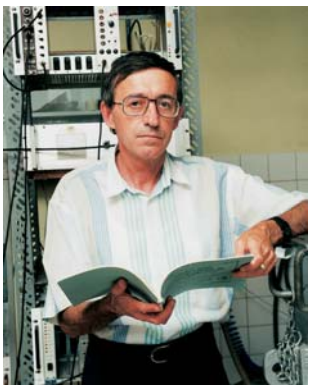
External staff

10. Tea Bilić Zabric, M.Sc.
11. Tomaž Setnikar
12. Egon Srebotnjak, M.Sc.
13. Aljaž Škerlavaj, M.Sc.

RADIATION PROTECTION UNIT

SVPIS

The main tasks of the Radiation Protection Service are to carry out personal dosimetry and to monitor the working areas and the general environment of the Reactor Centre.



Head:
Bogdan Pucelj, M. Sc.

In 2006 a total of 116 radiation workers were monitored using thermo-luminescent dosimeters. Most doses were at the level of the natural background. The highest annual dose recorded was 0.16 micro Sievert; a value much below the annual limit for radiation workers (20 mSv per year).
Additional TLDs were used to monitor external radiation exposure at different locations of the Reactor Centre. Only background levels were recorded.
The environmental impact of activities within the Reactor Centre was estimated by evaluating source term monitoring. The dose to the population due to atmospheric and liquid discharges was estimated to be much lower than one micro Sievert per year, which is only one thousandth of the annual limit for the population.

REVIEW ARTICLES AND CHAPTERS IN BOOKS

1. Bogdan Pucelj
   Izvleček
   In: Meritve radioaktivnosti v okolici Nuklearne elektrarne Krško: poročilo za leto 2005, Denis Glavič-Cindro, ed., Benjamin Zorko, ed., Ljubljana, Institut "Jožef Stefan", 2006, pp. 1/122-8/122.
2. Bogdan Pucelj
   Doza zunanjega sevanja
   In: Meritve radioaktivnosti v okolici Nuklearne elektrarne Krško: poročilo za leto 2005, Denis Glavič-Cindro, ed., Benjamin Zorko, ed., Ljubljana, Institut "Jožef Stefan", 2006, pp. 77/122-85/122.
3. Matjaž Stepišnik
   Reka Sava
   In: Meritve radioaktivnosti v okolici Nuklearne elektrarne Krško: poročilo za leto 2005, Denis Glavič-Cindro, ed., Benjamin Zorko, ed., Ljubljana, Institut "Jožef Stefan", 2006, pp. 1/122-24/122.
4. Matjaž Stepišnik
   Ocena letnih doz referenčne skupine za savske prenosne poti za leto 2005
   In: Meritve radioaktivnosti v okolici Nuklearne elektrarne Krško: poročilo za leto 2005, Denis Glavič-Cindro, ed., Benjamin Zorko, ed., Ljubljana, Institut "Jožef Stefan", 2006, pp. 103/122-106/122.
5. Matjaž Stepišnik, Matjaž Koželj
   Program B
   In: Meritve radioaktivnosti v okolici Nuklearne elektrarne Krško: poročilo za leto 2005, Denis Glavič-Cindro, ed., Benjamin Zorko, ed., Ljubljana, Institut "Jožef Stefan", 2006, pp. 107/122-112/122.

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3. Thomas Breznik, B. Sc.

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4. Bogdan Pucelj, M. Sc., Head
5. Dr. Matjaž Štuhec

TECHNOLOGY TRANSFER OFFICE U-9

Head:
Prof. Peter Stegnar

The main fields of activity of the Technology Transfer Office are as follows:
- ***Knowledge and technology transfer from the JSI to the Slovenian and European industrial spheres,***
- ***Technology transfer from Europe,***
- ***Research and applied project management,***
- ***Assistance in the JSI's patent-application assessment procedures,***
- ***Promotion of the JSI's scientific and research activities,***
- ***Support for the commercialization of the JSI's patents.***

In 2006 the Innovation Relay Centre Slovenia (IRC Slovenia) team continued to encourage innovation and competitiveness in Slovenian companies and research institutions through connecting knowledge, technologies and people. The IRC Slovenia is part of the European IRC network, with over 240 participating organisations since 1997. In 2006 the IRC Slovenia's staff from the JSI visited over 100 companies and other organisations. Over 30 Slovenian technology offers and requests were promoted in Europe. Over 80 foreign organisations expressed their interest in cooperation. We also received over 260 Slovenian expressions of interest for profiles from abroad. Those and other activities led to 30 negotiations. Together with our partner from Maribor we assisted in 10 international agreements for technical cooperation.

We organised two technology missions in 2006. The first one was to Villach (Beljak) in Austria for the electronics sector, with the focus on laser technologies. The second one was for the HVAC (heating, ventilation and air-conditioning) sector in Spodnja Idrija. The newsletter "Obvestila IRC" was prepared on a bi-monthly basis. We were also coorganisers of workshops and seminars dealing with the protection of intellectual property, technological innovations and the possibilities for participation in EU projects.

TINIS

The principal aim of the TINIS project is to improve regional development with initiatives to increase the number of innovations in the field of information communications technologies (ICT) and to direct local political measures towards the same goal.

The secondary goals were as follows:
- to improve existing methods and develop new ones,
- to provide all TINIS members with easy access to new methods,
- to improve ICT networking in the regions participating in the TINIS project,
- to re-establish sustainable connections between partners in the project and the regions,
- to develop a professional ICT network in all the participating regions.

In 2006 we participated in three workshops and we organized two meetings in Ljubljana.

The results of the TINIS project were as follows:
- the website (www.tinis-project.net) and the intranet page of the project TINIS were established;
- Catalogue 1, Existing Helps, and Catalogue 2, Innovative methods, were completed;
- Catalogue 3, Selected methods, and Catalogue 5, Existing networks, are in progress.

The Technology Transfer Office will coordinate Catalogue 7.

BoostIT

The BoostIT project is a European project involving the cooperation of six countries (Portugal, Israel, Slovenia, Croatia, Poland and Ukraine). Its goal is to involve small and medium-sized companies from the information and communications area in the European market as well as in new projects in the EU's 7FP. The Technology Transfer Office is the coordinator of this project in Slovenia, Tehnološki park Ljubljana and Tehnološki park Primorska are its main Slovenian partners.

The Technology Transfer Office organized workshops in Slovenia, Ukraine, Portugal and Croatia dedicated to explaining the financial aspects of European projects, project management, business plans and intellectual property rights. The purpose was to help in the preparation for cooperation in European projects.

In 2006 we contacted over 100 Slovenian and Croatian companies and we received 54 Slovenian and 8 Croatian replies.

In the second part of the project (2007–2009) we are going to help the project's participants with an even more successful incorporation into European projects. We are going to select four new project proposals, we will organize workshops for dedicated topics, we will assist in finding new partners and we will prepare project documentation for selected projects.

NATO RESCA

The NATO Science for Peace project called Legacy of uranium extraction and environmental security in the central Asian republics of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan (RESCA) started in 2006. The Technology Transfer Office is the coordinator of this project.

The main goals of the project are the characterization of source terms and the determination of local contamination in selected uranium tailing sites, radiation dose and impact assessment, and identification of appropriate mitigation/remediation countermeasures. The project is expected to contribute to the establishment and upgrading of environmental radioactivity laboratories, as well as to the training of personnel, especially young scientists, in the use of modern equipment, survey methods and protocols.

In 2006 four field missions were organized to the contaminated areas of Kyrgyzstan, Tajikistan and Uzbekistan, and at the end of the year another mission was organized in Ljubljana, where the closeout and remediation programme of the former uranium mine at Žirovski vrh was presented.

NPD Net

The Interreg IIIC project "Innovation and New product development based on Inter-Regional Networks/NPD-net" was closed.

We organized a seminar with the title "Network for new product development" in June when the project ended. In the seminar, we and our partners presented some projects of new-product development and also a handbook "Načrtno do cilja" which is the first book of its kind in Slovenian and which includes good practices for Slovenian companies. The handbook presents the whole process of new-product development, from business ideas to new-product market promotion, and at the same time it offers a rich set of possible solutions at each point of the product development.

We have also established a virtual centre for new-product development at www.rni.si.

Quintessa

We cooperated with our English partner Quintessa in nuclear-waste characterization at the nuclear power plant in Cernavoda, Romania, where we planned, organized and established an analytical laboratory for radionuclide detection in different kinds of radioactive waste produced in this power plant. Methods and protocols for managing specific radioactive waste were made and the personnel in analytical laboratory were trained. The project was financed by the European Commission through its PHARE programme.

The most important achievement in 2006

1. In March 2006 our cooperation with the Department of Automation, Biocybernetics and Robotics resulted in their signing an agreement with Thelma AS, a Norwegian company. The agreement includes the common development and production of test models for testing lifejackets, gloves for sports and work, and work shoes (in some cases adapted to children's sizes). In the final phase the agreement also foresees marketing cooperation.

Organization of conferences, congresses and meetings

1. Workshop "Advisers possibilities in The Centre for the Development of New Products", Ljubljana, 17 May 2006
2. ITER – Opportunities and challenges for industry, Ljubljana, 1 June 2006
3. Conference "Development of new products", Ljubljana, 20– 21 June 2006
4. Workshop on the subject of the appreciation risk projects, Ljubljana, 20 November 2006
5. Workshop 5 & Steering Committee 3 on the TINIS project, Ljubljana, 21–23 November 2006

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ORIGINAL ARTICLE

1. Špela Stres, Rok Pestotnik
   Study of possibilities for a spin flip in high energy elecron ring HERA
   In: IEEE trans. nucl. sci., Vol. 53, pp. 484-490, 2006.

PH. D. THESIS

1. Špela Stres: Numerical and analytical investigations of spin dynamics in storage rings (Prof. Andrej Likar)

INTERNATIONAL PROJECTS

1. Eliminating Waste and Boosting Productivity in Transnational Technology Transfer
   LeanTTT
   6. FP; 030648
   EC; Bjorn Westling, IVF Industrial Research and Development Corporation, Moelndal, Sweden
   Marjeta Trobec, B. Sc.
2. Set-up of a Collaborative Permanant Network for Boosting the Participation of Incubated SMEs in Innovation Processes under FP6 Activities
   Boost-IT
   6. FP; 023437
   EC; Eurique Neves, Inovamais - Servicos de Consultadoria em Inovacao Technologica, Matosinhos, Portugal
   Prof. Peter Stegnar
3. Innovation Relay Centre of Slovenia
   Si-IRC-04-08
   6. FP; 510419
   EC
   Prof. Peter Stegnar
4. Innovation and New Product Development based on Inter-Region Networks
   NPD-NET
   INTERREG IIIC Operation
   EC; Dr. Dimitris Milossis, Urban and Regional Innovation Research Unit (URENIO), Aristotle University of Thessaloniki, Thessaloniki, Greece
   Prof. Peter Stegnar, Dr. Žiga Bolta, Dr. Anton Ružić
5. Technological Innovation Network in the Field of Information Systems
   TINIS
   INTERREG IIIC, West Zone
   EC; Veronique Pirot, INFOPOLE Information Systems, Namur, Belgium
   Andrej Gyergyek, B. Sc.
6. Uranium Extraction and Environmental Security in the Central Asian Republics
   NATO SfP - Uranium Extraction Legacy
   ESP.EAP.SFPP 981742
   NATO Public Diplomacy Division, North Atlantic Treaty Organisation, Brussels, Belgium
   Prof. Peter Stegnar
7. Leasing of Hot Cell Facility within the Framework of the Phare Project
   JSI/IRE
   Henri Bonet, L'Institut National Des Radioéléments (IRE), A Belgian Public Utility Fondation, Fleurus, Belgium
   Prof. Peter Stegnar

VISITORS FROM ABROAD

1. Dr. Gallieno Denardo, International Centre for Theoretical Physics, Trieste, Italy, 26 January 2006
2. Davor Čerljenko, The City of Labin, Istrian mayoralty, Labin, Croatia, 31 January 2006
3. Aleardo Furlani, Innova S.p.A., Rome, Italy, 17 February 2006
4. Dr. Joel Tassignon, CeRDT, Gosselies, Belgium, 20 November 2006
5. Thierry Villers, Etienne Sermon, INFOPOLE, Namur, Belgium, Olivier Pirot, Laurence Johannsen, Centre Henri Tudor, Luxembourg – Kirchberg, Luxembourg, Jiri Stursa, Lucie Malikova, VTPO, Ostrava, Czech Republic, Joel Tassignon, CeRDT, Gosselies, Belgium, Catherine Christodoulopoulou, CTI PATRAS, Patras, Greece, 21–23 November 2006
6. Kubanychbek Noruzbaev, Ministry of Ecology, Department for the Environment, Dr. Raia Beishenkulova, Ministry for Health, Dr. Baigayl Tolongutov, Chu ecology laboratory, Bishkek, Kyrgyzstan, 3–9 December 2006

STAFF

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1. *Dr. Žiga Bolta, left 01. 10. 2006*
2. David Aleksander Fabjan, B. Sc.
3. Andrej Gyergyek, B. Sc.
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5. Matjaž Rus, B. Sc.

6. Prof. Peter Stegnar, Head**

7. Marjeta Trobec, B. Sc.

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8. Dr. Špela Stres
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