

**Institute of Solid State Physics
University of Latvia**



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2007

Riga 2008

Annual Report 2007, Institute of Solid State Physics, University of Latvia.

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Riga, Institute of Solid State Physics, University of Latvia, 2008, p. 127

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2008

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INTRODUCTION

The research in solid state physics at the University of Latvia restarted after World War II. The **Institute of Solid State Physics** (ISSP) of the University of Latvia was established on the basis of Laboratory of *Semiconductor Research* and Laboratory of *Ferro- and Piezoelectric Research* in 1978. Since 1986 the ISSP has the status of an independent organization of the University and now is the main physics research institute in Latvia.

Four laboratories from the Institute of Physics of the Latvian Academy of Sciences, working in the field of solid state physics joined our Institute in 1995. Twenty scientists of the former Nuclear Research Centre joined the ISSP in 1999 and established Laboratory of Radiation Physics. In 2004 scientists from Latvian Institute of Physical Energetics joined ISSP and established Laboratory of Organic Materials (Table 1).

In mid 90-ties the ISSP has intensified its **teaching activities**. Three research staff members of the Institute have been elected as professors of the University of Latvia. Post-graduate and graduate curricula are offered in solid state physics, material physics, chemical physics, physics of condensed matter, semiconductor physics, and experimental methods and instruments. In 2002 the Chair of Solid State and Material Physics University of Latvia was established at ISSP.

Research and training in optometry and vision science is taking place in the Laboratory of Visual Perception of the ISSP since 1992. Co-located with the Institute, the Optometry Centre has been established in 1995 with facilities for primary eye care and serving as a technological research basis for students and staff.

In 2004 the Institute finished its activities as a **Centre of Excellence of the European Commission** (Centre of Excellence for Advanced Material Research and Technologies). The ISSP was awarded this title by EC in December 2000. This honorary recognition with the accompanying financial support of 0,7 million EUR has increased our research activities, particularly extending the list of our research partners and scientists who come to work to our Institute from the leading European research centres.

The research of the ISSP includes:

- studies of electronic and ionic processes in wide-gap materials with different degrees of structural ordering;
- development of new inorganic materials (single crystals, glasses, ceramics, thin films) for optics and electronics;
- vision research, development of new technologies for psycho-physical testing and primary vision care;
- design and manufacturing of scientific instruments and instruments for analytical tasks and environmental monitoring.

The highest decision-making body of the Institute is the **Scientific Council** of 21 members elected by the employees of the Institute (Table 2). Presently Dr. phys. L.Trinklere is the elected chairperson of the ISSP Council. The Council appoints director and its deputy.

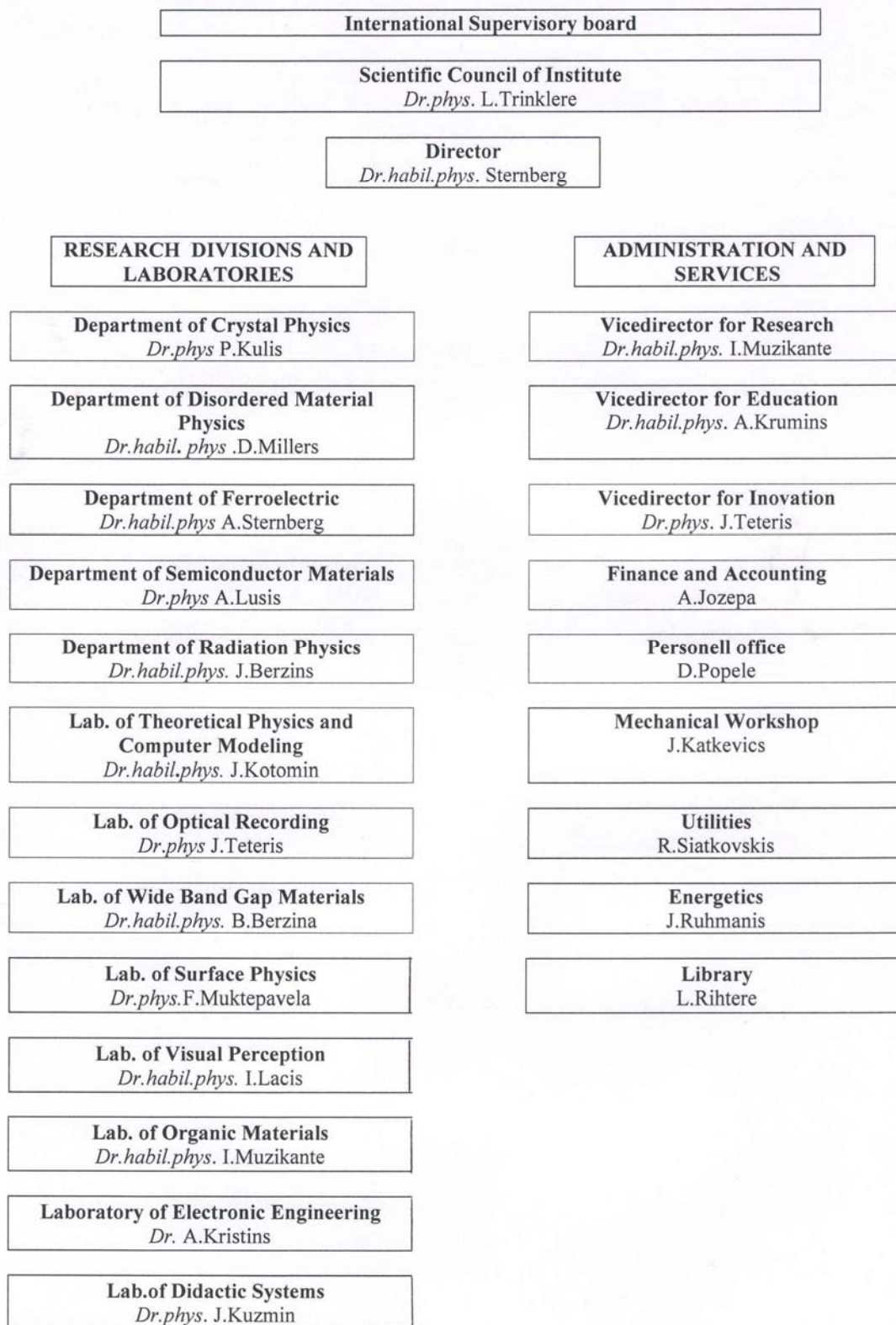
The International Supervisory board of ISSP was established in 1999 and it consists now of 11 members (Table 3). The first International evaluation of ISSP was performed 2002. The second Meeting of International Supervisory board took place at April 3, 2007. Below is a short excerpt citation from the evaluation report: "... the overall development of ISSP has been good with excellent quality of research as evidenced by publications, active participation in international projects etc..." Full text of report is included here below after the introduction.

The interdisciplinary nature of research at the ISSP is reflected by its **highly qualified staff**. At present there are 220 employees working at the Institute, 32 of 102 members of the research staff hold Dr.habil.degrees, 56 hold Dr. or PhD. At the end of

2007 there were 16 PhD students and 46 undergraduate and graduate students in physics and optometry programmes working at the ISSP. Educational activities of the Institute were continued and extended in 2007.

Table 1

ORGANIZATIONAL STRUCTURE OF THE ISSP IN 2007



The Scientific Council of the Institute

1. Laima Trinklere, Dr.phys., chairperson of the Council
2. Marcis Auzins, Dr.habil.phys.
3. Jelena Butikova, PhD student
4. Larisa Grigorjeva, Dr.habil.phys.
5. Anastasija Jozepa
6. Andris Krumins, Prof., Dr.habil.phys.
7. Peteris Kulis, Dr.phys.
8. Aleksejs Kuzmins, Dr.phys.
9. Donats Millers, Dr.habil.phys.
10. Inta Muzikante, Dr.habil.phys.
11. Daina Riekstina, Dr.phys.
12. Uldis Rogulis, Dr.habil.phys.
13. Andrejs Silins, Prof., Dr.habil.phys.
14. Linards Skuja, Dr.habil.phys.
15. Maris Springis, Dr.habil.phys.
16. Anatolijs Sharakovskis, PhD student
17. Andris Sternbergs, Dr.habil.phys.
18. Janis Teteris, Dr.phys.
19. Anatolijs Truhins, Dr.habil.phys.
20. Vismants Zauls, Dr.phys.
21. Guntars Zvejnieks, Dr.phys.

International Advisory Board of the Institute

1. Prof. Dr. Gunnar Borstel, University of Osnabruck, Germany
2. Prof. Niels E.Christensen (chairman), University of Aarhus, Denmark
3. Prof. Claes – Goran Granqvist, Uppsala University, Sweden
4. Prof. Andrejs Silins, Latvian Academy of Sciences, Latvia
5. Prof. Sergei Tuituinnikov, Joint Institute for Nuclear Research, Dubna, Russia
6. Prof. Juris Upatnieks, Applied Optics, USA
7. Prof. Harald W.Weber, Atomic Institute of Austrian Universities, Vienna, Austria
8. prof. Dr.J.Banys, University of Vilnius, Lithuania
9. Prof. Dr.M.Kirm, University of Tartu, Estonia
10. Prof. Dr.R.Evarestov, St.Petersburg University, Russia
11. Prof. M. Van de Voorde, Max – Planck – Institute, Stuttgart, Germany

The annual report summarizes the research activities of the ISSP in 2007. The staff of the Institute has succeeded in 31 **national science grants** and in **two national cooperation projects** (“Functional Materials and Technologies for Microelectronics and Photonics” and “Nanomaterials and Nanotechnologies”), with the total financing 301.0 thous. Ls (ca. 4.3 thous. EUR).

In 2005 a the new Law of Science was passed by Parliament of Latvia. According to this law the state **budgetary financing in Latvia** for science has to **increase yearly per 0.15% from GDP** up to reaching a 1% value in the future. The budgetary increase was focused on scientific infrastructure financing and launching of National Research Programmes (NRP). One of the scientific priorities in Latvia is **materials science**. ISSP became coordinating institution for the Materials NRP and collaborates as well in the NRP “Energetics” attracting 420,9 thous. Ls budget in 2007. The infrastructure financing for ISSP in 2007 was 957,4 thous. Ls. and it was partly used also for the salaries of the scientific and maintenance staff of the institute. (Table 4). 6 projects the total amount of 1 202,7 thous. Ls supported by the EU Structural funds have been realised in the Institute: 5 applied science projects and 1 project for purchasing of modern research equipment.

The average salary of scientific staff has significantly increased to 911 Ls/month, surpassing the average salary in Latvia. This provides an incentive and carrier perspective for young researchers to work at ISSP.

Main awards, received at 2007:

No	Author	Award
1.	Dr.habil.phys. L.Skuja	RD Electronics annual prize in physics and engineering
2.	Dr.habil.phys. J.Purans	Edgars Silins award
3.	Dr.habil.phys. I.Muzikante	Annual prize from Ministry of Education and Science
4.	Mg.phys. L.Grinberga	L’Oreal prize for woman scientists
5.	Mg.phys. A.Vembris	Award for young scientists in physics
6.	Dr.habil.phys. L.Skuja	Award for Outstanding Research from Materials and Structures Lab. Tokyo Institute of Technology

At the end of 2007, more than 50 students, master’s candidates and doctoral candidates worked in our institute under the supervising of our scientists. The Institute has always strived to be actively involved in student teaching on all levels. During 2006 – 2008 a teaching module “Functional material and nanotechnologies” was introduced in bachelor and master physics curricula. This work was supported by European Social fund. Many co-workers of Institute are involved in preparation of lecture courses. To ensure a better co-ordination of the study work a vice-director post for education was introduced at the Institute. In 2007 3 PhD thesis, 5 master thesis and 8 bachelor thesis were completed and defended at the Institute (Table 5).

In 2007 at Institute three **conferences** have been organised at the Institute:

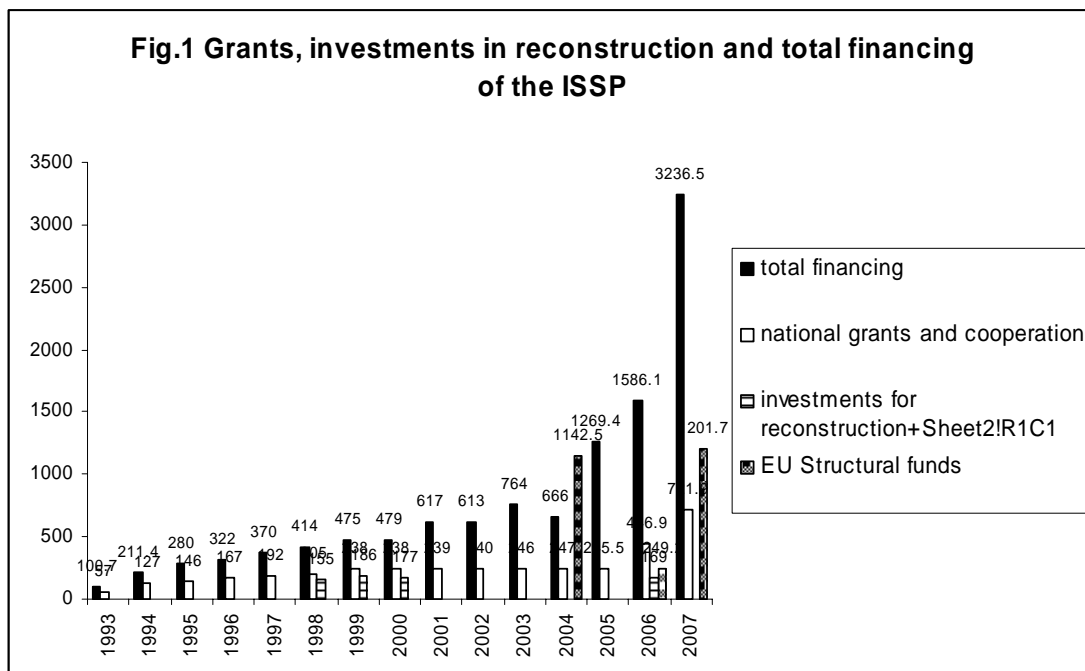
- 23th Scientific Conference of the Institute of Solid State Physics, University of Latvia, February 13 - 15, 2007;
- International Baltic Sea Region conference “Functional materials and nanotechnologies”, April 2 – 4, 2007;
- NORSTORE workshop on Hydrogen Storage, May 3 – June 2, 2007.

Table 4

INCOME OF ISSP, THOUSAND Ls, FROM 1993 - 2007

Year	Total financing	Grants and programmes from budget	Other financing from budget	Contracts, market oriented research	Internat. funds	Rent of space	Structural funds from EU
1993	100.7	56.8	-	40.8	-	3.1	
1994	211.4	127.8	-	64.2	9.6	9.8	
1995	281	145.7	45	38.2	40	12.1	
1996	322.5	167.1	11.7	62.4	68	13.3	
1997	370	192.1	39	93	26	15.2	
1998	414 + 156	205.2	26	114	42	26.5	
1999	475.6+186	238.1	48.8	156.5	16.5	15.6	
2000	478.8 + 77	238.3	36.9	146.3	43	14.3	
2001	617.3	238.8	64.5	116.5	183	14.5	
2002	612.8	239.9	90.0	133.0	131	18.9	
2003	764.6	245.7	172.3	152.5	179	15.1	
2004	1 809	246.7	123.5	166.5	121.8	8.0	1142,5
2005	1 269,4	245,5	358,8 + 120)*	172,8	387,6	4,7	
2006	1586,1	466,9	403,4 + 169)*	152,4	135,6	9,6	249,2
2007	3 236,5	721,9	1110,2	98,7	92,6	8,7	1201,7

*) – investment for building reconstruction



**PhD, Master of Science (M.Sc.) and Bachelors of Science (B.Sc.)
Thesis prepared at the Institute in 2007**

PhD thesis

No	Author	Title	Supervisor
1.	V.Kashcheyevs	Quantum pumping in mesoscopic systems	Prof. A.Aharony (Israel)
2.	L.Grinberga	Research of new composite materials for hydrogen storage	Dr.phys. J.Kleperis
3.	L.Dimitrocenko	Synthesis of complex fluoride single crystals, glass ceramics containing nano-crystals and their optical properties	Dr.habil.phys. U.Rogulis

M.Sc. thesis

No	Author	Title	Supervisor
1.	A.Gopejenko	Perfect and defective lead zirconate atomic and electronic structure: first principle calculations	Dr.phys. R.Eglitis
2.	R.Dobulans	Investigations of electrical properties of a metal phtalocyanine molecular diode in ammonia	Dr.habil.phys. I.Muzikante
3.	A.Kaļinko	Time – resolved luminescence of nanostructured ZnO	Dr.habil.phys. L.Grigorjeva
4.	V.Korsaks	Luminiscence processes in boron nitride	Dr.habil.phys. B.Berzina
5.	M.Vanags	Hydrogen production from water in electrolysis and dissociation processes	Dr.phys. J.Kleperis

B.Sc. thesis

No	Author	Title	Supervisor
1.	A.Belijs	Electroelastic interactions using lattice model of anharmonic oscillators	Dr.phys. E.Klotins
2.	I.Bidermane	Switching of electrical properties of polar organic molecules in host – guest polymer films	Dr.habil.phys. I.Muzikante
3.	M.Dunce	Structure and dielectric properties of lead – free ceramics	Dr.phys. V.Zauls
4.	M.Ergle	Investigation of physical and chemical properties of the Lanthanum Nickel alloy for Hydrogen storage	Dr.phys. J.Kleperis
5.	A.Kuznecovs	Critical Dynamics in Joint Hamiltonian and Stochastic Model	Dr.phys. E.Klotins
6.	A.Strauss	Lithium (Li) contained oksifluorid fotoluminiscenc	Dr.habil.phys. M.Springis

7.	G.Malins	Study of relationship between translation and rotational movement based on impulse and angular momentum conservation laws	Dr.habil.phys. J.Tambergs
8.	Dz.Berzins	Low temperature EPR experiments	Dr.habil.phys. U.Rogulis

Many thanks to everybody who contributed to this report as well as to the organizations that supported the Institute financially: Science Department of the Latvian Ministry of Education and Science, Latvian Council of Science, University of Latvia, EC 7th Framework Programme, Programme of EU Structural funds, COST Programme, and to many foreign Universities and institutions for cooperation.

Prof. Dr. A.Krumins

EVALUATION REPORT
of the International Supervisory Board
on Research, Education and Development activities
of the Institute of Solid State Physics, University of Latvia

Board meeting, Riga, Latvia, April 3, 2007

Overview

Institute of Solid State Physics (ISSP), University of Latvia was established on the basis of the University's two Laboratories: Semiconductor Physics and Ferro- and Piezoelectric Physics – in 1978. Since 1986 the ISSP had the legal status of an independent scientific institution of the University, but was reorganized as agency of the University of Latvia in 2006.

The research activities of ISSP include:

- studies of electronic and atomic processes in wide-gap materials with different degree of structural ordering and chemical composition;
- development of new inorganic and organic materials (single crystals, polymers, glasses, ceramics, thin films) for optics and electronics;
- design and manufacturing of scientific instruments and devices for analytical tasks, environmental monitoring and energy storage;
- vision research, development of new technologies for psychophysical testing and primary vision care.

The highest decision-making body of the ISSP is the Scientific Council of 21 members elected by the employees of the Institute. The total staff number of the ISSP is 222, including 32 Habilitatus Doctors of Sciences, 54 Doctors of Sciences and 55 students.

The research activities of the ISSP in 2006 were reflected in 180 publications in the internationally recognised scientific journals. The Institute obtained 21 research grants from Latvian Science Council, participated in 4 trans-institutional co-operation projects, supervised the National Research Programme (NRP) in “Material sciences”, and collaborated in the NRP “Energetics” with total financing of 418 thousand Latvian lats (LVL, 1 EUR = 0.703 LVL) in 2006. The total amount of various contract works and market-oriented research projects in 2006 was 143 thousand LVL. In addition, 281 thousand LVL were received for basic staff salaries and for maintenance of infrastructure.

The ISSP carries out RTD projects in co-operation with technology-oriented Latvian enterprises, e.g., Sidrabe, Alfa, Alfa Pro, Baltic Scientific Instruments, Valmieras Stikla Skiedra (Valmieras glass fibres). Two SMEs (Hologramma Ltd., Dardedze Holografija Ltd.) are established at the Institute as a spin-off of research projects.

Energy efficiency of the building was improved by a large-scale reconstruction work in the laboratory part of the Institute's building as part of the state investment project (total sum of 581 thous. LVL). Thermal insulation of the outer walls and windows was improved, a new double-pitch roof was constructed, and the interior was partially renovated improving energy efficiency and making the working conditions in the Institute more comfortable.

From the beginning of 2001 the ISSP has the status of the European Commission (EC) Centre of Excellence for Advanced Material Research and Technologies (CAMART) with the following main tasks:

- promote restructuring of the science and technology sectors in Latvia;
- attract young researchers;
- collaborate with the European colleagues.

The research activities in the CAMART are carried out in the following main fields:

- functional disordered materials;
- theory and modelling;
- advanced ferroelectric materials;
- solid state ionics and devices;
- materials for vision science.

In the period 2001- 2004 these activities were supported by EC funding of 492 thousand LVL. Several EC projects (EURATOM, X-TIP, MIND) are continuing in the ISSP, amounting to 245 thousand LVL in 2006. This sum includes co-financing from the Latvian government. Including the EU structural funding for scientific equipment, the total funding for the ISSP in 2006 was 1586 thousand LVL. ISSP continues to participate in EU network on materials research ERANET MATERA.

The ISSP has recently intensified its teaching activities. Four research staff members of the Institute have been elected as professors of the University of Latvia, and three others - as professors of Riga Technical University and the University of Daugavpils. Postgraduate and graduate curricula are offered in solid state physics, material physics, chemical physics, physics of condensed matter, semiconductor physics, and in experimental methods and instruments.

Achievements

- 1) In the period since the first International evaluation (18.08.2002.) the overall development of ISSP has been good with excellent quality of research as evidenced by publications in internationally recognized journals, numerous citations, active participation in international projects etc. The average salary of scientific staff was recently (2006) significantly increased to 611 LVL/month,

surpassing for the first time the average salary in Latvia (around 300 LVL/month). This makes it now possible to attract young researchers to work in the ISSP.

- 2) In the last two years the renovation of scientific infrastructure was started and a number of modern scientific instruments have been acquired with a total investment of around 1.5 Mil. LVL.
- 3) An internationally recognized research group working in the field of organic semiconductors has joined the Institute with its staff and equipment in 2006.
- 4) According to the official data of the EC National Contact Point in Latvia, ISSP is the most active participant in international projects as compared with other national scientific institutions in Latvia.
- 5) The ISSP has increased its participation in higher education at the universities of Latvia.

Critical Issues

- 1) The average age of research staff in the ISSP is around 54 years, therefore there is an urgent need for a new generation of researchers.
- 2) The increase in research funding has an unfortunate side-effect of increasingly complex and time-consuming project management, both concerning Latvian and EC projects. This frequently forces project leaders to devote the bulk of their time to formal issues and makes it problematic for them to do active scientific investigations.
- 3) The project funding payments have been delayed in some cases, conflicting with the project time – planning and reporting schedules.
- 4) The ISSP should play a more active role in the science popularization (communication) activities, particularly addressing the younger generation starting with school-age children.

Recommendations

- 1) To guarantee the high internationally competitive level of scientific research in the ISSP, it is necessary to continue allocation of additional financial resources from the state budget of Latvia and EU Structural funds. This funding is needed both for reasonable salaries to attract and involve additional excellent scientists (young generation and researchers from abroad) and to further improve the scientific infrastructure to the internationally competitive level.
- 2) The ISSP must play a more active role in the fulfilment of the National Research Programmes, including the education of corresponding specialists.

- 3) Further development of modern scientific infrastructure with estimated cost of 15 Mio LVL is needed in ISSP for acquiring new and updating the existing equipment, and for laboratory renovation. Apart from improving the research capability, this will help to develop a modern research base for PhD students in material sciences.
- 4) Strong contacts of the ISSP with international large-scale experimental centres are highly desirable to promote the research activities to the highest level and expand scientific collaboration. In particular, a participation of the ISSP in European Synchrotron Radiation Facility (ESRF), located in Grenoble (France) and operating the most powerful synchrotron radiation source in Europe, should be a strategic goal, which will open an access for the ISSP staff to a first-class scientific environment for conducting experiments at the cutting edge of modern science.
- 5) For a variety of reasons, project payments have been delayed in the past, hampering the work. While this should be avoided, such unpredictable delays can still happen in the future. Therefore, for efficient work, national resources should be made available as an emergency buffer, which would help to bridge financial "holes" in case of delayed project payments.
- 6) To avoid inflexibility inherent to large hierarchical organizations, ISSP should acquire legal status of self-governed semi-autonomous scientific institution associated with the University of Latvia. This status would facilitate an efficient research work by minimizing efforts and resources spent on purely formal issues and would significantly streamline the processes of preparing proposals and the subsequent signing of contracts.
- 7) A sound long-term recruitment plan for staff members must be worked out for the ISSP.
- 8) ISSP should further increase efforts in public relations by promoting knowledge and technologies in public media and society, particularly among the younger generation, by explaining the significance of sciences for the long-term development of Latvia.

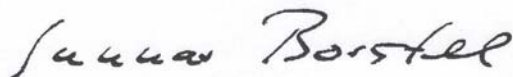
Signed (approved) by the International Supervisory Board:

October 20, 2007

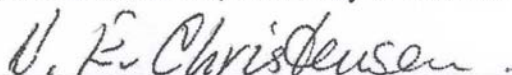
Prof. Juras Banys, Faculty of Physics, University of
Vilnius, Lithuania



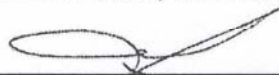
Prof. Marco Kirm, Institute of Physics, University of
Tartu, Estonia



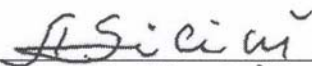
Prof. Gunnar Borstel, University of Osnaebrueck, Germany



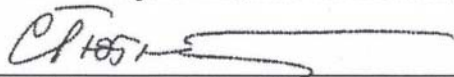
Prof. Niels E. Christensen, University of Aarhus, Denmark



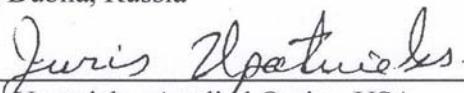
Prof. Claes-Goran Granqvist, Uppsala University, Sweden,



Prof. Andrejs Silins, Latvian Academy of Sciences, Latvia



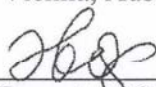
Prof. Sergei Tuituinnikov, Joint Institute for Nuclear
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Prof. Juris Upatnieks, Applied Optics, USA

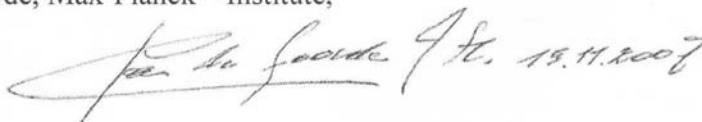


Prof. Harald W. Weber, Atomic Institute of Austrian
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Prof. Robert Evarestov, St. Petesburg University,
Department of Chemistry, Russia

Prof. Marcel Van de Voorde, Max-Planck – Institute,
Stuttgart, Germany



DEPARTMENT OF CRYSTAL PHYSICS

Head of Department Dr. phys. P. Kulis

Research Area and Main Problems

1. Recombination mechanisms of the electronic excitations in new optical binary and ternary compounds – the project is aimed to investigate the exact mechanisms of annihilation, localization and recombination of the electronic excitations and their relationships in new binary and ternary inorganic compounds (nominally pure and doped with some active impurities).
2. Magnetic resonance (EPR, optically detected EPR) investigations of the structure of the intrinsic and radiation defects, and their recombination process in some actual wide gap scintillator, x-ray storage phosphor and dosimeter materials. The scientific cooperation with other magnetic resonance groups, especially with the University of Paderborn, Germany. A contribution to the better understanding of the defects and processes in luminescent detector materials is expected.
3. Investigations on a new class of materials - oxyfluoride composites. One of the goals is to obtain fluoride micro- and nanocrystals with controlled size and properties in the oxide glass matrix. First samples of oxyfluorides on the basis of lithium borate glasses with lanthanum fluoride component have been obtained; investigations of their properties are in progress. The second goal is development of light emitters, detectors and visualization systems on oxyfluoride nanocomposite basis with enhanced quantum efficiency. In special conditions, oxyfluoride compounds containing lanthanide ion-doped fluoride crystallites may exhibit emission of photons of greater energy than those absorbed during the excitation (“up-conversion” of energy). These properties are essential to achieve the mentioned goal. For this purpose, the oxyfluoride composite glass samples based on Li_2CO_3 , B_2O_3 , LaF_3 , LiF and RbF , activated with Ce, Eu and Er, were synthesized and studied. The microscopy and X-ray diffraction measurements were performed to identify the crystallites liable to occur during the thermal processing of glass compounds and really the LiF crystallites were found in most cases. The possibility was checked to create also the crystallites of RbF in glass matrix. The “up-conversion” luminescence was observed in lithium and boron containing oxyfluoride glasses activated with Er ions.
4. Technology of Al-Ga nitride semiconductor heterostructures for light-emitting and laser diodes for violet and ultraviolet spectral regions - the goal of the project is the development of light-emitting diodes and laser diodes for violet and ultraviolet spectral region. The project involves installation of new MOCVD equipment AIXTRON AIX200 RF, synthesis and design of corresponding new materials on the basis of the third group nitrides, elaboration of the thin film heterostructures and further development of production of multifunctional fonic devices in joint stock company “Alfa”.
5. The main goals of EURATOM project are investigation and characterization of the impurity content in fusion plasmas and reactor hot wall. The objectives of this project require study of the influence of the liquid metal limiter on the main plasma parameters, including concentration of evaporated metal atoms in plasma. Laser spectroscopy techniques are proposed for development of procedures for research of impurities in plasma and plasma facing materials. According to the objectives emission of Ga metal vapours in plasmas during the evaporation of the metal gush has been considered. Density of metal vapours in plasma can be obtained using two spectroscopic methods: the steady state emission of the multiple ionised metal ions and the charge exchange emission during ionization of evaporated metal ions.

Scientific Staff

1. Dr. phys. L.Dimitrocenko
2. Dr. phys. P. Kulis
3. Dr. phys. B.Polyakov
4. Dr. habil. phys., asoc. prof. U. Rogulis
5. Dr. habil. phys. M. Springis
6. Prof., Dr. habil. phys. I. Tale
7. Dr. phys. E. Tamanis
8. Dr. phys. J. Trokss
9. Dr. phys. A. Veispals
10. Mg. phys. J. Jansons

Technical Staff

J. Straumens

PhD Students

1. J. Butikova
2. E. Elsts
3. A. Fedotovs
4. A. Gulans
5. A. Sarakovskis

Students

1. Dz. Berzins
2. M. Cubarovs
3. J. Grube
4. G. Marcins
5. A. Petruhins

Scientific visits abroad

1. Dr. habil. phys. U. Rogulis, University of Paderborn, Germany (4 weeks);
2. Dr. habil. phys. U. Rogulis, Wake Forest University, Winston-Salem, USA (9 days);
3. Dr. habil. phys. I. Tale, University Milano-Bicocca, San Francisco, USA (10 days);
4. Dr. habil. phys. I. Tale, Bucharest, Romania (1 week);
5. Mg. phys. A. Fedotovs, Wake Forest University, Winston-Salem, USA (9 days);
6. Mg. phys. J. Butikova, Max Plank Institute of Plasma Physics, Garching, Germany (4 weeks);
7. Mg. phys. J. Butikova, Nica, France, (1week).
8. Dr. phys B. Polyakov, Palanga, Lithuania, (1week).
9. J. Grube, Palanga, Lithuania, (1week).

Cooperation

Latvia

Joint stock company "Alfa"

Czech Republic

Institute of Physics, Academy of Science of the Czech Republic Prague, Czech Republic (Dr. J. Rosa, Dr. M. Nikl).

Germany

1. University of Paderborn, Germany (Prof. Dr. R. Wehrspohn, Prof. Emeritus, J.-M. Spaeth, Dr. hab. S. Schweizer, Dr. hab. S. Greulich-Weber).
2. University of Rostock, Germany (Prof. H.-J. Fitting).
3. "Aixtron" Aachen, Germany
4. Max Plank Institute of Plasma Physics, Garching, Germany

Portugal

Instituto Superior Tecnico (IST), Lisbon Portugal (Prof. Varandas).

Scientific publication

Published in 2007

- 1) L. Dimitrocenko, U. Rogulis, A. Veispals, M. Springis, P. Kulis, A. Fedotovs, and A. Mishnev, Luminescence of Ce-doped borate-oxyfluoride glass ceramics, - phys. stat. sol. (c) 4, No. 3, 753–756 (2007).
- 2) A. Gulans, I. Tale, Ab initio calculation of wurtzite-type GaN nanowires, - phys. stat. sol. (c) 4, No 2, 1197-1200 (2007).
- 3) F.Muktepavela, G.Bakradze, E.Tamanis, L.Grigorjeva, P.Kulis, R.Krutohovostovs. Obtaining of ZnO nanostructured coatings by mechanoactivated oxidation, - J. Phys.: Conf. Ser., 93, 2007, 012007.
- 4) J.Butikova, A.Sarakovskis, B.Polyakov, I.Tale. Laser ablation for analysis of nanoscale layers. *Journal of Physics: Conference Series*, **93**, 012043, 2007.
- 5) A.Skudra, G.Revalde, Z.Gavare, J.Silins, N.Zorina, B.Polyakov. Study of the high-frequency inductive coupled discharge plasma interaction with walls. *Plasma processes & Polymers*, **4**, S1, S1026-S1029, 2007.
- 6) B.Polyakov, J.Prikulis, L.Grigorjeva, D.Millers, B.Daly, J.Holmes, D.Erts. Photoconductivity of Germanium Nanowire Arrays Incorporated in Anodic Aluminum Oxide. *Journal of Physics: Conference Series*, **61**, 283-287, 2007.
- 7) A. Fedotovs, E. Elsts, U. Rogulis, A. Gulans, I. Tale, M. Nikl, N. Ichinose, K. Shimamura EPR Hyperfine structure of F-type centres in pure LiBaF₃ Crystal, *physica status solidi (c)*, 2007, vol.4/3, pp. 1284-1287.
- 8) B. Henke, U. Rogulis and S. Schweizer, Optical and Electron Paramagnetic Resonance Studies on Radiation Defects in Mn-activated RbCdF₃, *physica status solidi (c)*, 2007, vol. 4/3, pp. 1071-1074.
- 9) S. Schweizer, B. Henke, U. Rogulis, and W. M. Yen, Recombination processes in rare-earth doped MAI₂O₄ (M = Ca, Sr) persistent phosphors investigated by optically-detected magnetic resonance, *physica status solidi (a)*, 2007, vol. 204/3, pp. 677-682.
- 10) S. Schweizer, B. Henke, U. Rogulis, W.M. Yen, Optically-detected magnetic resonance investigations of recombination processes in undoped and rare-earth doped MAI₂O₄ (M = Ca, Sr) persistent phosphors, *Applied Physics Letters*, 2007, vol. 90, p. 051902.

Lectures on Conferences

23rd Scientific Conference of the Institute of Solid State Physics, University of Latvia, Riga, February 13-15, 2007.

1. A. Sarakovskis, L.Dimitrocenko, A.petruhins, J.Grube, I.Tale, U.rogulis, M.Springis, Up-conversion luminescence of Er³⁺ in LiF crystals, Abstracts of the

23rd Scientific Conference of Institute of Solid State Physics UL, Riga, 2007, p. 35 (oral presentation).

2. A.Klukins, O.Lielausis, A.Mikelsons, E.Platacis, A. Sarakovskis, I.Tale, The liquid metal experiment and results at tokamak Istok, - Abstracts of the 23rd Scientific Conference of Institute of Solid State Physics UL, Riga, 2007, p. 51 (oral presentation)..
3. J. Butikova, A. Sarakovskis, I.Tale, Development for laser ablation spectroscopy, - Abstracts of the 23rd Scientific Conference of Institute of Solid State Physics UL, Riga, 2007, p. 53 (oral presentation).
4. P.Kulis, A. Sarakovskis, M. Springis, I.Tale, Trap spectroscopy of N- and B- doped 6H-SiC, -. Abstracts of the 23rd Scientific Conference of Institute of Solid State Physics UL, Riga, 2007, p. 63 (oral presentation)..

International Baltic Sea Region conference „Funcional materials and nanotechnologies”, Rīga, April 2-4, 2007

1. A.Gulans, M.Puska, I.Gerber, R.Nieman, DFT studies of extended Systems including Van Der Waals interactions, - International Baltic Sea Region conference „Funcional materials and nanotechnologies”, Rīga, April 2-4, 2007. Abstract, p.18. (oral presentation).
2. A.Sarakovskis, L.Dimitrocenko, A.Misnevs, U.Rogulis, M.Springis, Up-conversion process in erbium doped lithium fluoride bulk crystal, lithium borate oxyfluoride glass and glass ceramics, - - International Baltic Sea Region conference „Funcional materials and nanotechnologies”, Rīga, April 2-4, 2007. Abstract, p.74 (oral presentation).
3. F. Muktepavela, G. Bakradze, E. Tamanis, L.Grigorjeva, P.Kulis, R.Krutohvastovs, Obtaining of ZnO nanostructured coatings by mechanoactivated oxidation, - International Baltic Sea Region conference „Funcional materials and nanotechnologies”, Rīga, April 2-4, 2007. Abstract, p.89. (poster presentation).
4. J.Butikova, A.Sarakovskis I.Tale, Laser ablation for analysis of nanoscale surface layers, - - International Baltic Sea Region conference „Funcional materials and nanotechnologies”, Rīga, April 2-4, 2007. Abstract, p.124. (poster presentation).

IEEE 9th International Conference on Inorganic Scintillators and their Applications, Winston-Salem, NC USA, June 4-8, 2007

1. Fedotovs, U. Rogulis, L. Dimitročenko, "*EPR of intrinsic defects in LiYF₄ crystal*", IEEE 9th International Conference on Inorganic Scintillators and their Applications SCINT'2007, Winston-Salem, USA, Abstract, p. 104 (poster presentation).
2. Fedotovs, V. Pankratov, L. Grigorjeva, D. Millers, U. Rogulis, "*EPR spectra of radiation defects in YVO₄ crystals*", IEEE 9th International Conference on Inorganic Scintillators and their Applications SCINT'2007, Winston-Salem, USA, Abstract, p. 143 (poster presentation).

15th International Conference on Solid State Dosimetry SSD15, Delft, the Netherlands, 2007

B. Henke, U. Rogulis, S. Schweizer, "Structure sensitive investigations on luminescence centres in Mn-activated LiBaF₃ dosimeters", 15th International Conference on Solid State Dosimetry SSD15, Delft, the Netherlands, July 8-13, 2007, Abstract, p.15 (oral presentation).

13th International Conference on Fusion Reactor Materials, Nice, December 10-14, 2007

J. Butikova, A. Sarakovskis, I. Tale, "Laser-induced breakdown spectroscopy application for determining impurity content and depth profile in the plasma facing materials", Conference Proceedings of the 13th International Conference on Fusion Reactor Materials, Nice, December 10-14, 2007 (oral presentation).

Advanced Materials and Technologies, Palanga, Lithuania, August 27-31, 2007

A. Petruhins, J. Grube, J. Sipols, B. Polyakov, A. Kuzmin, I. Muzikante, I. Tale, Semiconducting Nanocrystals for Solar Cell Applications produced by Laser Ablation, - (poster presentation).

Development in Optics and Communications, Riga, April 2007

J. Butikova, A. Sarakovskis, I. Tale, Laser Ablation Spectroscopy of Plasma-facing Materials, - Abstract Book, p.15, (oral presentation).

EFDA Workshop Riga 2007. October

J. Butikova, A. Sarakovskis, Laser ablation spectroscopy for impurity depth profiling and concentration imaging in plasma – (oral presentation).

DEPARTMENT OF DISORDERED MATERIAL PHYSICS

Head of Department Dr.hab.phys.D.Millers

Solid state radiation physics laboratory Head of Laboratory Dr.hab.phys.L.Grigorjeva	Defect studies group Head of Group Dr.hab.phys. L.Skuja	Solid state optics laboratory Head of Laboratory Dr.hab.phys.A.Trukhin
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Research area and Main Problems

The luminescence and absorption methods were used for electron-hole and exciton energy transfer to defects states and dopands. The time-resolved spectroscopy allows studying these processes starting with nanosecond time region, for example polaron states relaxation processes in perovskite and others materials. The single crystal, nanopowders and ceramic materials are under study.

The pulsed electron beam accelerator was used for cathodoluminescence and induced short-lived absorption studies. The pulse duration 10 ns, density is 10^{12} electrons/pulse; energy is ~ 270 keV, Optical signal was detected by photomultiplier and displayed on storied oscilloscope.

The time-resolved luminescence measurements was measured by using the YAG:Nd laser for excitation (266 nm, 2-8 ns); optical signal was detected by photomultiplier and Ultrafast multiscaler P8777-1E. Spectra and decay kinetics was studied in wide spectral (270 nm-1000 nm), time (minimal time gate is 250 ps) and temperature (14K-350K un 80-500K) range. The FTIR spectroscopy was used for detection of molecular species.

Laboratory of solid state radiation physics 1. Dr. hab.phys. S.Chernov 2. Dr. hab.phys. L.Grigorjeva 3. Dr. hab.phys. D.Millers 4. Dr.phys.V.Pankratov Technical Staff 1. Eng. A.Sitdikov 2. Eng. E.Arhipova Doktorants 1. K.Smits 2. M.Shorohov Students A.Kalinko	Defect studies group 1. Dr.hab.phys. A. Silins 2. Dr.hab.phys L. Skuja 3. Dipl. phys. A. Lukjanska	Laboratory of solid state optics 1. Dr.hab.phys.A.Trukhins 2. Dr.hab.phys.K.Trukhins
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Scientific Visits Abroad

1. Dr.hab.phys. L.Grigorjeva, Poland, (8 days).
2. Dr.hab.phys.D.Millers, Poland, (8 days).
3. Dr.phys.V.Pankratov, Poland, (5 days).
4. K.Smits, Poland, (8 days)
5. Dr.hab.phys. L.Grigorjeva, France, (3 days).
6. K.Smits, France, (20 days)
7. Dr.V.Pankratov, France (20 days)
8. K.Smits , Finland (4 days)
9. K.Smits, USA (7 days)

10. Dr.L.Grigorjeva, USA (7 days)
11. Dr.Pankratov, USA (7 days)
12. A.Kalinko, Germany (5 days)
13. Dr.L.Grigorjeva, Germany (10 days)
14. Dr.V.Pankratov, Germany (10 days)

Visits from Abroad

Simas Sakirzanovas (Lithuania)
Dr. Kay Voss. Torsten Jenek (Germany)

Cooperation in Latvia

SIA "Baltic BRUKER" (Dr.V.Gostillo).
Riga Technical University, Institute of Inorganic Chemistry
(Dr.habil.sc.ing. J.Grabis)
Riga Technical University, Institute of Silicate Materials (Prof.G.Mezinskis)

USA

Wake Forest University (Prof. R.T. Williams).
Department of Physics and Engineering, Sweet Briar College (Prof. Hank Yochum).

Estonia

Institute of Physics, Tartu (Dr.V.Nagirnyj, M.Kirm, S.Zazubovich, V.Babin)

Russia

GOI, St.Peterburg, (Dr.L.Maksimov).
Burjatija State University (A.V.Nomoev)

Poland

High Pressure Research Center, Polish Academy of Sciences UNIPRESS
(Prof.W.Łojkowski, Dr.J.Fidelus)
Institute of Physics, University of Rzeszow (Dr.P.Potera)
Institute of Low Temperatures and Structure Researches, PAS, Wroclaw
(Prof.W.Strek)

Romania

Institute for Non-Ferrous and Rare Metals (Dr.R.M.Piticescu, Prof.R.Piticescu)

France

CNRS/Proc.Mat.Eng.Solaire, Font-Romeu (Dr. Claude Monty)

Lithuania

Faculty of Chemistry, Vilnius University (Dr.A.Kareiva)

Germany

Material Science Department, Institute for Electrical Materials, Darmstadt
University of Technology, Prof. H. von Seggern

Scientific Publications

Published in 2007

1. Pankratov, D. Millers, L Grigorjeva, W. Lojkowski, A. Kareiva, Time-resolved luminescence of nanocrystalline inorganic complex oxides, Journal of Physics: Condensed Matter, Journal of Physics: Condensed matter,2007, p. 012037.

2. V. Pankratov, D. Millers, L Grigorjeva, T. Chudoba, Luminescence of Cerium Doped YAG Nanopowders, *Radiation Measurements*, 42 (2007) 679-682
3. V. Pankratov, L. Grigorjeva, D. Millers, T. Chudoba, Time-Resolved Luminescence Characteristics of Cerium Doped YAG Nanocrystals, *Solid State Phenomena*, 128 (2007) 173-179.
4. V. Pankratov, H.M. Yochum, L. Grigorjeva, D. Millers Intrinsic Luminescence and Energy Transfer Processes in Pure and Doped YVO₄ Crystals, *Phys. Stat. Sol.* 4 (3), 801-804 (2007).
5. D. Millers, H.M. Yochum, V. Pankratov, P. Potera, L. Grigorjeva, Transient and Near-Edge Absorption in YVO₄ Crystals, *Phys. Stat. Sol.* 2007, 4 (3), p.1155-1158.
6. F. Muktepavela, G. Bakradze, E. Tamanis, L. Grigorjeva, P. Kulis and R. Krutohvostovs. Obtaining of nanostructured ZnO coatings using mechanoactivated oxidation. *Journal of Physics: Conference Series*, 2007, v.93, p.012007.
7. K Smits, D. Millers, L. Grigorjeva, J. D. Fidelus and W. Lojkowski. Comparison of ZrO₂:Y nanocrystals and macroscopic single crystal luminescence *Journal of Physics: Conference Series*, 2007, v.93, p.012035.
8. L. Grigorjeva, D Millers, V Pankratov, A Kalinko, J Grabis and C Monty. Blue luminescence in ZnO single crystals, nanopowders, ceramic. *Journal of Physics: Conference Series*, 2007, v.93,p.012036.
9. A Kalinko, J D Fidelus, L Grigorjeva, D Millers, C J Monty, A Presz and K Smits. The luminescence properties of ZnO nanopowders. *Journal of Physics: Conference Series*, 2007, v. 93, p. 012044.
10. K.Smits, L.Grigorjeva, D.Millers, W.Lojkowski, A.Opalinska, J.Fidelus. Luminescence of yttrium stabilized tetragonal zirconia. *Acta Metallurgica Slovaca*, 2007, v.13, p.8790.
11. A.Kalinko, L.Grigorjeva, D.Millers, J.Grabis, W.Lojkowski, C.J.Monty. Time-resolved luminescence in micro and nanostructured ZnO powders. *Acta Metallurgica Slovaca*, 2007, v.13, p.113-116.
12. A.Katelnikovas, L.Grigorjeva, D.Millers, V.Pankratov, A.Kareiva. Sol-gel preparation of nanocrystalline CaWO₄. *Lithuanian Journal of Physics*, 2007, v. 47, No.1, p.63-68.
13. B.Polyakov, J.Prikulis, L.Grigorjeva, D.Millers, B.Daly, J.D.Homes, D.Erts. Photoconductivity of Germanium Nanowire Arrays Incorporated in Anodic Aluminum Oxide. *J.of Physics: Conference Series*, 2007, v.61, p.283-287.
14. L.Grigorjeva, D.Millers, K.Smits, C.J.Monty, J.Kouam, L.El Mir. The luminescence Properties of ZnO:Al Nanopowders Obtained by Sol-gel, Plasma and Vaporization-condensation Methods. *Solid State Phenomena*, 2007,v.128, p.135-140.
15. K.Smits, L.Grigorjeva, W.Łojkowski, J.D.Fidelus. Luminescence of oxygen related defects in zirconia nanocrystals. *Phys.Stat.Sol. (c)*, 2007, v.4, No.3, p.770-773.
16. J.Fidelus, W.Łojkowski, D.Millers, L.Grigorjeva, K.Smits, R.Piticescu. Zirconia based nanomaterials or oxygen sensor – generation, characterization and optical properties. *Solid State Phenomena*, 2007, vol.128, p.141-150.
17. A. Silins "Light energy accumulation and emission processes in optical glasses", *Phys.and Chem. of Glasses*, 2007, Vol.48, No.4, pp.225-228.
18. K. Kajihara, M. Hirano, L.Skuja, H.Hosono Reactivity of SiCl and SiF groups in SiO₂ glass with mobile interstitial O₂ and H₂O molecules. *J. Non-Crystalline Solids*, v.353, p.514-517 (2007).
19. K. Kajihara, M. Hirano, L.Skuja, H.Hosono Formation of Intrinsic Point Defects in Fluorine-doped Synthetic SiO₂ Glass by ⁶⁰Co gamma-ray Irradiation. *Chemistry Letters* Vol.36, No.2, p.266-267 (2007).
20. L. Skuja, K. Kajihara, M.Hirano, H.Hosono. Fluorine laser-induced silicon hydride Si-H groups in silica. *J. Non-Crystalline Solids*, v.353, p.526-529 (2007).

21. K.Kajihara, M.Hirano, Y.Takimoto, L.Skuja, H.Hosono. Diffusion of nitrogen molecules in amorphous SiO₂. Appl.Phys. Lett. v.91, p.071904 (1-3) (2007).
22. L. Skuja, K. Kajihara, M.Hirano, H.Hosono. Ultraviolet absorption of hydrogen-related species in glassy silica, Physics and Chemistry of Glasses, European Journal of Glass Science and Technology B vol.48, No3, p.103-106 (2007).

Lectures in Conferences

10th International Conference and Exhibition of the European Ceramic Society, ECERS2007, 10—15 June, Berlin, Germany

A.Kalinko, L.Grigorjeva, D.Millers, V.Pankratov, K.Smits. Time-resolved Cathodoluminescence and Photoluminescence of Nanoscale Oxides

International Baltic Sea Region conference “Functional materials and nanotechnologies”, 2-4 April, 2007, Riga, Latvia

1. J.Fidelus, W.Łojkowski, D.Millers, K.Smits, L.Grigorjeva. Advanced nanostructured zirconia materials for oxygen sensor, p.64.
2. K.Smits, L.Grigorjeva, J.D.Fidelus, W.Łojkowski, D.Millers. Comparison of ZrO₂ nanocrystals and macroscopic single crystal luminescence, p.65.
3. L.Grigorjeva, D.Millers, J.Grabis, C.Monty. Blue luminescence in ZnO crystal, nanopowders, ceramic, p.67.
4. V.Pankratov, L.Grigorjeva, D.Millers. Time-resolved luminescence of nanocrystalline inorganic oxides, p.68.
5. A.Kalinko, J.D.Fidelus, L.Grigorjeva, D.Millers, C.J.Monty, K.Smits. The luminescence properties of ZnO nanopowders, p.126.

LU Cietvielu fizikas institūta 23. zinātniskā konference, 2007.gada 13. -15. februāris, LU CFI, Rīgā, Latvijā

1. K.Šmits, D.Millers – Cirkonija dioksīda monokristāla luminiscence
2. A.Fedotovs, V.Pankratovs, L.Grigorjeva, D.Millers, U.Rogulis. Tīru un aktivētu YVO₄ kristālu EPR spektri, p.

IEEE 9th International Conference on Inorganic Scintillators and their Application, June 4 – 8, 2007, Wake Forest University, Winston-Salem, NC, USA

1. L.Grigorjeva, D.Millers, J.Grabis, C.Monty, A.Kalinko, K.Smits, V.Pankratov – Luminescent properties of ZnO nanocrystals and ceramic – Abstracts, p.28
2. K.Smits, L.Grigorjeva, D.Millers, J.D.Fidelus, W.Łojkowski – Radiative decay of electronic excitations in ZrO₂ nanocrystals and macroscopic single crystals – Abstracts, p.108.
3. V.Pankratov, L.Grigorjeva, D.Millers, A.Kuzmin, A.Kareiva. Time-resolved luminescence characteristics of nanocrystalline CaWO₄, p.159.
4. V.Pankratov, D.Millers, L. Grigorjeva, T.Chudoba. Luminescence properties of nanocrystalline YAG, p.180.

Nanotech Northern Europe, 2007 (NITE-2007), 27-29 March, Helsinki, Finland

D.K.Millers, K.Smits, L.Grigorjeva, J.Fidelus, W.Łojkowski. ZrO₂ nanocrystal luminescence dependence on oxygen content. Book of abstracts, p.85.

European Material Research Society Fall Meeting (E-MRS 2007), 17th – 21st September, 2007, Warsaw University of Technology, Warsaw, Poland

1. D.Fidelus, W.Łojkowski, D.Millers, K.Smits, L.Grigorjeva – Advanced nanostructured ceramics for oxygen sensors - Book of Abstracts, p. 310.

2. V.Pankratov, L.Grigorjeva, D.Millers, T.Chudoba, W.Lojkowski – Luminescence properties of cerium doped $Y_3Al_5O_{12}$ nanopowders and nanoceramic – Book of Abstracts, p. 311.
3. D.Millers – oxygen defects related luminescence of ZrO_2 nanocrystals – Book of Abstracts, p. 295.
4. L.Grigorjeva, A.Kalinko, D.Millers, C.J.Monty, A.Presz, J.Grabis. Fast luminescence in ZnO structures, p.311.

Conf. on Radiation Effects in Insulators, Caen, France,. Aug.28 - Sept.1, 2007

L. Skuja, K. Kajihara, M.Hirano, H.Hosono. Hydrogen-related radiation defects in SiO_2 - based glasses. Abstracts of 14th Internat., p.B-27.

XXI International Congress on Glass, July 1 - 6, 2007 Strasbourg, France

L.Skuja,K.Kajihara, M.Hirano, H.Hosono, Variation of infrared absorption cross sections of hydrogen-bonded silanol groups in silica modified by vacuum-UV photons.

Tokyo Institute of Technology MSL Symposium, Oct.30, 2007, Yokohama, Japan

L.Skuja "Atomic scale defects in silicon dioxide based materials"

SOLID STATE OPTICS LABORATORY

Head of Laboratory, Professor, Dr. hab. Phys., Anatoly Trukhin

Research area and Main Problems

The electronic excitations, intrinsic and impurity defect of the ordered materials (crystals) and the disordered material (optical glasses) are the main object of Solid State Optics Laboratory of DMP. Electronic structure and electronic processes of crystalline and glassy materials was studied. The localized states are studied in details. The properties of such “static” localized states determine almost all properties of glassy materials in their application in modern optoelectronics and telecommunication (Bragg grating and related optoelectronic devices).

Scientific staff

1. Professor, Dr. hab. Phys. A. Trukhin
2. Dr. Phil., Dr. Phys. K. Truhins

Scientific Visits Abroad

1. Professor, Dr. hab. Phys. A. Trukhin, 21 International Congress on Glass, ICG2007, Strasbourg, France, 1. July - 6 July 2007
2. Dr. Phil., Dr. Phys. K. Truhins, USA, Postdoctoral position at University of Illinois at Chicago, Chicago, Illinois, USA

Cooperation

Russia

State University of Irkutsk, Institute of Geochemistry (Professors E.A. Radzhabov, A.I. Nepomnyaschikh)

L.F. Verechshagin Institute of High pressure Physics of RAS, Troitsk, Russia (Dr. T. Dyuzheva)

Fiber Optics Research Center of the Russian Academy of Sciences, 119333, Moscow, Russia (Prof. K. M. Golant)

Germany

University of Rostock, Germany (Professor, Dr. H.-J. Fitting)

USA

impactGlass research international, 3938 E. Tucson, AZ 85712, USA (Ph.D. D.L. Griscom)

Solid State Division, Oak Ridge National Laboratory. Oak-Ridge, TN. 37831 (Ph.D. Lynn A. Boatner)

University of Central Florida, CREOL (Professor, Dr. L.B. Glebov)

France

Universite Paris Sud, Orsay, Lab. Labo. Physico-Chimie des Solides UMR8648, (Dr. B. Poumellec)

Laboratoire de Physique des Lasers, Université des Sciences et Technologies de Lille, France (Prof. B. Capoen)

Italy

University of Palermo, Prof. Roberto Boscaino, Inst. Nazionale di Fisica della Mat. and Dipartimento di Scienze Fisiche ed Astronomiche dell 'Università, via Archirafi, 36, I-90123 Palermo, Italy

Estonia

Institute of Physics, University of Tartu, Estonia (Prof. C. Luschchik, Dr. R. Kink, Dr. Yu. Maksimov)

THE MAIN RESULTS

THERMOSTIMULATED LUMINESCENCE AND ELECTRON SPIN RESONANCE IN X-RAY- AND PHOTON-IRRADIATED OXYGEN-DEFICIENT SILICA

A.N. Trukhin, J. Troks, D.L. Griscom¹
¹*ImpactGlass research international, Tucson, USA*

Influences of oxygen deficiency on radiation properties of high-purity, low-OH fused silica were studied. It is found that thermostimulated luminescence (TSL) peaks are different for photo (7.7 eV) and X-ray excitation at 77 K. X-ray excitation produces TSL peaks at 125 K and 170 K corresponding to the anneal temperatures of two types of self-trapped holes centers (STH) detected by electron spin resonance (ESR). Deficiency of oxygen apparently increases the number of electron traps, stabilizing a larger number of STHs in the continuous defect-free silica network than is observed in similarly X-irradiated stoichiometric silica glasses. Photoexcitation of oxygen-deficient glass at 7.7 eV produces TSL peaks at 105 and 200 K, presently attributed to STHs at perturbed sites in the immediate vicinity of oxygen-deficiency centers (ODCs). High temperature TSL peaks at 240 and 400 K are produced by both types of irradiations and are followed by ESR detection of E' centers only. All observed TSL and ESR signals were proportional to the level of oxygen deficiency. The main spectral band in TSL near 2.7 eV is a triplet-singlet transition, ascribable to the two-fold-coordinated silicon center (ODC(II)) modified by nearest structure. It is proposed that this recombination process results when a thermally detrapped STH encounters an electron trapped on modified two-fold-coordinated silicon. The latter (paramagnetic) defect is argued to be identical with the E'_{α1} center, previously characterized by Griscom (Nuc. Inst. Methods B1 (1984) 481) but regarded at the time as a trapped-hole center.

LUMINESCENCE OF LOW-HYDROXYL SILICA EXCITED BY F₂ LASER RADIATION

A. N. Trukhin, K. M. Golant¹
¹*Fiber Optics Research Center of the Russian Academy of Sciences, Moscow, Russia*

The luminescence of low hydroxyl high purity silica while irradiated with a F₂ excimer laser (157 nm wavelength) is studied. Two types of glass are investigated: non-fused amorphous silicon dioxide prepared by the surface-plasma chemical vapour deposition (SPCVD), and its fused counterpart. The luminescence possesses two broad bands, the one at 2.6-2.9 eV (the blue band) and the other at 4.4 eV (the UV band). Both bands are associated with oxygen deficient centres (ODCs). The luminescence intensity of non-fused silica is found to grow up with irradiation dose thus demonstrating the creation of extra ODCs. The blue band's decay kinetics obeys τ^{-1} hyperbola in the range of time 10 ns - 300 μ s. An exponential decay component is also revealed at the end of the decay curve, time constant being about 10 ms. We attribute this component to an intra-centre luminescence of the ODCs created in the process of laser irradiation. Fast components duplicating the shape of 5 ns laser pulses are revealed both in the blue luminescence and in the UV one. Slow components with exponential decay are also observed for the UV luminescence band, time constants being 3 and 130 μ s. Peculiarity of decay

kinetics is discussed in a model of close pairs of electron and hole traps recombining through excimer-like states.

EXCITATION PROCESSES OF THE BLUE LUMINESCENCE IN CRYSTALLINE SiO₂ PROBED BY SYNCHROTRON RADIATION MEASUREMENTS

A. Trukhin, M. Cannas¹, S. Agnello¹, R. Boscaino¹, F. M. Gelardi¹,
¹*Physical and Astronomical Sciences Department, University of Palermo, Italy*

Luminescence properties of crystalline α -quartz were investigated by time-resolved spectroscopy under pulsed synchrotron radiation excitation in the vacuum ultraviolet range. Our results evidence that two emission bands overlap at 2.7 eV, both being observed only at low temperature. The first contribution is excited by band-to-band transition and is related to the radiative recombination of a self trapped exciton occurring in a time scale of a few ms, the second is associated with defects induced in quartz by γ - and β -radiation, is excited at 7.6 eV and its lifetime is 3.6 ns at T = 10 K.

Presentation at conferences

1. A. Trukhin, M. Kink, Y. Maksimov, R. Kink, Silica glass luminescence excited by ArF laser, 23. CFI LU Zinātniskās konferences referātu tēzes, Rīga, Latvija, 13.-15. Februāris 2007, 33.lpp.
2. A.Trukhin, K.Golant, Luminescence of low-hydroxyl silica excited by F2 laser radiation, book of abstract of 21 International Congress on Glass, ICG2007, Strasbourg, France, p.161.
3. A.Trukhin, K.Golant, Luminescence of low-hydroxyl silica excited by F2 laser radiation, paper on CD of 21 International Congress on Glass, ICG2007, Strasbourg, France, L21, 4 pages.
4. D.Y. Kislitsyn, K.M.Golant, A.N.Trukhin, Fundamental absorption edge of Si_x Ge_{1-x} O₂ (0<x<1) glassy films deposited by SPCVD technology, book of abstract of 21 International Congress on Glass, ICG2007, Strasbourg, France, p.110.
5. D.Y. Kislitsyn, K.M.Golant, A.N.Trukhin, Fundamental absorption edge of Si_x Ge_{1-x} O₂ (0<x<1) glassy films deposited by SPCVD technology, paper on CD of 21 International Congress on Glass, ICG2007, Strasbourg, France, J6, 4 pages.

Scientific papers published in 2007

1. Raphael Blum, Anatolijs Truhins, Bertrand Poumellec and Suling Zhao The use of X-ray-induced and thermostimulated visible and UV luminescence for understanding X-ray poling of silica glasses • Journal of Luminescence, 122-123 (2007) 137-141
2. A.N. Trukhin, K.M. Golant, Absorption and luminescence in amorphous silica synthesized by low-pressure plasmachemical technology, Journal of Non-Crystalline Solids 353 (2007) 530–536
3. Trukhin, A.N. Troks, J. Griscom, D.L. Thermostimulated luminescence and electron spin resonance in X-ray-and photon-irradiated oxygen-decient silica, J. Non-Cryst. Solids. 353(2007)1560-1566.
4. Marco Cannas , Simonpietro Agnello , Roberto Boscaino , Franco Mario Gelardi , and Anatoly Trukhin, Excitation processes of the blue luminescence in crystalline SiO₂ probed by synchrotron radiation measurements, phys. stat. sol. (c) 4, No. 3, 968–971 (2007)

DEPARTMENT OF FERROELECTRICS

Head of Department Dr. hab. phys. A. Sternberg

Research Area

The research issues of the Department of Ferroelectric Physics include various aspects of theoretical modelling, sample production related material synthesis, processing and characterization of ferroelectrics. Besides of traditional production methods synthesis of ceramics is oriented towards development of new lead-free based materials. Characterization methods include X-ray diffraction, atomic force microscopy and piezo response force microscopy, electron scanning microscopy with EDX option, dielectric spectroscopy and hysteresis measurements, optical studies by reflectometry and ellipsometry. Phase transitions and ordering effects in “ordinary” ferroelectrics and ferroelectric relaxors are studied along with new compositions, including doped multicomponent systems and thin film ferroelectric and antiferroelectric heterostructures. A possible applications of ferroelectric materials in electronics, photonics and microelectromechanical systems are considered.

Main research topics in 2007

Lattice Representation of Joint Hamiltonian and Stochastic Dynamics for Field Induced Polarization Switching

- Theoretical modelling of the structural phase transitions in ferroelectric materials with microscopic scale features determined by a connection between classical and quantum physics.

Synthesis of Ferroelectric Ceramics

- Investigation of Ceramic Compositions Based on Lead Containing Niobates;
- Obtaining of Lead Free Ferroelectric Materials on the Bases of Alkaline Niobates;
- Production of Transparent Electrooptic PLZT Ceramics for Vision Science Applications, Synthesized by Hydroxopolymer, Molten Salts and Sol-Gel Methods.
- Investigation of Surface Microstructure of Ceramics and Thin Films

Dielectric Properties of Perovskite Ferroelectric Relaxor Ceramics and Thin Films

- Dielectric Impedance Fourier Spectroscopy and Characterization of Functional Materials.

Structural and Optical Properties of Ferroelectric Thin Films

- Structural and Optical Studies of NaNbO_3 Thin Films Grown by PLD on SrRuO_3 Bottom Electrode;
- Structural and Optical Characterization of $\text{Ba}_{0.8}\text{Sr}_{0.2}\text{TiO}_3$ PLD Deposited Films.

SEM and AFM studies and modification of surfaces

- Nanoscale Piezoresponse and Electrostatic Force AFM Imaging
- Test structures for AFM and SNOM produced by Electron Beam Lithography

Ferroelectric and Antiferroelectric Thin Films for Future Thermonuclear Reactor Diagnostics Applications

- Physical Properties of Ferroelectric and Antiferroelectric Thin Films After Electron Irradiation;
- Characterization of active components for use in bolometric radiation diagnostics systems.

Optical Materials for Vision Science

- Dynamics Of Eye Aberration Detected By High-Speed Hartmann-Shack Aberrometer;
- Application of PLZT and PDLC Passive and Active Optical Elements in Infrared Laser Systems for Bio-Optical Experiments and Medicine.

Scientific staff

1. Dr. phys. Eriks Birks
2. Dr. phys. emeritus Karlis Bormanis
3. Dr. sc. ing. emeritus Maruta Dambekalne
4. Dr. habil. phys. Vilnis Dimza
5. Dr. phys. Eriks Klotins
6. Dr. habil. phys. Andris Krumins
7. Dr. phys. Maris Kundzins
8. Dr. phys. Anatoly Mishnev
9. Dr. habil. phys. Maris Ozolins
10. Dr. phys. Ivan Shorubalko
11. Dr. habil. phys. Andris Sternberg
12. Dr. phys. Vismants Zauls
13. Dr. habil. phys. Juris Zvirgzds
14. Mg. chem. Maija Antonova
15. Mg. phys. Laila Chakare-Samardzija
16. Mg. chem. Marite Kalnberga
17. Mg. chem. Anna Kalvane
18. Mg. phys. Karlis Kundzins

Technical staff

1. Mg. phys. Maris Livins
2. Mg. phys. Astrida Spule
3. Ing. Modris Logins
4. Ing. Alberts Tupulis

Doctorants

1. Mg. phys. Ilze Aulika
2. Mg. phys. Roman Krutohvastov
3. Mg. ing. Ilze Smeltere
4. Mg. phys. Sergejs Fomins
5. Mg. phys. Varis Karitans

Graduate Students

1. B. sc. Andrej Bely
2. B. sc. Marija Dunce
3. B. sc. Eriks Klotins (junior)
4. B. sc. Ainars Kuznecovs

Visitors from Abroad

1. **Marks Tomass Valdmanis**, Queen's University, Kingstone, Canada (3.5 months).
2. **Kārlis Gross**, Melbourn University, Australia (1 week)

Scientific Visits Abroad

Mg. Maija Antonova

1. International Meeting on Materials for Electronics Applications (IMMEA-2007), Marrakech, Morocco, April 30- May 2, 2007.
2. Pedagogical University, Institute of Physics, Krakow, Poland (2 weeks).

Mg. phys. Ilze Aulika

1. 11th European Meeting on Ferroelectricity „EMF-2007” Bled, Slovenia, September 3-7, 2007.
2. Institute of Physics, Academy of Science, Prague, Czech Republic, (1 month + 1 month);
3. Conference „COIN & ACOFT 2007”, Melbourne, Australia, 23 – 29 June, 2007;

4. International Conference „ICMAT 2007”, Singapore, 30 June - 7 July, 2007.
5. Participating at the MIND meeting, 1 - 3 October, 2007, Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC).

Dr. phys. **Karlis Bormanis**

1. 11th European Meeting on Ferroelectricity „EMF-2007” Bled, Slovenia, September 3-7, 2007.
2. Международная конференция «Фазовые переходы, критические и нелинейные явления в конденсированных средах» Махачкала, Россия, 12-15 сентября 2007 г.
3. III Международная научная конференция «Актуальные проблемы физики твердого тела», Минск, Белоруссия, 23-26 октября 2007 г.

Dr. sc. ing. **Maruta Dambekalne**

1. International Meeting on Materials for Electronics Applications (IMMEA-2007), Marrakech, Morocco, April 30- May 2, 2007.
2. 10th International Conference and Exhibition of the European Ceramic Society, Berlin, Germany, June 17-21, 2007.
3. Pedagogical University, Institute of Physics, Krakow, Poland (2 weeks).

Mg. chem. **Anna Kalvane**

1. International Meeting on Materials for Electronics Applications (IMMEA-2007), Marrakech, Morocco, April 30- May 2, 2007.
2. Pedagogical University, Institute of Physics, Krakow, Poland (2 weeks).

Dr. phys. **Eriks Klotins**

1. Second International Symposium Micro- and Nano-Scale Domain Structuring in Ferroelectrics (ISDS '07), Ekaterinburg, Russia, August 22-26, 2007.
2. 11th European Meeting on Ferroelectricity „EMF-2007” Bled, Slovenia, September 3-7, 2007.
3. Fundamental Physics of Ferroelectrics 2007, Colonial Williamssburg, VA, USA, February 11-14, 2007
4. 32nd Conference of the Middle European Cooperation in Statistical Physics MECO32, Poland, April 16 – 18, 2007.
5. International conference Statphys 23, Genova, Italy, July 09 – 13, 2007.
6. 2nd International Workshop „Smart Materials and Structures”, Kiel, August 29-31, 2007.

Mg. Phys. **Roman Krutohvostov**

1. The 4-th International Workshop on Functional Materials FNMA'07. Gdansk-Jelitkowo and Hel Peninsula, Poland, September 1-6, 2007.

Mg. phys. **Maris Livins**

1. 10th International Conference and Exhibition of the European Ceramic Society, Berlin, Germany, June 17-21, 2007.

Dr. habil. phys. **Maris Ozolins**

1. 11th European Meeting on Ferroelectricity „EMF-2007” Bled, Slovenia, September 3-7, 2007.

Dr. habil. phys. **Andris Sternberg**

1. Nanoforum EULA workshop: Priorities in Nanomaterials Research in Latin America and Europe; In conjunction with XVII International Materials Research Congress. Cancun, Mexico, August 23-30, 2007.
2. 33rd International Conference on Micro- and Nano-Engineering, Copenhagen, Denmark, September 23-26, 2007.
3. EFDA Fusion Programme Workshop, Garching, July 18-20, 2007.
4. 2nd EFDA Programmatic Workshop, Cadarache, October 8-9, 2007.
5. The European Joint Undertaking for ITER and the Development of Fusion Energy, Barcelona, Spain:
 - 2nd Preparatory Governing Board Meeting, Barcelona, Spain, May 31, 2007;
 - Extraordinary Meeting of the Governing Board, Barcelona, Spain, July 17, 2007;
 - Third Meeting of the Governing Board, Barcelona, Spain, October 22, 2007;
 - Fourth Meeting of the Governing Board, Barcelona, Spain, December 18, 2007.

Dr. phys. **Vismants Zauls**

1. POLECER Conference "Piezoelectricity for End-Users III", Liberec, Czech Republic, February, 7-9, 2007.
2. 11th European Meeting on Ferroelectricity „EMF-2007” Bled, Slovenia, September 3-7, 2007.
3. MIND Project meeting, Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC). October 1 - 3, 2007.

Cooperation

Latvia

1. Daugavpils Pedagogical University (Prof. G. Liberts).
2. Riga Technical University, Faculty of Material Science and Applied Chemistry (Prof. M. Knite, Prof. A. Ozols).
3. University of Latvia, Institute of Chemical Physics (Dr. D. Erts).
4. Riga Technical University, Institute of Inorganic Chemistry (Prof. J. Grabis)

Austria

1. Atomic Institute of Austrian Universities, Technical University Vienna (Prof. H.W. Weber).
2. Institute for Experimental Physics, University Vienna (Prof. A. Fuith).

Belorussia

1. Institute of Solid State Physics and Semiconductors, National Academy of Science, Minsk (Prof. N.M. Olekhovich).

Czech Republic

1. Institute of Physics, Academy of Sciences of the Czech Republic (Prof. J. Petzelt, Dr. I. Hlinka, Dr. S. Kamba).
2. Prague Technical University, Prague (Prof. H. Jelinkova).

Denmark

1. Ferroperm, Ltd., Kvistgard (W. Wolny).

Estonia

1. Institute of Physics, University of Tartu (Dr. R. Jaaniso, Dr. V. Sammelselg).

Finland

1. University of Oulu (Dr. J. Levoska).
2. Colour Research Laboratory, University of Joensuu (Prof. J. Parkkinen).

France

1. Laboratoire Régional des Ponts et Chaussées de Clermont-Ferrand (Prof. M. Colomb).

Japan

1. Shonan Institute of Technology (Prof. S. Sugihara).
2. Shizuoka Institute of Science and Technology (Prof. T. Ogawa).

Lithuania

1. Vilnius University, Vilnius (Prof. J. Banys).

Norway

1. Kongsberg Optometric Institute, Buskerud Highschool (Prof. J.R. Bruenich, Dr. K.I. Daae).

Poland

1. Institute of Physics, Krakow Pedagogical University, Krakow (Prof. Cz. Kus, Dr. B. Garbarz – Glos, Dr. W. Smiga, Dr.hab. J. Suchanicz).
2. Institute of Physics, University of Silesia, Sosnowiec (Prof. Z. Surowiak, Mg. M. Plonska).

Portugal

1. University of Aveiro, Department of Ceramic and Glass Engineering Research Unit on Ceramic Materials, Aveiro (Prof. A. Kholkina).

Russia

1. Ural State University, Ekaterinburg (Prof. V. Shur).
2. Volgograd State Architectural and Engineering Academy, Volgograd (Dr. phys. A. Burkhanov).
3. Joint Institute for Nuclear Research, Dubna (Dr. S. Tiutiunnikov, Dr. V.V. Jefimov).
4. Institute of Chemistry and Technology of Rare Elements and Minerals, Apatity (Prof. N.V. Sidorov, Dr. M.N. Palatnikov).
5. Russian Academy of Science, Dagestan Research Centre, Institute of Physics (Prof. Z.M. Omarov).
6. Dagestan State University (S.A. Sadikov).

Slovenia

1. Jozef Stefan Institute, University of Ljubljana (Dr. M. Kosec).

Spain

1. Laboratory of Optics, University of Murcia (Prof. H.M. Bueno, Prof. P. Artal)
2. CIEMAT, Madrid (Dr. E. Hodgson).

MAIN RESULTS

DIELECTRIC STUDIES AND THERMAL-EXPANSION OF PLZT CERAMICS

M. Kundzins, E. Birks, I. Aulika, and A. Fuith*

$\text{Pb}_{1-x}\text{La}_x(\text{Zr}_{1-y}\text{Ti}_y)\text{O}_3$ solid solutions (PLZT) are one of most intensively studied ferroelectrics. Initially the main reason was related to expectation of practical applications, such as electro-optic devices. Soon it was recognised, that compositions with most promising properties lie in the region of diffused phase transitions. Solid solutions of the PLZT $x/85/15$ with low La concentration have ferroelectric phase at the room temperature region, which transfers to antiferroelectric around $x = 4$ according to the phase diagram. The aim of the present work is to re-examine role of La in the PLZT 85/15, which is quite close to the antiferroelectric state, and where influence of the La, according to the existing phase diagrams, is more expressed in comparison with solid solutions of the higher Ti content. The role of La on nature of the phase transition is compared with the PLZT compositions of lower Zr/Ti ratio. Diffused thermal dependence of the static dielectric permittivity and thermal expansion is discussed in terms of behaviour of the polar microregions and stability of low temperature phase.

* *Institute of Experimental Physics, University of Vienna, Austria*

APPLICATIONS OF FERROELECTRIC LIQUID CRYSTAL SHUTTERS AND FILTERS FOR VISION RESEARCH

M. Ozolins, S. Fomins, and V. Karitans

Ferroelectric Liquid Crystal filters offer the speed of electronic shutters and the vibration free operation of Standard liquid crystal shutters. These characteristics make them ideal for applications requiring short exposure times and minimal blur, offering exposure times of 1/5000 of a second.

The filters can be used as the optical shutter and also in vision research. On the basis of FLC filters we have made ferroelectric glasses, allowing to separate temporal optical information for eyes.

The system is equipped with two channel power supply taking input from PC parallel port. The duration of the signal for each of the filters is controlled through the Matlab (Mathworks) written script.

Basically system is ment to be used for ambliopia training. The system working frequency is 800 Hz. Filters polarization properties allow them to use also for stereo vision research.

OPTICAL PROPERTIES OF FERROELECTRIC THIN FILMS IN THE TEMPERATURE RANGE OF 4 – 820 K

I. Aulika, A. Deyneka*, V. Zauls, and K. Kundzins

The goal of this work is to show an efficiency of the spectral ellipsometry to study the phase transitions of ferroelectric thin films in the wide temperature range (4 – 820 K). Results will be presented on such new thin film as $\text{PbEr}_{1/3}\text{Nb}_{2/3}\text{O}_3$, and well known NaNbO_3 . Films were made by the pulsed laser ablation technique on the $\text{Si/SiO}_2/\text{Ti/Pt/SrRuO}_3$ substrates. High temperature measurements (300 – 820 K) were performed by self made PC-controlled heating stage specially contracted for the J. A.

Woollam spectroscopic ellipsometer, what allowed the real-time measurements of ψ and Δ during heating. Low temperature measurements (4 – 293 K) were accomplished at the 10^{-7} mbar vacuum in the liquid He atmosphere by the Oxford Optistat CF cryostat. Data were analyzed with the software package WVASE32. The importance to choose right fitting parameters will be discussed to minimize correlation, and eliminate obtaining of unphysical values during dynamic ψ and Δ data analysis.

PLD sodium niobium NaNbO_3 thin films were studied at the wide temperature range 4 – 850 K by spectral ellipsometry in the wavelength range 250 – 1000 nm. Four structural phase transitions were found to be at 210, 650, 750 and 790 K.

The nanocomposite materials were studied consisted of alternating layers of barium strontium titanate $\text{Ba}_{0.8}\text{Sr}_{0.2}\text{TiO}_3$ (BST) and lead zirconate titanate PbZrTiO_3 (PZT) deposited by PLD on $\text{Si}/\text{SiO}_2/\text{Ti}/\text{Pt}/\text{SrRuO}_3$ substrates to obtain improved dielectrical and optical properties. The BST is as the 1st layer on Pt/SRO substrate to decrease the Pb diffusion and deficit in PZT.

The technical data of these films predicts that BST and PZT film has ultra thin thickness ~ 3 nm; due to that properties may become nonlinear with layer thickness as thinner layers are used in the construction. The thicknesses of the 1st BST, alternating layers of PZT and BST were found to be 1.90, 2.56 and 2.58 nm, respectively. Optical properties were established to be very similar for BST and PZT at the visible range, and slightly different at the UV range. Extension coefficient starts to increase already at ~ 2.5 eV what could be caused by the film stress.

** Institute of Physics, Academy of Science, Czech Republic*

($\text{K}_{0.5}\text{Na}_{0.5}$) NbO_3 PIEZOELECTRIC CERAMICS DOPED WITH SINTERING AIDS OF DIFFERENT OXIDES

M. Dambekalne, I. Smeltere, M. Livins, and A. Mishnev

In the Department of Ferroelectrics the densification, structure and dielectric parameters of ceramics from different powders of undoped ($\text{K}_{0.5}\text{Na}_{0.5}$) NbO_3 (KNN) and KNN doped with 1.0 wt.% of Li_2O , CdO , Sb_2O_3 , MnO_2 , V_2O_5 and WO_3 have been studied.

Powder of pure KNN was synthesized by solid state reaction method from reagent grade oxides and carbonates. The optimal thermal regime of undoped KNN is 1180°C, 2 hours in case of traditional sintering and 1150°C, 2 hours and pressure of 25 MPa in case of hot-pressing. Similar to a pure KNN ceramic all doped ceramics have a single-phase perovskite structure with orthorhombic symmetry. The doping of sintering aids did not affect the crystal structure of the ceramics significantly. Almost all sintering aids, except Sb_2O_3 and WO_3 , effectively decreased the sintering temperature of KNN (50°-100°C), and improved density from 94.5 % (pure KNN) to 96.5 % of the theoretical density (4.51 g/cm³). Among all sintering aids the most pronounced improvement in KNN sintering was derived from the additions of V_2O_5 and MnO_2 . The optimum content of sintering aids were 0.5-1.0 wt.%. All sintering aids stimulated grain growth. The size of grain increased from 5-6 μm (pure KNN) to 8-10 μm for doped ceramics. In ceramics, doped with 1.0 wt.% Li_2O and CdO , some abnormal grain growth was observed.

(K_{0.5}Na_{0.5})(Nb_{1-x}Sb_x)O₃ PIEZOELECTRIC CERAMICS WITH MnO₂ SINTERING AID

**M. Dambekalne, M. Antonova, M. Livins, A. Kalvane,
A. Mishnev, K. Bormanis, and A. Sternberg**

Lead-free piezoelectric ceramics of (K_{0.5}Na_{0.5})(Nb_{1-x}Sb_x)O₃ ($x = 0.02 - 0.10$) with MnO₂ have been prepared, and their structure, dielectric and piezoelectric properties were studied. The powder in stoichiometric ratio of (K_{0.5}Na_{0.5})(Nb_{1-x}Sb_x)O₃ was synthesized by solid state reaction from reagent grade oxides and carbonates. Raw materials were homogenized and milled in agate balls mill in dehydrated ethanol for 20 hours, than dried and calcinated at 850⁰C for 4 h. After calcination 0.5 – 1.5 mol% of MnO₂ was added and the mixture was ball milled again for 20 h in dehydrated ethanol. The dried powder was pressed into disk samples and finally sintered at 1100⁰ – 1150⁰C for 4 h in case of traditionally ceramic method and 1050⁰ – 1100⁰C for 2 h and pressure of 20 MPa in case of hot-pressing technology. The ceramic samples reached 96.5% and 97.5% of the theoretical density (TD 4.51g/cm³), respectively. RTG diffraction studies revealed, that Sb⁵⁺ diffused into (K_{0.5}Na_{0.5})NbO₃ lattices and form a solid solution with a single phase orthorhombic perovskite structure and decreased phase transition T_c to 300⁰C. The ceramics exhibited improved density and ferroelectric, piezoelectric properties: d₃₃ = 150 – 180 pC/N, k_r = 0.40 – 0.45, P_r = 18.1 – 22.0 μC/cm², E_c = 8.0 – 10.2 kV/cm.

LATTICE REPRESENTATION OF JOINT HAMILTONIAN AND STOCHASTIC DYNAMICS FOR FIELD INDUCED POLARIZATION SWITCHING

E. Klotins, A. Kuznetsov, and A. Bely

The research is focused on semi-empirical and first-principles based techniques to study the yet largely unexplored aspects of condensed matter physics – time dependent phenomena emerging as a combined effect of thermal environment and alternate driving field.

Far reaching implications concern structural phase transitions in ferroelectric materials which microscopic scale features determined by a connection between classical and quantum physics.

Appropriate model Hamiltonians and the applicability of canonical statistics determine the key conceptual problems managed by application both the empiric Landau Hamiltonians and the first-principles effective Hamiltonians as complementary approaches. As a result the available length scale, much larger than lattice spacing in Landau models reduces down to the spatial period of supercells. The list of application-grade entities includes finite size, spatial inhomogeneity, alternate external field, and electro-elastic effects.

Related mathematical techniques we apply to solve problems emerging from stochastic dynamics include lattice representation of variation approach within the framework of Langevin – Fokker – Planck scheme and its extensions toward symplectic integration. The mathematical techniques are valid for arbitrary model Hamiltonians, dimensionality and boundary conditions. The test solutions include dynamic hysteresis, birth and growth of a ferroelectric domain, and domain switching by driving field.

Aforementioned results contribute to solving many of certainly hard problems associated with the role of grain boundaries, impurities and delocalized electrons essential for applications and as a challenge for future developments.

PATTERNED TEST SAMPLES FOR SCANNING NEAR-FIELD OPTICAL MICROSCOPE BY ELECTRON BEAM LITHOGRAPHY

R. Krutohvastov, A. Kuzmin, R. Kalendarev, and V. Zauls

Electron beam lithography (EBL) is a technique for creating sub micron patterns with high accuracy. Thus makes it attractive for production of test samples for near-field scanning optical microscope. This research is dedicated to find such patterned materials that can be applied for testing luminescence mode of Scanning Near-Field Optical Microscope and to study optical properties of these materials. A good candidate is $ZnWO_4$ because of its stability and it can be easily identified by its luminescence and Raman spectra. Samples of patterned $ZnWO_4$ thin films were prepared by e-beam lithography and magnetron sputtering. Optical properties were studied using Scanning Confocal Raman Microscopy technique.

PERSPECTIVE MATERIALS ON THE BASIS OF Gd-DOPED $LiNbO_3$ SINGLE CRYSTALS

K. Bormanis, M. Palatnikov¹, N. Sidorov¹, and P.G.R. Smith²

A number of papers have reported anomalous thermal behaviour of optical, dielectric and pyroelectric properties and conductivity in both nominally pure and doped $LiNbO_3$ crystals in the 300-400 K range. We have grown single crystals doped with Gd in the concentration range 0.002-0.6 wt.% and studied conductivity, the static and dynamic piezoelectric and dielectric properties in a wide range of frequencies in the 300 – 400 K interval.

A significant anomaly of the $\epsilon'_{33}(T)$ curves of $LiNbO_3:Gd$ single crystals was revealed in the interval of ~340-385K decreasing with the increase of frequency f and virtually disappearing at $f \geq 10kHz$. Within the same interval of temperature an anomaly of increased conductivity is observed in the thermal behaviour of conductivity. The evidence points to relaxation of the observed dielectric anomalies. The findings suggest that, in a wide range including infralow frequencies the dielectric permittivity of $LiNbO_3:Gd$ is due to a single relaxation process of the Debaye type the characteristic relaxation time at room temperature being $\tau \sim 2.5 \cdot 10^{-2}$ sec. Increasing the temperature and annealing for 1-2 hours at $T > 340K$ results in a sharp decrease of the dispersion depth.

As revealed by chemical etching, the $LiNbO_3:Gd$ crystal has a regular domain structure. The discovered low-frequency dielectric dispersion is associated with relaxation of point defects (caused by Gd admixture) interacting with domain boundaries in the initially polydomain crystal. The thermal dependences of both static and dynamic piezoelectric effects showed small values of d_{33} at $T < 340$ K because of apparently a weak natural unipolarity, whereas at temperatures $T > 340$ K corresponding to anomalies of dielectric properties and conductivity the piezomodulus (d_{33}) increases abruptly to a value close to that characteristic of a nominally pure single-domain crystals. The figures of etching connected with the regular domain structure are not observed after the sharp increase of piezomodulus d_{33} . Hence, the $LiNbO_3:Gd$ single crystals may be used to obtain periodically polarized structures for expansion of generating waves in the short-wave range.

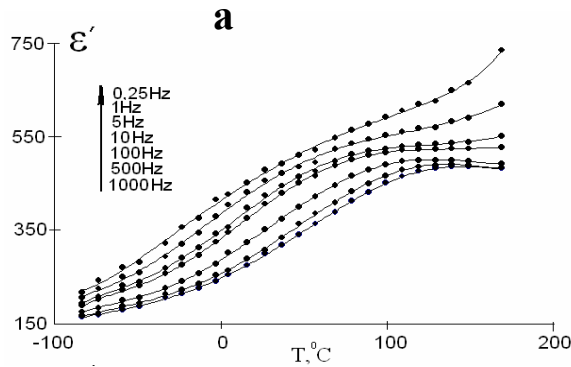
¹ *Institute of Chemistry, Kola Science Centre RAS, Fersman St. 26 a, 184200, Apatity, Murmansk Region, Russia.*

² *University of Southampton, Optoelectronic Research Centre*

LOW FREQUENCY DIELECTRIC RESPONSE OF BaBi₂Nb₂O₉ CERAMICS

K. Bormanis, A. I. Burkhanov*, Yu. V. Kochergin*, V. N. Nesterov*,
A. Kalvane, M. Antonova, and A. Sternberg

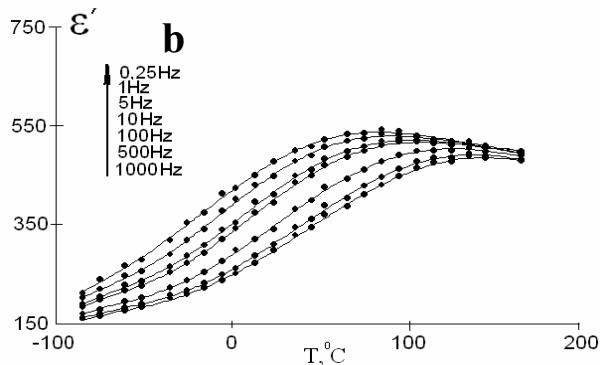
By studying the dielectric properties of BaBi₂Nb₂O₉ ceramics, a representative of layered ferroelectrics, significant dispersion of ϵ^* has been revealed at low- and infra-low frequencies in the region of phase transition (Fig. a).



Dispersion of ϵ^* observed in “low-temperature” region ($T < T_m$) is caused by relaxation of polar formations and their borders. The “high-temperature” dispersion is observed in the region $T > T_m$ where the basic contribution to ϵ^* is provided by processes of the Maxwell-Wagner relaxation. The low-temperature dispersion of ϵ^* is well described by the Cole-Cole equation:

$$\epsilon^* = \epsilon' - i\epsilon'' = \epsilon_\infty + \frac{\epsilon_s - \epsilon_\infty}{1 + (i\omega\tau)^{1-\alpha}}$$

Analysis of thermal behaviour of parameters of the "high-temperature" dispersion caused by relaxation of polarization has allowed to describe the dielectric response of BaBi₂Nb₂O₉ in the region of phase transition as the response of a glass-like system (Fig. b).



*Volgograd State Architectural and Engineering University

Papers 2007

1. I. Aulika, A. Deyneka, V. Zauls, and K. Kundzins. Thermo-Optical Studies of NaNbO_3 Thin Films. *J. Phys.: Conf. Ser.*, 2007, Vol. 93, 012016.
2. I. Aulika, J. Petzelt, J. Pokorny, A. Deyneka, V. Zauls and K. Kundzins. Structural and Optical Studies of NaNbO_3 Thin Films Grown by PLD on SrRuO_3 Bottom Electrode. *Reviews on Advanced Materials Science*, 2007, Vol. 15, No 2, pp. 158-166.
3. G. Bakradze, J. Kajaks, S. Reihmane, R. Krutohvostov, and V. Bulmanis. The Influence of Water Sorption-Desorption Cycles on the Mechanical properties of Composites Based on Recycled Polyolefine and Linen Yarn Production Waste. *Mechanics of Composite Materials*, 2007, Vol. 43, No 6, pp. 573-578.
4. Juras Banys, Robertas Grigalaitis, Algirdas Brilingas, Andris Sternberg, Vismants Zauls, and Karlis Bormanis. Anomalous Broad Distribution of Relaxation Times in Mixed PMN-PSN Ceramics. *Ferroelectrics*, 2007, Vol. 347, pp. 236(30) - 242(36).
5. Juras Banys, Andrius Dziaugys, Algirdas Brilingas, Andris Stenberg, Vismants Zauls, Karlis Bormanis. Broad Distribution of Relaxation Times in 0.6PMN-0.4PZN Relaxor Ceramics. *Ferroelectrics*, 2007, Vol. 353, pp. 3-9.
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LECTURES ON CONFERENCES

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10. E. Klotins, A. Kuznetsov, and A. Bely. Stochastic Dynamics of Ferroelectric Polarization. Programme and Book of Abstracts, p. 127.

Международная конференция «Фазовые переходы, критические и нелинейные явления в конденсированных средах» Махачкала, Россия, 12-15 сентября 2007 г.

1. Ю.В. Кочергин, А.И. Бурханов, В.Н. Нестеров, К. Борманис, А. Калване, М. Дамбекалне. Диэлектрическая нелинейность в области размытого фазового перехода в слоистой керамике BaBi₂Nb₂O₉. Программа, Б2-6. Сборник трудов «Фазовые переходы, критические и нелинейные явления в конденсированных средах», Махачкала, 2007, с. 131-134.
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III Международная научная конференция «Актуальные проблемы физики твердого тела», Минск, Белоруссия, 23-26 октября 2007 г.

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2. Н.В. Сидоров, М.Н. Палатников, К.Я. Борманис. Исследование влияния упорядочения структурных единиц катионной подрешетки и дефектов на физические характеристики монокристаллов ниобата лития разного состава. Программа Г-С-9. Сборник докладов «Актуальные проблемы физики твердого тела», Минск, Издательский центр БГУ, 2007, том 3, с. 221-223.

DEPARTMENT OF SEMICONDUCTOR MATERIALS

Head of Department *Dr.phys. A.Lusis*

Research areas and expertise

- Resource science – resource physics and chemistry
- Electrophysics and electrochemistry of specific semiconductor materials, mixed conductors, ion conductors (transition metal oxides, bronzes, metal hydrates, solid electrolytes, nanostructured and porous materials, composites etc.);
- Material preparation methods: thin and thick film technologies, sol-gel process, leaching;
- Material characterization by spectroscopic methods (Raman scattering, optical and X-ray absorption, EXAFS), electrical and electrochemical impedances, AFM, TGA/DTA, etc;
- Solid state ionics:
 - electro-, photo-, thermo-, chemo- or gaso-chromic phenomena in transition metal oxides,
 - structural changes due to ion intercalation,
 - lattice dynamics and structural and electronic phase transitions,
 - solid state reactions at interfaces electrode – solid electrolyte,
 - gases and ions sensing phenomena and detection technologies;
- Functional coatings and multi layer electrochemical systems;
- Hydrogen absorption phenomena in metals, semiconductors and insulators;
- Development of hydrogen generation equipment and new nano structured materials for hydrogen storage;
- New measurement technologies and instruments with artificial intellect (encl., eNose);
- Development methods and techniques for quality and reliability testing for lead -free joints of PCB

Scientific staff:

- | | |
|----------------------------|---------------------------|
| 1. Dr.phys. P.Cikmacs | 9. Dr.phys. G.Chikvaidze |
| 2. Dr.chem. G. Bajars | 10. Dr.phys A.Kuzmins |
| 3. Dr.phys. V.Eglitis | 11. Dr.phys. A.Lusis |
| 4. Dr.phys. J.Gabrusenoks | 12. Dr.phys. E.Pentjuss |
| 5. Dr.phys. R.Kalendarjovs | 13. Dr.hab.phys. J.Purans |
| 6. Dr.phys. J.Kleperis | 14. Dr.phys. V.Ogorodņiks |
| 7. Dr.phys. J.Klavins | 15. Dr.chem. G.Vaivars |
| 8. Dr.phys. L.Grinberga | 16. Dr.chem. A.Vitins |

Technical staff:

1. A.Kursitis
2. L. Nēmcovs
3. L. Jēkabsons
4. A.Kalinko

Postgraduate students:

1. J. Hodakovska
2. M.Vanags

Students:

1. A.Apals
2. J.Blūms
3. D.Brūveris
4. P. Nazarov,
5. L.Tiļuga
6. J. Timošenko
7. L.Pētersone

Laboratories of Semiconductor Material Division

Laboratory of Solid State Ionics – Head of Laboratory Dr. phys. E.Pentjuss

Laboratory of EXAFS Spectroscopy – Head of Laboratory Dr. hab. phys. J.Purans

Laboratory of Hydrogen and Gass Sensors – Head of Laboratory Dr.J.Kleperis

Mobility / visits:

- February 5 – December 20, 2007, Geesthacht, Germany – J. Hodakovska
- May 22–24, 2007, Aberdin, Scotland (UK) – J. Kleperis.
- June 3-9, 2007, St.Petersburg (Russia) - V. Ogorodnik.
- July 5-21, 2007, Montreal, Canada – L. Grinberga
- July 17-20, 2007, Sibiu, Romania, - J. Hodakovska
- July 30 – August 8, 2007, Belfast, UK – L. Grinberga
- September 22-28, Sudak, Ukraine – L. Grinberga

Cooperation**Latvia**

1. University of Latvia - Department of Chemistry (Prof. J.Tīliks, Dr. A.Vīksna)
2. University of Latvia, Faculty of Medicine, Riga, Latvia;
3. Riga Technical University (RTU) – Faculty of Electronics and telecommunications (Doc. I.Slaidins, Doc. P.Misans)
4. Riga Technical University - Institute of Inorganic Chemistry (Dr. J. Grabis, Dr. I.Zalite, Dr. A. Dindune).
5. Latvian Academy of Science - Institute of Physical Energetics (Prof. N.Zeltins)
6. Latvian Electroindustry Business Innovation Centre (LEBIC).
7. Riga City Council - Environmental Department.

Denmark

RISO National Research Center of Denmark (A.S. Pedersen, F.W. Poulsen)

Estonia

Tartu University - Department of Chemistry (Prof. E.Lust);

France

CRMC-N, Universite de la Mediterranee (Aix-Marseille II) (Marseille, France) - Prof. Y.Mathey, Eng. D. Pailharey, Prof. D. Tonneau.

China

Institute of High Energy Physics, Chinese Academy of Science (Beijing, China) – Prof. Z.Y. Wu.

Czech Republic

Institute of Physics of the Academy of Sciences (Prague, Czech Republic)– Dr.O.Šipr.

Germany

1. Max-Planck-Institut für Festkörperforschung (Stuttgart, Germany) – Prof. J. Maier.
2. Tuebingen University – U. Weimar, N. Papamichail

Italy

1. University of Trento (Trento, Italy) - Prof. G.Dalba, Prof. P.Fornasini
2. IFN-CNR CeFSA (Trento, Italy) - Dr. F. Rocca.
3. Universita della Calabria (Arcavacata di Rende, Italy) - Prof. E.Cazzanelli.
4. Laboratori Nazionali di Frascati, INFN, Frascati (National Lab. of Synchrotron Radiation) – Dr. A. Marcelli

Lithuania

University of Vilnius - Department of Physics (Prof. A.Orliukas)

Norway

Institute for Energy Technology, Kjeller

Poland

University of Warsaw , Department of Chemistry (Prof. A.Czerwinski)

Russia

1. Joint Institute for Nuclear Research (Dubna, Russia) - Dr. S.I. Tjutjunnikov.
2. St. Petersburg University (St. Peterhof, Russia) - Prof. R.A. Evarestov
3. Moscow State Engineering Physics Institute (Moscow, Russia) - Prof. A. Menushenkov.

South Africa

West Cape University, Institute of Advanced Material Chemistry, Porous Media Laboratory (Cape Town, Dr. Linkov).

NEXUS – Network of excellence in multifunctional microsystems (Dr. A.Lusis).

NOSE2 – EC Network of Excellence on Artificial Olfactory Sensing
(Partners from ISSP: Dr.J.Kleperis, Dr.A.Lusis).

Renovation of research equipment and facilities

Purchasing and adaptation of new equipment in Laboratory of ISSP UL (thanks to financial support from Structural Funds of European Community and Latvian Government (Ministry of Education and Science of Latvia):

- Oscilloscope GDS2000;
- Multimeter MTX3250-A;
- Agilent N5700 Series System DC Power Supply.

Main results

NANO STRUCTURED AMOURPHOUSS FILMS BASED ON TUNGSTEN OXIDE

J.Gabrusenoks, G.Bajars, A.Lusis, E.Pentjuss

Symmetry Properties of Lattice Dynamics of W-O Network. The tungsten-oxygen compounds have crystalline lattices with different topology. It determines dynamic behaviour of lattice. $WOCl_4$, WO_2Cl_2 and WO_3 form crystals lattices with one-, two- and three-dimensional network of W-O bonds respectively. In case of $WOCl_4$

octahedron are linked by oxygen and form one dimensional chains –W-O-W-O-. In the two and three dimensional lattice –W-O-W-O-W-O- chains are placed in two or three directions and are mutually perpendicular.

Analysis of the symmetry of lattice vibrations of WOCl_4 , WO_2Cl_2 and WO_3 has been carried out in the work. Symmetry and form of vibrations which correspond to lattice deformation changing to a lower symmetry have been determined. Vibrations involving oxygen and chlorine atom have been identified. Symmetry of vibrations and their activity in IR and Raman spectra has been determined. The results of calculation have been compared with Raman spectra.

Amorphous Films Based On Tungsten Oxide. The model for nanostructured mixed electron-ion conductor thin films have been developed based on thin tungsten oxide films with different microstructure from polycrystalline to amorphous controlled by deposition conditions. Transition metal oxides (TMO) as well as their thin films have applications in different solid-state electronic and ionic devices based on ion insertion/extraction and mixed (ion and electron) conduction phenomenon. The typical representative of such TMO is tungsten oxide, which belongs to group of materials with wide non-stoichiometry. The last is responsible for variety of phases based on $[\text{WO}_6]$ -octahedron sharing in structural units-particles of pure tungsten oxide with nano dimensions and oxygen deficiency during deposition of thin films with different microstructure. The tungsten oxide is good absorber of atomic hydrogen and proton and can be used as injection or insertion electrode in the hydrogen fuel cells as well as hydrogen storage material. The morphology of tungsten oxide films surface and inner pores are responsible for sorption – adsorption efficiency of hydrogen. The typical morphology of amorphous tungsten oxide film ($\sim 1 \mu\text{m}$ thick, deposited by thermal evaporation in vacuum chamber) surface is shown in Figure 1. The amorphous tungsten oxide films have nanostructured morphology with particle size 30-50 nm and physical surface and inner pores area more than $10^6 \text{ cm}^2/\text{g}$.

STRUCTURAL STUDIES OF OXIDE MATERIALS BY X-RAY ABSORPTION SPECTROSCOPY AND SCANNING PROBE MICROSCOPY

J. Purans, A. Kuzmin, R. Kalendarev

EXAFS Spectroscopy Laboratory performs the research and development of nano-sized materials, new experimental methods and procedures of x-ray absorption spectra data analysis. We use complex approach based on a combination of modern experimental techniques such as x-ray absorption spectroscopy (EXAFS/XANES) using synchrotron radiation and atomic force microscopy with advanced data analysis methodologies, based on the use of high performance cluster computing. The main results, obtained in 2007, are described briefly below.

Near field X-ray spectromicroscopy: a new tool for nanoscience

A combination of Local Probe Microscopy and XAS techniques, realised with in the FP6 STRP “X-TIP” project in collaboration with our colleagues from CRMC-N laboratory (Marseille, France) and IFN-CNR CeFSA (Trento, Italy), has been developed using optical luminescence (XEOL) detection by SNOM in AFM mode. The first results obtained with the prototype system at the synchrotron beamline ID03 at ESRF show the possibility to detect an element-specific contrast and to perform nanoscale x-ray absorption spectroscopy experiments at the Zn K and W L_3 absorption edges in mixed zinc oxide-zinc tungstate thin films.

Femtometer-EXAFS: negative thermal expansion in cubic perovskite ReO_3

Negative thermal expansion (NTE) affects a number of systems: a weak NTE is observed, for example, in some tetrahedrally coordinated crystals, like silicon, germanium, GaAs and CuCl, within a small low-temperature interval. Here the NTE effect have been studied in cubic perovskite ReO_3 in collaboration with the University of Trento (Trento, Italy) and IFN-CNR CeFSA (Trento, Italy). The EXAFS has been measured at the Re L_3 -edge in ReO_3 from 30 to 600 K and the x-ray diffraction (XRD) has been contemporarily measured above 300 K at the ESRF using synchrotron radiation. In this way, it has been possible to compare the expansion of the lattice parameter (XRD) and of the bond lengths (EXAFS), measured at the same time. According to our results, ReO_3 shows a complicated behaviour of thermal expansion: (i) ultra low or negative expansion below 100 K, (ii) moderate positive expansion above 150 K up to 500 K, (iii) negative expansion from 500K up to the decomposition temperature. The EXAFS parallel and perpendicular MSRDC (mean square relative displacements) have been calculated for the 1st and 4th shells from experimental data. An unexpected result is that the perpendicular MSRDC of the first coordination shell shows a weak temperature dependence.

XAS study of Jahn-Teller effect in $\text{Sr}(\text{Fe}_x\text{Ti}_{1-x})\text{O}_{3-\delta}$ solid solutions

$\text{Sr}(\text{Fe}_x\text{Ti}_{1-x})\text{O}_{3-\delta}$ perovskites (strontium titanate ferrite solid solution) with well-defined oxygen stoichiometry have been studied in collaboration with the Max-Planck-Institut für Festkörperforschung (Stuttgart, Germany) and ESRF (Grenoble, France) as a function of iron concentration by XRD, Fe and Ti K-edge XAS, and vibration (Raman and infrared) spectroscopy. In reduced $\text{Sr}(\text{Fe}_x\text{Ti}_{1-x})\text{O}_{3-x/2}$ samples, the analysis of the Fe K-edge extended x-ray absorption fine structure indicates the expected presence of oxygen vacancies V_{O} in the first coordination shell of Fe^{3+} ions. In oxidized $\text{Sr}(\text{Fe}_x\text{Ti}_{1-x})\text{O}_3$ samples, the combination of XAS and vibration spectroscopy results yields strong indications for the presence of a Jahn-Teller distortion around Fe^{4+} ions, which is most pronounced for $x \approx 0.03$ and decreases for higher iron concentrations.

RESEARCH AND DEVELOPMENT OF MATERIALS AND DEVICES FOR HYDROGEN ENERGY

J. Kleperis, L. Grīnberga, G. Vaivars*, G. Chikvaidze, G. Bajārs, J. Hodakovska, M. Vanags, V. Nēmcēvs, M. Ērgle¹, J. Blūms¹, D. Bruvers¹, J. Zalāns², J. Vinklers²

Institute of Solid State Physics of University of Latvia;

** In collaboration with University of the Western Cape, Institute of Advanced Material Chemistry, Cape Town, South Africa*

¹Students from Faculty of Physics and Mathematics of University of Latvia

²Students (12th year) from France Lyceum Riga, Latvia

Estimation of hydrogen transfer mechanisms in composite materials for hydrogen storage. Spill-over effect as a hydrogen transfer mechanism is proposed to explain an increased capacity of hydrogen absorption and improvement of hydrogen activation kinetics in composite material based on the AB_5 type metal hydride and powdered glass. A rare earth lanthanum nickel alloy AB_5 with small amount of additives was used as catalyst and bulk material for hydrogen storage, and a borosilicate glass powder with developed surface was applied as a support material. Thermogravimetric technique to determine an absorbed amount of the hydrogen in materials and X-ray powder diffraction analysis for structural investigations was used. The high pressure balance data treatment and calculations showed that hydrogen uptake in the composite alloy AB_5 with glass exceeds the pure alloy that can be explained as the spill-over from the AB_5 catalyst. The

following mechanism is deduced – the hydrogen chemisorbs at the surface sites on the AB_5 cluster. Bridges between the catalyst cluster and glass particles allow the chemisorbed hydrogen to migrate onto the glass surface. Desorption occurs directly from the relatively lower energy glass sites or with migration back to the catalyst, making deeper hydrogenation of an alloy. Hydrogen spill-over depends upon the glass-catalyst contact. The contact changes with the quality of the mixing and milling, as well as the position of alloy AB_5 grains in the mixture.

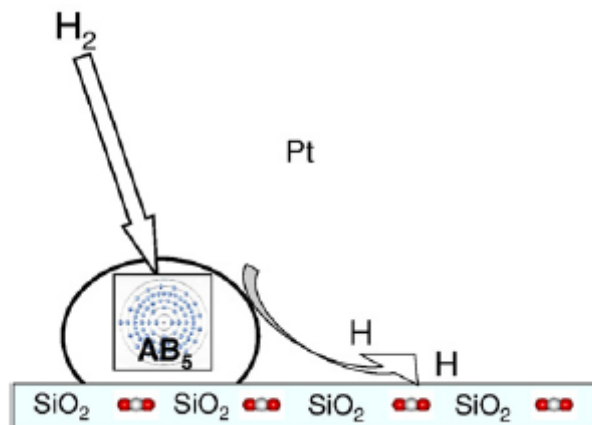


Figure 1. The result from dissociation of hydrogen molecule over the AB_5 cluster is two hydrogen atoms, ready to spill over on the surface of glass phase or to diffuse in the bulk of AB_5 .

Water electrolysis using electrodes with modified surface/volume. Steel (12X18H10T) as the real electrode material is investigated to be used for different electrolysis applications, as the parallel plate electrodes for standard electrolysis in alkaline solutions, as well as the coaxial electrodes for high voltage short pulse electrolysis in water. The increase of catalytic activity of steel electrodes for the hydrogen evolution reaction (HER) in different electrolytes could be easily achieved by co-deposition of metal hydride ($LaNi_5$) particles with electrolytic nickel. From the results obtained it was found that electrodes produced from conventional steel 12X18H10T with high nickel and chromium content are useful for different electrolyzers, as well for classic alkali, as well as for non-traditional high voltage electrolyzers working with deionized water as electrolyte. The increase of catalytic activity of steel electrodes for the HER in different electrolytes could be easily achieved by co-deposition of metal hydride ($LaNi_5$) particles with electrolytic nickel. The results revealed that $Ni + LaNi_5$ with high real surface have a very high activity for the HER, due to the high active surface and specific microstructural features determining the electrocatalytic activity of the investigated alloys. Investigation on the long term performance of the $Ni+LaNi_5$ thin film alloys is the subject of future studies.

Application of micro Raman and FTIR spectroscopy to proton conducting polymer membranes. Raman spectra from virgin (dry) and hydrated in methanol membranes were measured with Ar laser. It was found that sulfonated tetrafluoroethylene copolymer membrane Nafion® NRE-212 after hydration in methanol reveals intense molecular vibration peaks in the spectral region where O-H bond vibrations in methanol exist. For the first time the Raman and IR spectra are reported of FumaSep membranes. Raman spectra of caustic stable ion exchange membrane FAA in dry condition is poorly resolved due to very high luminescence under excitation with Ar laser, but after hydration in methanol the molecular vibration peaks in spectra are well-resolved. Most of peaks in vibration spectra of membranes are interpreted with C-F, C-S, C-O-C, SO_3 , C-C bonds, nevertheless the region connected with hydrated protons and H-O bond is poorly analysed. Vibration spectra of membranes hydrated in methanol are firstly reported.

The sulphonated poly(ether ether ketone) (SPEEK) ionomers were synthesized using original and simple method (patent application is in preparation). Homogeneous proton-conducting membranes were developed from the obtained SPEEK by solvent casting method. Membranes were assessed for their suitability in fuel cell applications. The membranes were characterized by FTIR to confirm sulphonation, and DSC and TGA to investigate the thermal stability. The proton conductivities of such membranes were found to be excellent in the order of 10⁻² S/cm in the fully hydrated condition at room temperature. The durability of the membranes was also tested.

Classical and unconventional aspects of water electrolysis. Classical electrolysis using alkali has some disadvantages as extra heat, interaction between electrodes and alkali, but PEM based devices are expensive due platinum based catalyst used for both electrodes. Water electrolysis is known from M. Faraday's experiments already 3 centuries, however, investigations, how to split water with a less energy, still are very actual. In our work the resonant electrostatic phenomena of water fracturing is investigated. The distilled water is used as electrolyte, and simple steel plates are electrodes. Constructed device is forming capacitor, where water is serving as dielectric layer. In the serial connection with induction-coil, capacitor forms serial oscillation circuit. The resonance of alternative current (AC) voltage must be observed at certain frequency. It is expected, that there will be remarkable water splitting at the resonance frequency, because the bonds between atoms in water molecules can be disrupted and formed gas species evaporate out. Two and three electrode measurements were made, using standard calomel reference electrode. Different nickel and carbon electrodes (plate, porous and textile -type) were used to learn classical Faraday electrolysis in strong alkali solutions. Flying increase of current was indicator of the presence of electrolysis, and characteristic potential was used to differ between materials accordingly they effectiveness for usage in an electrolyser device.

NANOSTRUCTURED MATERIALS FOR SORPTION OF PHYSIOCHEMICAL ACTIVE SUBSTANCES AND HEAVY METALS

V. Eglitis, A. Vitiņš, A. Lusiš, G. Dobeļe*, G. Veveris, E. Pentjušs, L. Pētersone**,

**Institute of wood chemistry*

*** Student Physics & Mathematics faculty of UL*

Influence of ultrasound on leaching kinetics of glass fibers and pores structure. The leaching is very sensitive to temperature T , time t and ultrasonic power $P \cdot t$. These parameters (T , P and t) have to be optimized for nanostructuring glass fibers. The data of isothermal analyses are giving the wide pore spectrum in range 3-160 nm. The AFM analyses of surface morphology are giving size of nanopores in range from 2 to 15 nm with depth at least 5 nm. Sodium aluminosilicate glass fibres in the leaching process occur degradation in shape of longitudinal cracks. The total pour volume and surface are 160 cm³/g un 0,1 m²/g for pore size 10 nm. The optimization of leaching process is in progress.

Experimentally have been tested the influence of ultrasound on the leaching process of the E-glass fibers. The leaching had been done in 1N H₂SO₄ solution at 90±2 °C. The reference weight losses of E-glass fibers for comparison of ultrasound influence have been measured for leaching time 30 minutes. The weight losses for glass fibers leached with ultrasonic is up to 20%, but without US is 8,7-11,8%.

During leaching process the non silica oxides are solved in acid and pores and hydrated compounds in SiO₂ network are formed. For determination of ultrasound influence the leaching time had been varied and TGA/DTA-grammas and sorptometry data analyzed. The ultrasonic shifted pores distribution to micropores direction reduced

volume of mesopores and stimulated the shrinking of glass fibers – reduced amount of adsorbed H₂O. The ultrasonic reduced the leaching time too.

The dielectric properties of different glass fibre fabrics had been used to determine influence of leaching. An impedance meter HP 4284A was found to be a better choice for these measurements in comparison with HP 4194A. Impedance was measured with HP 4284A in the frequency range 100 Hz – 1 MHz. Frequency dependences of relative dielectric permittivity, ϵ , and dissipation factor, D, were obtained. The values of the packing density have been calculated from the respective values of the weight and the thickness. The black glass fibre fabric TG 125P (weight 128 ± 10 g/m², thickness 0.19 mm) was found to have a direct current conductivity of $1.33 \cdot 10^{-6}$ S/m.

SOLID STATE IONICS – RESOURCE SCIENCE AND SUSTAINABLE DEVELOPMENT

G. Bajārs, A. Lūsis, Ē. Pentjušs

Participation of ISSP in two EC financed projects “GreenRoSE” and “EcoDesign” as well as in activities organized by Ministries of Economics and Environment (for example, investigation contract EM 2006/11: “Handbook for implementation of RoHS directive in Latvian E&E industry”), from one side, and from other side - EU concept of Sustainable Development and Lisbon strategy give us possibility to continue new research area related to resources science.

Now one of basic issues of knowledge based economy is sustainable development. We need technologies and products with zero impact on environment, e.g. clean technologies and products with minimal material and energy consumption. The civilization faces-off with resource problems, first of all with energy resources. Now the civilization faces before challenge what we have to do. The material science and solid-state ionics close related to such technologies, for example, technologies of electrochemical energy generation and accumulation. We have to create new area of knowledge based on natural sciences (physics, chemistry and biology) named resource science (resource physics, resource chemistry and resource biology).

The first steps to build up some framework as driving force is EU directives (RoHS and EuP–EcoDesign) and activities of implementation of them.

ACTIVITIES FOR IMPLEMENTATION OF THE “GreenRoSE” PROJECT ON LEAD-FREE SOLDERING ACCORDING EC “RoHS” DIRECTIVE

Ē. Pentjušs, G. Bajārs, A. Vītiņš, A. Lūsis

Lead-free soldering quality and reliability laboratory. According tasks of EC FP6 project “GreenRoSE” in ISSP have been set up soldering quality laboratory to help the local small and medium enterprises to change the technologies to lead-free and solve associated problems. Available services for quality and reliability testing:

Tests for lead-free materials applied in PCB assemblies

1. Chemical test methods
2. Mechanical test methods
3. Flammability
4. Miscellaneous for analysis of RoHS Directive restricted elements and materials

Tests for PCB with lead-free finishes

1. Visual and dimensional examination
2. Surface conditions tests
3. Mechanical test methods*
4. Electrical tests

5. Environmental tests

Tests for lead free components for SMT and THT

1. Visual and dimensional examination
2. Surface conditions tests

Tests for PCB assemblies

1. Visual and dimensional examination
2. Miscellaneous test (Analysis of metallographic cross-section of solder joints; pull test)

Prepared and published (in Latvian) guidelines about RoHS and handbook for SMEs on internet: http://www.em.gov.lv/em/images/modules/items/item_file_13148_1.doc

http://www.letera.lv/pic/rohs_direktiva.doc

Tritium sorption, desorption and release from beryllium tiles under temperature, electron radiation and magnetic field

Juris Tīliks*, Gunta Ķizāne*, Aigars Vītiņš, Elīna Kolodinska*, Juris Tīliks Jr.*,
Ingars Reinholds*, Vija Tīlika*, Bronislavs Leščinskis*;

* - Laboratory of Radiation Chemistry of Solids, Institute of Chemical Physics,
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Tritium release at annealing of samples cut from beryllium tiles exposed to D+D, D+T plasma in the Joint European Torus (JET) was investigated under 5 MeV fast-electron radiation of the dose rate 14 MGy/h and in magnetic field of 1.7 T separately and simultaneously in order to evaluate possible effects of these factors. Abundances of chemical forms of tritium – molecular T₂ (44%), atomic T⁰ (42%), and ionic T⁺ (14%) and their distribution were determined in the plasma-exposed beryllium samples with lyomethods. Fast-electron radiation considerably increased the fractional tritium release at annealing by a factor of approx. 5. Magnetic field increased the fractional tritium release at annealing both without and under electron radiation by approx. 25%. Irradiation with fast electrons increased the sorption of tritium from 3.4 to 6.2 kBq/cm² at about 1 Pa of T₂ at 773 K for 3 h in samples cut from an unused beryllium tile, magnetic field increased the sorption of tritium to 4.5 kBq/cm², but the simultaneous action of magnetic field and radiation did not change the amount of the tritium sorbed. The most part of the tritium sorbed was localized in subsurface layers up to depth of 80 μm of the beryllium samples.

Results on radiation and magnetic field (MF) effects on tritium release at annealing of the beryllium pebbles from the EXOTIC-8-3/13 irradiation were obtained and compared with those for other irradiated beryllium materials. Abundance ratios of chemical forms of tritium in the EXOTIC-8-3/13 beryllium pebbles were determined: T₂ – 65%, T⁰ – 23%, T⁺ – 12%. A complete detritiation of these pebbles was achieved at 1123 K for 4 h; MF of 2.35 T had no appreciable effect on the tritium release. At 991K for 4 h, the degree of detritiation was 96.6% without MF; MF of 2.35 T decreased it to 86.7%. At 940 K for 47 min, the degree of detritiation was 60%, 5 MeV fast-electron radiation of 14 MGy/h increased it to 76%, but the simultaneous action of the fast-electron radiation and MF of 1.7 T increased it to 88%.

Organized Conferences:

May 30, June 2, 2007, NORSTORE conference/workshop was held in Sigulda, Latvia. This year, 23 participants from 7 different countries attended the annual NORSTORE conference. In conference program was included presentations from the project leaders, 9 PhD- and postdoc scholarship holders, and 3 invited speakers. The conference was organized by

Institute of Solid State Physics of University of Latvia and Institute for Energy Technology (IFE, Norway) on behalf of Nordic Energy Research (NER). The workshop was opened by Dr. Janis Kleperis (University of Latvia), project manager Volodymyr A. Yartys (IFE), and Dainis Garancs (Executing Director of the Latvian Hydrogen Association). Birte Holst Jørgensen (Director of Nordic Energy Research) gave an excellent overview of the Hydrogen Activities at NER, while Andzela Petersone (Climate and Renewable Energy Department, Latvia) contributed to the conference with an overview of the Renewable Energy Policy and Practice in Latvia. Prof. Hirohisa Uchida (Tokai University, Editor of *J. Alloys & Compounds*) gave an admirable presentation on Metal Hydride Freezer Systems as Eco-Technology, while project manager Prof. Volodymyr A. Yartys (Institute for Energy Technology) very elegantly summarized the main project outcomes in his presentation NORSTORE 2002-2007: 5 Years of Nordic and Regional Collaboration on Hydrogen Storage.

Scientific Publications

1. L.Gringera, J.Hodakovska, J.Kleperis, G.Vaivars and J.Klavins. Electrochemical hydrogen storage and usage aspects: Nickel electrode in acidic electrolyte. *Russian Journal of Electrochemistry*, 43, 5 (2007) 598-602.
2. L. Gringera, J. Kleperis, Development of new composite materials for hydrogen storage. *Journal of Physics: Conference Series* 93 (2007)
3. M. Vanags, J. Kleperis, G. Bajars, A. Lusiš, Water electrolysis using electrodes with modified surface/volume. *Journal of Physics: Conference Series* 93 (2007).
4. G. Chikvaidze, J. Gabrusenoks, J. Kleperis, G. Vaivars, Application of micro Raman spectroscopy to industrial FC membrans. *Journal of Physics: Conference Series* 93 (2007)
5. J. Kleperis, L. Gringera, M. Ergle, G. Chikvaidze, J. Klavins, Thermogravimetric research of hydrogen storage materials. *Journal of Physics: Conference Series* 93 (2007)
6. M. Vračar, A. Kuzmin, R. Merkle, J. Purans, E. A. Kotomin, J. Maier and O. Mathon, Structural studies of $\text{Sr}(\text{Fe}_x\text{Ti}_{1-x})\text{O}_{3-\delta}$ solid solutions by XAS, XRD and vibrational spectroscopy, *Phys. Rev. B* 76 (2007) 174107:1-12.
7. N.D. Afify, G. Dalba, C. Armellini, M. Ferrari, F. Rocca and A. Kuzmin, Local structure around Er^{3+} in $\text{SiO}_2\text{-HfO}_2$ glassy waveguides using EXAFS, *Phys. Rev. B* 76 (2007) 024114:1-8.
8. J. Purans, G. Dalba, P. Fornasini, A. Kuzmin, S. De Panfilis and F. Rocca, XAFS and XRD studies with subpicometer accuracy: The case of ReO_3 , *AIP Conf. Proc.* 882 (2007) 422-424.
9. J. Purans, A. Kuzmin, E. Cazzanelli and G. Mariotto, Disorder-induced Raman scattering in rhenium trioxide ReO_3 , *J. Phys.: Condens. Matter* 19 (2007) 226206 (8pp).
10. V. Efimov, E. Efimova, D. Karpinskii, D.I. Kochubey, V. Kriventsov, A. Kuzmin, S. Molodtsov, V. Sikolenko, S. Tiutiunnikov, I.O. Troyanchuk, A.N. Shmakov and D.Vyalikh, XAFS and neutron diffraction study of $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$, *Phys. stat. sol. (c)* 4 (2007) 805-808.
11. V.V. Efimov, E. Efimova, D. Karpinsky, D.I. Kochubey, V. Kriventsov, A. Kuzmin, S. Molodtsov, V. Sikolenko, J. Purans, S. Tiutiunnikov, I.O. Troyanchuk, A.N. Shmakov and D. Vyalikh, XAFS and neutron diffraction study of $\text{La}_{1-x}\text{Sr}_x\text{Co}_{1-y}\text{Nb}_y\text{O}_3$, *Nucl. Instrum. and Methods A* 575 (2007) 176-179.

12. A. Kuzmin, R. Kalendarev, A. Kursitis and J. Purans, Confocal spectromicroscopy of amorphous and nanocrystalline tungsten oxide films, *J. Non-Cryst. Solids* 353 (2007) 1840-1843.
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14. J. H. Agondanou, I. Nicolis, E. Curis, J. Purans, G. A. Spyroulias, A. G. Coutsolelos, and S. Benazeth, Gadolinium Acetylacetonate Tetraphenyl Monoporphyrinate Complex and Some of Its Derivatives: EXAFS Study and Molecular Dynamics Simulation, *Inorg. Chem.* 46 (2007) 6871-6879.
15. M. Castriota, E. Cazzanelli, G. Das, R. Kalendarev, A. Kuzmin, S. Marino, G. Mariotto, J. Purans and N. Scaramuzza, Proton Presence and Motion in Rhenium Oxide Films, *Mol. Cryst. Liq. Cryst.* 474 (2007) 1-15.
16. D. Pailharey, Y. Mathey, F. Jandard, S. Larcheri, F. Rocca, A. Kuzmin, R. Kalendarev, J. Purans, G. Dalba, R. Graziola and O. Dhez, Nanoscale x-ray absorption spectroscopy using XEOL-SNOM detection mode, *J. Phys.: Conf. Series* 93 (2007) 012038 (5 pp).
17. A. Kuzmin, S. Larcheri and F. Rocca, Zn K-edge XANES in nanocrystalline ZnO, *J. Phys.: Conf. Series* 93 (2007) 012045 (6 pp).
18. A. Lūsis, V. Eglītis, G. Vēveris. Influence of surface modification on physiochemical properties of glass fibers. Iesniegts publicēšanai *Journal of Physics: Conference Series* (2007).
19. E. Pentjuss, V. Eglītis, A. Lūsis. "Mecmesin test stand (MultiTest 1-i model) for mechanical testing of PCB". *Latvian Journal of Physics and Technical Sciences*, No.5, 2007, p.51-61.
20. G. Veveris, V. Eglītis, A. Lūsis, D. Erts. Effect of temperature on the micropore sizes in leached NaAlSi glass fibres. *Latvian Journal of Physics and Technical Sciences*, 2007, No.4, p 63-68.
21. J. Tīliks, G. Ķizāne, A. Vītiņš, E. Kolodinska, E. Rabaglino. Magnetic field effects on tritium release from neutron-irradiated beryllium pebbles. – *Nuclear Technology*. September 2007. Vol. 159. No. 3. Pp. 245-249.
22. A. Vītiņš, G. Ķizāne, J. Tīliks, J. Tīliks Jr., E. Kolodinska. Tritium release from breeding blanket materials in high magnetic field. – *Fusion Engineering and Design*. October 2007. Vol. 82. Nos. 15-24. Pp. 2341-2346.

Participation in Conferences

1. **23th Scientific Conference of Physics of Institute of Solid State Physics of University of Latvia, February 13-15, 2007,:**
 - 1) E. Pentjuss, G. Bajars, A. Lūsis „Reliability testing of printed circuit boards to mechanical deformation”. Abstracts, p.82.
 - 2) J. Blums, M. Vanags, J. Kleperis, Water electrolysis at different current – voltage regimes. Abstracts, p.54.
 - 3) D. Bruvers, J. Blums, J. Kleperis, Properties of gas electrodes for different metals and composites. Abstracts, p.55.

- 4) J. Hodakovska, L. Grinberga, J. Kleperis, Electrodes for fuel cells – facilities and results. Abstracts, p.56.
- 5) M. Vanags, V. Nemcevs, J. Kleperis, Classical and unconventional aspects of water electrolysis. Abstracts, p.57.
- 6) L. Grinberga, J. Kleperis, Amount of absorbed hydrogen in materials as a case of the particle size and local environment. Abstracts, p.58.
- 7) A. Apals, L. Tiluga, J. Kleperis, Reference classes for breath analysis of different groups of responding people. Abstracts, p.70.
- 8) L. Tiluga, A. Apals, J. Kleperis, Measurement technique of breath for different groups of responding people and sportists. Abstracts, p.77.
- 9) V. Ogorodnik, J. Kleperis, N. Jurks, I. Taivans, The possibility of diseases diagnostic by the electronic nose: lung`s diseases patients. Abstracts, p.84.
- 10) J. Tiliks, G. Kizāne, A. Vītiņš, E. Kolodinska, B. Leščinskis. Tritium sorption and desorption from fusion reactor plasma facing materials. Abstracts, p.49.

2. International Baltic Sea Region Conference “Functional materials and nanotechnologies” FM&NT-2007, Riga, April 2-4, 2007:

- 1) L. Grinberga, J. Kleperis, Development of new composite materials for hydrogen storage. Abstracts, p.43.
- 2) M. Vanags, J. Kleperis, G. Bajars, A. Lūsis, Water electrolysis using electrodes with modified surface/volume. Abstracts, p.44.
- 3) G. Chikvaidze, J. Gabrusenoks, J. Kleperis, G. Vaivars, Application of micro Raman spectroscopy to industrial FC membrans. Abstracts, p.45.
- 4) J. Kleperis, L. Grinberga, M. Ergle, G. Chikvaidze, J. Klavins, Thermogravimetric research of hydrogen storage materials. Abstracts, p.109.
- 5) J. Kalnacs, V. Grekhov, A. Murashov, J. Kleperis, Fullerenes and nanotubes in energy production. Abstracts, p.110.
- 6) J. Tiliks, V. Tilika, G. Kizane, B. Leschinskis, A. Vitins, A. Actins. Tritium breeding ceramic pebbles synthesized from nanopowders. Abstracts, p.21.

3. International conference Eco-Balt 2007 May 11-12, Riga:

- 1) J. Kleperis, Air quality in Riga: monitoring results 2006, indicated problems. Abstracts, p.105-106.
- 2) M. Vanags, J. Kleperis, Position of hydrogen energy in Latvian economics; Abstracts, p.109.
- 3) L. Grinberga, M. Vanags, J. Kleperis. Vision on ecological and self-sufficient house based on hydrogen energy; Abstracts, p.110.
- 4) G. Bajārs, A. Lūsis, Ē. Pentjušs, J. Smilga. „Implementation of RoHS directive in electrical and electronics sector of Latvia” – poster.
- 5) G. Bajārs, A. Lūsis, Ē. Pentjušs „An ecodesign study course at the University of Latvia” - oral

4. 8th International Symposium on Systems with Fast Ionic Transport, (8 ISSFIT), May 25-29, 2007, Vilnius (Lithuania):

- J. Kleperis, L. Grinberga, G. Bajars, G. Vaivars, A. Lūsis. Estimation of hydrogen transfer mechanisms in composite materials. Abstracts, p.48.

- 5. International Symposium on Olfaction and Electronic Nose ISOEN`07, May 3-5, 2007. St.Petersburg (Russia):**
V.Ogorodnik, J.Kleperis, I. Taivans, N. Jurka, M. Bukovskis. Identification of the lung diseases by an electronic nose..
- 6. Scientific seminar of Deutsche Bundesstiftung Umwelt July 9-13, 2007, Osnabrück, Germany:**
J. Hodakovska. Basics of hydrogen energy: materials and devices for hydrogen production, storage and usage;
- 7. Scientific Seminar of GKSS Forschungszentrum GmbH, Hamburg, Germany:**
J. Hodakovska, „SPEEK and Polyaniline Composite membranes for Fuel Cells”
- 8. 2nd International Hydrogen Energy Congress and Exhibition IHEC 2007; Istanbul, Turkey, 13-15 July 2007:**
M. Vanags, P. Shipkovs, J. Kleperis, G. Bajars and A. Lusiš. Water electrolysis: unconventional aspects.
- 9. RTU Annual Scientific Conference, Section “Power and Electrical Engineering”, October 12-13, 2007, Riga (Latvia):**
L. Grinberga, J. Kleperis. The role of different binders in the formation of cathode for metal hydride batteries.
- 10. International conference on nanomaterials NANOVED`2007, November 11–14, 2007, Bratislava (Slovakia):**
G. Chikvaidze, Hongze Luo, G. Vaivars, J. Kleperis. Characterization of sulfonated poly(ether ether ketone) polymer electrolyte for fuel cells by FTIR spectroscopy..
- 11. International Baltic Sea Region conference “Functional materials and nanotechnologies”, Riga, April 2-4, 2007, Latvia:**
A.Kuzmin, R.Kalendarev, J.Purans (oral and poster presentations).
- 12. Invited talk at Kurchatov Center for Synchrotron Radiation and Nanotechnology, July, 2007, Moscow, Russia**
A.Kuzmin (oral presentation).
- 13. E-MRS Fall Meeting, September 17-21, 2007, Warsaw, Poland**
A.Kuzmin, R.Kalendarev, J.Purans (oral presentation).
- 14. Invited talk at the COE international symposium “Atomistic Fabrication Technology”, Icho-Kaikan, Osaka University, Suita, Osaka, Japan, October 15-17, 2007:**
J.Purans (oral presentation).
- 15. Invited talk at post-graduate school „Giornate di studio: metodi di caratterizzazione dei materiali”, Politecnico di Milano, December 4, 2007 :**
A.Kuzmin (oral presentation).
- 16. XVIII International School-Seminar ‘Spectroscopy of molecules and crystals’, 20.09.-27.09.2007, Berezove, Crimea, Ukraine:**
J. Gabrusenoks, Symmetry Properties of Lattice Dynamics of W-O Network, Abstracts, p.113.
- 17. 21st IAEA Fusion Energy Conference, held in Chengdu, 16-21 October 2006, China:**
G. Kizane, J. Tiliks, A. Vitins, E. Kolodinska. Influence of high magnetic field on fusion reactor blanket processes. – The Proceedings available online at: http://www-naweb.iaea.org/naweb/physics/FEC/FEC2006/papers/ft_p5-17.pdf

18. 8th International Symposium on Fusion Nuclear Technology (ISFNT-8), Heidelberg, Sept. 30 – Oct. 5, 2007, Germany:

J. Tiliks, G. Kizane, A. Vitins, E. Kolodinska, V. Tilika, B. Lescinskis. Tritium release from beryllium materials under the real operation conditions. The book of abstracts is available online at <http://iwrwww1.fzk.de/isfnt/boa-isfnt-8.pdf>.

19. 8th IEA International Workshop on Beryllium Technology (BeWS-8), Lisbon, December 5-7, 2007, Portugal:

G. Kizane, J. Tiliks, A. Vitins, E. Kolodinska, A. Supe, B. Lescinskis. Detritiation of Be materials under action of temperature, radiation and magnetic field. –The book of abstracts is available online at <http://iwrwww1.fzk.de/bews-8/BoA-BeWS8.pdf>

LABORATORY OF DIDACTIC SYSTEMS

Head of Laboratory – Prof., Dr.phys. J.Kuzmin

Research Area and Main Problems

Research field of the Laboratory is related to

- investigation of possibilities to use internet technology to create new methods of e-education;
- development, application and education on cluster computing.

Scientific Staff

1. Prof.,Dr.phys. J.Kuzmin
2. Dr.phys. A.Kuzmin

Students

1. Aizupietis Jānis
2. Balode Baiba
3. Ločmele Agnese
4. Mendiks Aigars

Didactic Laboratory activities at the University of Latvia

1. LU PPF “Internet and Intranet” – lectures, Prof. J.Kuzmin.
2. LU PPF “Operational Systems” – lectures, Prof. J.Kuzmin.
3. LU PPF “System Approach” – lectures, Prof. J.Kuzmin.
4. LU PPF “Informatics for Educators” – lectures, Prof. J.Kuzmin.
5. LU PPF “Modern Educational Environments” – lectures, Prof. J.Kuzmin.
6. LU PPF “Introduction to programming languages” – lectures, Prof. J.Kuzmin.
7. LU PPF “Knowledge testing Systems” – lectures, Prof. J.Kuzmin.
8. LU PPF “Introduction to Cluster Computing” – lectures, Dr. A.Kuzmin.

Scientific Visits Abroad

1. Prof. J.Kuzmin, USPU, Ural State University, Yekaterinburg, Russia
2. Dr. A.Kuzmin, IFN-CNR, Institute for Photonics and Nanotechnologies, Section "CeFSA", Trento, Italy

Cooperation

Latvia

1. LU Faculty of Education and Psychology (Prof.. A.Geske, lect. L.Kuzmina)
2. Fond of Latvian Education (Z.Grinpauks)
3. Latvian schools

Italy

1. IFN-CNR CeFSA (Trento, Italy) - Dr. F. Rocca.

Russia

1. Ural State Pedagogical University (dean of Informatics Faculty, M.Lapionok)

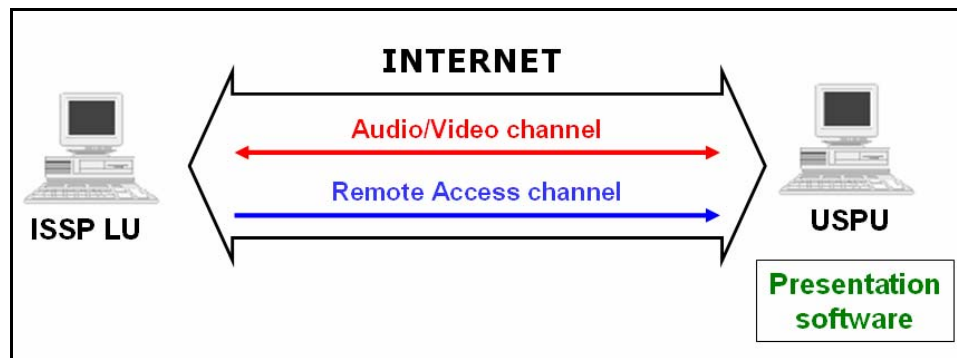
Main Results

During the year 2007, the Didactic System Laboratory was specialised in the investigation of the internet technologies for the implementation of the online real-time teaching system and in the further development of the Latvian SuperCluster (LASC) system. Main results are described briefly below.

- *Internet technology in the e-education applications.*

This part of investigations was devoted to the real-time online teaching problem. Main idea of the investigation consists in the analysis of existing software alternatives for e-lectures realisation. All work was done in cooperation with Ural State Pedagogical University (USPU).

Technology, based on three components – voice/video-over-IP, remote access and presentation software, was found to provide currently the best solution for online teaching problems. We have utilized the SKYPE software for a voice/video-over-IP transmission; the VNC (Virtual Network Communication) program to control remotely a PC situated in USPU and MS PowerPoint software as an e-lectures presentation software. However, other analogous software can be also used.



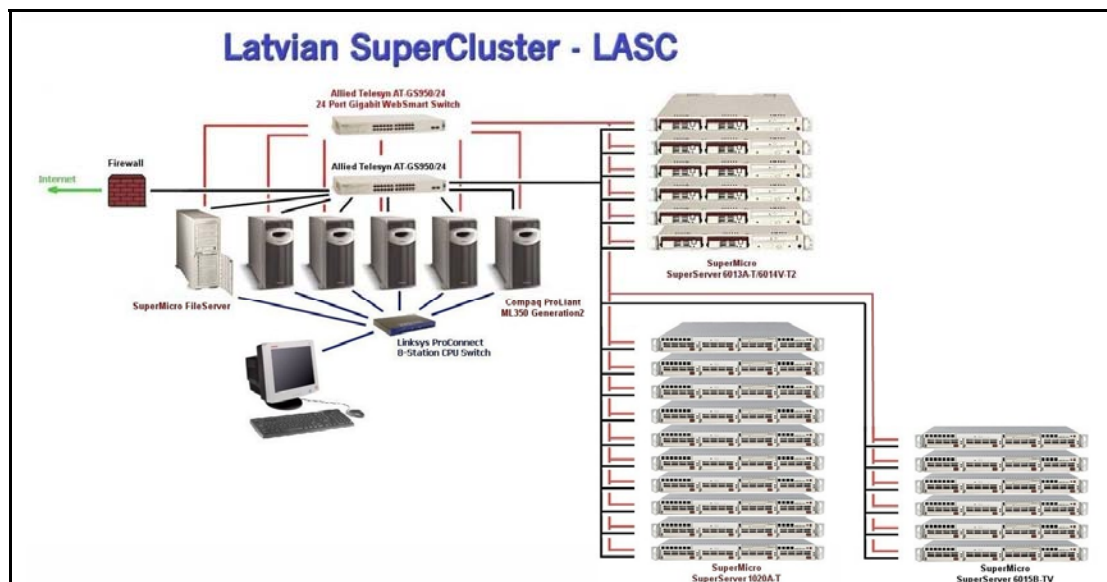
The e-lectures process was organized in the following way. A lector at the Latvian University used Skype and VNC on the own PC to deliver audio/video information through the internet to the USPU students. Audio information was synchronized with visual information provided by the presentation software such as MS PowerPoint on USPU PC. As a result, USPU students received in real-time visual information with audio comments. USPU students could also ask questions to the LU lector.

An approbation of this system proved feasibility of the online real-time e-lectures, based on currently available rather simple software and communication technologies.

- *Developments of the Latvian SuperCluster (LASC) system.*

Further developments of the LASC system has been performed during the last year. LASC is a Beowulf-like Linux cluster project, developed at the ISSP starting from 2002.

The cluster is running the RedHat Linux operating system and consists presently of 28 heterogeneous (Pentium III/XEON/Opteron) nodes: one front-end (master) node used as a file server, and 27 computational nodes. The nodes are interconnected by two local area networks (LANs) operated through four 24-ports Gigabit Ethernet switches. The first LAN is used for file exchange and communication purposes, whereas the second LAN is dedicated for data exchange during parallel computations. The resources available to the users are 110 CPUs, having the theoretical peak performance of about 218.9 GFLOPS, 220 GB RAM memory and 10.3 TB total hard disk space.



The detailed information on the cluster configuration, its resources, and different useful documentation/links are available at the LASC website (<http://www.cfi.lu.lv/lasc/>). The website provides also with real-time status monitoring of the LASC activity. The experience gained during development of the LASC system is presently used within the lecture course "Introduction to Cluster Computing" at LU PPF.

Scientific Publications

1. J.Kuzmins, A.Gazeikina, M.Lapionoka, „Distance Education technologies in informatics students training", Proceedings of International Conference “Quality of informatics and physics teachers training.”, Russia, Yekaterinburg, April 2007, 63-69.pp.
2. J.Kuzmins, L.Kuzmina, Notions based education model. Proceedings of Contemporary Problems of Higher Education. 3.International Conference, Russia, Yekaterinburg, September 2006, 32-40.pp.

Participation in Conferences

1. J.Kuzmins, L.Kuzmina, Bāzes zināšanas skolas informātikā. LU 65. Zinātniskā konference. 2007. feb.
2. J.Kuzmins, Ž. Sedaja, Daži izglītojamo modeļu aspekti. Zinātniskā konference. 2007.
3. J.Kuzmins, A.Gazeikina, M.Lapionok, „Distance Education technologies in informatics students training" Quality of informatics and physics teachers training. International Conference. Russia. Ekaterinburg. 2007.april.
4. J.Kuzmins, Internetmācīšana. Izglītības zinātne un inovācijas mūsdienai. Jūrmala.
5. J.Kuzmins, L.Kuzmina, Notions based education model. Proceedings of Contemporary Problems of Higher Education. Proceedings of 3.International Conference. Russia. Ekaterinburg. 2006.sept.

LABORATORY OF THEORETICAL PHYSICS AND COMPUTER MODELING

Head of Laboratory *Dr. hab. phys. Eugene Kotomin*

Research Area and Main Problems

Our theoretical research interests are focused on five classes of problems related to:

- kinetics of diffusion-controlled processes, with emphasis on pattern formation and catalytic surface reactions;
- the atomic and electronic structure of numerous advanced materials, with emphasis on calculations of properties of defects, surfaces, metal/insulator interfaces.
- theoretical simulations and experimental studies of nanostructures and nanomaterials;
- stochastization of magnetic field lines in magnetized fusion plasma;
- gyrotron development.

We combine several different techniques, including analytical formalisms and large-scale computer simulations (quantum chemical methods, stochastic simulations as well as Monte Carlo/cellular automata modeling).

Scientific staff

1. Dr. hab. E. Kotomin
2. Dr. hab. V. Kuzovkov
3. Dr. O. Dumbrajs
4. Dr. Yu. Zhukovskii
5. Dr. A. Popov
6. Dr. R. Eglitis
7. Dr. G. Zvejnieks
8. Dr. S. Piskunov
9. Dr. D. Gryaznov
10. Dr. V. Kashcheyevs

PhD students

11. Yu. Mastrikov
12. D. Bocharov
13. A. Gopejenko

Scientific visits abroad

Dr. hab. E. Kotomin, EC Institute of Transuranium Elements, Karlsruhe, Germany (7 months), Max Planck Institute for Solid State Research, Stuttgart, Germany (3 months).

Dr. O. Dumbrajs, Fukui University, Japan (3 months), Max Planck Institut für Plasmaphysik, Garching, Germany (3 months).

Dr. Yu. Zhukovskii, Northwestern University, Evanston, USA (4 months), Max Planck Institute for Solid State Research, Stuttgart, Germany (3 weeks), Institute for Materials Research I, Karlsruhe (3 weeks), National Laboratory of Frascati, Italy (2 weeks), St. Petersburg State University, Russia (2 weeks), EC Institute of Transuranium Elements, Karlsruhe, Germany (1 week).

Dr. A. Popov, Institute Laue-Langevin, Grenoble, France (7 months), National Laboratory of Frascati, Italy (1 month).

Dr. R. Eglitis, Sung Kyun Kwan University, Suwon, Korea (4 months) and Rutgers University, USA (5 months)

- Dr. S. Piskunov, Forschungszentrum Jülich, Germany (5 months), Northwestern University, Evanston, USA (3 months), University of Duisburg-Essen (2 months), LNF Frascati, Italy (1 week)
- Dr. D. Gryaznov, EC Institute of Transuranium Elements, Karlsruhe, Germany (10 months), Max Planck Institute for Solid State Physics, Stuttgart, Germany (1 month).
- V. Kashcheyevs, [Ben-Gurion University of the Negev, Beer-Sheva, Israel](#) (8 months), Physikalisch-Technische Bundesanstalt, Braunschweig, Germany (1 month).
- Yu. Matrikov, Max Planck Institute for Solid State Research, Stuttgart, Germany (11 months).
- A. Gopejenko, Forschungszentrum Karlsruhe, Institut für Materialforschung I, Karlsruhe, Germany (3 months).

International Cooperation

Finland	1. Helsinki University of Technology (Dr. T.M.J. Ikonen)
France	2. Laue-Langevin Institute, Grenoble (Dr. G.J. McIntyre)
	3. EC Institute of Transuranium Elements, Karlsruhe (Dr. P. van Uffelen).
	4. Institut für Hochleistungsimpuls & Mikrowellentechnik, Karlsruhe (Dr. B. Piosczyk)
Germany	5. Institut für Materialforschung I Forschungszentrum Karlsruhe (Dr. A. Möslang)
	6. Universität Duisburg-Essen (Prof. Dr. E. Spohr)
	7. Max Planck Institut (MPI) für Festkörperforschung, Stuttgart (Prof. Dr. J. Maier)
	8. Max Planck Institut für Plasmaphysik, Garching (Prof. Dr. H. Zohm)
	9. Physikalisch-Technische Bundesanstalt (PTB), Braunschweig (Dr. Bernd Kästner).
Greece	10. School of Electrical and Computer Engineering, National Technical University of Athens, Zographou (Dr. Y. Kominis)
Israel	11. Ben Gurion University of the Negev, Beer Sheeva (Profs. A. Aharony and D. Fuks)
Italy	12. Laboratori Nazionali di Frascati (Dr. S. Bellucci, Dr. M. Cestelli-Guidi)
Japan	13. FIR Center, University of Fukui (Prof. T. Idehara)
Korea	14. Sung Kyun Kwan University, Suwon (Dr. J.C. Lee)
Lithuania	15. Institute of Semiconductor Physics (SPI), Vilnius (Dr. E. Tornau)
Romania	16. University of Craiova (Dr. D. Constantinescu)
Russia	17. St. Petersburg University (SpbU) (Prof. R.A. Evarestov)
Spain	18. University of Barcelona (Prof. F. Illas)
	19. Imperial College London (Prof. R.W. Grimes)
UK	20. King's College London (Prof. L. Kantorovich)
	21. University College London (Profs. A.M. Stoneham and A. Shluger)
Ukraine	22. National University of Lviv (Prof. I. Bolesta and Prof. V. Savchyn)
	23. Northwestern University, Evanston, Illinois (Prof. D.E. Ellis)
USA	24. <i>University of Maryland, College Park (Dr. G.S. Nusinovich)</i>
	25. California Institute of Technology, Pasadena (Dr. E. Heifets)

Main Results

KINETIC MONTE-CARLO SIMULATION OF Au/Ni SURFACE ALLOY PHASE SEPARATION

G. Zvejnieks and V. Kuzovkov

E.E. Tornau (*Semiconductor Physics Institute, Vilnius, Lithuania*)

Bimetallic catalysts allow us to fabricate perspective materials with improved properties in activity and selectivity. Recently obtained surface catalysts (bimetallic system that forms alloy just in a surface layer, while the alloy components are immiscible in the bulk) substantially extend the class of available catalysts. However, before the practical application, the stability of the novel alloy has to be analyzed at the industrially relevant high CO pressures, which substantially differ from traditionally studied systems at low vacuum.

In collaboration with the Semiconductor Physics Institute (Vilnius, Lithuania) we proposed a simplified theoretical model for AuNi surface alloy on Ni(111) substrate at high CO pressures. We studied the model using kinetic Monte-Carlo computer simulations and found a parameter interval which correspond to experimentally observed alloy $\text{Au}_{0.3}\text{Ni}_{0.7}$ phase separation, when Ni atoms are removed due to a carbonyl $\text{Ni}(\text{CO})_x$ formation, but remaining Au atoms form clusters. In the simplified model Au diffusion has to be taken into account, while Ni and CO can be immobile. Adsorption and desorption of CO has to be included in the model, but carbonyl formation reaction can be approximated as $\text{Ni} + (\text{CO})_2 \rightarrow 0$. Within this model we can describe the experimentally observed step flow rate dependence on CO surface concentration (CO pressure). In turn, an increase of Au mobility increases Au cluster size as well as distance between Au clusters.

ANDERSON LOCALIZATION PROBLEM: AN EXACT SOLUTION FOR 2D ANISOTROPIC SYSTEMS

V. Kuzovkov

W. von Niessen (*TU Braunschweig, Germany*)

Our previous results [*J. Phys.: Condens. Matter* **14** (2002) 13777] dealing with the analytical solution of the two-dimensional (2D) Anderson localization problem due to disorder is generalized for anisotropic systems (two different hopping matrix elements in transverse directions). We discuss the mathematical nature of the metal-insulator phase transition which occurs in the 2D case, in contrast to the 1D case, where such a phase transition does not occur. In anisotropic systems two localization lengths arise instead of one length only.

SAWTOOTH CRASH IN ASDEX UPGRADE TOKAMAK

O. Dumbrajs

V. Igochine, and H. Zohm (*MPI für Plasmaphysik, Garching, Germany*),

In magnetically confined fusion plasmas, a variety of magnetohydrodynamic (MHD) instabilities can occur, driven by gradients of kinetic pressure or current density. The sawtooth oscillation is one of the fundamental instabilities in tokamaks. This phenomenon is characterized by a repetitive and rapid crash of the central electron temperature. We demonstrate on the basis of the soft X-ray and electron cyclotron emission measurements that during the pre-crash phase the quasiperiodic transition to chaos occurs. Magnetohydrodynamic oscillations with two frequencies develop before the crash. Consistent with the most energetically favorable transition from quasi-

periodicity to chaos, their frequency ratio is close to the golden mean ratio $G = f_2 / f_1 = (\sqrt{5} - 1) / 2 \approx 0.618$.

We use a hysteresis model to describe experimental data on sawtooth crash in ASDEX Upgrade tokamak. The model is based on hysteresis which arises due to the fact that the value of the current density gradient (approximated, for the H-mode discharges studied here, by the temperature gradient) at the $q=1$ surface required to turn on the instability is greater than the gradient required to maintain the instability once it is turned on. The value of the hysteresis parameter can be chosen such that the model reproduces correctly the two time scales of the sawtooth crash in ASDEX Upgrade tokamak: the slow rise time (~ 7 ms) and the rapid crash time (~ 50 micros).

GYROTRON DEVELOPMENT FOR ITER AND GENERAL GYROTRON THEORY

O. Dumbrajs,

G. Gantenbein, S. Kern, and B. Piosczyk (*Forschungszentrum Karlsruhe, Germany*),
Y. Kominis and K.A. Avramides (*National Technical University of Athens, Greece*),
Z. C. Ioannidis and I. G. Tigelis (*Dept. Electronics, Computing, Telecommunications and Control, Faculty of Physics, National and Kapodistrian University of Athens*),
G.S. Nusinovich (*University of Maryland, College Park, USA*)

T. Idehara (*Fukui University, Fukui, Japan*)

The development of high-power high-frequency gyrotrons is strongly driven by the needs of fusion technology. Gyrotrons are superior to other rf sources in the frequency range relevant for electron cyclotron resonance heating (ECRH), or about 170 GHz for ITER. To make an ECRH system cost-effective, the output power of a single gyrotron should be around continuous 2 MW power. Coaxial cavity gyrotrons have the potential to fulfill this requirement as has been experimentally demonstrated within the development program performed as an *ITER task at Forschungszentrum Karlsruhe (FZK)*. In proof of principle experiments carried out at FZK Karlsruhe on a 165 GHz coaxial cavity gyrotron during the last years, the feasibility of manufacturing a 2 MW, CW coaxial gyrotron at 170 GHz has been demonstrated and information necessary for a technical design has been obtained. Our laboratory actively participates in this development mainly by investigating mode competition scenarios.

In addition several contributions to general gyrotron theory have been made. In particular, linear and non-linear inserts for genuinely wideband continuous frequency tunable coaxial gyrotron cavities have been proposed, the mathematical formulation and numerical results for the resonance characteristics of the TM_{mp} modes in a coaxial cavity with longitudinally corrugated insert has been developed, and single mode hysteresis calculations have been generalized to the multimode case with emphasis on mode competition in 170 GHz gyrotrons for ITER.

SINGLE-PARAMETER NON-ADIABATIC QUANTIZED CHARGE PUMPING

V. Kashcheyevs,

B. Kästner (*Physikalisch-Technische Bundesanstalt, Braunschweig, Germany*)

An important application of quantum dot devices is the development of a current standard based on a controlled dc current generation in response to external ac driving. The goal of the so-called quantized charge pumping is to insure that the average number of electrons passing in the circuit during one cycle is as close as possible to an integer as possible. In *collaboration with the experimental group at Physikalisch-Technische Bundesanstalt (Braunschweig, Germany)* we have proposed a new mechanism of non-

adiabatic blockade of tunnelling which makes quantized charge pumping possible with a single driving gate. Such possibility may have decisive implications for achieving metrological accuracy in a battery of electron pumps. The first experiment, performed on a single wet-etched AlGaAs/GaAs nanowire, has demonstrated single-parameter quantized pumping with up to four current quantization plateaus.

We have developed a quantum-mechanical model for the double-barrier structure employed in the experiment, and calculated the pumped current as a function of experimentally controllable parameters. Our time-dependent rate equation calculations demonstrate the quantization mechanism and show the formation of the first quantization plateaux.

***AB INITIO* CALCULATIONS OF DEFECTS IN ADVANCED NUCLEAR FUELS**

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The actinide nitrides belong to the family of non-oxide ceramic nuclear fuels which are considered as promising candidates for so-called Generation-IV nuclear reactors. Prediction of their behavior under normal and extremal conditions needs knowledge of the physico-chemical properties including effect of defects produced as a result of self-irradiation. In a close collaboration with the *Institute for Transuranium Elements, Karlsruhe*, we continued first-principles calculations of UN fuels using the plane wave computer codes combined with large supercells containing up to 250 atoms.

Our study has demonstrated that atomic scale DFT-GGA-plane wave calculations with scalar relativistic pseudopotentials as implemented in the VASP and CASTEP codes (collaboration with *Imperial College, London*) could be used successfully to model a series of uranium nitride perfect lattice structures and also point defects in uranium mononitride. The only difference between the two sets of calculations were the pseudopotentials employed PAW (VASP) vs. ultrasoft pseudopotentials (CASTEP). Small differences in results that arose are attributed to this.

In particular, we have shown that V_N defects have hardly any affect on the UN lattice constant, even for concentrations as high as 25%. For this defect the lattice response is confined to small inward displacements of the nearest neighbour uranium ions and a very local defect induced electronic density redistribution. (This response to the formation of a vacancy is more reminiscent of a metal rather than an ionic or semiconducting material, *e.g.*, UO_2). Conversely, V_U defects induce somewhat larger (but still small) defect volumes which increase in magnitude as a function of defect concentration. In this case the nearest neighbour nitrogen atoms are displaced outwards and the hole is distributed over first and to a lesser extent second neighbour atoms. Lastly, we find that, once complete lattice relaxation has been performed, the Frenkel and Schottky pair formation energies are very similar. Consequently, intrinsic vacancy and interstitial defects will exist in comparable concentrations so that both are available to mediate defect transport. Analysis of the electron density redistribution shows that the effective charge of N atoms depends critically on their position and environment, which limits the applicability of MD simulations based on formal invariant charged species to defect studies in nitrides.

As a continuation of this study, we modelled UN surfaces. The main findings are as follows: (i) at low temperatures the FM magnetic state of the thin films of UN(001) become energetically more preferable, although experimental observation at room temperature indicate higher stability of the AFM magnetic state, (ii) The formation energy of surface U vacancy at UN(001) substrate is found to be noticeably lower than that for N vacancy, which contradicts the results obtained for defects in the UN bulk. It

can be explained by a higher flexibility of neighboring N atoms at surface, which results in their substantial outward displacement from regular lattice sites. (iii) Atomic adsorption upon the UN(001) substrate clearly demonstrate metallic behavior of UN chemical bonding due to high values of adsorption energy per O atom (8.1 vs. 7.1 eV atop surface U or N atoms, respectively). (iv) Spontaneous O₂ molecule dissociation is energetically favorable on the UN(001) surface. This can occur when a molecule is oriented parallel to the substrate and its bond directed towards the nearest surface U atoms (the center of molecule is located atop either a hollow position or surface N atom). Neither a vertical adsorption of O₂ molecule nor horizontal one with the oxygen ends oriented towards the nearest surface N atoms lead to its dissociation; (v) The calculated projected DOS can be used for the interpretation of the UPS experimental data for oxidised UN obtained recently at ITU.

ABO₃ PEROVSKITE SOLID SOLUTIONS AND DEFECTS

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Understanding and control of properties for a wide class of functional materials - mixed electronic and ionic conductors such as (Sr,La)MnO₃ or Sr(Fe,Ti)O₃ solid solutions – important for their numerous applications in fuel cells, electrochemical sensors, permeation membranes, spintronics, and catalysis. In collaboration with the *Research Center in Juelich*, we have performed hybrid DFT-HF calculations with the B3LYP exchange-correlation functional of the magnetic and electronic structure of La_{0.875}Sr_{0.125}MnO₃ and pure LaMnO₃. The calculations show that, in agreement with previous calculations, LMO has an antiferromagnetically ordered ground state. The metallic LSM, on the other hand, has at low temperature a strong prevalence for a ferromagnetically ordered state. This prevalence for the ferromagnetic state is more pronounced as the one for the antiferromagnetic state in LMO and increases further in the high-temperature pseudo-cubic phase. Furthermore, we see, at least for the system sizes studied here, no indication of significant charge ordering around the Sr defect. Thus, we concluded from our calculations that LSM at high temperature is pseudo-cubic and prefers ferromagnetically ordered domains. Contrary to LMO, the LSM DOS shows half-metallic spin states in the band gap, which could be responsible for the electronic conductivity of LSM SOFC cathodes.

In collaboration with the *laboratory of EXAFS spectroscopy at ISSP and Max Planck Institute in Stuttgart*, we performed structural studies for a whole series of solid solutions Sr(Fe_xTi_{1-x})O₃-perovskites as a function of composition, 0 < x < 1 and iron oxidation state. The XRD, Fe and Ti K-edge XAS, and vibrational Raman and infrared spectroscopy were used with the emphasis on the possible Jahn-Teller distortion around Fe⁴⁺ ions predicted by us theoretically. The local electronic structure probed by XANES, as well as the long range order probed by XRD and the short range order reflected in EXAFS, showed a dependence on composition as well as on iron oxidation state. The variation of the pre-edge peak intensity in the XANES signals is attributed to the modification of the Fe-Ti-O bond lengths and B-O-B bonding angles, resulting in a change of localization of 3d-metal states and their occupation numbers *n_d*. Although none of the individual observations alone gives a final proof of a JT distortion around Fe⁴⁺ ions, the combination of results obtained by XAS, especially the iron concentration dependence of the Fe⁴⁺-O²⁻ MSRD and vibrational spectroscopies, strongly supports its

presence, most pronounced for $x < 0.03$ and decreasing for higher iron concentrations. The decrease of the JT effect with increasing x can be understood qualitatively by the change in the electronic structure of the materials from insulator to metal. A quantitative modeling of the variation of the $\text{Fe}^{4+}\text{O}^{2-}$ MSDR and the intensities of the Raman lines remains a challenging theoretical problem.

The atomic and electronic structure of a main defect in oxides, in general, and ABO_3 -type perovskites in particular -- oxygen vacancy—is important for understanding their properties. *In collaboration with St. Petersburg University and Northwestern University*, we wrote a review article summarizing recent first principles simulations of the neutral oxygen vacancies (F centers) existing as native or radiation-induced point defects in various crystalline metal oxides in different forms (bulk, bare substrate surface, and on the interface with metal adsorbates). We considered periodic models in calculations of point defects using the metal oxide supercell or cyclic clusters. We compared different formalisms of first principles calculations, mostly the Density Functional Theory (DFT) as implemented in the framework of either localized basis set of atomic orbitals or delocalized basis sets of plane waves. We analyzed in detail the structural and electronic properties of the F centers in binary oxides of light metals (MgO and Al_2O_3) and ternary metal oxides (SrTiO_3 , BaTiO_3 , PbTiO_3 , KNbO_3 , and PbZrO_3 perovskites). When available, we compared results of *ab initio* periodic defect calculations with experimental data, results of *ab initio* cluster calculations (both embedded and molecular) as well as semi-empirical calculations.

FIRST-PRINCIPLES CALCULATIONS OF BaZrO_3 (001) AND (011) SURFACES

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Atomistic study of perovskite surfaces is important for ferroelectric and many other applications. The atomic/electronic structure of BaZrO_3 (001) and (011) surfaces was modeled using the B3PW hybrid functionals. According to the results of these calculations, all upper layer atoms for ZrO_2 - and BaO terminated surfaces relax inwards. The surface rumpling for the BaO -terminated surface is much larger than for the ZrO_2 -terminated. Both BaO -terminated and ZrO_2 - terminated surfaces are stable and energetically equally favourable. Unlike the BaZrO_3 (001) surface, different terminations of the (011) surface lead to great differences in the surface energies. The A-type O-terminated surface has the lowest energy (2.32 eV); the Ba-terminated surface has much higher surface energy of 2.90 eV, while the ZrO -terminated (011) surface has the highest energy (3.09 eV). We predict a considerable increase of the Zr–O chemical bond covalency near the (011) surface, as compared to both the bulk and the (001) surface.

FIRST-PRINCIPLES CALCULATIONS ON SURFACE REACTIVITY OF LIGHT METAL OXIDES AND FLUORIDES

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Prediction and control of the metal adhesion and growth mode of thin metallic films is important for micro- and nanoelectronics. In collaboration with *Northwestern University, Evanston and Ben Gurion University, Beer Sheva*, we performed first principles calculations based on the hybrid B3LYP method combined with the thermodynamic study of Ag and Cu adhesion onto defective MgO (001) substrate.

We observe a strong change of the bonding between the metal adatoms and substrate in the vicinity of the surface F_s centers (neutral O vacancies), which affects the thermodynamic conditions and the morphology of the growing metallic layer. For a perfect MgO surface we confirm the experimentally observed submonolayer growth of *metallic islands*. However, the surface F_s centers weaken the trend toward metal atom aggregation and above some critical surface concentration lead to formation of *disordered* 2D metallic films; *i.e.*, introduction of surface defects could change the island formation mode for the layer-by-layer growth mode. For silver films, the effect of the F_s centers is less pronounced than for copper: substantially higher atomic fraction of defects (at least 35-40 per cent) is needed for the growth of uniform Ag film, which is substantially larger than that for Cu (<10 per cent).

To clarify the mechanism of lithium storage anomaly in LiF nanocomposites in the context of lithium batteries, we have performed comparative DFT hybrid calculations on the atomic and electronic structure of the non-polar Cu/LiF(001) and model Li/LiF(001) interfaces, *in collaboration with Max Planck Institute for Solid State Research, Stuttgart*. For this aim, we have modeled the extra Li atoms incorporated at several possible sites of the Me/LiF interface, including the free surface of the substrate slab and interstitial sites inside a slab. Increase of Li concentration at the substrate side of interfaces is accompanied by an increased electron charge transfer from the extra Li atoms towards the transition metal adlayers, in agreement with a proposed mechanism of interfacial charge storage. Interfacial stability and charge transfer depends on the number of extra Li atoms and Me adatoms *per* LiF(001) surface unit cell. The Li diffusion on the interface is found to be energetically much easier than Li penetration into the bulk.

THEORETICAL SIMULATIONS OF OXIDE DISPERSED STRENGTHENED STEELS AS STRUCTURE MATERIALS FOR FUSION REACTORS

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Reduced activation steels strengthened by Y_2O_3 precipitates are considered as candidate structure materials for future fusion reactors. Both size and spatial distributions of oxides significantly affect mechanical properties and irradiation resistance of oxide dispersion strengthened (ODS) steels synthesized by hot isostatic pressing at temperature around 1000-1200°C and pressure ~100 MPa. It was proposed that the morphology and structure of oxide particles are determined besides powder composition primarily by the *milling* process and the *hipping* temperature. However, the recent experimental findings indicate that the picture of oxide particle formation is still not clear. There is evidence that their formation occurs at the *hipping* stage as a result of yttrium-oxygen co-precipitation. Comprehensive experimental studies on ODS steels with atomic resolution performed at the *Institute for Materials Research I, Karlsruhe Research Center, Germany*, show *stability* of pure Y_2O_3 -ODS and yttria nanoparticles.

The first step of multi-scale modeling of ODS particle formation in steel performed together with *IMR-I, Karlsruhe*, has included large-scale VASP calculations on *fcc* lattice of γ -Fe with further inclusion of O and Y impurities and formation of Fe vacancies. Together with calculated pair-wise interactions (Fe-O, Fe-vacancy, Fe-Y, O-O vacancy-O, O-Y vacancy-vacancy, vacancy-Y and Y-Y) as well as energy barriers for diffusion of impurities and vacancies supply us with the necessary parameters for further kinetic simulations. VASP calculations have been performed for large Fe supercells (at least for 4×4×4 extension using full geometry optimization). We have developed the methodology for these calculations, choosing proper sets of computational parameters as well as electronic and magnetic states of systems. Perdew-Wang-91 GGA (Generalized

Gradient Approximation) non-local exchange-correlation functional and the scalar relativistic PAW (Projected Augmented Wave) pseudopotentials have been used. The Monkhorst-Pack scheme for $12 \times 12 \times 12$ k-point mesh in the Brillouin zone was used.

We have calculated key parameters of the atomic and electronic structure for all configurations described above: lattice parameter and bulk modulus, densities of states (DOS) and band structure, equilibrium geometry of defective structures around vacancies and impurities re-distributions of electronic and spin densities in *fcc*-Fe under influence of vacancies and impurities. Presence of Fe vacancy noticeably re-distributes the electronic density in iron matrix. The vacancy formation energy for has been found to be 2.95 eV with 0.75% inward relaxation. Energy gain due to insertion of O atom at the center of octahedron formed by the nearest six Fe atoms has been found to be 3.21 eV whereas relaxation energy is 2.67 eV necessary for expansion of the first coordination sphere around impurity atom by ~ 9 percent. It was found that O impurities possess excessive electronic charge -1.3-1.4 e whereas Y can only substitute Fe atom in its vacancy (in the center of cuboctahedron formed by the nearest twelve Fe atoms) serving as a donor of electronic density ($\sim 1 e$). The energy gain due to insertion of Y atom into γ -Fe lattice can be considered as 0.71 eV (substantially smaller than after insertion of oxygen impurity) with relaxation energy 1.40 eV and 7% expansion of the first coordination sphere. The next step of atomistic simulation on ODS is the kinetic MC modelling based on our *ab initio* calculations.

AB INITIO SIMULATIONS ON THE ATOMIC AND ELECTRONIC STRUCTURE OF REGULAR AND DEFECTIVE AlN NANOTUBES

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Due to numerous technological applications, AlN nanostructures attract enhanced attention of both experimentalists and theorists. Different AlN nanotubes (NTs) of a wide range of diameters (up to 80 nm) were recently synthesized using either a method of highly non-equilibrium direct current (DC) arc-plasma-induced melting of aluminium in N-Ar ambient or simply nitriding impregnated Al powder in a tubular furnace. In both cases, nanotubes identified using high-resolution transmission electron microscopy (HRTEM) were accompanied by nanoclusters and nanowires. AlN nanosystems containing both nanotubes and nanoparticles have been recently studied experimentally using spectroscopic methods of XANES (X-Ray absorption near edge spectroscopy), FTIR (Fourier transform infra-red spectroscopy), XAS (X-ray absorption spectroscopy) as well as by neutron scattering and luminescence.

For theoretical simulation on AlN nanotubes (NTs) of different chiralities (armchair and zigzag-type) and uniform diameters, we have considered their single-walled (SW) 1D periodic models. For this aim, we have performed *ab initio* DFT calculations on AlN SW NTs using formalism of the localized Gaussian-type atomic functions as implemented in *CRYSTAL-03* computer code. We have shown that the smaller the diameter of AlN single-walled nanotube is, the closer its electronic and structural properties to AlN bulk. We have analysed an influence of N vacancies (neutral F centres) created by either soft irradiation of nanotubes or under experimental conditions of their growth, on the atomic and electronic structure of AlN SW NTs. We have found the small inward relaxation of the Al nearest neighbours and the N next-nearest neighbours around each point defect formed on 1 nm AlN NTs of both chiralities. Presence of N vacancy in both types of nanotubes has resulted in appearance of the two defect energy levels in their band gaps consisting of mainly $3s$ and $3p$ states of the nearest Al atoms.

OPTICAL PROPERTIES OF CADMIUM CLUSTERS IN CdI₂ LAYERED CRYSTALS.

A. Popov

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Cadmium iodide single crystals, CdI₂, belong to the class of compounds having layered structure. These crystals can be considered as two-dimensional systems and their investigations are important for the physics of low-dimensional structures. Besides that, CdI₂ also has relevance from the industrial point of view as a prospective scintillator with subnanosecond luminescence decay time for use in electromagnetic calorimeters. In collaboration with National University of Lviv and LNF INFN, Frascati we have investigated the influence of overstoichiometric Cdi atoms on the optical properties of cadmium iodide crystals. The results of optical absorption, luminescence, and luminescence excitation studies of CdI₂ crystals with controlled deviation from stoichiometric composition allow observing correlations between the Cdi concentration and features in absorption and emission spectra up to concentrations of 10¹⁸ cm⁻³. At higher concentrations the overstoichiometric cadmium atoms form clusters, which were observed using scanning electron microscopy. The extinction spectra of (CdI_i)_n clusters are calculated in the frame of Mie theory and are found to correlate with the optical studies.

CHARGE TRANSPORT IN ELECTRICALLY RESPONSIVE POLYMER LAYERS

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A great interest to nano-opto-electronic devices based on the conducting polymers (polythiophenes, polyaniline, polyphenylenevinylene) such as “smart windows”, optical memory devices, IR-switching, electrochromic displays and sensors caused a study of electrochromic materials in wide spectral range – from near UV to visible and near IR-region

In collaboration with *National University of Lviv, Ukraine*, we have studied the processes of charge transport in the conducting polymer electrochromic films by means of spectral-electrochemical method, impedance spectroscopy and cyclic voltametry measurements. The polymer films on ITO surface were obtained by means of the electrochemical polymerization.

It was shown that charge transport during the coloration-bleaching processes is not a symmetric phenomenon. Using impedance spectroscopy the effective diffusion coefficients for anode and cathode charge transport have been measured. The higher rate of charge transport in the bleaching process as compared to coloration is considered in the frame of conformation rebuilding of conducting polymer chains. The obtained results show that the rate of color switching is defined by the both the polymer structure and electrolyte nature.

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1. V. Kashcheyevs, B. Kästner, and M. Buitelaar, "Pumping versus bias: elements of adiabatic transport theory for recent experiments on double quantum dots".

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III. International Workshop "Fundamental Physics of Ferroelectrics", (Williamsburg, VA, USA, February, 2007).

3. R.I. Eglitis, A. Gopejenko, S. Piskunov, Yu.F. Zhukovskii, and J. Lee, "Electronic structure of perfect and defective PbZrO₃(001): *ab initio* simulations. Abstracts: p. 37.

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4. G. Zvejnieks, E.E. Tornau, and V.N. Kuzovkov, "Simulation of Au/Ni(111) alloy at high CO presserues". Abstracts: p. 16.
5. D. Bocharov, Yu.F. Zhukovskii, and E.A. Kotomin, "First-principles simulations of oxygen adsorption on perfect and defective UN(001) surface". Abstracts: p. 17.
6. A. Gopejenko, R.I. Eglitis, and S. Piskunov, "*Ab initio* calculations of perfect and defective PbZrO₃ surfaces". Abstracts: p. 18.

V. International Workshop: "First Principles Calculations of Nuclear Fuels" (Karlsruhe, Germany, March, 2007).

7. E.A. Kotomin, "Atomistic modelling of defects in UN using VASP".
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14. Yu.F. Zhukovskii, A.I. Popov, C. Balasubramanian, and S. Belucci, "Theoretical simulations of regular and defective aluminum nitride nanotubes". Abstracts: p. 53.
- O. Aksimentyeva, O. Konopelnyk, I. Bolesta, I. Karbovnyk, A.I. Popov, and D. Poliovyi, "Charge transport in electrically responsive nanostructured polymer layers". Abstracts: p. 118.
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- A.I. Popov, V. Savchyn, I. Karbovnyk, C. Balasubramanian, and S. Belucci, "Luminescence from nanostructured AlN under electron beam excitation at 80-300 K". Abstracts: p. 128.
- VIII. The 5th International Conference "Information Technologies and Management", IT&M'2007 (Riga, Latvia, April, 2007).**
- V.N. Kuzovkov and O. Dumbrajs, "Bounded Tokamak: A Hamiltonian map for magnetic field lines in a Tokamak". Abstracts: p. 7-8.
- Yu.F. Zhukovskii, D. Bocharov, and E.A. Kotomin, "Oxygen chemisorption on the UN(001) surface: periodic DFT simulation". Abstracts: p. 9-10.
- A. Gopeyenko, S. Piskunov, R.I. Eglitis, and Yu.N. Shunin, "*Ab initio* calculations of perfect and defective $\text{PbZrO}_3(001)$ surfaces". Abstracts: p. 13-14.
- IX. Korean Ceramics Society Meeting, (Seoul, South Korea, April, 2007).**
- R.I. Eglitis and J. Lee, "*Ab initio* modeling of SrTiO_3 , BaTiO_3 and PbTiO_3 perovskite surfaces". Abstracts: p. 29.
- X. International Conference on Radiation Effects in Insulators REI-14 (Caen, France, August-September, 2007).**
22. D. Fuks, Yu.F. Zhukovskii, and E.A. Kotomin, "A role of surface defects in thin metallic film growth mode on oxide surfaces". Abstracts: C49.
- E.A. Kotomin, R.W. Grimes, D. Parfitt, D. Gryaznov, Yu.F. Zhukovskii, Yu. Mastrikov, P. van Uffelen, V.V. Rondinella, and R.J.M. Konings, "First principles modelling of radiation defects in advanced nuclear fuels". Abstracts: O3.

XI. The Joint 32nd International Conference on Infrared and Millimetre Waves and 15th International Conference on Terahertz Electronics (Cardiff, UK, September, 2007).

24. O. Dumbrajs, K.A. Avramides, and B. Piosczyk, "Mode competition in the 170 GHz Coaxial Gyrotron Cavity for ITER". Abstracts: p. 48-49.
25. B. Piosczyk, T. Rzesnicki, G. Dammertz, O. Dumbrajs, J. Flamm, G. Gantenbein, S. Illy, J. Jin, O. Prinz, and M. Thumm, "Investigation on an experimental 170 GHz coaxial cavity gyrotron". Abstracts: p. 96-97.
26. O. Dumbrajs, Z.C. Ioannidis, and I.G. Tigelis, "Wide band continuous frequency tunable coaxial gyrotron oscillators". Abstracts: p. 583-584.

XII. 11th European Conference on Solid State Chemistry, ECSSC-XI (Caen, France, September, 2007).

27. Yu.F. Zhukovskii, E.A. Kotomin, P. Balaya, and J. Maier, "Enhanced interfacial lithium storage in nanocomposites of transition metals with LiF or Li₂O: experimental studies and theoretical simulations". Abstracts: p. 58.

XIII. 8th International Workshop on Nanoscience & Nanotechnology (Frascati, Italy, October, 2007).

28. Yu.F. Zhukovskii, S. Piskunov, B. Berzina, L. Trinkler, and S. Bellucci, "*Ab initio* simulations on the atomic and electronic structure of single-walled BN nanotubes and nanoarches". Abstracts: p. 38-39.
29. I. Bolesta, I. Karbovnyk, R. Grytskiv, G. Fafilek, A.I. Popov, and S. Bellucci, "Microstructure of Ag₂BI₄ (B = Ag, Cd) superionics studied by SEM, impedance spectroscopy and fractal dimension analysis". Abstracts: p. 43.
30. I. Bolesta, A.I. Popov, I. Karbovnyk, S. Bellucci, M. Cestelli-Guidi, and M. Piccicini, "FIR reflectivity of microcrystalline Ag₂CdI₄ between 10 and 420 K". Abstracts: p. 48.
31. P. Savchyn, A. Voloshynovskii, S. Myagkota, I. Karbovnyk, A.I. Popov, S. Bellucci, and M. Cestelli Guidi, "CsPbCl₃ nanocrystals dispersed in the Rb_{0.8}Cs_{0.2}Cl matrix: vibrational studies". Abstracts: p. 52.

XIV. Workshop of FP6 ALISTORE Network on Nanomaterials for Negative Electrodes in Lithium Batteries (Paris, France, October, 2007).

32. E.A. Kotomin, Yu.F. Zhukovskii, and J. Maier, "Enhanced interfacial Li storage in nanocomposites - *ab initio* modeling".

XV. 6th Russian Conference on Application of X-Ray and Synchrotron Radiations as well as Neutrons and Electrons for Material Researches (Moscow, Russia, November, 2007).

33. N.A. Zaporina, O. Doynikova, A. Krumina, D. Bocharov, and J. Grabis, Methods of electron microdiffraction and X-Ray analysis in structure study of nanodisperse partially stabilized ZrO₂ powders. Abstracts: p. 272.

XVI. Workshop on Ceramic Membranes (Jülich, Germany, December 2007).

34. E.A. Kotomin "First principles calculations of manganite surfaces and reactivity".

XVII. Theoretical workshop "Towards Reality in Nanoscale Materials", TRNM (Levi, Finland, December 2007).

35. Yu.F. Zhukovskii, S. Piskunov, B. Berzina, L. Trinkler, and S. Bellucci, "Influence of N vacancies on structural and electronic properties of AlN and BN nanotubes". Abstracts: p. 31.

LABORATORY OF OPTICAL RECORDING

Head of Laboratory Dr. J.Teteris

Research Area and Main Problems

Synthesis and research of amorphous chalcogenide semiconductor (As-S, As-Se and As-S-Se) thin films for optical recording, nanotechnology and holography have been performed. Photoinduced changes of optical properties, holographic recording and hologram self-enhancement effects, and relaxation processes in amorphous films are studied. The main task was RTD of high sensitive photoresists in the visible region for holography and lithography for production of diffractive optical elements. Rainbow hologram production technology based on chalcogenide semiconductor photoresists was developed. The methods for fabrication of subwavelength-gratings and surface-relief features with nanometer scale have been developed. An interaction between light and soft materials (amorphous organic and inorganic polymers, liquids) recently was studied.

Scientific Staff

1. Dr. M.Reinfelde
2. Dr. J.Teteris
3. Dr. K.Jefimovs

PhD Students

O.Balcers
A.Gerbreders
E.Sledevskis

Technical Staff

1. J.Gurovs
2. D.Popele

Students

1. Vl.Duboviks
2. U.Gertners
3. A.Jaunpetrovičs
4. J.Aleksejeva
5. A.Daņilovs

Scientific visits abroad

1. Dr. K.Jefimovs, post-doc researcher, Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, Switzerland (12 months).

Cooperation

Latvia

1. Riga Technical University (prof. A.Ozols).
2. Daugavpils Pedagogical University (Dr. V.Paškēvics and Dr. Vj.Gerbreders).

Finland

3. University of Joensuu (prof. T.Jaaskelainen and prof. J.Turunen).

USA

4. University of Arizona, Optical Science Center, Tucson (Dr. O.Nordman and Dr. N.Nordman)

5. National Renewable Energy Laboratory, Colorado (Dr. P. Stradins).

Lithuania

6. Institute of Physics, Vilnius (Dr. R. Petruskevicius).

Scientific Publications

1. J.Teteris and M.Reinfelde, *Solid immersion holographic recording in amorphous chalcogenide thin films*, *Microsystem Technologies*, **13** (2007) 197-201.
2. J.Teteris and M.Reinfelde, *Holographic recording in amorphous chalcogenide thin films*, *Journ. Non-Cryst.Sol.*, **353** (2007) 1450-1453.
3. V.Gerbreders, J.Teteris, E.Sledevskis and A.Bulanovs, *Photoinduced changes of optical reflectivity in As_2S_3 -Al system*, *Journ. Optoelectronics and Adv.Mat.*, **9** (2007) 3153-3156.
4. V.Gerbreders, E.Sledevskis, G.Liberts, J.Teteris and V.Pashkevich, *Optical recording on surface and inside As_2S_3 thin films*, *Journ. Optoelectronics and Adv.Mat.*, **9** (2007) 3161-3163.
5. A.Gerbreders and J.Teteris, *Recording of surface-relief gratings on amorphous As-S-Se films*, *Journ. Optoelectronics and Adv.Mat.*, **9** (2007) 3164-3166.

Lectures on Conferences

23th Scientific Meeting of Institute of Solid State Physics, University of Latvia, Riga, February 13 – 15, 2007.

- A.Gerbreders un J.Teteris, *Kodināšanas procesa pētījumi As-S-Se fotorezistos*. Tēzes, 64 lpp.
- J.Aleksejeva, M.Reinfelde un J.Teteris, *Hologramu pašpastiprināšanās amorfās As-S-Se kārtiņās*. Tēzes, 65 lpp.
- O.Balcers un J.Teteris, *Planārie gaismas vadi uz amorfo As_2S_3 kārtiņu bāzes*. Tēzes, 66 lpp.
- M.Reinfelde un J.Teteris, *Refleksijas hologrammu ieraksts*. Tēzes, 44 lpp.
- U.Gertners un J.Teteris, *Reljefa „tiešais” ieraksts amorfās As_2S_3 kārtiņās*. Tēzes, 45 lpp.
- E.Sledevskis, Vj.Gerbreders un J.Teteris, *Fotoinducētie procesi amorfās Sb-Se kārtiņās*. Tēzes, 46 lpp.
- J.Teteris, *Amorfo halkogenīdu praktiskā izmantošana*. Tēzes 73 lpp.

3rd International Conference on Amorphous and Nanostructured Chalcogenide (ANC-3), Brasov, Romania, July 2-6, 2007.

- V.Gerbreders, J.Teteris, E.Sledevskis and A.Bulanovs, *Photoinduced changes of optical reflectivity in As_2S_3 -Al system*. Abstracts, p.16.
- A.Gerbreders and J.Teteris, *Recording of surface-relief gratings on amorphous As-S-Se films*. Abstracts, p.35.
- O.Balcers and J.Teteris, *Waveguiding properties of As_2S_3 films*. Abstracts, p. 35.
- M.Reinfelde, J.Teteris and J.Aleksejeva, *Holographic self-enhancement in amorphous arsenic films*. Abstracts, p. 35.
- U.Gertners and J.Teteris, *Direct holographic recording of surface-relief gratings on amorphous chalcogenide films*. Abstracts, p.36.
- J.Teteris, *Immersion holography based on amorphous chalcogenide films*. Abstracts, p. 38.
- V.Gerbreders, E.Sledevskis, G.Liberts, J.Teteris and V.Pashkevich, *Optical recording on the surface and inside As_2S_3 thin films*. Abstracts, p 42.

Int. Conf. on Optical, Optoelectronic and Photonic Materials and Applications – ICOOPMA2007, London, United Kingdom, July 30- August 3, 2007.

J.Teteris. *Immersion holography based on amorphous chalcogenide films*. Abstracts, p. 47.

22nd International Conference on Amorphous and Nanocrystalline Semiconductors –ICANS22, Colorado, USA, August 19-24, 2007.

J.Teteris. *Immersion interference lithography based on chalcogenide photoresists*. Abstracts, ThO5.3.

U.Gertners and J.Teteris, *Direct holographic recording of surface-relief gratings on amorphous chalcogenide films*. Abstracts, ThP13.7.

LABORATORY OF VISUAL PERCEPTION

Head of Laboratory *Dr.hab.Phys., Prof. I.Lācis*

Research Area and Main Problems

Laboratory is trying to find synergies between material science (physics), vision research (perception) and everyday optometry (profession). Human vision is a complex phenomenon. Its optical part is essential, however optical image stays only at the very beginning of the visual pathway and information processing in the cortex. We see with our brains, and as a result in some provocative cases it is very hard for us to accept the final outcome.

Research in laboratory is focused on following problems:

- investigation of advanced optical materials and designs of vision appliances – tinted, high refractive glasses, antireflective coatings, multifocal and progressive, and contact lenses;
- effect of aberrations in eye structures and appliances on retinal image formation and on the psychophysically detected human visual response;
- design of the model eye with externally controllable light scattering;
- effect of stimuli blurring and decrease of contrast and colour contrast on the stereo threshold;
- designs of software to display visual stimuli on computer screen for studies of monocular vision perception, suppression and rivalry mechanisms of binocular vision;
- digital visual stimuli image processing determinant for analyse of the human visual response;
- evaluation of suppression strength and depth on quality of vision binocular functions and on dominant eye;
- vision ergonomics and behavioural optometry;
- evaluation of accommodation/convergence mechanisms reading print materials and for regular computer users;
- eye kinematics studies for children and adults without and with several disorders of visual perceptions.

Scientific Staff:

1. Prof. I.Lācis
2. Prof. M.Ozolins
3. Dr. G. Krūmiņa
4. M.Sc. R.Paeglis

PhD Students:

1. M.Sc. A.Švede
2. M.Sc. G.Ikaunieks
3. M.Sc. S.Fomins
4. M.Sc. V.Karitāns

Educational

Every year up to 25 bachelor and 10 master students of Department of Optometry and Vision science are graduated from University of Latvia. Lot of them perform their diploma experimental works tied with research topics of Laboratory of Visual Perception.

Awards

Varis Karitans – *Verner von Siemens Excellence Prize Contest 2007* winner (master thesis “Perception of saturation of colours and dominant wavelength discrimination in central and peripheral retina”).

Partners abroad

Italy	Florence University , Italy, (Prof. S. Villani) Universita` di Roma "Tor Vergata" (Prof. I. Davoli) Chalmers TH, Sweden (Prof. L.Komitov)
Norway	Buskerud Høgskolan, Institutt for optometri (Prof. J.R.Bruenich).
England	Bradford University (Prof. D.Whittaker)
Spain	Laboratorio de Optica, Universidad de Murcia, Spain (Prof. P. Artal) Universidad Complutense Madrid, Spain (Prof.. Miguel. Ángel Muñoz)
Scotland	Psychology Department, University of Glasgow, Scotland (Dr.D.Simmons)
Finland	Colour Research Laborotry, University of Joensuu (Prof. J.Parkkinen)
Germany	Institut fur Arbeitsphysiologie an der Universität Dortmund
The Netherlands	Utrecht University (Prof. R. van Ee)
France	Laboratoire Régional des Ponts et Chaussées de Clermont-Ferrand (Dr.M.Colomb)

Main Results

KINEMATICS OF THE EYE

I. Lacis and R. Paeglis

Inst.of Solid State Physics, University of Latvia
Dept.of Optometry, University of Latvia

As physical concepts are applied to biological systems, the results are less predictable, yet they require the same strict processing of the experimental data. This year is signified by novel eye tracking equipment as well as advanced statistical algorithms in data processing. Thus a helmet-mounted eye-tracker has been used to monitor a person's gaze in nearly natural posture, and K-Means clustering algorithms have been introduced to explore at what sites a person looked.

Like some other physical processes, the motion of the human eye does not always comply with the normality criteria. Non-parametric statistical tests, such as Mann-Whitney U test, have been applied to compare a group of athletes, namely, female basketball players, and age-matched group of non-athletes. The results are informative of what distinguishes individuals trained in sports.

Another branch where the physics of the eye motion has been applied is the reading and learning. Are the available text-books easy to perceive? What reading advantages do editors possess over the general population? The findings have been repeatedly reported at the seminars of the Latvian Ministry of Science and Education and the Riga City Council.

Notably, the eye movement research has been presented at the 1st International Inventor's Day Convention in Bangkok, Thailand.

NO AVERAGE READER: PROFESSIONAL READERS EMPLOY A DIFFERENT FIXATIONAL STRATEGY

I. Lacis¹, R. Paeglis², K. Bagucka²

¹Inst.of Solid State Physics, University of Latvia

²Dept.of Optometry, University of Latvia

Ability to read efficiently is an increasing challenge in the modern society. Malformed reading practices are to blame for insufficient academic accomplishments of students. In eye-movement recordings, properties of fixations emerge as predictors of text comprehension and word skipping. We extend the concept of a skilled reader to a person whose professional duties consist of text analysis and reviewing. 'Reading professionals' demonstrated their fixational length and saccadic velocity pattern (iViewX). As compared to students of various fields, 'professionals' exhibited higher word-grouping selectivity and information retention. Their pattern cannot be extrapolated from the common skilled reading. To test the effect of educational practice, 5 'non-professionals' were subjected to a speed-reading training for two months. After the training, the reading speed, number of fixations, and quality of text retention testified to higher processing efficiency. However, the reading pattern diverges from that of 'professionals'. We also stress that reading efficiency is language-specific. Fluent readers fixate about 60% more when reading in a second language, as compared to the native one. Eye movements in reading are specific to language and depend on education. Experimental data lend support to the conclusion that the concepts of 'average reader' and 'skilled reader' should be used with caution.

PERCEPTION OF SATURATION OF COLOURS AND DOMINANT WAVELENGTH DISCRIMINATION IN CENTRAL AND PERIPHERAL RETINA

V. Karitans and M. Ozolinsh

University of Latvia

Perception of colour saturation in central and peripheral retina was studied by two kinds of psychophysical methods. The method of constant stimuli, in which pairs of stimuli with different saturation are presented, was used. Shift of the saturation perception equality was found: peripheral stimuli were perceived to be less saturated than the central one when the observer was not adapted before answer was given. In a step-by-step method, the observer was asked to find equilibrium by adjusting saturation of the peripheral stimulus. Hysteresis of the shift of the perception of saturation equality was observed: the shift depended on whether the initial saturation of the peripheral stimuli was maximal or zero. Results can be explained in terms of saturation adaptation. After adaptation to saturated stimulus, sensitivity to saturation of the eye is reduced. After adaptation to unsaturated stimulus, the sensitivity is increased. The method of constant stimuli with adaptation phase was also used. There was strong time dependence of the shift of the saturation perception. In a step-by-step method, the observer was asked to find equilibrium by adjusting saturation of the peripheral stimulus. These two methods were compared by keeping saturation of peripheral stimulus constant but varying the saturation of the central stimulus. This shows that adaptation occurs at retinal level.

DYNAMICS AND ACCURACY OF EYE ABERRATION MEASUREMENTS.

M. Ozolinsh, S. Fomins, and V. Karitans
University of Latvia

Deviations of the eye aberration terms that are determined using the Hartman-Shack wavefront sensors can be explained either due to methodological reasons: non-stability of the eye positioning, the validity criteria of the hartmanogram spots for the waveform reconstruction; or that can have physiological origins - eye tearfilm breakup process, feedback to keep eye in focus, breathing and heartbeats. We have studied eye aberrations using a fast (up to 30 frames per second) aberrometer "Multispot-2500" simultaneously together with records of the heart beat rhythmus. The Fourier and correlation analyses were applied to characterize the aberration dynamics during the tearfilm formation (first 2-3 sec after eye blinks) and to detect possible correlation of the aberration terms to various physiological factors. Spectral power analyze reveals inverse proportionality to frequency beyond 10 Hz. In some cases (for defocus and astigmatism terms) a maximum in the power spectrum is observed at frequencies close to arterial pulse frequency. However the correlation analyze does not reveal a clear correspondence of the heart beat and aberration time sequences. It is confirmed that the accurate determination of the aberration terms is possible after statistical processing of high speed measurements done between two sequent eye blinks.

[SF is supported by the European Social Fund.]

SUMMATION OF RETINAL AFTER-EFFECTS AND CORTIAL MECHANISMS IN CONTRAST ADAPTATION

M Ozolinsh¹ and D. Lauva²

¹University of Latvia, Institute of Solid State Physics

²Department of Optometry and Vision Science

We investigated perception of Gabor gratings after adaptation to high contrast gratings. Four symmetrically positioned achromatic and R, G and B adaptation Gabor stimuli were presented for 8 sec on a monitor. After that a lower contrast test stimulus – one Gabor grating of the same spatial frequency and direction - was presented spatially coinciding with one of the previously demonstrated gratings of the adaptation stimuli. Subjects had to detect the position of the test stimulus.

We measured two time parameters: the time of recovery of retinal after effects (RRA) and the instant of appearance of the test stimuli (ATS time). When test and adaptation gratings were spatially in-phase, we observed a weak diminishing of RRA (0.6-0.8s) and a pronounced decrease in ATS times (7 to 2s) when the contrast of the test stimuli increased up to 70%. When test and adaptation gratings were spatially in counterphase (*i.e.*, the retinal aftereffect image in phase with the modulation of the test stimuli attenuated by adaptation) RRA time revealed a slight increase with the test stimulus contrast. To separate cortical mechanisms and retinal effects in contrast adaptation, red and green colour filters were used for the right and left eye, and adaptation and test stimuli were presented - red and green, correspondingly. Thus the right eye was contrast adapted, but the ATS time was measured for the non-adapted left eye only. Results were qualitatively similar to the tests mentioned previously, confirming the high contribution of cortical mechanisms in contrast adaptation. Measurements for monochromatic (R,G,B) stimuli did not reveal significant differences in ATS and RRA time values.

LIGHT SCATTERING EFFECT ON COLOR PATTERN VEP RESPONSE

G. Ikaunieks, M. Ozolinsh, and S. Fomins
University of Latvia

To assess the effect of light scattering on colour pattern VEP (CP-VEP), the quality of stimuli was reduced with a light scattering occluder. The results were compared with results of visual acuity and retinal stray light measurements. In CP-VEP studies white-black, red-black, green-black and blue-black gratings were used. For visual acuity measurements black Landolt optotypes on the coloured backgrounds were used. Retinal stray light was measured with a compensation comparison method (Van den Berg, T.J.T.P. et al, 2005, IOVS, 46:ARVO, E-Abstract, 4315).

We found good correlation between CP-VEP and psychophysical visual acuity test results. Our results show, that reduction of different colours stimuli perception due to light scattering is not related only with the presence of retinal stray light effect in the eye and physiological behaviour of spatially organized neural receptive fields should be taken into account.

[GI is supported by the European Social Fund.]

DOES THE BLUE - YELLOW CONTRAST CONTRIBUTE TO STEREOVISION?

M Ozolinsh and K. Desmitniece
University of Latvia

The contribution of the blue - yellow visual pathway neural activity in stereopsis is still under discussion. We present experimental data for real depth sensation studies with two vertical bars (one of them movable) emitting white, yellow, red, green, or blue light. Emission was produced by different-colour LED set inside the bars, that allowed varying the presentation time in millisecond range. The bars were placed in the front of LCD display; thus such setup allowed to create various colour contrast stereo stimuli and to select only red - green, blue - yellow, or luminance channel contributing to formation of stereo sense. We observed stereopsis for subjects participating in studies for all colour-contrast stereo stimuli. The lowest stereoacuity was revealed for pairs of blue-emitting bars on black background and for yellow bars on isoluminant achromatic background. The latter presents a scene where mainly the short wavelength (blue light intensity spatial modulation) contributes to the stereo disparity. We discuss stereopsis time responses induced by achromatic and different colour-contrast stimuli and analyze specific contributions of luminance, red - green, and blue - yellow pathway neural activity acting in stereopsis.

Scientific publications

Published in 2007.

1. M. Ozolinsh, S. Fomins, and G. Ikaunieks "Eye aberration dynamics studies using Hartman-Shack aberrometer," Abstr. Int. Baltic Sea Region Conf. "Functional materials and nanotechnologies," Riga, April 2-4 p.137 (2007).
2. V. Karitāns, „Aktīvā un adaptīvā optika”, *Zvaigžņotā Debess* (Pavasaris 2007), 42-44. lpp. (2007).
3. S.Fomins, M.Ozolinsh, and G.Ikaunieks. „Temporal stimuli and texture segmentation”. *Perception*, Vol. 36, p. 44 (2007).
4. J. Bueno, M. Ozolinsh and G. Ikaunieks “Depolarization and scattering in a polymer dispersed liquid crystal cell.” *Ferroelectrics* (submitted 2007).

5. M Ozolinsh and D. Lauva "Summation of retinal after-effects and cortical mechanisms in contrast adaptation." *Perception*, Vol. 36, (2007).
6. V. Karitans and M. Ozolinsh "Perception of saturation of colours and dominant wavelength discrimination in central and peripheral retina." *Perception*, Vol. 36, 2007, p. 193.
7. V. Karitāns „Lielā Saņa paaugstinātā zvaigžņu blīvuma mīkla”. – *Zvaigžņotā Debess* (Ziema 2007/08), 34-37 lpp.
8. M. Ozolinsh, M.. „Dynamics and accuracy of eye aberration measurements.” *Journal of Vision*, Vol. 7(15):92 (2007).
9. G. Ikaunieks, M Ozolinsh, S Fomins. Light-scattering effect on colour-pattern VEP response, *Perception*, Vol. 36, p. 39 (2007).
10. M Ozolinsh, K Desmitniece “Does the blue-yellow contrast contribute to stereo vision?” *Perception*, Vol. 36, 2007, p. 184.

Reports in conferences

1. International Baltic Sea Region conference "*Functional materials and nanotechnologies*", Riga, Apr. 2007.
2. „*Applied Vision Association Annual Meeting 2007*”, Bradford, Apr. 2007.
3. „*Development in Optics and Communications 2007*”, Rīga, Apr. 2007.
4. „*30th European Conference on Visual Perception*”, Arezzo, Italy, Aug. 27-31.
5. „*European Meeting on Ferroelectrics – EMF2007*”, Bled, Sept. 2-9.
6. „*OSA-Visison 2007*”, Berkeley, Oct. 2007.
7. “1st International Inventor’s Day Convention”, Bangkok, Thailand.

LABORATORY OF WIDE BAND GAP MATERIALS

Head of Laboratory *Dr. hab. phys., Assoc. prof. B. Berzina*

Research Area and Main Problems

The field of interests of the Laboratory of Wide Band Gap Materials are focused on spectral research of the wide band gap nitrides such as AlN, BN and some related materials, which are promising for the various applications including optoelectronics and dosimetry. The special interests are focused on the nanostructured forms of these materials which could present some new features compared to those of the bulk materials. The properties of each material strongly depend on its defect structure presenting its own spectral characterization. Therefore, the spectral investigations performed in this laboratory which are based on luminescence studies (photoluminescence (PL) and its excitation (PLE), optically stimulated luminescence (OSL) and thermoluminescence (TL)), can give the essential information about the defects and the optical properties of the material, including revealing of light-induced processes, luminescence mechanisms, energy accumulation and its release mechanisms. These problems could be prevalently related to the fundamental physics. In the field of innovations the interests are focussed on application of AlN and related-materials for the UV light dosimetry. Part of the investigations was performed together with the collaboration partners from abroad.

Scientific Staff:

1. Dr. Hab.Phys, Assoc. Prof. B.Berzina
2. Dr. L.Trinkler
3. J.Sils
4. V.Korsaks

Students - Technicians:

1. D.Kasjan

Visitors from abroad:

1. Prof. R.T. Williams Wake Forest University, Department of Physics, Winston-Salem, USA (3 days).

Scientific Visits Abroad:

- B.Berzina, Frascati Research Center, Italy (3 days).
J.Sils, University of Osnabruk, Germany (11 month)

Collaborations

Latvia

Institute of Inorganic Chemistry, Riga TU (Dr. E.Palcevskis, Prof. J.Grabis)

France

University of Nice-Sophia Antipolis, Nice (Prof. M.Benabdesselam, Prof. P.Iacconi)

USA

Wake Forest University, Department of Physics, Winston-Salem (Prof. R.T. Williams, Dr. U.Burak)

Wake Forest University, Center of Nanotechnologies, Winston-Salem (Prof. D. Carroll).

Belarus

Institute of Solid State Physics and Semiconductors, Belarus Academy of Sciences, Minsk (Dr.E.Shishonok).

Taiwan

National Taiwan University, (Prof. Li-Chyong Chen)

Romania

National Institute for Material Physics in Solids, Bucharest, (Prof. S.Nistor)

Main investigations and results

SPECTRAL CHARACTERIZATION OF h-BN NANOTUBES CONTAINING MATERIAL AND ITS RAW MATERIAL - h-BN MACRO-SIZED PARTICLES

B. Berzina, L.Trinkler, V.Korsak, R.T.Williams¹, B.Ucer¹, D.Carroll²

¹ *Department of Physics, Wake Forest University, USA*

² *Center of Nanotechnologies, Wake Forest University, USA*

A detailed investigation of nanotubes containing h-BN material was realized during the previous years. At present the spectral characteristics – the photoluminescence (PL) spectra and its excitation spectra (PLE) were studied for h-BN powder with macro-size grains. This is a raw material from which the nt-BN/h-BN nano-material containing the h-BN nanotubes was synthesized in the Center of Nanotechnologies, Wake Forest University, USA.

The phonon-affected substructure of 395 nm PL was obtained and the PLE spectra of this luminescence were precisely studied. It was proposed that the 395 nm luminescence could be caused by the nanoarches situated at a surface of the h-BN grains. The mechanisms of the exciton relaxation and self-trapping in the case of h-BN nanoarches were proposed and discussed.

OPTICAL PROPERTIES OF AlN NANOSTRUCTURED MATERIALS: NANOTIPS AND NANORODS.

L.Trinkler, B.Berzina, D.Kasjan, L.C. Chen², S.C.Shi²

¹ *Institute of Inorganic Chemistry, Riga Technical University, Latvia*

² *Center of Condensed Matter Sciences, National Taiwan University, Taiwan*

The AlN nanotips and nanorods were synthesized in National Taiwan University, Center of Condensed Matter Sciences. The photoluminescence (PL) and its excitation (PLE) spectra were examined and compared to those of macrosized material – AlN ceramics.

It was found that in the case of nanostructured materials the 480 nm luminescence is predominant. The excitonic mechanism of its excitation was proposed and discussed.

Scientific Publications

1. L.Trinkler, B.Berzina, A.Auzina, M.Benabdesselam, P. Iacconi, UV light energy storage and thermoluminescence in AlN ceramics. *phys. stat. sol. (c)* 4, No.3, 1032-1035 (2007).
2. L.Trinkler, B.Berzina, A.Auzina, M.Benabdesselam, P. Iacconi, Use of aluminum nitride for UV radiation dosimetry, *Nuclear Instruments and Methods in Physics Research A* 580 (2007) 354-357.

3. V.Skvortsova, L.Trinkler, L.Grigorjeva, Spectroscopy of defect centers in magnesium oxides crystals irradiated by fast neutrons. Сборник докладов Международной научной конференции Актуальные проблемы физики твердого тела, 23-26 окт. 2007г., Минск, том 3, стр. 266-268.
4. L.Trinkler, B.Berzina, D.Kasjan, L.-Ch. Chen, Luminescence processes induced by UV radiation in AlN nanotips and nanorods. Radiation measurements (2008), doi:10.1016/j.radmeas.2007.12.025
5. L.Trinkler, B.Berzina, D.Kasjan, L.-Ch. Chen, Luminescence properties of AlN nanostructures revealed under UV light irradiation. Journal of Physics: Conference Series **93** (2007) 012040. doi:10.1088/1742-6596/93/1/012040

Lectures on Conferences

15th International Conference on Solid State Dosimetry (SSD15), July 8-13, 2007, The Netherlands

1. L.Trinkler, B.Berzina, D.Kasjan, L-C Chen. *Luminescence processes induced in AlN nanotips and nanorods*. Delft University of Technology, Netherlands, Book of Abstracts, p.89.

International Baltic Sea Region Conference Functional Materials and Nanotechnologies (FM&NT), April 2-4, 2007, Riga, Latvia

2. B.Berzina, L.Trinkler, V.Koraks, R. Williams, B.Ucer, D.Carroll., *Luminescence from nanoarches in h-BN*. , Book of Abstracts, p.72.
3. L.Trinkler, B.Berzina, D.Kasjan, L-C.Chen. *Luminescence properties of AlN nanostructures revealed under UV light irradiation* . Book of Abstracts, p.73.

23rd LU Scientific Conference of Institute of Solid State Physics, University of Latvia, February 13-15, 2007, Riga, Latvia

4. V.Korsaks, L.Trinkler, B.Berziņa. *Luminescence processes of h-BN nanostructures: nanotubes and nanoarches*. Book of Abstracts, p 36.
5. D.Kasjan, L.Trinkler, B.Berziņa. *Photoluminescence of AlN nanotips and nanorods*. . Book of Abstracts, p 37.

International Roundtable on Advanced Wide Band Gap Materials for Radiation Detectors MATRAD, June 17-20, 2007, Sinaia, Romania

6. B. Berzina, L.Trinkler, V.Korsaks, R.Williams, B.Ucer, D.Carroll, *Luminescence of nano-structured h-BN*, , Book of Abstracts, p. VIII.1
7. B.Berzina, L.Trinkler. *AlN-prospective material for radiation detection (Invited lecture)* Book of abstracts, p. VII.1

LABORATORY OF SURFACE PHYSICS

Head of Laboratory Dr. phys. F.Muktepavela

Research Area and Main Problems

The research interests of the Laboratory of Surface Physics are focused on problems related to structure and micromechanical properties of surfaces, interfaces and thin films of advanced tribological and optical materials and materials for micro/nanotechnologies (e.g. metals and alloys, oxides, halides, fullerenes and composite systems). Research area includes development of the methods of surface modification and studies of surface and interface effects in adhesion, indentation hardness and plasticity. The research is based on methods of AFM, SEM with EDX option, XRD, optical microscopy, micro- and nanoindentation.

Main research topics in 2007

- Obtaining of nanostructured functional coatings by mechanoactivated oxidation and investigating their mechanical and optical properties;
- Studies of the structure and micromechanical properties of thin film systems, grain boundaries and interfaces in heterogeneous structures;
- Surface modification by irradiation with swift heavy ions.

Scientific Staff

1. Dr.hab. J.Maniks
2. Dr. I.Manika
3. Dr. F.Muktepavela

Technical Staff

1. A.Petersons

PhD Students

1. M.Sc G.Bakradze

Students

1. R.Lisovskis

Scientific visits abroad

1. Dr.I.Manika, Cavendish Laboratory Cambridge, UK (1 week).
2. Dr.I.Manika, REI, Caen, France (1 week).
3. Dr.F.Muktepavela, Barselona, Portugal (1 week).
4. Dr.F.Muktepavela, Toljati, Russia (1 week).
5. Dr.habil. J.Maniks, Cavendish Laboratory Cambridge, UK (1 week).

Cooperation

Latvia

1. Daugavpils University (Dr. E.Tamanis).
2. Institute of Physics, University of Latvia (Dr.A.Shishko).
3. Riga Technical University (Prof.V.Mironovs).

Germany

GSI, Darmstadt (Prof.K.Schwartz).

France

CIRIL, Caen (Prof. M.Toulemonde).

Israel

Technion, Haifa (Dr.S.Stolyarova).

Russia

Institute of Solid State Physics RAN, Chernogolovka (Prof.B.Straumal)

Main Results

Scientific publications

Published in 2007

1. F.Muktepavela, G.Bakradze and S.Stolyarova. Nanostructured metal/oxide coatings.- *Phys.Stat.Sol. (c)* 2007,vol.4, No3, p.740-743.
2. A.Medvids, P. Onufrijevs, E. Mellikov, D. Kropman, F. Muktepavela, G. Bakradze. Low-K factor of SiO₂ layer on Si irradiated by YAG:Nd laser.- *Journal of Non- Crystalline Solids*, 2007, vol.353, p.703–707.
3. I. Manika, J. Maniks, K. Schwartz. Heavy-ion induced damage and reduction of dislocation mobility in LiF single crystals, -*Proc. SPIE, Advanced Optical Materials, Technologies, and Devices*; Steponas Ašmontas, Jonas Gradauskas; Eds. 2007, vol. 6596, p.65961F.
4. F Muktepavela, G Bakradze, E Tamanis, L Grigorjeva, P Kulis and R Krutohvostovs. Obtaining of nanostructured ZnO coatings using mechanoactivated oxidation,- *J Phys.: Conf. Ser.*, 2007, vol.93, p.012007.
5. G. G. Bakradze, J. A. Kajaks, S. A. Reihmane and J. E. Lejniaks. Correlation between the mechanical properties and the amount of desorbed water for composites based on a recycled low-density polyethylene and linen yarn production waste.- *J.Mech. Comp. Mat.*, 2007, vol.43, N 5, p. 427-432.
6. F.Muktepavela, G.Bakradze, V.Sursaeva. Microhardness of grain boundaries and triple junctions in Zn. -*Proc.XVII Peterburg's Readings on problems of durability*, Sankt-Petersburg, 2007, vol.1, p.75-77.

Lectures on Conferences

III International Indentation Workshop, Cambridge, UK, July 15-20, 2007.

1. I.Manika, J.Maniks, K.Schwartz. *Swift-ion-induced hardening and reduction of dislocation mobility in LiF crystals*. Abstracts, p.9 (oral presentation).
2. J.Maniks, I.Manika. *Effect of substrate hardness and film structure on indentation depth criteria for film hardness testing*. Abstracts, p.12 (oral presentation).

14th International Conference on Radiation Defects in Insulators, Caen, France, August 28-September 1, 2007.

1. I.Manika, J.Maniks, K.Schwartz. *Investigation of heavy ion tracks in LiF crystals by dislocation mobility method*. Abstracts, p. O20 (oral presentation).

XVII Peterburg Readings on problems of durability. Sankt-Petersburg, Russia, April 10-12, 2007

1. F.Muktepavela, V.Sursaeva, G.Bakradze. *Microhardness of grain boundaries and triple junctions in Z* (oral presentation).

XII International Conf. "Intergranular and Interphase Boundaries in Materials" (iib 2007). Barselona, Portugal, July 10-13, 2007.

1. F.Muktepavela, G.Bakradze, V.Sursaeva. *Micromechanical properties of grain boundaries and triple junctions in polycrystalline metals exhibiting grain boundary sliding at 293K*. Abstracts, p.83 (poster)

9th International Workshop of Radiation Imaging Detectors, Erlangen, Germany, 22-26 July, 2007.

1. M.Shorohov, F.Muktepavela, J.Maniks, L.Grigorjeva, D.Millers, V.Gostillo. *Microstructures, microhardness and spectrometrical performance of TlBr detector crystals*. Abstracts, p.43 (poster).

III Междунар.Школа-конференция «Физическое материаловедение: Наноматериалы технического и медицинского назначения», Россия, Тольятти, 24-28 сентября, 2007 г.

1. Ф.Муктепавела, Г.Бакрадзе, Л.Григорьева, Э.Таманис. *Наноструктурные Me-O покрытия, полученные методом механоактивированного окисления*. Тезисы, стр.217-218 (oral presentation).

5th International Conference Metals, Welding & Powder Metallurgy (MET-2007), Riga, Latvia, September 13-14, 2007

1. F.Muktepavela, G.Bakradze, E.Tamanis, L.Grigorjeva. *Properties of ZnO nanostructured coatings obtained by mechanoactivated oxidation* (oral presentation).

International Baltic Sea Region conference "Functional materials and nanotechnologies", Riga, Latvia, April 2-4, 2007

1. Faina Muktepavela, Georgijs Bakradze, Edmunds Tamanis, L.Grigorjeva, P.Kulis, R.Krutohvastovs. *Obtaining of ZnO nanostructured coatings by mechanoactivated oxidation*. Abstracts, p.89 (poster).
2. J.Maniks, I.Manika,. *Effect of the surface charge on hardness at the sub-micrometer scale indentation on cleavage surfaces of LiF*. Abstracts, p.89 (oral presentation).

23th Scientific Conference of Physics of Institute of Solid State Physics of University of Latvia, Riga, Latvia, February 13-15, 2007

1. G.Bakradze, F.Muktepavela, V.Sursajeva. *Peculiarities of grain boundaries micromechanical properties in polycrystalline zinc*. Abstracts, p.25 (oral presentation).
2. A.Shishko, F.Muktepavela, R.Krishbergs, E.Platacis. *Theoretical analysis of stationary Eurofer steel corroding interaction with the laminar PbLi melt flow*. Abstracts, p.52 (oral presentation).
3. M. Shorohovs, F.Muktepavela, L.Grigorjeva, J.Millers, J.Maniks. *Microstructure and microhardness of TlBr detector crystals*. Abstracts, p.21 (oral presentation).

DEPARTMENT OF RADIATION PHYSICS

Head of Department *Dr. hab. J. Berzins*

Research Area and Main Problems

The Laboratory consists of four groups – the nuclear spectroscopy and theory, applied nuclear physics, oxide physics and fine particles cooperative effects. The following main problems are developed in the laboratory:

- experimental and theoretical investigation of nuclear structure at medium and high excitation energies;
- development of the nuclear spectral methods for the identification of radioactivity and nuclear materials in Latvia
- development of gamma spectrometric methods for investigation of radionuclides, its migration in the soils and ground waters in the most potentially polluted regions of Latvia.
- application of the liquid scintillation methods for monitoring tritium content in surface, underground and drinking waters.
- study on possibility to use planning Salaspils cyclotron in activation analysis.
- the magnetic ions exchange interaction in the antiferromagnetic oxides MeO-MgO solid solutions were studied using of optical absorption, luminescence, EPR and Raman spectroscopies
- exchange interaction between radiation defects and transition metals ions in the dielectric crystals doped with the transition metals ions
- physical, structural and magnetic properties of solid state fine particles.

International projects:

Participation in the project „Investigation of nuclear structure via (n, γ), (d,p) and (d,t) nuclear reactions” with Institute of Nuclear Physik (Rzez, Czech Republic), Technical University Munich, Institute Laue-Lanževena Institutu (Grenoble, France).

Scientific Staff

- | | |
|--------------------------------|------------------------|
| 1. Dr.hab. J.Berzins | 11. Dr. V.Skvortsova |
| 2. Dr.hab. M.Balodis | 12. Dr. O.Veveris |
| 3. Dr.hab. V.Bondarenko | 13. Dr. A.Petrovs |
| 4. Dr.hab. A.Afanasjevs | 14. Dr. J. Ruza |
| 5. Dr. hab. U.Ulmanis | 15. Dr. G. Smilskalne |
| 6. Dr.hab. N.Mironova - Ulmane | 16. Dr.Ing. A.Pavlenko |
| 7. Dr. hab. J. Tambergs | 17. Mag. J. Proskurins |
| 8. Dr. L.Simonova | 18. Mag. I. Motmillere |
| 9. Dr. T. Krasta | 19. Mag. A.Polakov |
| 10. Dr. D.Riekstina | |

Technical Staff

1. S.Afanasjeva
2. L. Neiburgs
3. A. Sotaks

Students

1. Bach. sc. A. Andrejevs
2. Stud. D. Magone
3. Stud. K. Bavrins

Scientific visits abroad

- Dr. hab. A.Afanasjev Mississippi University,USA (10 month).
Dr. hab. J. Berzins European Commission Euratom, Brussels,Belgium (10 days).
Dr. hab. J. Berzins Cyclotron Workshop, Ispra, Italy (4 days).
Dr. D.Dr. D. Riekstina, 21. Seminar Akvierungsanalyse und Gammaskopie (SAAGAS 21), Deutschland, (3 days).
Mainz, Mag. Sc. J. Proskurins Voronezh, Russia, 25-29 June, 2007
Dr. hab.N.Mironova-Ulmane, Institute of Physics Tartu Estonia (1week +1week)
Dr. Hab. U.Ulmanis . State University “ Lvivska Politechnika” , Lvov, Ukraine (1 week)
Dr. hab.Mironova-Ulmane State University “ Lvivska Politechnika” , Lvov, Ukraine (1week)
Dr. V. Skvortsova University of Caen, France. (1week)
Dr. hab.N.Mironova-Ulmane 13 university Bobigny, Paris region (France) (1week)
Dr. hab.U. Ulmanis Institute of solid state physics Minsk Belorussia (1 week)
Dr. hab.Mironova-Ulmane- Institute of solid state physics Minsk Belorussia(1 week)
Dr.V. Skvortsova Institute of solid state physics Minsk Belorussia (1week)
Dr. hab.Mironova-UlmaneP.Vinogradov Insitute of Geochemistry,Irkutsk, Russia (1week)
Dr. hab.N.Mironova-Ulmane University of Technology Kaunas Lithuania (2 days)
M.Polakovs University of Technology Kaunas Lithuania (2 days)
A.Pavlenko IAEA Wiena,Austria (11 month)
Dr. A. Petrov, University of Roma (5 days).
Dr. A.Petrov , Pedagogical University of Kaluga, Russia (6 days).

Cooperation

Latvia

1. Medical Academy of Latvia (Dr. hab., Prof. M.Eglite, Dr.T.Zvagule).
2. Hazardous Waste Management State Agency “BAPA”.
3. Radiation Safety Center (A.Skujina)
4. Riga Technical University, Institute of Inorganic Chemistry(Dr. I.Vitina,).
5. University of Latvia, Chemical faculty (Dr. A.Viksna,)
6. Institute of Wood Chemistry (Dr. hab. G. Dobele Dr.hab. G. Telesheva, Dr.hab.T.Dizbit)
7. Riga Technical University, Faculty of Material Science and Applied Chemistry ((Prof. L.Berzina-Cimdina).
8. Hazardous Waste Management State Agency “BAPA”.
9. National Diagnostic center.

USA

1. Lawrence Livermoor National Laboratory, California (Prof. R. W. Hoff).
2. Brookhaven National Laboratory, Upton (Prof. R.F. Casten).
3. Notre Dame University, Notre Dame,USA (Prof. S. Frauendorf).

Germany

1. Technical University Munich (Prof. T. von Egidy, Dr. H.-F. Wirth)

Brasil

- 1.Instituto de Fisica Teorica, Universidade de Sao-Paulo (Dr.Castilho-Alcaras).

Lithuania

1. Institute of Theoretical Physics and Astronomy, Vilnius (Dr.O.Katkevičius)

France

1. Institute Laue-Langevin, Grenoble, France (Prof. H. Börner, Dr. M. Jentchel).

Canada

1. Memorial University of Newfoundland, Newfoundland (Dr.A.Aleksejevs)
2. Department of Physics, Acadia University, Wolfville, NS (Dr.S.Barkanova)

Czech Republik

1. Nuclear Research Institute, Řež (Dr. J.Honzatko).
2. Department of Nuclear Physics, Charles University (Prof. J. Kvasil).

Estonia

1. Institute of Physics , Tartu (Prof. Ch.Luschik, Prof. A.Luschik , Dr. A.Sildos Dr.T.Kärner).

Italy

1. Laboratori Nazionali di Frascati, Istituto Nazionale di Fisica Nucleare, Frascati (M. Cestelli Guidi, A. Marcelli)
2. Dipartimento di Scienze Geologiche, Università Roma Tre, Rome (M. Piccinini)
3. INFN and Dipartimento di Fisica, Università di Trento, Povo (Trento)(G.Mariotto)
4. INFN and Dipartimento di Fisica, Università della Calabria, Arcavacata di Rende (Cosenza) (E.Cazzanelli)

Ukraine

1. R&D Institute of Materials RPA “ Carat” Lviv (Dr. D.Sugak, Dr. S.Ubizskii).
2. Institute of Physics of the Ukrainian Academy of Science, Kiev (prof. S. Nepijko).
3. Pedagogical University, Kaluga, Russia (prof. K.Nikiforov),
4. Institute of Chemical Physics, Chernogolovka, Russia (prof.V.Petinov).

Croatia

1. Ruder Boskovic Institute, Zagreb (Prof. S.Music).

Poland

1. Institute of Physics, PAS, Warsaw (Dr. A.Suchocki).

Russia

1. Ural State University, Ekaterinburg (Prof. A. Nikiforov).
2. Ural Technical University, Ekaterinburg (Prof. B.Shulgin)
3. St.Petersburgh Nuclear Physics Institute, Gatchina (Dr.V.Bunakov, Dr.A.Sushkov)

Austria

1. IAEA (Dr. A Shakhashiro)

Denmark

1. Riso National Laboratory, Roskilde,(Dr. S. Nielsen)

Main Results

TRANSFER AND NEUTRON CAPTURE REACTIONS TO ^{194}Ir AS A TEST OF $U_v(6/12) \otimes U_\pi(6/4)$ SUPERSYMMETRY

M. Balodis, H.F. Wirth, G. Graw, R. Hertenberg, J. Berzins, N. Kramere, J. Jolie, S. Christen, O. Möller, D. Tonev, J. Barea, R. Bijker, A. Frank and T. von Egidy

The structure of ^{194}Ir is investigated via (n,γ) and (n,e^-) and (d,p) spectroscopy. The use of different methods leads to a rather complete level scheme up to high excitation energies including γ -decay and spin-parity assignments. The experimental level scheme is compared to predictions using extended supersymmetry, showing a nearly one-to-one correspondence for excitation energies below 450 keV with very similar structures for the experimental and calculated level schemes. The two nucleon transfer reaction strengths show a remarkable agreement between the experimental values and the theoretical predictions. A Nilsson classification is discussed as well.

NUCLEAR STRUCTURE OF ^{187}W STUDIED WITH (n,γ) AND (d,p) REACTIONS

V. Bondarenko, I. Tomandl, H.-F. Wirth, J. Honzatko, L.A. Malov, A.M. Sukhovej, L.I. Simonova, R. Hertenberger, T. von Egidy, J. Berzins

The level structure of ^{187}W has been studied using the prompt and delayed gamma-gamma coincidences from thermal neutron capture in ^{186}W and also measuring the (d,p) reaction. From these data and those of previous studies a total of 170 levels (121 connected by gamma-transitions) have been established for energies below 2.35 MeV. Some of these levels have been grouped into rotational bands built on 14 intrinsic states of quasi-particle and quasi-particle plus phonon character. Of particular interest has been the identification of "quasi bands" with inverse spin sequence based on the newly established isomeric $11/2^+$ state at 410.1 keV. Although the DWBA analysis permitted definite spin-parity assignments for most states a large number of particle transitions have "anomalous" angular and asymmetry shapes with respect to the DWBA which indicate an influence of strong mixing between particle and probably hole states. The exchange of phonons across the Fermi surface leads to a fine structure in the extra fragmentation of most single particle strengths and, at the same time, it produces the effect of breakdown of individual properties of Nilsson states. The extracted $l=1, 2$ and 3 (d,p) sums below 2 MeV have about the same magnitudes as in ^{185}W that comprise a rather small fraction of the expected strengths. The observed states below 2 MeV are compared with predictions of the quasi-particle-phonon nuclear model. The discussion focuses on transition aspects from rigid rotors of light W to gamma-soft nuclei in the Os, Pt region.

STUDIES OF QUANTUM CHAOS IN THE NUCLEAR TRIAXIAL ROTATOR MODEL

J. Proskurins, K. Bavrins, A. Andrejevs, J. Tambergs

Quantum chaos dynamical criteria (wave function entropy $W(\Psi_i)$ and basis state fragmentation width $\kappa(\Phi_k)$) were analyzed in the frameworks of geometrical A. Davidov's rigid triaxial rotator model. This model has a relatively simple structure,

allowing one to express nuclear level energies and wave functions in dependence from just one model parameter - the triaxiality angle γ ($0^\circ < \gamma < 30^\circ$).

The triaxial rotator model Hamiltonian matrices were diagonalized in the basis of axially-symmetric rotator wave functions at all nuclear spin values $I=2,3,4,\dots,101$. The maximal ranks n of diagonalized matrices were $n(I=100)=51$ and $n(I=101)=50$. These calculations were performed for $N_\gamma=28$ values of triaxiality angle $\gamma=3^\circ, 4^\circ, 5^\circ, \dots, 30^\circ$. So, the theoretical nuclear level energies and corresponding wave functions were obtained in the whole triaxial rotator model parameter and nuclear spin range. Afterwards, in all these cases, the wave function entropy $W(\Psi_i)$ and basis state fragmentation width $\kappa(\Phi_k)$ calculations were performed.

It has been found that, even at maximal triaxiality angle value $\gamma=30^\circ$, when the wave function mixing is most prominent for this model, the evaluated wave function entropy $W(\Psi_i)$ value, averaged over all $n(I)$ states at given nuclear spin I value, amounts only to $0.75 \div 0.85$ from the theoretically possible maximal value $W(\Psi_i)_{\max}=\ln(n)$, independently from spin value. It means that the internal structure of the rigid triaxial rotator model does not allow to achieve a maximal quantum chaos level.

The possibilities to evaluate basis state fragmentation width $\kappa(\Phi_k)$ are considerably restricted by the requirement that the diagonal amplitude of the mixed wave function should meet the condition $|c_{i=k,k}|^2 < 0.5$. Because of this requirement, one can start to study this quantum chaos criterion only starting with triaxiality angle $\gamma > 23^\circ$, even at relatively high nuclear spin values $I=24$ (when $n=13$). The theoretically predicted transition region from the "soft chaos" with $\kappa(\Phi_k) < 1$ to the „hard chaos" with $\kappa(\Phi_k) > 1$, one can obtain in the frameworks of rigid triaxial rotator model only at nuclear spin values $I \geq 50$, when the number of mixed basis states $n \geq 26$.

APPLYING THE LIQUID SCINTILLATION SPECTROMETRIC METHOD FOR MONITORING TRITIUM IN GROUND WATERS

D. Riekstina, O. Veveris, A. Skujina, A. Zalkalne

The monitoring of tritium concentration level in the wells around the shut-down nuclear research reactor Salaspils and the radioactive waste depository has been carried out for the period of 7 years. The increased concentration of tritium was detected in three wells of the reactor territory and in one well of the radioactive waste repository. The periodic changes of tritium concentration level were observed in some wells of the reactor territory. In the territory of radioactive waste repository, the increased concentration of tritium was observed in one well in the direct vicinity of the waste basin. The tritium concentration in this well is more than 10 times lower than that according to the 1997 year data. The H-3 concentration in the rest of this territory wells is within 2-18 Bq/l limits during last 5 years.

EVALUATION OF RADIONUCLIDE ACCUMULATION IN SOIL AROUND THE SHUT DOWN NUCLEAR REACTOR AND RADIOACTIVE WASTE REPOSITORY OF LATVIA

D. Resting, O. Veers, J. Berzins, J. Alksnis, A. Skujina

The level of radioactivity in soil in the 3x3 km area around the Salaspils (Latvia) nuclear reactor 5 year after its shutting down and the radioactive waste repository was investigated. The results indicate that the average gamma background achieve $50 \text{ nSv/h} \pm 15\%$. The concentration of Cs-137 was established using high-resolution gamma-spectrometry. In soils it varies in the range $0.3-227 \text{ Bq/kg}$ ($20-1940 \text{ Bq/m}^2$). In the territory around radioactive waste repository activity of Cs-137 was in interval 0.3-47

Bq/kg. The content of Sr-90 in soils, collected in the territory around nuclear reactor, for a two year period was 0.17-7.4 Bq/kg and in the territory around waste repository 0.06-3.9 Bq/kg.

GADOLINIUM CONTAINING FERRITES AND SUPERCONDUCTORS AFTER THERMAL NEUTRON IRRADIATION (COMPARING CONSIDERATION)

A.Petrovs, I.Kudrenickis

Experimental study both gadolinium containing ferrites ($Gd_3Fe_5O_{12}$) and high temperature superconductors ($GdBa_2Cu_3O_{7-\delta}$) after thermal neutron irradiation (that gives a chance to create structural defects only in Gd sub lattice) shows the similar behavior in degradation of their magnetic and structure properties. The regions of weak magnetic and no superconducting phase are formed as the result of soft displacement of Gd^{T3} ions. While the concentration of these regions increases and the distance between them becomes comparable with characteristic lengths (for exchange correlation and electron coherence), ferrimagnetisms and superconductivity as cooperative phenomena are growing weak and disappearing.

RAMAN STUDY OF MAGNETIC ORDERING IN $Co_cMg_{1-c}O$ SOLID SOLUTIONS

N. Mironova-Ulmane, U. Ulmanis, A. Kuzmin, I. Sildos¹, M. Pärs¹, M. Cestelli Guidi²,
M. Piccinini^{2,3}, A. Marcelli³

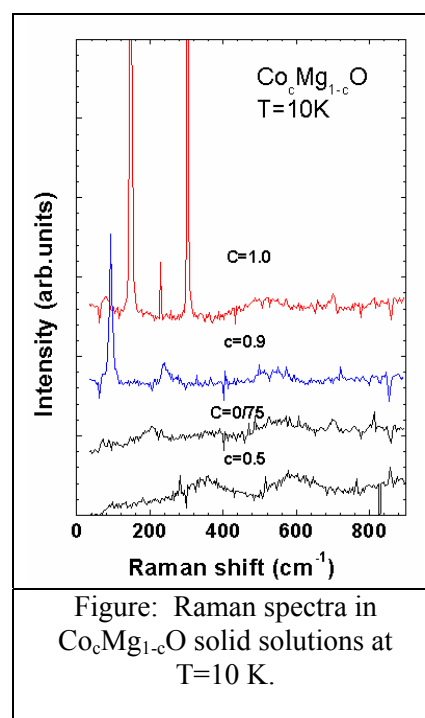
$Co_cMg_{1-c}O$ system is a nice example of diluted antiferromagnet. It forms a continuous series of solid solutions, whose magnetic properties vary with the composition, from antiferromagnetic-like behaviour with the Néel temperature $T_N=300$ K for pure CoO to diamagnetic-like behaviour for pure MgO. For intermediate compositions with $c>0.5$, the paramagnetic-to-antiferromagnetic phase transition occurs upon cooling.

In order to examine the influence of the dilution by diamagnetic ions on the magnetic ordering of single-crystal $Co_cMg_{1-c}O$ solid solutions, we have performed Raman spectroscopy and domain structure studies. The far-IR temperature dependent measurements were also performed for pure CoO. The temperature dependence of the intensity of Raman scattering from $Co_cMg_{1-c}O$ solid solutions has been measured in a wide range of compositions ($0.5<c<1$) and temperatures ($6\text{ K}<T<200\text{ K}$).

¹*Institute of Physics, University of Tartu, Tartu, Estonia*

²*Laboratori Nazionali di Frascati, Istituto Nazionale di Fisica Nucleare, Frascati, Italy*

³*Dipartimento di Scienze Geologiche, Università Roma Tre, Rome, Italy.*



RADIATION DEFECTS AND TRANSITION IONS INTERACTION IN MAGNESIUM OXIDE

V. Skvortsova, N. Mironova-Ulmane, U. Ulmanis

There is investigated the absorption spectra of nickel and manganese doped and pure MgO single crystals before and after fast neutron irradiation and after annealing. It is shown, that the fast neutron irradiation leads to the formation of two types complex centers: “ $\text{Me}^{2+}\text{-F}^+$ (or F) center” and “ $\text{Me}^{3+}\text{-V}_{\text{Mg}}$ ”. From the behaviour of the ~ 570 nm and ~ 357 nm absorption bands during annealing the activation energies of the corresponding defects are determined. The obtained activation energy values ($E_a < 1$ eV) allow assumes that the transition ions play an important role in the migration of vacancies and interstitials

Investigation of EPR signals on tooth enamel

A Pavlenko, N Mironova-Ulmane, M. Polakovs

Calcified tissues are involved in continues metabolic process in human organism exchanging a number of chemical elements with environment. The rate of biochemical reactions is tissue dependent and the slowest one at the tooth enamel, the most mineralized tissue of human organism. The long time stability and unique chemical composition make tooth enamel suitable for number of application. The assessment of individual radiation dose by Electron Paramagnetic Resonance (EPR) and evaluations of elemental composition by Instrumentation Neutron Activation Analysis (INAA) are the well known procedures where properties of tooth enamel intensively used. The current work is focused on investigation of EPR signals and determination of chemical composition on several teeth samples having different origin. The EPR spectra and INAA element content of milk tooth, caries tooth, and paradantose tooth have been compared to each other. The results showed that the intensity of EPR signal is much higher for the caries tooth than the for paradantose tooth that is in agreement with depleted Ca content.

Scientific Publications

Published in 2007

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2. P. J. Davies, A.V. Afanasjev, R. Wadsworth, C. Andreoiu, R. A. E. Austin, et al, Identification of the $g_{9/2}$ proton and neutron band crossing in the $N=Z$ nucleus ^{76}Sr . *Physical Review C* 75 (2007) 011302(R):1-5.
3. E. S. Paul, A. O. Evans, A. J. Boston, C. J. Chiara, M. Devlin, D. B. Fossan, S. J. Freeman, D. R. LaFosse, G. J. Lane, M. J. Leddy, I. Y. Lee, A. O. Macchiavelli, P. J. Nolan, D. G. Sarantites, J. M. Sears, A. T. Semple, J. F. Smith, K. Starosta, A. V. Afanasjev, I. Ragnarsson „Gamma-ray spectroscopy of neutron-deficient ^{110}Te II: High-spin smooth-terminating structures”, *Physical Review C* 76 (2007) 034323: 1-9.
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13. V. Skvortsova, N. Mironova-Ulmane, A. Kuzmin, U. Ulmanis Growth and optical properties of transition metal oxides single crystal solid solutions *Journal of Alloys and Compounds(JALLCOM)* Volume 442, Issues 1-2, 13 September 2007, Pages 328-330
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- 16.N. Mironova-Ulmane, A.Kuzmin, J. Grabis, I. Šteins, I. Sildos, M. Pārs, Raman scattering in nanosized nickel oxide. *J.Phys. Conf. Series* 93 (2007) 012039 (5 pages).
17. A. Pavlenko, N. Mironova-Ulmane, M. Polakovs. Investigation of EPR signals on tooth enamel. *IOP Conf. Series* 93 (2007) 012047.(5 p).
- 18.T. Dizhbite, N. Mironova-Ulmane, A. Volperts, A. Andersone, L. Jashina, S. Popov, T. Kärner and G. Telysheva Elaboration and characterization of organic/inorganic hybrid nanoporous material incorporating Keggin-type Mo-Si polyanions *IOP Conf. Series* 93 (2007) 012011(6 p)
- 19.N. Mironova-Ulmane, U. Ulmanis, A. Kuzmin, I. Sildos, M. Pārs, M. Cestelli Guidi, M. Piccinini, A. Marcelli Magnetic ordering in $\text{Co}_c\text{Mg}_{1-c}\text{O}$ solid solutions *Phys .St.solid* (in press).
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- 21.N. Mironova-Ulmane, M.Polakovs, A. Pavlenko,D. Riekstina T.Zvagule, E. Churbakova, Kurjane, N. Gabrusheva, M. Eglite, T.Kärner Estimation of internal and

external exposition in retrospective dosimetry of Chernobyl clean-up workers
Proceedings of International Conference “Medical Physics 2007” 5 – 6 October 2007,
Kaunas, Lithuania. pp55-59

22.M.Polakovs, N. Mironova-Ulmane, M. Grube and E.Reinholds. Micro-raman and infrared spectra of blood. International Conference “Medical Physics 2007” 5 – 6 October 2007, Kaunas, Lithuania.pp 50-54.

23.N. V. Skvortsova, L. Trinkler, L. Grigorjeva, Spectroscopy of defect centers in magnesium oxides crystals irradiated by fast neutron. Proc. Int. Conf. Actual Problem of Solid State Physics –2007. October 23-26, 2007, Minsk, Belarus, v 3, p.266-268.

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Lectures on Conferences

23-th Scientific Meeting of Institute of Solid state Physics, University of Latvia, Riga, 13-15 February, 2007.

1. M. Balodis, J.Berzins,N.Kramere,H.-F. Wirth,, G.Graw, R.Hertenberg, T.von Egidy, J.Jolie, S.Chisten, O.Moeller, D.Tonev, J. Barea, R.Bijker, A.Frank, „Supersymetry model for the ¹⁹⁴Ir structure”,

2. D.Riekstina, J.Malnacs, O.Veveris, J.Berzins.A.Grivite, „Evaluation of ²²⁶Ra pollution”,

3. J. Bērziņš „Nacionālais daudzfunkcionālais ciklotrona centrs Latvijā”,

4. J.Proskurins. „Studies of quantum chaos in the triaxial rotator model”,

5. T.Krasta. „Isotopic symmetry effects in 4≤A≤40 nuclei in the framework of Strictly Restricted Dynamics Model”.

6. N. Mironova-Ulmane, U. Ulmanis A. Kuzmins, I.Sidos, M.Pärs.Magnetic faze transition in Co_cMg_{1-c}O solid solution -15, 2007, p.23.

7.V. Skvortsova. Optical Properties of complex defects of irradiated MgO -15, 2007, p.40.

Cyclotron Networking Meeting, Ispra, Italy, 3-6 December 2007.

1. J. Berzins „Multipurpose cyclotron center in Latvia”

3rd Internat Conf. Metals in Environment, Vilnius, 2007

1. D.Riekstina, O. Veveris, J. Berzins, J. Alksnis, A. Skujina, „Evaluation of Radionuclides accumulation insoil around the shutdown nuclear reactor and radioactive waste repository of Latvia”, p.66-69.

65th Scientific Conference of the Latvian University, section of the History of Sciences and Museum Science, Riga, 29.01.2007

1. J.Tambergs. History of theoretical nuclear physics in Latvia: 1936-2006.

2. J.Tambergs. „Nonlocality as a Reality”.

3. J.Tambergs. „Cosmological constant and vacuum”.

International Conference „NUCLEUS-2007” (25-26 June, 2007, Voronezh, Russia), 27.06.2007

1. J.Proskurins. „Study of Quantum Chaos in the Framework of Triaxial Rotator Model”, 11.

21. Seminar Akvierungsanalyse und Gammaskpektroskopie (SAAGAS 21), Mainz, Deutschland, 21-23 Marz 2007

1. D. Riekstina,O. Veveris, J. Berzins „Quality assurance in gamma spetrometric measurements”, S.43.

EcoBalt'2007, Riga, May 10-11, 2007

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1.N.Mironova-Ulmane, A. Kuzmin J.Grabis, I.Šteins. “Raman scattering in nanosized nickel oxide” (abstract p.71).

2.T. Dizhbite, N. Mironova-Ulmane, A. Volperts, A. Andersone, L. Jashina, S. Popov, T. Kärner and G. Telysheva “Elaboration and characterization of organic/inorganic hybrid nanoporous material incorporating Keggin-type Mo-Si polyanions” (Abstract p.131)

3.A. Pavlenko, N. Mironova-Ulmane, M.Polakovs “Investigation of EPR signals on tooth enamel” (Abstract p.77).

Developments in Optics and Communications, Riga, 27-29 April 2007

21.M. Polakovs “The optical absorption of Fe^{2+} and Fe^{3+} ions in the blood”.

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22. N. Mironova-Ulmane A. Kuzmin, U. Ulmanis, I. Sildos, M.PärsE. Cazzanelli, G. Mariotto. “Study magnetic excitations in $Ni_cMg_{1-c}O$ solid solutions”.

XIII-th Feofilov symposium on spectroscopy of crystals activated by rare earth and transition metal ions.

23.N. Mironova-Ulmane, U. Ulmanis, A. Kuzmin, I. Sildos, M. Pärs, M. Cestelli Guidi, M. Piccinini, A. Marcelli. “Magnetic ordering in $Co_cMg_{1-c}O$ solid solutions”.

12th European Conference on the Spectroscopy of Biological Molecules ECSBM'2007 Bobigny, Paris region (France) 1-6 September 2007.

24.N.Mironova-Ulmane, M.Polakovs, A.Pavlenko and E. Reinholds “The EPR and optical spectra of blood”.

14th International conference “Radiation Effects in Insulators REI-2007”, Caen (France), 27 august- 1 September 2007.

25.M.Polakovs, N. Mironova-Ulmane, M. Grube and E.Reinholds. Micro-raman and infrared spectra of blood.

International Conference “Medical Physics 2007” 5 - 6 October 2007, Kaunas, Lithuania.

26.V. Skvortsova, N. Mironova- Ulmane, L. Grigojeva, D. Millers, K. Smits, Transient and stable color centers in neutron irradiated MgO.

27.N. Mironova-Ulmane, M.Polakovs, A. Pavlenko,D. Riekstina T.Zvagule, E. Churbakova, Kurjane, N. Gabrusheva, M. Eglite, T.Kärner Estimation of internal and external exposition in retrospective dosimetry of Chernobyl clean-up workers.

Int. Conf. Actual Problem of Solid State Physics –2007. October 23-26, 2007, Minsk, Belarus.

1.M.Polakovs, N. Mironova-Ulmane, M. Grube and E.Reinholds. Micro-raman and infrared spectra of blood,

- 2.N. Mironova-Ulmane, A. Kuzmin, I. Sildos, M. Pārs , I. Steins, J. Grabis Magnetic ordering in $\text{Ni}_c\text{Mg}_{1-c}\text{O}$ solid solution.
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International Conference Abstracts, Kaluga, Russia, May 22-25, 2007

1. A.E.Petrov, I.V.Kudrenickis. "Gadolinium Containing Ferrites and Superconductors after Thermal Neutron Irradiation (Comparing Consideration)".

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6th International Conference on Fine Particles Magnetism (ICFPM).

Scientific seminar of LU ISSP, Riga, 26.11.2007.

- 1.J.Tambergs, G.Māliņš, A.Andrejevs. „Inertoid – the motion of the non-trivial system”.

Scientific seminar of LU ISSP, Riga, 17.12.2007

1. J.Proskurins. „The study of phase transitions and quantum chaos in the framework of geometrical and boson interaction models”.

Scientific seminar of the LU PMP Inst. of Atomic Physics and Spectroscopy, Riga, 10.05.2007

1. A.Andrejevs. „CH (correlated history) approach to the interpretation of quantum mechanics”.

Scientific seminar of the LU PMP Institute of Atomic Physics and Spectroscopy, Riga, 25.01.2007.

A.Andrejevs, J.Tambergs. „Free hydrogen atom in modern physics”

Scientific seminar of the LU PMP ERAF project group, Riga, 16.02.2007.

1. J.Ruža. „Von Neumann quantum measurement theory”,

LU PMP ERAF project group, Riga, 09.03.2007.

1. J.Ruža. „Entangled states in quantum physics”,

Lectures at Universities, Institutes ...

During 2007, J.Tambergs was engaged in following activities related with LU study programs:

1) supervision of the physics doctor dissertation work „Theoretical study of quantum chaos and phase transitions in nuclear models” of Jevgenijs Proskurins (continued in 2008);

2) supervision of the physics bachelor works of LU Physics and Mathematics Faculty 4th year students:

- Konstantins Bavrins, “Studies of Quantum Chaos in the triaxial rotator model” (started in 2007 Spring semester and would be continued in 2008);

- Antons Jakimovičs, “Structure of odd-odd nucleus ^{188}Re in the frameworks of rotator plus two quasiparticles model” (started in 2007 Autumn semester and would be continued in 2008) ;

- Gatis Māliņš, “Study of relationships between mechanical translational and rotational motions based on the laws of moment and angular moment conservation” (defended).

J. Ruža Lecture course General physics in Riga Technical University.

LABORATORY OF ORGANIC MATERIALS

Head of the Laboratory: Dr.habil.phys. I.Muzikante

Research Area and Main Problems

The laboratory's research interests cover polar organic materials for application in optics, photonics and molecular electronics. Research area is optical, electrical and photoelectrical properties of new advanced organic materials and structures. Studies include energy structure and charge carrier transport of low mobility organic solids; charge carrier trapping phenomena, surface potential investigations, optically induced switching effect and second harmonic generation effects in organized polar organic films.

Scientific Staff:

1. Dr.phys. E.Fonavs
2. Dr.chem. L.Gerca
3. Dr.habil.phys. I.Muzikante
4. Dr.phys. M.Rutkis
5. Dr.phys. O.Vilitis

Assistant:

1. J.Latvels

Engineers:

1. I.Bidermane
2. E.Laizāne
3. A.Tokmakovs
4. A.Vembris

Technicians:

1. E.Nitishs
2. J.Sipols

Scientific visits abroad

1. Dr.h. I.Muzikante, Angers University, France (1 week)

LIGHT INDUCED PROCESSES IN THIN FILMS OF INDANDIONE TYPE ORGANIC MOLECULES

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The optically induced switching of material properties is important for investigations of opto-electronic effects and opto-mechanical properties. Investigated organic materials contain chromophore dipole consisting of acceptor and donor groups bridged by a delocalized π -electron system. Both calculations and experimental data show a reversible highly dipolar photoinduced intra molecular charge transfer in indandione type molecules (DMABI) accompanied by change of the sign and the value of the dipole

moment. Investigations of optical properties of thin host-guest polymer films show that the photoinduced process of DMABI is related to the photoinduced switching between two equally stable states of the molecule. In this work first results of formation of the surface relief in polymer films incorporated with DMABI derivatives will be presented. The refractive index gratings of DMABI host-guest films show that red light is less diffracted than blue one. The reversible surface potential changes on irradiation in photoinduced intramolecular electron transfer band in polymer host-guest films is observed. The DMABI molecules in solid state have nonlinear optical properties, which can be used and investigated in host-guest polymer matrix. The influence of concentration of DMABI molecules on photoinduced processes is discussed.

NEW HYBRID FILMS BASED ON CELLULOSE AND HYDROXYGALLIUM PHTHALOCYANINE. SYNERGETIC EFFECTS IN THE STRUCTURE AND PROPERTIES

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Hydroxygallium phthalocyanine (HOGaPc) and cellulose (from a trimethylsilyl derivative) have been used as native elements for the preparation of a novel family of hybrid films. By spin-coating, both components allow the building of films with different configurations on various substrates in a controlled way. The particularities of these hybrid films have been characterized by a range of techniques as Fourier Transform Infrared Spectroscopy (FTIRS) in Attenuated Total Reflection using Multiple Internal Reflections (ATR/MIR), Absorption Ultraviolet and Visible Spectroscopy (UV-Vis), X-Ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM) and Surface Potential measurements using the Kelvin-Zisman vibrating capacitor probe (KP). This enabled to determine the influence of cellulose on the arrangement of HOGaPc and consequently to control the relation between the structure and the properties of the films. Finally, gas sensor tests were performed to check the potentialities of these hybrids films. In particular, the synergetic behavior between the film-forming materials allows a fast and sensible change in surface potential after cyclic exposures to ozone (O₃, 100 ppb) and nitrogen. Overall, we present the advantages of combining phthalocyanine with cellulose in enhancing the properties of the final product. We want to remark the introduction of cellulose as a host material in the formation of new families of hybrid films.

PV EFFECT IN VISIBLE AND INFRARED LIGHT IN P3HT/C61(CO2Et)2/ GaOHPc BLEND AND MULTILAYER CELLS

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P.Shipkovs¹, A.Murashov¹, V.Parra³, V.Kampars²

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The blend of regio-regular poly(3-hexylthiophene) (P3HT) and a soluble fullerene derivative is widely used for creation of efficient organic solar cells. However, its main drawback is a limited spectral range of only 350–650 nm. The authors report about the possibility to extend this spectral range to the near infrared (NIR) region by adding an extra electron donor – hydroxygallium phthalocyanine (GaOHPc) having a strong and wide intermolecular charge transfer (CT) band around 830 nm.

The sandwich-type samples were prepared on an ITO glass substrate covered first by a 50–100 nm thick PEDOT:PSS layer and then by several layers of GaOHPc using spin coating from its solution in chloroform. Thus obtained rough surface was covered by a ~100 nm thick layer of P3HT:C61(CO2Et)2 blend from solution in chlorobenzene. As the top electrodes, Al or In were used. A significant photosensitivity of the cell was observed in the 370–900 nm spectral range. However, the short-circuit photocurrent quantum efficiency was found to be 2–3 times higher for illumination in the P3HT absorption band as compared with that in the GaOHPc CT band at 830 nm. But when GaOHPc was mixed in the blend forming an active P3HT:C61(CO2Et)2:GaOHPc layer, its CT band shifted to the IR part with the maximum at 875 nm, with the efficiency of charge carrier photogeneration for illumination in the GaOHPc CT band increased significantly, exceeding its value for illumination in the P3HT absorption band at its maximum.

NON-LINEAR OPTICAL PROPERTIES OF POLYMER SYSTEMS WITH POLED INDANDIONE DERIVATIVES AS CHROMOPHORE

M.Rutkis, A.Vembris, V.Zauls, A.Tokmakovs, E.Fonavs

A novel class of molecules for production of advanced materials for photonic applications with considerable NLO efficiency based on polar indandione derivatives as chromophores have been presented. Several types of non-centro - symmetrical materials – LB films, poled polymers films where indandione derivatives are attached to polymer backbone or mixed with polymer as host – guest system was produced. The non-linear optical efficiency of corona poled host- guest system of the DMABI in the polymer sPMMA matrix is comparable with the best organic materials of that class. Capability to manipulate these systems by light may arouse interest in non-linear optics and photonics technology. The effect of spatial SHG hole burning is proposed as mechanism for information storage, capability to perform “write” and “read” operations have been demonstrated.

IMPACT OF AGGREGATES ON EXCITATION DYNAMICS IN TRANSPARENT POLYMER FILMS DOPED BY DIPOLAR MOLECULES

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Optical properties of transparent polymer films of polymethylmethacrylate doped (up to 25 wt.%) by dipolar N,N-dimethylaminobenzylidene 1,3-indandione (DMABI) molecules were studied. Formation of DMABI nanocrystallites, increasing in their density and size with dopant concentration, was revealed by optical microscopy. Transformation of the fluorescence spectrum from the molecular-like emission (for the low dopant concentration below 1 wt.%) to highly red-shifted fluorescence corresponding to self-trapped excitons in the crystallites was observed. It was shown, that due to the resonant energy transfer in the blend, the DMABI nanocrystals can serve as efficient fluorescence markers. A reverse dependence on the dopant concentration was observed for high intensity excitation, when the DMABI nanocrystals act as nonradiative traps due to efficient exciton–exciton annihilation.

POLYMERS FILMS WITH INDANDIONE DERIVATIVES AS ALTERNATIVES TO AZOBENZENE POLYMERS FOR OPTICAL PATTERNING

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Surface relief gratings (SRGs) on organic thin films are studied extensively for both scientific interest and in relevance to the applications. Among the chromophores being used the azobenzenes showed the best performance, but the use of alternative photosensitive groups provides better general understanding of the phenomena. A thermodynamic theory and molecular dynamics simulations of photoinduced effects are discussed. In this study we use indandione derivatives, known as promising materials for photonics applications, as an alternative to the azobenzenes. We consider their photoreactions when incorporated into a polymer film. One of interesting features is the spectral dependence of the diffraction of indandione containing gratings.

A NOVEL GAS SENSOR TRANSDUCER BASED ON PHTHALOCYANINE HETEROJUNCTION DEVICES

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Experimental data concerning the changes in the current-voltage (I-V) performances of a molecular material-based heterojunction (Au|Ni(F16Pc)|NiPc|Al) consisting of hexadecafluorinated nickel phthalocyanine (Ni(F16Pc)) and nickel phthalocyanine (NiPc), are introduced as an unprecedented principle of transduction for gas sensing

performances. The respective *n*- and *p*-type doped-insulator behaviors of the respective materials are supported, owing to the observed changes in surface potential (using the Kelvin probe method) after submission to electron donor (ammonia) and electron acceptor gases (ozone). On the other hand, the bilayer device exhibits strong variations in the built-in potential of the junction and in its rectification ratio. Moreover, large increases occur in forward and reverse currents in presence of ammonia vapours. These make possible a multimodal principle of detection controlled by a combined effect between the heterojunction and the NiPc|Al contact. Indeed, this metal/organic junction plays a critical role regarding the steady asymmetry of the I-V profiles during the device's doping even using high ammonia concentrations. This approach offers a more sophisticated alternative to the classically studied, but at times rather operation-limited, resistive gas sensors.

TOWARD DEVICE APPLICABLE SECOND ORDER NLO POLYMER MATERIALS: DEFINITION OF THE CHROMOPHORE FIGURE OF MERIT.

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Maximal achieved second order non linear optical (NLO) efficiency of the PMMA based host –guest systems containing eight dimethylaminobenzylidene -1, 3 indandione (DMABI) related chromophores have been analysed. Two contradicting sets of NLO chromophore figure of merit (FOM) equations were tested. One of them predicts that NLO efficiency of the poled polymer host -guest film is proportional to ground state dipole $d_{33} \sim \mu_g$, another to $d_{33} \sim 1/\mu_g$. The best correlations for the maximal achieved nonlinearity were obtained with second set of FOM, especially if high ground state dipole ($\mu_g > 7D$) chromophores are included in analysis.

Cooperation

Latvia

1. Department of Material Science and Applied Chemistry, Riga TU (Prof. V.Kampars)
2. Latvian Institute of Organic Synthesis (Dr. E.Markava)
3. Institute of Chemical Physics, University of Latvia, (Dr. D.Erts)
4. Institute of Physical Energetics, Latvian Academy of Sciences (Dr. I.Kaulačs)

Lithuania

Institute of Physics (Prof. L.Valkunas)

Institute of Material Science and Applied Research, Vilnius University, Vilnius, Lithuania (Prof. S.Juršenas)

Germany

Lehrstuhl Physik kondensierter Materie, Universität Potsdam, Potsdam (Prof. D.Neher, B.Stiller)

France

1. Laboratoire de Chimie Inorganique et Matériaux Moléculaires, Université Pierre et Marie Curie, Paris, (Dr.habil. M.Bouvet)
2. Laboratoire POMA, Université d'Angers, Angers (Prof. J.M.Nunzi)

Scientific publications

Published in 2007

1. I.Muzikante, M.Rutkis, E.Fonavs, B.Stiller,D.Neher, V.Kampars, P.Pastors, Light induced processes in thin films of indandione type organic molecules, *SPIE Proceedings*, 2007, Vol. 6470, 647012
2. V.Parra, M.Rei Vilar, N.Battaglini, A.M.Ferraria, A.M.Botelho do Rego, S.Boufi, M.L. Rodríguez-Méndez, E.Fonavs, I.Muzikante, M.Bouvet, New Hybrid Films Based on Cellulose and Hydroxygallium Phthalocyanine. Synergetic Effects in the Structure and Properties, *Langmuir*, 2007, vol.23,Iss.7, 3712-3722
3. I.Kaulachs, I.Muzikante, G.Shlihta, L.Gerca, M.Plotniece, M.Roze, J.Kalnachs, P.Shipkovs, A.Murashov, V.Parra, V.Kampars, PV effect in visible and infrared light in P3HT/C₆₁(CO₂Et)₂/GaOHPc blend and multilayer cells, *Latv.J.Phys Tehn. Sci.*, 2007, No.3, pp.61-68.
4. M.Rutkis, A.Vembris, V.Zauls, A.Tokmakovs, E.Fonavs, Non-linear optical properties of polymer systems with poled indandione derivatives as chromophore, *Nonlinear optics, quantum optics*, 2007, Vol.37, No.1/3, pp.31-42.
5. S.Jursenas, N.Kurilcik, R.Karpicz, V.Gulbinas, L.Valkunas, M.Rutkis, I.Muzikante, Impact of aggregates on excitation dynamics in transparent polymer films doped by dipolar molecules, *Thin Solid Films*, 2007, doi:10.1016/j.tsf.2007.11.066
6. B.Stiller, M.Saphiannikova, K.Morawetz, J.Ilnytskyi, D.Neher, I.Muzikante, P.Pastors, V.Kampars, Optical patterning of azobenzene and indandione containing films, *Thin Solid Films*, 2007, doi:10.1016/j.tsf.2007.11.106
7. A.Vembris, M.Rutkis, V.Zauls, E.Laizane, Stability of the Functional NLO Polymers - Optical Induced De- poling of the DMABI Molecules in sPMMA Matrix, *Thin Solid Films*, 2007, doi:10.1016/j.tsf.2007.11.090.
8. I.Muzikante, R.Dobulans, E.Fonavs, J.Latvels, A.Tokmakov, V.Parra, M.Bouvet, Changes in conduction features of a phthalocyanine-based heterojunction as a novel principle of transduction for gas sensing, *Sensors*, 2007, Vol.7, No.11, pp.2984-2996
9. I.Kaulach, I.Muzikante, L.Gerca, M.Plotniece, M.Roze, J.Kalnachs, G.Shlihta, P.Shipkovs, V.Kampars A.Tokmakov, PV and Magnetic Field Effects in Poly(3-Hexylthiophene)-Fullerene Cells Doped with Phthalocyanine Soluble Derivative, *EPJ AP The European Physical Journal Applied Physics*, 2007, Vol.40-2, pp169-174.
10. M.Rutkis, A.Jurgis, V.Kampars, A.Vembris, A.Tokmakovs,V.Kokars, Toward device applicable second order NLO polymer materials: definition of the chromophore figure of merit, *Journal of Physics, Conference Series*, 2007, Vol.93, doi:10.1088/1742-6596/93/1/012028.

Lectures on Conferences

1. Photonics West Symposium OPTO 2007, San Jose, USA, January 21-24, 2007

I.Muzikante, M.Rutkis, E.Fonavs, B.Stiller,D.Neher, V.Kampars, P.Pastors, Light induced processes in thin films of indandione type organic molecules, , Abstracts, CD (oral)

2. Nanotech Northen Europe 2007, Helsinki, Finland, March 27-29, 2007

A.Sternberg, I.Muzikante, Nanomaterials and nanotechnologies in Latvia, Abstract, (poster)

3. International Baltic Sea Region Conference on Functional materials and Nanotechnologies FM&NT 2007, Riga, Latvia, April 2-4, 2007:

1. E.Jecs, M.Rutkis, J.Kreicberga, A.Jurgis, A.Vembris, V.Kampars, Synthesis and NLO characterization of Novel Azobenzene Monomers for Electro optical active polyurethane, Book of Abstracts, pp. 115 (poster)
2. A.Vembris, M.Rutkis, E.Laizane, J.Sipols, Effect of the corona poling and thermo cycling sequence on the host – guest system properties, Book of Abstracts, pp. 47, (poster)
3. M.Rutkis, V.Kampars, A.Jurgis, A.Vembris, A.Tokmakovs, V.Kokars, Toward device applicable polymers second order nonlinear optical materiāls, Book of Abstracts, pp. 46 (oral)
4. E.Laizane, A.Vembris, D.Gustina, E.Markava, Photoisomerisation process in azobenzene host – guest film, Book of Abstracts, pp. 119 (poster)
5. J.Sipols, I.Muzikante, E.Fonavs, P.Pastors, V.Kampars, Photoelectrical properties of polymer films consisting of indandione derivatives, Book of Abstracts, pp. 116 (poster)
6. I.Muzikante, E.Fonavs, B.Stiller, D.Neher, V.Kampars, P.Pastors, Light induced electrical and mechanical processes in thin films of indandione type molecules, Book of Abstracts, pp. 49 (oral)
7. I.Kaulach, I.Muzikante, L.Gerca, M.Plotniece, M.Roze, J.Kalnachs, G.Shlihta, P.Shipkovs, V.Parra, V.Kampars, PV effect in multilayer cells of fullerene/poly(3-hexylthiophene) and phthalocyanine having NIR charge transfer absorption band, Book of Abstracts, pp. 50 (poster)
8. J.Latvels, E.Fonavs, I.Muzikante, M.Bouvet, V.Parra, G.Juska, K.Genevicius, Electrical properties of heterojunction-based device of phthalocyanine devices, Book of Abstracts, pp. 51 (poster)

4. The European Materials Research Society (E-MRS) 2007 Spring Meeting, Strasbourg, France, May, 2007:

I.Kaulach, I.Muzikante, L.Gerca, M.Plotniece, M.Roze, J.Kalnachs, G.Shlihta, P.Shipkovs, V.Kampars, V.Parra, PV effect in multilayer cells of GaOH phthalocyanine and fullerene doped poly(3-Hexylthiophene), Abstract ID: 9R0W7, report D-1653. (poster)

5. 12th International Conference on Organized Molecular Films (LB-12), July 1-5, 2007, Kraków, Poland:

M.Bouvet, V.Parra, R.Dobulans, E.Fonavs, J.Latvels, I.Muzikante, Phthalocyanine-Based Gas Sensors: From Classical Thin Film Resistors to Organic Heterojunctions, Abstracts, (oral)

6. IX International Conference on Frontiers of Polymers and Advanced Materials ICFPAM, Kraków, Poland, July 8-12, 2007

1. I.Muzikante, J.Latvels, E.Fonavs, M.Bouvet, V.Parra, G.Juska, K.Genevicius, Electrical properties of heterojunction-based device of phthalocyanine and indandione derivatives, Book of Abstracts, pp. 166
2. M.Rutkis, A.Vembris, A.Tokmakovs, V.Kampars, V.Kokars, A.Jurgis, Optimizing the second order NLO performance of the host-guest polymer systems by tailoring the chromophores structure, Book of Abstracts, pp.188. (oral)
3. A.Vembris, M.Rutkis, E.Laizane, Influence of corona poling on host – guest polymer system NLO properties, Book of Abstracts, pp.394. (poster)
4. I.Muzikante, E.Fonavs, E.Laizane, A.Vembris, Photoelectrical properties of polymer films consisting of indandione derivatives with photoinduced intramolecular electron transfer, Book of Abstracts, pp. 391 (poster)

5. A.Tokmakovs, A.Vembris, M.Rutkis, V.Kampars, V.Kokars, A.Maleckis, Linear and nonlinear optical properties of novel polymers containing indan-1,3-dione derivatives as side chain chromophores, Book of Abstracts, pp. 415 (poster)
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- 7. The 9-th International Conference-School Advanced Materials and Technologies, Palanga, Lithuania, August 27-31, 2007:**
A.Petruhin, J.Grube, J.Sipols, B.Polyakov, I.Muzikante, I.Tale, Semoconducting nanocrystals for solar cell applications produced by laser ablation, Abstracts, pp. 46. (poster)
- 8. 22nd European Photovoltaic Solar Energy Conference and Exhibition, Fiera Milano, Italy, September 3-7, 2007:**
I.Kaulach, I.Muzikante, L.Gerca, G.Shlihta, M.Plotniece, M.Roze, J.Kalnachs, A.Murashov, P.Shipkovs, G.Kashkarova, V.Kampars, V.Parra, PV Effect of Fullerene/Poly(3-Hexylthiophene) Blend Sensitized by GaOH Phthalocyanine, Proceedings, report, 1DV.1.29, pp.617-620
- 9. International Conference on Renewables in a changing climate. Innovation in built environment, Lausanne, Switzerland, September 4-5, 2007:**
I.Kaulach, I.Muzikante, G.Shlihta, L.Gerca, M.Plotniece, M.Roze, J.Kalnachs, P.Shipkovs, A.Murashov, V.Parra, V.Kampars, PV Effect in Multilayer Cells and Blends of Fullerene/Poly(3-Hexylthiophene) and GaOH Phthalocyanine having NIR Charge Transfer Absorption Band, , Book of Abstracts, p.44. Proceedings on CD.
- 10. Solar World Congress 2007 (SWC2007), , Beijing, China, September 18 - 21, 2007:**
I.Kaulachs, I.Muzikante, L.Gerca, G.Shlihta, M.Plotniece, M.Roze, J.Kalnachs, A.Murashov, P.Shipkovs, G.Kashkarova, V.Kampars, V.Parra, PV effect of fullerene/poly(3-hexylthiophene) blend sensitized by phthalocyanine having infrared absorption CT band, Proceedings of ISES World Solar Congress 2007, CD, Tsinghua University Press, Beijing and Springer-Verlag GmbH Berlin Heidelberg, pp. 1083-1042, 2007
- 11. 4th European Conference on Organic Electronics and Related Phenomena - ECOER'07, Varenna, Italy, October 1-4, 2007:**
 1. I.Muzikante, J.Sipols, E.Fonavs, E.Laizane, A.Jurgis, P.Pastors, V.Kampars, Photoelectrical properties of polymer films consisting of indandione derivatives, Book of Abstracts, p. J3.
 2. J.Latvels, I.Muzikante, E.Fonavs, A.Jurgis, P.Pastors, V.Kampars, Electrical properties of heterojunction based device of indandione derivatives, Book of Abstracts, p. P4.

LABORATORY OF ELECTRONIC ENGINEERING

Head of laboratory *Dr. phys. A. Kristins*

Main Problems

1. Implement developing and manufacturing of unique measuring and monitoring apparatus and systems, which:
 - provide authorised access on the base of Touch Memory™ elements and Proximity Cards to different objects, including
 - ⇒ entrance check-points (entrance gates, access control systems, systems for multilevel parking buildings etc.);
 - ⇒ computers and programmes;
 - ⇒ car and other technical devices (anti-theft systems);
 - execute electronic documentation functions (Touch Memory™ -based electronic invoices, credit cards and so on);
 - test power units (high-voltage switches, automatic disconnecting switches, power-transformers);
 - determine a content of heavy metals (As, Cd, Co, Cu, Fe, Hg, Tl, Ni, Pb, Sn, Zn, Bi, Mn) in liquids, ground, food-stuffs;
 - check various environment parameters (temperature, lighting, humidity, radiation level);
 - control temperature and lighting at the different objects (housings, hothouses, production storehouses);
 - are used in medicine and for determining of agricultural production parameters (digestion systems, fluorimetres, fall number determinators).
 - drive and management of automatic devices.
2. Provide physical measuring and manufacturing process automation.
3. Also solve the other problems, not afore-mentioned.

Scientific Staff

1. Dr. A.Kristins
2. Dr. Hab. A.Zelenkovs
3. Mg. ing. D.Gusevs
4. Mg. ing. S.Zelenkovs
5. Mg. ing. E.Garkajs

Technical Staff

1. I.Guza
2. I.Gvardina
3. J.Melderis
4. J.Veinbergs
5. A.Grablevskis

Cooperation

Latvia

1. Joint-stock company *Latvenergo*
2. *Kokarde* Ltd
3. Latvia Technology Park
4. Riga Technical University
5. *Trafik* Ltd
6. *IB Biakss*
7. *GROG* Ltd
8. *Apollo AS* Ltd
9. *AlarmLat* Ltd
10. *Mikoniks* Ltd

11. *Energoremonts Rīga* Ltd

Denmark

DanBalt Electronics

Russia

St. Petersburg I. Joffe's
Institute of Physics and
Techniques

Estonia

1. Tallinn
University of
Technology
2. Competence
Centre ELIKO

The prospects of the instruments look at appendix.

Our Clients

1. Latvijas Krājbanka;
 2. Latvijas Pasts;
 3. *LatRosTrans*; Ltd
 4. Latvijas Kuģniecība;
 5. Latvijas Gāze;
 6. Latvian Environment Agency;
 7. Latvian Hydrometeorological Agency;
 8. *Augstceltne* Ltd;
 9. CSDD (Road Traffic Safety Directorate);
 10. *Avantime Amusement Technology* Ltd;
 11. Joint-stock company *Latvenergo*;
 12. Latvia's Ministry of Foreign Affairs;
 13. *Nienhaus & Lotz Lettland* Ltd;
 14. *Godske Latvian Textile* Ltd;
 15. *VAIDE* Ltd;
 16. *Flexoplastic* Ltd
- etc.

Lectures on Conferences

23th Scientific Meeting of Institute of Solid State physics, University of Latvia, Riga, February, 2007

1. I.Gvardina, A.Kristiņš. *The multichannel multilevel data collection system*. Abstracts, p.74.
2. D.Gusevs, I.Gvardina, J.Veinbergs, J.Tībergs, J.Melderis. *The device of soft start with three-phase management*. Abstracts, p.75
3. A.Grabļevskis, G.Pikurs. *The converter of frequency on the basis of the ADMCF326microcontroller*. Abstracts, p.76
4. S.Zeļenkovs, A.Kristiņš, J.Melderis. *The modernization of Proximity card reader*. Abstracts, p. 68.
5. E.Garkājs, A.Kristiņš, J.Tībergs *Comparative research of parameters of thyristor modules produced by CHINAZENLI RECTIFIER and SEMIKRON*. Abstracts, p.77
6. I.Gūža, A.Kristiņš. *Power supply filters for the current rate up to 150 A*. Abstracts, p. 69.
7. A.Grabļevskis, M.Poljaks. *Measuring instrument of pulse-duration signals with memory*. Abstracts, p.78
8. D.Gusevs, V.Narnicka. *WEB document processing on the base of statistical characteristics of entering inquiries*. Abstracts, p.80.
9. I.Gvardina, A.Kristiņš. *The concentrator for information gathering systems* Abstracts, p.80
10. P.Annus, A.Kuusik, E Haldre, A.Kristiņš. *Monitoring of healing process by measuring of tissue transplant impedance*. Abstracts, p.83.

Latvian Journal of Physics and Technical Sciences

D.Gusevs, I.Gvardina, A.Kristiņš, J.Melderis, J.Tībergs, J.Veinbergs, J.Zvirgzds. *A soft-start device with three-phase control* . 2007, Nr.3, 76.lpp.



**Electronic Engineering Department
Institute of Solid State Physics
University of Latvia**

Apparatus for Metal Determination in Liquids "AHPS-2"

The AHPS-2 is a device for determination of metals in water and other liquids. It is based on a very sensitive electro-chemical method and allows us to determine the concentration of

Cu, Zn, Cd, Sn, Au, Tl, Pb, Bi

at a low levels of contents as 0,1 ppb. In special cases the sensitivity of the AHPS-2 is even higher and allows us to determine metals at concentrations below 0,1 ppb. The upper limit of the metal concentration determination by the AHPS-2 is in the ppm region.

The sample preparing procedure for analysis is very simple and can be completed within a matter of minutes. In a single analysis process more than one metal can be detected. The analysis procedure is rather fast: for ppm region measurements it lasts approximately one minute and for measurements of levels within the 0,1 ppb region it takes no more than ten minutes.

The analysis procedure is fully controlled by the computer (preferably IBM PC compatible).

The AHPS-2 can be used in environmental control as well as for analytic tasks for determination of trace elements.

The AHPS-2 is produced in cooperation with Division of Disordered Material Physics.

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**Electronic Engineering Department
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Apartment Security System

The device is constructed for individual apartments or small offices security and alarm signalization.

The device controls different kinds of detectors (movement detectors, hermetic contacts or similar devices) on the "own – alien" base in the presence of the owner or in his absence alarming in the case of criminal non-authorized actions.

Switching on and off of system security mode is implemented with the aid of the *Dallas Semiconductor Touch Memory*TM identification code keys.

Reprogramming of the key list is operative - with the assistance of two Master keys.

The device has a sound and light indication and it provides an electrical signal for security service or alarming device in some difficult of access place.

The device works in auto testing mode and reports about all its faults or criminal actions by the light indication.

This device is very simple in using and doesn't need any special knowledge.

Technical Specification

Power supply:	+(10 - 15) V
Consumption:	
System in security mode:	≤ 40 mA
System in alarming mode (defined by alarming device):	< 4 A
Access time:	20 seconds
Detectors with disconnecting ability:	≤ 4 pcs.
Detectors without disconnecting ability:	≤ 3 pcs.
Possible combinations of keys:	$2,8 \cdot 10^{14}$
Maximal number of user keys:	56 (250) pcs.
Dimensions:	115x55x30 mm

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**Electronic Engineering Department
Institute of Solid State Physics
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**Vehicle Alarm System and Immobilizer
with TM Identification Code Keys**

This product is an electronic device for vehicle anti-thieves protection and can be activated and deactivated by Dallas Semiconductor firm Touch Memory™ identification keys with a brief touch of the key to the key-reader.

The electronic keys are all different, there are about $2.81 \cdot 10^{14}$ possible combinations and it is impossible to produce 2 equal keys.

The activated protecting system takes under its control vehicles hood, trunk and doors pin switches and disconnects one or two (optionally) main electric circuits of the vehicle (ignition coil, fuel pump, starter solenoid etc.). A flashing LED on the dashboard warns potential thieves of its presence. A protecting mode is switched on by connecting of power supply.

Additional sensors - shock detectors, ultrasonic sensors etc. may be connected to this system. Also the system remind about headlight state.

This system has some operation modes and gives information to driver by LED indicator and sound signals.

Technical Specification

Power supply:	+ (10 - 15) V
Consumption:	
System armed (including LED):	≤ 8 mA
Armed only engine deactivation:	≤ 4 mA
Consumption by driving (immobilizer relay "on"):	≤ 35 mA
Disarming delay:	10 seconds
Rearming delay:	30 seconds
"Secret" button delay:	2 minutes
Possible combinations of keys:	$2,8 \cdot 10^{14}$
Duration of alarm signal sound - 2 minutes total by 4 secs sound and 4 secs pauses.	
Alarm relay contact capacity:	20 A
Immobilizer relay contact capacity:	20 A
Dimensions:	130x100x30 mm
Automatic switching on of the immobilizing mode after ignition switching off - in 20 secs.	

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**Electronic Engineering Department
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Car parking and access control systems

The car parking and access control systems are designed for both - ordinary and multilevel parking places. The systems can service casual as well as regular clients.

The systems consists of one PC or some personal computers, connected in network, that are connected with peripheral devices for service, control and execution (check's printers, cash machines, control devices for barriers and signal lights, readers for Dallas electronic keys, proximity cards, bar codes etc.). The system is corresponding to LR law about fiscalisation.

Software of the system allows controlling peripheral devices, to provide registration of clients and calculate service fees in accordance to client category and parking time, as well as to create necessary database.

Systems can operate with MS Windows 98, Windows NT, 2000, ME and XP.

These systems (in cooperation with "Alarm Lat" Ltd) are put into operation at multilevel parking places "Rīgas Pirmā Garāža", "Arēna Plus" and "Latvijas Gāze"

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**Electronic Engineering Department
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Electronic Documentation

There is a portable system based on Dallas Semiconductor firm Touch Memory™ chips for data saving and moving without paper. The silicon chip packs in TM memory more as 8000 signs (~ 4-5 pages).

TM replaces paper documents that are difficult to attach to objects and are prone to damage or illegibility. If copying is undesirable, lock bits, add-only memory, passwords and encryption can be employed.

TM based electronic documents are very convenient and safe for persons who have contacts with confidential or strict registration papers.

Each TM chip has a unique registration number up to $2,81 \cdot 10^{14}$ variants.

A personal computer with special interface and special software can read and write data from/to Touch Memory.

TM is housed in a durable hermetic stainless steel case (\varnothing 17,4 x 5,89 mm) and is tolerant to mechanical shock, static electricity, and electromagnetic fields and to other harmful environmental factors.

TM has an ambient temperature range -40°C to $+85^{\circ}\text{C}$.

Touch Memories can accommodate over one million data changes.

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**Electronic Engineering Department
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University of Latvia**

Digestion System

The digestion system provides digestion of various samples in sulphuric acid, using the Kjeldahl method.

Into six deep hollows of electrical heater are placed tubes, containing samples and sulphuric acid. The temperature controller provides the thermal regime of heater. The thermal regime includes two plateaus of temperature: the first (in time) - in the temperature region of boiling water, and the second - in the temperature region of boiling acid. The temperature controller provides also three different heating rates for transition from starting temperature to the first and second plateau. The thermostation time control up to six hours is possible.

The digestion system is provided by water aspiration pump for the removal of exhaust gases, produced in digestion procedures.

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**Electronic Engineering Department
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University of Latvia**

**Device for Authorized One-Door Access System
with TM Identification Code Keys**

The device is constructed for creation of authorized access system for apartments.

The device controls electromagnetic keys of any construction.

Accessing in the apartment is implemented with the aid of the *Dallas Semiconductor Touch Memory™* identification code keys. In the emergency case it is possible to enter the apartment with the aid of ordinary mechanical key.

Exiting of the apartment is provided either with the button or with the TM (if the second reader is available).

Reprogramming of the TM list is operative - with the assistance of two Master keys.

The device has a sound and light indication and it provides an electrical signal for security service.

This device is cheaper than most of similar ones.

Technical Specification

Power supply:	+(10 - 15) V
Consumption:	
System armed in waiting state:	≤ 8 mA
System activated in access mode (defined by el. mech. lock):	< 0,5A (typically)
Access time:	5 seconds
Sound signal on non-authorized opening of the door:	Immediately
Sound signal delay after authorized opening of the door:	5 seconds
Possible combinations of keys:	$2,8 \cdot 10^{14}$
User keys:	≤ 56 pcs.
Dimensions:	83x55x35 mm

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**Electronic Engineering Department
Institute of Solid State Physics
University of Latvia**

**Device for Authorized One-Door Access System
with TM Identification Code Keys and Event Registering**

The device is constructed for creation of authorized access system for apartments.

The device controls electromagnetic keys of any construction.

Accessing in the apartment is implemented with the aid of the *Dallas Semiconductor Touch Memory*TM identification code keys. In the emergency case it is possible to enter the apartment with the aid of ordinary mechanical key.

Exiting of the apartment is provided either with the button or with the TM (if the second reader is available).

Reprogramming of the TM list, setting of the time and time access zones (optionally) and also transferring of the data on the events registered from the device to PC is realized with the assistance of the special identification Master-key with 64K bits of read/write nonvolatile memory.

This device is cheaper than most of similar ones.

Technical Specification

Power supply:	+(10 - 15) V
Consumption of system activated in access mode (defined by el. mech. lock):	< 0,5A (typically)
Access time (standard):	5 seconds
Sound signal on non-authorized opening of the door:	Immediately
Sound signal delay after authorized opening of the door:	5 seconds
Possible combinations of keys:	$2,8 \cdot 10^{14}$
Number of user keys (standard):	56 pcs.
Number of events registered:	500
Time of data retention in Master-key:	over 10 years

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High-voltage Breaker Analyzer Device "OSKARS"

The device was designed for the verification of high-voltage (110 and 330 kV) breakers. 14 timing channels and the current in the driving solenoid are simultaneously controlled and necessary time parameters calculated.

Only one minute - and you have the operating sequence and the time control results printed out on the A4 format (210 x 297 mm) paper sheet by ordinary printer without using of the computer.

The device has four modes of operation: *OPEN (O)*, *CLOSE (C)*, *OPEN-CLOSE-OPEN (O-C-O)*, *CLOSE-OPEN (C-O)*. The delay time between pulses (O-C) and (C-O) can be set on the thumbwheels (0 ÷ 0,15 s).

The device can be used for testing of 10 types of breakers: BBIII-110; BBБ-110; BBY-110; BBH-110/6; BB-330Б; BBH-330/15; HGF-115/2B; HPL-362/B2; LTB-145D1.

The time resolution is 0,001 s.

Dimensions are 490 x 480 x 165 mm.

Weight is 20 kg.

The device specifications may be changed according to customer's requirements.

The device may be used to study reaction velocity, delay and vibrations of different kinds of the relays and for registration of different processes in other branches of science and technique.

These devices are put into operation by power engineering departments of "LATVENERGO" and "LIETUVOS ENERGIJA".

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**Operating with remote objects
based on TCP/IP communication protocol**

Usage of this communication protocol makes possible to work without wiring of additional communication lines and allows to transmit information in far distances practically without difficulties.

In the developed remote control systems “Rabbit” controllers are used.

Different modifications of microcontrollers permit to collect information due from contact sensors (hercons, magnetic loop controllers, move detectors etc.), from data carriers based on DS19XX protocol (i-Buttons, thermometers and others) or based on Viegand protocol (Proximity cards).

It is possible to connect the system with other peripheral devices via standard RS232/485 ports.

Controllers can provide communication with main server via TCP/IP ports by using local, corporative or world wide nets.

Practical applications:

1. The system of access, control and management is worked out for LatRosTrans company. The system consists of 24 controllers (number of technological blocks on Russia-Ventspils oil pipeline), dispatcher program (in Daugavpils) and some client applications.

2. Entrance in/out system for “Latvijas Gāze” company is worked out, which consists of three in/out gates with automatic barriers, server administrator and guard programs and some other client applications.

3. The system including checkpoint, the authorized access in cabinets and the security signal system for two buildings of the Latvian Shipping Company with a unified database.

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Security Drawers and Safes for the Cash Points

There are some versions of safes produced by Solid State Physics Institute & Co for storage of banknotes, coins and forms. A safe has an electromechanical lock, activated by electronic system with time delay.

The safe-drawer SF-1 has the keys based on Dallas Semiconductor firm Touch Memory™ identification chips with unique registration number (up to $2,81 \cdot 10^{14}$ numbers), but safes KT-2F may be completed both TM and mechanical key. The electronic time delay system can be activated by TM or control button, then a red LED flashes intermittently until the delay time has run out. At that moment a buzzer beeps and a green LED flashes for access time. During of that time the safe may be pulled open.

	SF-1	KT-2FA	KT-2FB
Delay times (minutes)	3, 5, 10, 15	3, 5, 10, 15	3, 5, 10, 15
Access times (s)	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20
Dimensions (mm)	400 x 370 x 140	300 x 300 x 300	300 x 300 x 200
Weight (kg)	12	14	10,5

The safe is connected to the mains (50 Hz, 220 V A.C.) by a transformer or to the 9 V 300 mA D.C. source.

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Register system on supervision of route checkpoints

This system is designed to monitor the schedule of visiting route checkpoints by guard patrol. The system also allows monitoring arrivals (and optionally leavings) the object (optionally remote) if there is a checkpoint at this object.

The system consists of one or more portable data readers (DR), identification keys (IK) as checkpoints and software.

The system doesn't require permanent use of computer. Data readers are completely autonomous and the information about attendance of checkpoints (codes of checkpoints and time of making corresponding checks) is saved in non-volatile memory (EEPROM), where it can be stored until the device is connected to computer.

The code-keys of checkpoint identification (Dallas Semiconductor) do not require power supply and also do not require installation. The checkpoint identification keys are attached at necessary place with a special holder. Sizes of checkpoint identification keys are $\varnothing 17.35 \times 5.89$ mm.

Program software allows programming the rules of passing route, but after receiving the data from data readers it allows to analyze adequacy of the guards activities; compose reports and print the reports or send by E-mail if necessary.

The user interface is in Latvian and operates under Win9x/2000/NT/XP. The language of user interface can be changed in accordance with special order.

The fact of date reading by ICK is confirmed with sound and light signals.

The information of the same ICK can be written in the data-reader repeatedly if the next reading takes place no sooner than after one minute. The memory volume of the data-reader is designed for registering 1700 events. A special cable is used for data transmitting to PC. Date reader sizes do not exceed 26x40x160mm.

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Working time monitoring system

This system consists of a software package and a data reading block.

Software package provides the following functions:

- adding, editing and erasing of user data (name, surname, working number, key number, telephone number);
- working time calculation by four time types (ordinary working time, reserve time, evening working time + working time on days off till ten o'clock p.m., night working time) (*these parameters could be changed*);
- event searching by surname or working number, by date and time interval;
- printing of searching results;
- function "present – absent";
- text (*or different*) password system;
- calendar for setting of days off and working days and for setting of date intervals with reserve time;
- automatic archive creating in the form of text files;
- the other functions could be added by customer wishes.

Data reading block with the following parameters:

- identification device - Dallas identification button or Proxy card;
- data readers – two (entry and exit);
- real time indication / working number indication;
- user count up to 200 (*this count could be greater*);
- operational memory for 500 events (in autonomous regime) (*this count could be greater too*);
- connection with computer by RS485 port;
- powered from mains (220 V) with guarding from short voltage disappearance;
- the block is easy mounted to vertical wall.



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Soft Start Devices for Electric Motors

There are many problems with starting of high power electric devices (motors) because initial current may be some times greater as nominal current for these devices. High initial current may be dangerous for power supply devices as well as for powered devices.

In the ISSP in cooperation with “Fonons” Ltd there were worked out soft start devices for electric motors in general, but it is possible to use the soft starters also for other devices (high power heaters, for example).

The devices are based on phase drive of two thyristor pairs and are able to manage power up to 100 kVA and more.

Main features:

- digital controlled AC semiconductor soft starter
- start time from 5 to 20 seconds
- start voltage from 40 to 80%
- stop time from 1,5 to 20 seconds
- built in by-pass function.



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