Institute of Solid State Physics
University of Latvia

ANNUAL REPORT

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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.

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.

Research and training in optometry and vision science is taking place in the Laboratory of Optical Materials 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 student and staff .

The research of the ISSP includes:

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

The highest decision-making body of the Institute is the **Council** of 23 members elected by the employees of the Institute. Presently Dr. hab. M.Springis is the elected chairman of the ISSP Council. The Council appoints director and its deputy.

The International Supervisory board of ISSP was established in 1999 and it consists of 8 members. In August 18, 2002 the Workshop of Supervisory Board takes place at ISSP. The Evalution report with recommendations is attached (see chapter 2).

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 science, chemical physics, physics of condensed matter, semiconductor physics, and experimental methods and instruments. In 2002 the chair of Solid State and Material Physics was established at ISSP.

The Scientific Board of the ISSP is eligible to award **PhD degrees** in physics in the specialities mentioned above and in medical physics.

The annual report summarizes research activities of the ISSP in 2002. The staff of the Institute has succeded in 31 **national science** grants and in the national cooperation project (Intelligent Materials and Structures for Microelectronics and Photonics) with the total financing of 239,9 thous. lats (Ls) (exchange rate: 1 Ls ~ 1,6 EUR), see Table 1 and Fig.1., 2.

Additional funding from the **state budget** in 2002 was 90.0 thous. Ls as a support for participation in international conferences (10 thous. Ls), development of scientific equipment (43 thous. Ls) and support to the Centre of Excellence CAMART (19.0 thous. Ls)

Table 1

INCOME OF ISSP, THOUSAND Ls, FROM 1993 - 2000

Year	Total financing	Grants and programs from budget	Other financing from budget	Contracts, market oriented research	Internat. funds	Rent of space
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

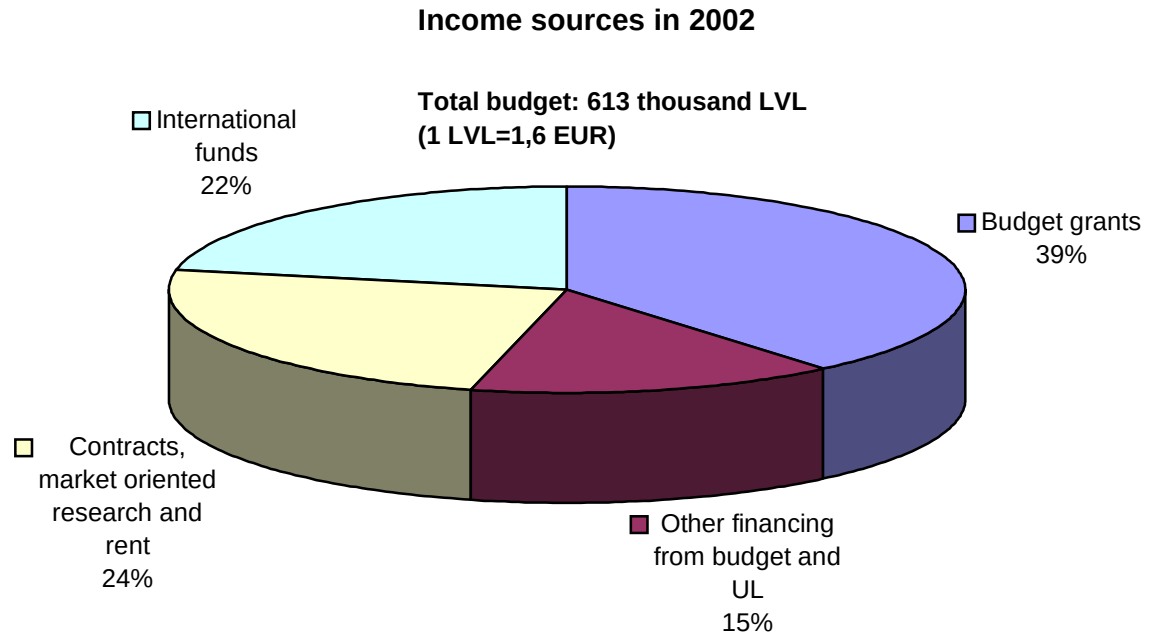


Fig.1. Distribution of income sources during 2002

2002 was successful for **national contracts**: the market oriented contracts reached 86.9 thous. Ls, contracts with Latvian companies including SMEs – 46.1 thous. Ls. The

descriptions of some instruments and materials developed at the ISSP as a result of contracts are enclosed in the Appendix.

The ISSP income dynamics for 1993 – 2002 is given in Table 1 and Figure 2.

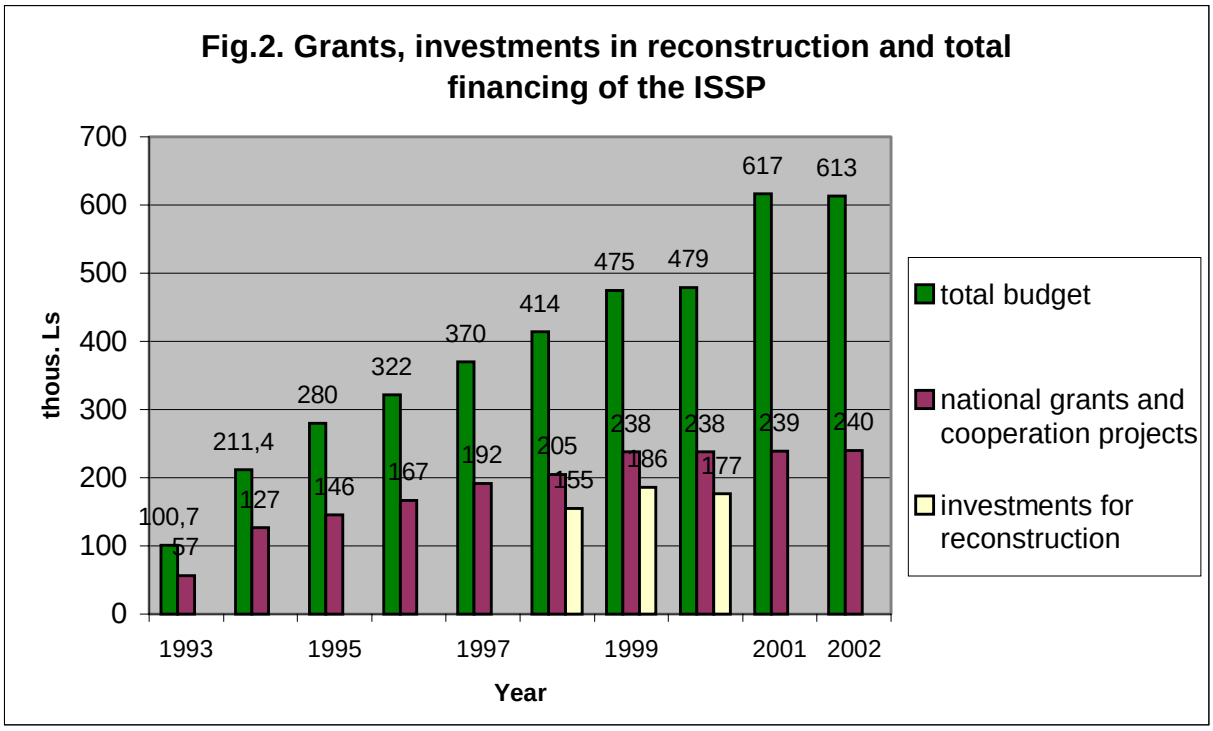
The **international funding** in 2002 is smaller than in 2001. The main part came from the EC 5th Framework programme:

- for the Centre of Excellence CAMART – 88.6 thous. Ls;
- for three EURATOM projects – 32.3 thous. Ls.

As well as for Taivan - Lithuania – Latvia joint agreement – 8.4 thous. Ls

The Institute obtained 18.9 thous. Ls from leasing part of its space.

The interdisciplinary nature of research at the ISSP is reflected by its **highly qualified staff** (see Figure 5). At present there are 180 employees working at the Institute, 30 of 87 numbers of the research staff hold Dr. hab. degrees, 46 hold Dr. or PhD. At the end of 2002 there were 7 post-graduates 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 2002.



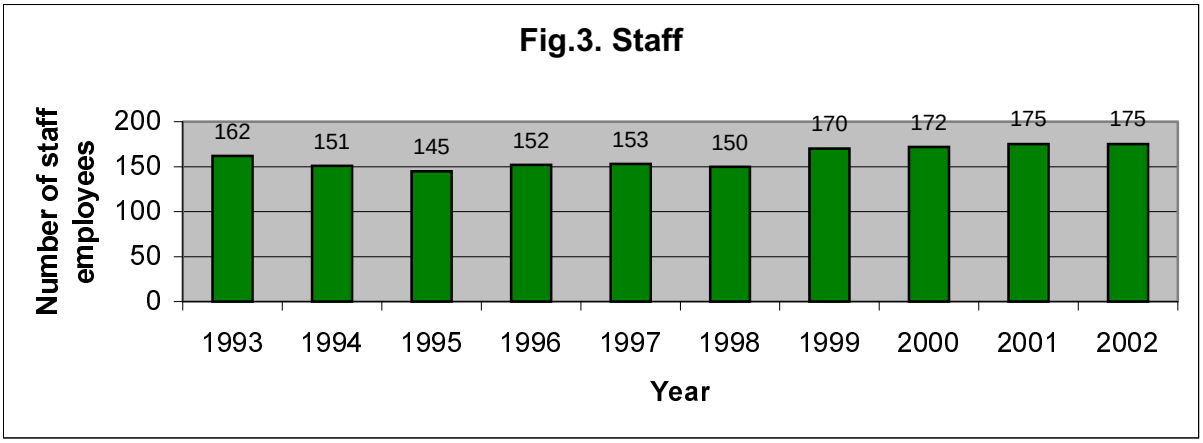


Fig.3. Staff
Number of staff employees
200
150
100
50
0
162
151
145
152
153
150
170
172
175
175
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year

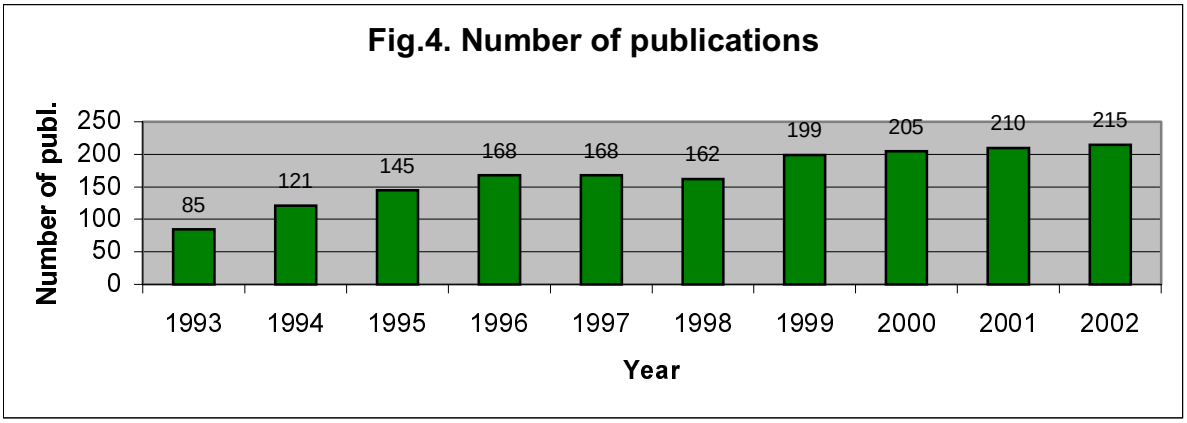


Fig.4. Number of publications
Number of publ.
250
200
150
100
50
0
85
121
145
168
168
162
199
205
210
215
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year

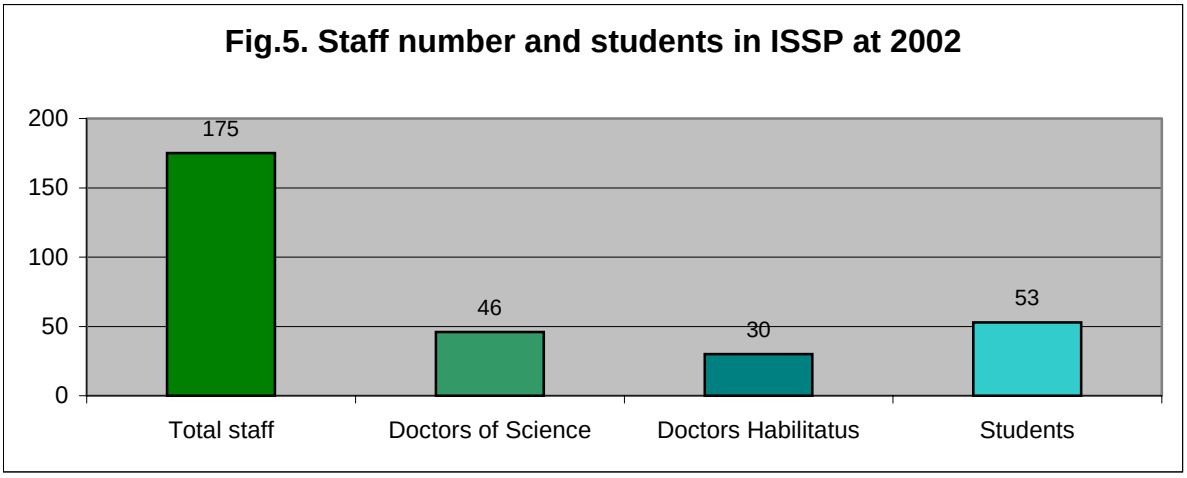


Fig.5. Staff number and students in ISSP at 2002
200
150
100
50
0
175
46
30
53
Total staff
Doctors of Science
Doctors Habilitatus
Students

Main achievments in 2002:

1. Improving the research activities through Centre of Excellence CAMART (see the next chapter)
2. Establishment of Association EURATOM – University of Latvia at ISSP
3. The chair of "Solid State and Material Physics" was established at Faculty for Physics and Mathematics University of Latvia and located at ISSP in order to attract more new researchers to the Institute.
4. Dr. hab. L.Skuja received annual Science Award in Physics of Latvian Acadamy of Sciences
5. Succesful organization of International Conference "Advanced optical materials and devices" (AOMD-3) in Riga 19-22 August, 2002.
6. Two issues of International journal "Proceedings SPIE" – vol. 5122 "Advanced optical materials" and vol 5123 "Advanced optical devices" have been prepared as Proceedings of AOMD-3.
7. The papers of regional seminar on Solid State Ionics (Riga, 2001) are published in special issue of "Journal of Solid State Eletrochemistry".
8. The Workshop of International Supervisory Board was organised at ISSP in August 18, 2002. The evalution report is attached.

Many thanks to everybody who contributed to this report as well as to the organizations that supported the Institute financially: Latvian Council of Science, Science Department of the Latvian Ministry of Education and Science, EC 5th Framework Programme, European Community Council Program COST, NATO Scientific Affairs Division and to many foreign Universities and institutions.

Prof. Dr. A.Krumins

Table 2

ORGANIZATIONAL STUCTURE OF THE ISSP IN 2001

International Supervisory board

Council of Institute
Dr.hab. M.Springis

Director
Dr.hab. A.Sternberg

Deputy director
Dr.hab. A.Krumins

RESEARCH DIVISIONS AND LABORATORIES

Crystal Physics Division
Dr. P.Kulis

Disordered Material Physics Division
Dr.hab.D.Millers

Ferroelectric Physics Division
Dr.hab. A.Sternberg

Semiconductor Materials Division
Dr. A.Lusis

Lab. of Didactic Systems
Dr. J.Kuzmin

Lab. of Nonlinear Processes Theory
Dr.hab. J.Kotomin

Lab. of Optical Recording
Dr. J.Teteris

Lab. of Defect Physics in Ionic Materials
Dr.hab. B.Berzina

Lab. of Surface Physics
Dr.hab. J.Maniks

Lab. of Optical Materials
Dr.hab. I.Lacis

Lab. of Radiation Physics
Dr.hab. J.Berzins

ADMINISTRATION AND SERVICES

Finance and Accounting
A.Jozepa

Mechanical Workshop
J.Katkevics

Domestic services
R.Siatkovskis

Division of Electronic Engineering
Dr. A.Kristins

Library
L.Rihtere

Testing Laboratory
Dr. J.Klavins

ACTIVITIES OF THE CENTRE OF EXCELLENCE

2002 was the second activity year of the Centre of Excellence CAMART - the Centre of Excellence for Advanced Material Research and Technologies. The project was established by the 5th framework Programme of the European Comission. **The main tasks** of the Centre being:

- to promote restructuring of the science and technology sectors;
- to promote the economic and social needs of the regions;
- to attract young researchers;
- to adopt the best experience in collaboration with the European colleagues.

The support from EC is 703 000 EUR or 400 000 Ls for three years and the **funding should be** spent on:

- extended visits (more than one month of duration) of foreign colleagues at the ISSP (31%);
-visits of the ISSP employees abroad, including conferences attendance (35%);
- purchase of equipment and materials necessary for foreign colleagues during their visits (9%);
- overhead expenses (25%).

During the second year the following **common activities** of CAMART have been carried out:

1. Increased **activity** of the staff **in the research.** Intensification of collaboration with European universities and companies, increased participation at international conferences and collaboration with colleagues from EC Member States and Associated States.

2. Adoption of the best experience in **collaboration with the European colleagues**. 13 visitors from EC Member States, 11 visitors from EC Newly Associated States, and one visitor from Israel, revealed a remarkable growth of the scientific status of the Institute (table 3).

Table 3

Long term visits to CAMART in 2002

From EC Member States:	
Germany:	4
Netherlands:	2
Austria:	1
Italy:	1
Sweden:	1
UK:	1
France:	1
Belgium:	1
Total:	**13**

From Newly Associated States:	
Hugary:	3
Lithuania:	3
Estonia:	2
Czech Rep.:	2
Poland:	1
Total:	**11**

From other States: Israel: 1

3. Improving of **scientific seminar** of the Institute. In the second year 24 lectures have been presented by the visitors of CAMART to the staff and students of the Institute.

4. Joint **RTD projects with Latvian enterprises** for development prototypes of new multilayer solid state batteries (A/S Sidrabe), intelligent sensor instruments (RTU, A/S Alfa Pro), scintillators (Baltic Scientific Instruments), as well as development of technology of nitride thin films (A/S Alfa) and glass fibers (A/S Valmieras stikla skiedra). Presentation of these projects at international exhibition "Baltic Dynamic".

5. **Enhanced participation in other areas of 5th Framework Programme** and in other **international projects.**

In 2002 we continue to work at following International projects:

- Research Training Network "Optical Devices Using Photosensitivity for their Elaboration", supervisor Dr.hab. L.Skuja;
- Network in "Growth" programme "Polar Electroceramics", supervisor Dr. V.Zauls;
- EURATOM projects:
  - Irradiation effects in ceramics for heating and current drive and diagostics systems, supervisor Dr.hab. A.Sternberg;
  - Vapor detection system by liquid metal protection of plasma facing surface, supervisor Dr.hab.I.Tale;
  - Materials for detection and imaging arrays of thermal neutrons and neutral particles, supervisor Dr.hab. I.Tale;
- COST projects:
  - D 18 "Lanthanide chemistry for diagnosis and therapy", supervisor Dr.hab. J.Purans;
  - P8 "Materials and systems for optical data storage and proceedings", supervisor dr.J.Teteris;
  - 525 "Advanced electronic ceramics: grain boundary engineering", supervisor dr.hab.A.Sternbreg;
- Project of bilateral Latvian – German in Science and Technology "Acumulating Luminiscence Dosimetrs", supervisor Dr.hab. U.Rogulis;
- Program of Mutual Funds for Scientific Co-Operation of Republic of Lithuania and Republic of Latvia with Republic of China (Taiwan) "Materials Research on Wide Gape Group III Nitride Compounds for Advanced Light Emitters", supervisor: Prof. I.Tale

6. The International Conference "Advanced Optical Materials and Devices" (AOMD-3) organized at August 19-22 in Riga, Latvia. The Conference was attended by 130 scientists from 21 countries. Part of papers will be published in two issues of International journals "Proceedings SPIE"(2003)

7. About 30 **young researchers**, mainly students from Latvian University have been associated with the CAMART projects.

8. Due to financial support from Latvian government, on condition that a part of expenses in covered by EC through 5-th Framework Programme, the following **scientific equipment was purchased** during 2002:

- Tektronix digital storage oscilloscope (Cost 13 488 EUR, included 600 EUR from CAMART)

- Scanning Probe Microscope Smena - H (Cost 40 000 EUR, included 3 000 EUR from CAMART)
- Supercomputer consisting of cluster of 5 Compaque PCs (Cost 18 333 EUR, included 2 500 EUR from CAMART)

The new scientific equipment was already used by our guests, thus improving the network between Centres and increasing the scientific value of the joint research.

9. **Activities of Network of Centres of Excellence** "Interfacial Effects, Novel Properties and Technologies of Nanostructured Materials":
The second Workshop of Network took place June in Budapest (Hungary). Dr.A.Sternberg and Prof. A.Krumins from our Institute attended this Workshop and initiated collaborative research of advanced nanostructured materials for soptics and microelectronics. Fruitfull collaboration was developed with the following Centres of Centres of Excellence:

- HIGH PRESSURE, Poland,
- CEBIOLA, Lithuania,
- ESTOMATERIALS, Estonia,
- KFKI-CMRC, Hungary,
- AMAS, Poland.

Prof. Dr.A.Krumins
Scientific coordinator of CAMART

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

Overview

Institute of Solid State Physics (ISSP), University of Latvia was established on the basis of the University's two Problem Laboratories: Semiconductor Physics and Ferro- and Piezoelectric Physics – in 1978. Since 1986 the ISSP has the legal status of an independent organization of the University. The research activities of ISSP include:

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

The highest decision-making body of the ISSP is the Council of 23 members elected by the employees of the Institute. The total staff number of the ISSP is 175, including 31 Habilitatus Doctors of Sciences, 46 Doctors of Sciences and 52 students.

The research activities of the ISSP in 2001 were reflected in 210 publications in the internationally recognised scientific journals. The staff of the Institute has succeeded in 31 national science grants and one national co-operation project with total financing in 2001 (maintaining the same in 2002) of 238.8 thousand lats (LVL). Contracts and market orientated research in 2001 was for sum – 116.5 thousand LVL. Other financing -79 thousand LVL.

The ISSP carries out RTD projects in co-operation with Latvian enterprises (Joint Stock Companies Sidrabe, Alfa, Alfa Pro., Baltic Scientific Instruments, Valmieras stikla skiedra), as a spin-off of some other projects two SMEs (Hologramma Ltd., Dardedze Holografija Ltd.) are established at the Institute.

In order to improve the energy efficiency of the building a large scale reconstruction work in the framework of the State investment project, comprising the total sum of 418 thous. LVL, has been carried out in the laboratory part of the house during the last four years (change of thermal insulation of outer walls and windows, building of double-pitch roof, a partial renovation of the interior), making the stay in the Institute more comfortable and conserving energy.

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:

- to promote restructuring of the science and technology sectors;
- to promote the economical and social needs of the region;
- to attract young researchers;
- to adopt the best experience in collaboration with the European colleagues.

The research activities in the CAMART are carried out on:

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

In 2001 these activities were supported by the EC financing - 158 thousand LVL. In addition several other EC projects (EURATOM, POLECER) are going on in the ISSP which give total international funding 183 thousand LVL.

The total financing for the ISSP in 2001 thus comprised 617.3 thousand LVL (the international funding making 30%).

ISSP has developed different kinds of wide-scale international collaboration and has submitted more than 10 "Expressions of interest" for the Integrated Projects and Networks of Excellence in 6 FP.

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

Achievements and Problems

1) Most of the research activities of the ISSP have high internationally recognised scientific quality (publications, good citation, active participation in the international projects, etc.), but the average salary of scientific staff (120 LVL/month) is lower than the average salary in Latvia (157 LVL/month) in 2001. The low salaries make it hard to attract young researchers to work in the ISSP.
2) Up to now the ISSP is accomplishing its research in a satisfactory way, but there is an urgent need for modern scientific infrastructure.
3) Large concentration of high quality scientific staff in important fields of solid state physics and material sciences is the basis for good scientific perspectives of the ISSP, but there is an urgent need for a new generation of researchers, because the average age of research staff in the ISSP is around 52 years.
4) The ISSP has increased its share in the higher education at the universities of Latvia, but special requirements for the election to the academic staff of the universities make the participation of the ISSP researchers in the teaching activities rather difficult.
5) Active participation of the ISSP in the international projects is welcomed, but long delays of the payments from EC and small co-financing from Latvia's side (only ~25%) make it hard to fulfil these projects.

Recommendations

1) To guarantee the internationally competitive level of scientific research in the ISSP, in the future it is necessary to allocate additional financial resources from the State budget of Latvia for the ISSP.
2) The ISSP must play a more active role to stimulate the start of the National Programme of Materials Science with appropriate additional financial resources from the budget.
3) Development of modern scientific infrastructure (equipment, e.g., SEM with EDX, IR Fourier spectrometer; multicluster computer; technologies, e.g., MOCVD reactor, PLD system, improved library facilities included online access to international journals etc.) estimated to costs of 2 Mio. LVL is urgent in the ISSP.
4) International projects must have appropriate co-financing in agreement with the rules of the European Commission from the State budget. Delays of EC payments

for the projects must be avoided. If this is not possible national resources must be available as a buffer.

5) For successful work in future the ISSP must have the legal status of a self-governing organization of the University of Latvia.
6) It is recommended that a sound long-term recruitment plan for staff members is made.

Signed (approved) by the International Supervisory Board:

18.08.02

Prof. Gunnar Borstel, University of Osnaebrueck, Germany

18.08.02

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

18.08.02

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

18.08.02

Prof. Andrejs Silins, Latvian Academy of Sciences, Latvia

18.08.02

Prof. Sergei Tuituinnikov, Joint Institute for Nuclear Research, Dubna, Russia

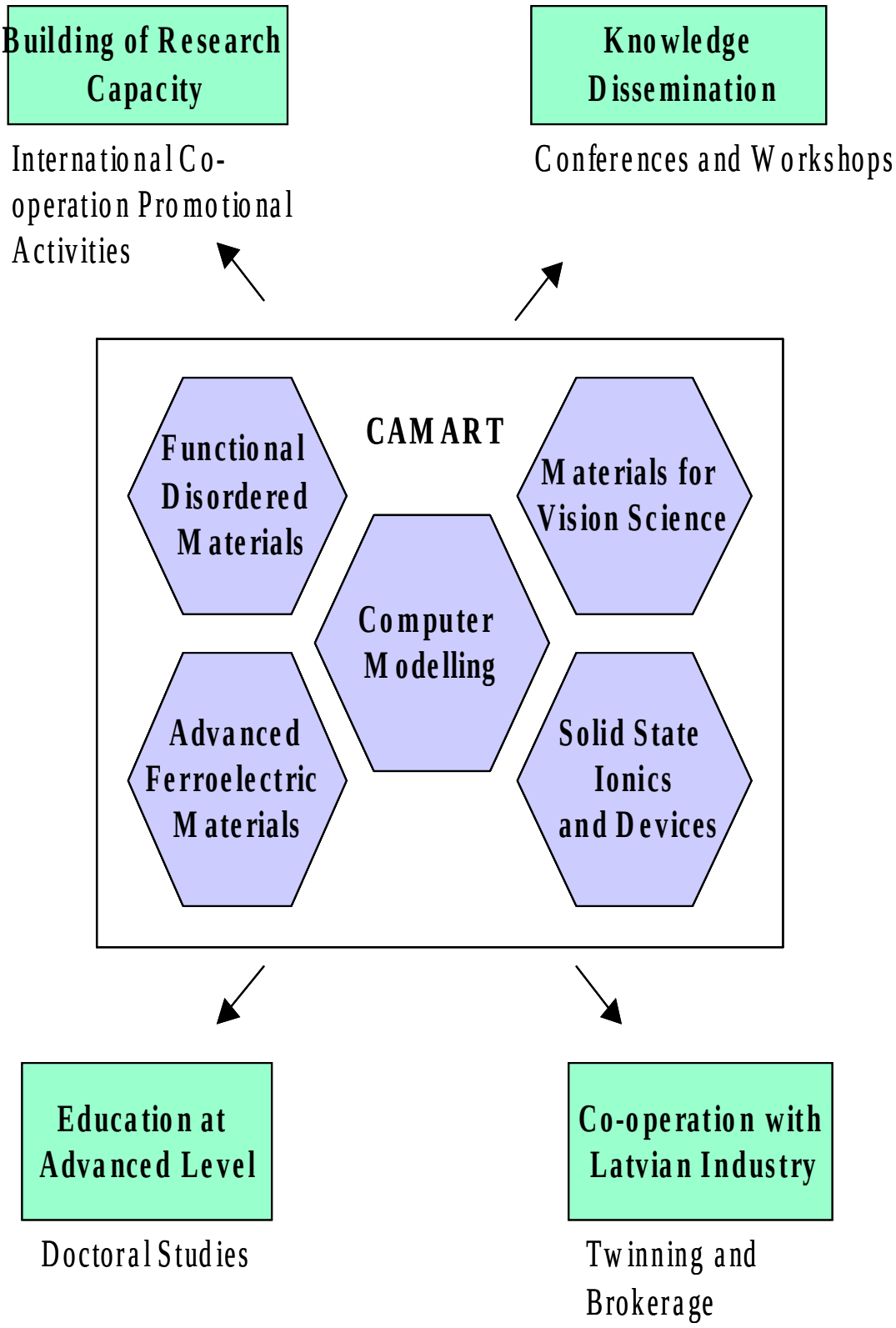
18.08.02

Prof. Juris Upatnieks, Applied Optics, USA

18.08.02

Prof. Harald W.Weber, Atomic Institute of Austrian Universities, Vienna, Austria

Activities of Centre of Excellence (CAMART)



CRYSTALS PHYSICS

Head of Division Dr. P.Kūlis

Research Area and Main Problems

The research area of Division is concern with three main projects:

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. 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 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 fotonic devices in joint stock company ”Alfa”.
3. Magnetic resonance (EPR, optically detected EPR) investigations of the structure of the intrinsic and radiation defects, and their recombination processes 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.

Scientific Staff

1. Mg. J. Jansons
2. Dr. P. Kūlis
3. Dr. A. Pujāts
4. Dr. hab. U. Rogulis
5. Dr. hab. M. Spriņģis
6. Prof. Dr. hab. I. Tāle
7. Dr. J. Trokšs
8. Dr. Ā. Veispāls
9. Dr. hab. V. Zīraps

Technical Staff

1. A. Muhins

Students

1. J. Babicha
2. Dz. Bērziņš
3. L. Dmitrichenko
4. E. Elsts (PhD student)
5. A. Fedotovs
6. A. Guļāns
7. I. Gromuls
8. J. Latvelis

9. M. Piesinshs
10. U. Plivcha
11. V. Ogorodņiks (PhD student)
12. A. Sharkovkis
13. P. Zarāns

Scientific visits abroad

1. Dr. hab. U. Rogulis - University of Paderborn, Germany (7.5 months);
2. Dr. hab. I. Tale - University of Paderborn, Germany (1 week);
3. Dr. hab. I. Tale – Sanfrancisco, USA (1 week);
4. Dr. hab. I. Tale – Wroclaw, Poland (1week);
5. Dr. hab. U. Rogulis Wroclaw, Poland (1week);
6. Dr. hab. V. Ziraps - Wroclaw, Poland (1 week);
7. Mg. V. Ogorodniks - Wroclaw, Poland (1 week);
8. Dr. hab. V. Ziraps - Achen, Germany (1 week);
9. L. Dimitichenko – Achen, " Extron", Gremany.

Cooperation

Latvia

Joint stock company "Alfa"

Germany

1. University of Paderborn, Germany (Prof. J.-M. Spaeth).
2. University of Rostock, Germany (Prof. H.-J. Fitting, Prof. H. Stolz)).
3. University of Osnabruck, Germany (Dr. H. Reyher)

Czech Republic

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

Main Results

EPR OF RADIATION DEFECTS IN $LiBaF_3$ CRYSTALS

U. Rogulis, V. Ogorodnik, I. Tale, and A. Veispals

EPR spectra of $LiBaF_3$ crystals have been investigated after X-irradiation at RT. A spectrum consisting of approximately 35 nearly equidistant EPR lines has a strong angular dependence of the line intensities. The spectrum is caused by a hyperfine interaction (hfs) of a spin S=1/2 with neighbouring groups of nuclei. The observed large number of hfs lines required Li nuclei being in the first shell and fluorine nuclei in the more distant second shell. We analysed the spectrum in the F- centre model, taking reduced hfs values of the F- centre in LiF and found qualitative explanation of the number of hfs lines. The angular dependence of the line intensities could be explained by an anisotropy of the g-tensor with its main axis along the [100] axis of the crystal.

ANNEALING OF RADIATION DEFECTS IN X- IRRADIATED $LiBaF_3$

P. Kulis, U. Rogulis, M. Springis, I. Tale, A. Veispals, V. Ziraps

Results of application of the glow rate technique GRT for analysis of the activation energy of thermostimulated annealing of X-ray created F-type color centers in $LiBaF_3$ crystals, pure and containing hetero-valence oxygen centers are presented. It is shown that depending on impurity composition in crystal two alternative mechanisms are involved in annealing of color centers. It is proposed that either the anion vacancy governed migration of F- centers resulting in annihilation with complementary defects, or the thermal delocalization of radiation created fluorine (F_i) interstitials captured by anti-structure defects followed by recombination with all kinds of complementary F-type centers are responsible for the recombination of radiation defects above RT.

MATERIALS AND METHODS FOR ADVANCED SLOW NEUTRON IMAGE DETECTION

I.Tale

In Neutron Radiography (NR) and Computed Neutron Tomography (CNT) there is an increasing interest for novel advanced neutron image detection systems. Advantages in the material research for neutron detectors based on Cooled Charged Coupled Devices (CCD) or photoluminescent Imaging Plates (IP) will be considered.
For direct slow neutron imaging at present the active layer of IP contains a mixture of storage phosphor, usually $BaFBr:Eu^{2+}$ used for imaging X-rays, and a neutron converter material, usually Gd_2O_3, LiF, B or even Dy, and In. Neutron imaging characteristics of CCD cameras are reported. It is shown that IP-ND and CCD systems enables detectability of a single neutron with accurate determination its two dimensional position.
The main disadvantages of present neutron converter-storage phosphor mixture based IP is reduced inherent spatial resolution to the film/Gd metal converter systems anf high sensitivity to X-rays. Prospective further development of slow neutron IP is elaboration of neutron-active storage materials, based on ^6Li- and Ga- compounds having reduced effective Z. Progress in investigation of perspective slow neutron energy storage-read-out materials for IP, e.g. $LiBaF_3$; $LiYF_4$ is considered.

OPTICALLY DETECTED MAGNETIC RESONANCE INVESTIGATION OF OXYGEN LUMINESCENCE CENTRES IN BaF_2

U. Rogulis, S. Schweizer, and J.-M. Spaeth**

The structure of two oxygen-related luminescence centres in oxygen-doped BaF_2 was investigated by means of photoluminescence (PL) and photoluminescence-detected electron paramagnetic resonance (PL-EPR). One of the oxygen-related luminescence peaking at 2.83 eV is associated with an excited triplet state ($S = 1$) of an oxygen-

vacancy complex with the *z*-axis of the fine structure tensor parallel to a <110> direction. This complex can be described as an oxygen on a fluorine lattice site with a *next nearest* fluorine vacancy along a <110> direction. The luminescence at 2.25 eV is also associated with a triplet state. its PL-EPR spectrum is probably due to oxygen-vacancy complexes with a *nearest* fluorine vacancy along the <100> direction.

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MAGNETIC RESONANCE INVESTIGATIONS OF $LaCl_3:Ce^{3+}$ SCINTILLATORS

U. Rogulis, S. Schweizer, J.-M. Spaeth*, E.V.D. van Loef**,P. Dorenbos**, C.W.E. van Eijk**, K. Krämer***, H.U. Güdel****

In undoped and Ce^{3+}-doped $LaCl_3$ EPR has been detected in the X-ray luminescence (XL-EPR) in K-band (25 GHz) at 1.5 K. Two excited triplet states with different EPR parameters and spectral shapes could be separated, both triplet states have been attributed to "out-of-plane" self-trapped excitons (STE) in $LaCl_3$. No EPR signals of V_K centres (self-trapped holes) could be detected in undoped or Ce^{3+}-doped $LaCl_3$ after X-irradiation at low temperatures. X-irradiation of undoped $LaCl_3$ creates also an EPR spectrum which can be tentatively attributed to F-type defects. The scintillation mechanism is discussed.

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ELECTRONIC EXCITATIONS AND DEFECTS IN FLUOROPEROVSKITE $LiBaF_3$

M. Springis, L. Brikmane, I. Tale, P. Kulis

A survey of the present situation with respect to knowledge of lattice defects, electronic excitations, such as excitons and localized excitons, as well as energy storage and transfer phenomena in $LiBaF_3$ crystals is given. Both phenomenological models and experimental interpretations of optical absorption bands, tentatively associated with F-type (electron) centres created by X-ray or electron irradiation , is reviewed. Interpretation of three radiative processes (super-fast core-valence transitions, slow trapped exciton luminescence and luminescence of structure defects) observed in undoped $LiBaF_3$ crystals is analysed with respect to practical application. Attention is paid to the behaviour of ultraviolet emission so far ascribed to self-trapped exciton luminescence and also observed as a result of electron recombination with localized hole at various temperatures (even at room temperature), depending on crystal purity and

growth conditions. Finally, some aspects of ionic processes in thermal relaxation of defects are pointed to.

LOCALIZED EXCITONS IN FLUOROPEROVSKITE $LiBaF_3$ CRYSTALS

M. Springis, A. Trukhin, I. Tale

Two radiating processes in $LiBaF_3$ crystals, fast valence-core transitions (5.4-6.5 eV) and slow, so-called self-trapped exciton luminescence (about 4.3 eV), are important for practical application. Here we present a study of 4.3 eV luminescence under X-ray excitation and photoexcitation as well as under photostimulation after X-irradiation of undoped and Ag-doped $LiBaF_3$ crystals at various temperatures. It is shown that 4.3 eV luminescence appears under X-ray excitation at least from 85 K to 400 K in both undoped and doped crystals. In all samples studied the excitation spectra of 4.3 eV luminescence contain both the main exciton like band at the edge of fundamental absorption at about 10 eV and weaker band in 7.8-8.6 eV region. Luminescence spectrum in the 3.8-4.8 eV region under 7.8-8.6 eV excitation differs slightly from that under 10 eV excitation. Several luminescence bands in 3.8-4.8 eV region arise in the temperature range 85-230 K under photostimulation in absorption band of F-type center at 2.9 eV created previously under X-irradiation. We propose the luminescence of $LiBaF_3$ crystals in the 3.8-4.8 eV region may be caused by localized excitons formed not only under excitation near the fundamental absorption but also in result of electron recombination with localized holes thermally destroyed above 230 K.

LUMINESCENCE OF INTRINSIC DEFECTS IN $LiBaF_3$

A.Pujats, A.Veispals

A wide emission band in the region of 425 nm is observed in all the examined crystals at photo and ionising irradiation. Maximum of the complex luminescence band is observed at 410 nm at 350 K and at 450 nm at 85 K. The shift of the peak of the band envelope towards shorter wavelengths as the temperature increases is related to thermal dependence of the intensity of elementary components of the luminescence band. The authors suggest that the complex luminescence band arises from electronic excitations at "antisite" defects, i.e., defects caused by stoichiometric deviations, when a portion of Li^+ cations (cations of one type of the $LiBaF_3$ crystal lattice) occupy sites of Ba^{2+} cations (cations of another type) and vice versa.

F-TYPE CENTERS IN $LiBaF_3$ CRYSTALS

L.Dimitrochenko, A.Pujats

A comparative study of optical properties of thermochemically reduced undoped $LiBaF_3$ crystals is reported. In $LiBaF_3$ crystals obtained or treated in a reducing atmosphere an absorption band at 240 nm and a corresponding luminescence band at 505 nm are observed at 85 K. The main constituent of the center may be an anion vacancy with a trapped electron (an F-type center in $LiBaF_3$ crystals).

Scientific publication

Published in 2002

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2. P. Kulis, U. Rogulis, M. Springis, I. Tale, A. Veispals, A. Groza, V. Ziraps, *Annealing of radiation defects in X-irradiated $LiBaF_3$,* - Mat. Res. Soc. Symp. Proc., 2002, vol. **718**, (On line), D4.9.1 - D4.9.6
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1. V. Ziraps, V. Graveris, M. Springis, *Radiation-induced electronic and ionic charge storage and release in sapphire,* - Radiation Effects & Defects in Solids (accepted for publication).
2. U. Rogulis, V. Ogorodnik, I. Tale, A. Veispals, *EPR of radiation defects in $LiBaF_3$ crystals,* - Radiation Effects & Defects in Solids (accepted for publication).
3. V. Ziraps, V. Graveris, P. Kulis, I. Tale, *Ion diffusion-controlled thermally stimulated processes in X-ray irradiated halide crystals,* – Radiation Effects & Defects in Solids (accepted for publication).
4. P. Kulis, M. Springis, I. Tale, *Annealing of color centers in $LiBaF_3$,* – Radiation Effects & Defects in Solids (accepted for publication).
5. M. Springis, L. Brikmane, I. Tale, P. Kulis, *Electronic exitations and defects in fluorperovskite $LiBaF_3$,* – Proceedings of SPIE, (accepted for publication).
6. M. Springis, A. Trukhin, I. Tale, *Localized exitations in fluorperovskite $LiBaF_3$ crystals,* - Proceedings of SPIE, (accepted for publication).
7. P. Pujats, A. Veispals, *Luminescence of intrinsic defects in $LiBaF_3$,* - Proceedings of SPIE, (accepted for publication).
8. L. Dimitrochenko, P. Pujats, *The F-type centres in $LiBaF_3$ crystals,* - Proceedings of SPIE, (accepted for publication).
9. P. Kulis, U. Rogulis, M. Springis, I. Tale, A.Veispals, V.Ziraps, *Annealing of Radiation Defects in X-Irradiated $LiBaF_3$,* - Proceedings of SPIE, (accepted for publication).
10. V. Ziraps, V. Graveris, *Thermostimulated electronic and ionic processes in irradiated sapphire,* - Proceedings of SPIE, (accepted for publication).
11. U. Rogulis, S. Schweizer, J.-M. Spaeth, P. Dorenbos, E:V.D. van Loef, C.W.E. van Eijk, K. Krämer, H.U.Güdel, *Magnetic resonance investigations of scintillator $LaCl_3:Ce^{3+}$ scintillators,* - Radiation Effects and Defects in Solids, (accepted for publication).
12. M. Secu, S. Schweizer, U. Rogulis, and J.-M. Spaeth, *Radiation induced defects and their recombination processes in the X-ray storage phosphor $BaBr_2$,* - J. of Physics: Condensed Matter, (accepted for publication).

Lectures on Conferences

18th Scientific Conference of the Institute of Solid State Physics University of Latvia, Riga, February 11-13, 2002.

1. L. Brigmane, M. Springis, Influence of photobleaching on recombination luminescence of $LiBaF_3$ crystals, – 18th Scientific Conference, Abstracts, Institute of Solid State Physics University of Latvia, Riga, 2002, p. 22, (oral presentation).
2. J. Jansons, Efforts of physicists return the fundamental science in University of Latvia, - Ibid. p. 49, (oral presentation).
3. U. Rogulis, V. Ogorodniks, I. Tale, A. Veispals, EPR of radiation defects in $LiBaF_3$ crystals , - Ibid. p 50, (oral presentation).
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5. I. Tale, Thin ZnO based semiconductor films and structures: production and applications, - Ibid. p.60, (oral presentation).

2002 MRS Spring Meeting, San Francisco, California, USA, April 16-20, 2002

1. P. Kulis, U. Rogulis, M. Springis, I. Tale, A. Groza, A.Veispals, V.Ziraps, Annealing of Radiation Defects in X-Irradiated $LiBaF_3$, - MRS Spring Meetings 2002, Abstracts, Session G, pp.65.

The 3rd International Conference Advanced optical materials and devices AOMD-3, August 19-22, Riga, Latvia:

1. M. Springis, L. Brikmane, I. Tale, P. Kulis, Electronic exitations and defects in fluorperovskite $LiBaF_3$, – Programme and Abstracts, The 3rd International Conference Advanced optical materials and devices, August 19-22, Riga, Latvia, p. 108, (poster presentation).
2. M. Springis, A. Trukhin, I. Tale, Localized exitations in fluorperovskite $LiBaF_3$ crystals, - Ibid. p.132. (poster presentation).
3. P. Pujats, A. Veispals, Luminescence of intrinsic defects in $LiBaF_3$, - Ibid. p.133. (poster presentation).
4. L. Dimitrochenko, P. Pujats, The F-type centres in $LiBaF_3$ crystals, - Ibid. p.134. (poster presentation).
5. P. Kulis, U. Rogulis, M. Springis, I. Tale, A.Veispals, V.Ziraps, Annealing of Radiation Defects in X-Irradiated $LiBaF_3$, - Ibid. p.135. (poster presentation).
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1. V. Ziraps, V. Graveris, M. Springis, Radiation-induced electronic and ionic charge storage and release in sapphire, - Program & Abstracts, Europhysical conference on defects in insulating materials, Wroclaw, Poland, 2002 p. OMo-A5, (oral presentation).

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3. V. Ziraps, V. Graveris, P. Kulis, I. Tale, Ion diffusion-controlled thermally stimulated processes in X-ray irradiated halide crystals, – Ibid. Tu-P86, (poster presentation).
4. P. Kulis, M. Springis, I. Tale, Annealing of color centers in $LiBaF_3$, - Ibid. Th-P81, (poster presentation).

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1. J. Jansons, *Latvijas Universitātes profesors Ilmārs Vītols – 70.* – "Zvaigžņotā Debess", 2001./2002. gada ziema, 46. – 59. lpp.
2. J. Jansons, *Fiziķu centieni atgriezt 1950.-60. gados fundamentālo zinātni Latvijas Universitātē.* – LU Cietvielu fizikas institūta 18. zinātniskā konference. 2002. gada 11.-13. februāris. Rīga: tēzes, LU CFI, 2002., 49. lpp.
3. J.Jansons, *Latvijas Universitātes sagatavotie pirmās paaudzes fiziķi.* – Latvijas Fizikas biedrības 7. zinātniskā konference. 2002. gada 7.-8. jūnijs. Daugavpils: DU izdevniecība "Saule", tēzes 18. lpp.
4. J. Jansons*, Latvijas Fizikas biedrības un Latvijas Astronomijas biedrības konference 2001. gada 2.-4. jūlijā Liepenē.* – Zvaigžņotā Debess 2002. gada pavasaris (175), 32.-35. lpp.
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6. J. Jansons, *LVU vecākajam pasniedzējam Valerianam Šmēlingam – 100.* – "Zvaigžņotā Debess" 2002. gada vasara (176), 23.-31. lpp.
7. J. Jansons, *Latvijas Fizikas biedrības un Latvijas Astronomijas biedrības konference 2001. gada 2.-4. jūlijā Liepenē (Nobeigums).* – Zvaigžņotā Debess 2002. gada vasara (176), 32.-35. lpp.
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9. J. Jansons, *Visuma brīnumu pētnieku atceroties. Valerians Šmēlings (1902-1979) – Universitātes Zemes mākslīgo pavadoņu novērošanas stacijas izveidotājs.* – "Universitātes Avīze", (4), 2002. gada 22. oktobrī.

DISORDERED MATERIAL PHYSICS

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

Solid state radiation physics laboratory and defect studies group

Main results

Materials for nonlinear optics, radiation detectors, fiber optics and high-power UV laser optics and optical properties of oxide nanocrystals were studied using optical absorption, luminescence and time-resolved spectroscopy methods. The key problems studied were:

- the mechanisms of charge self-trapping and trapping at different defects/impurities in complex oxides (congruent and stoichiometric $LiNbO_3$; GGG: $KNbO_3$; $SrTiO_3$; $SrTiO_3$:V; $SrTiO_3$:Nb);
- the nature and mechanism of scintillation formation in some tungstates ($CaWO_4$; $ZnWO_4$; $ZnWO_4$:Fe);
- luminescence dependence on nanocrystal size
- the hydrogen-related defect processes in silica glass under vacuum - ultraviolet irradiation
- the properties of oxygen intertitial atoms in silica glass
- the nature of the defects giving rise to vacuum-UV optical absorption of silica

Solid state optics laboratory

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 localized due to electron-phonon interaction electronic excitations are revealed in silicon dioxide, germanium dioxide and relevant aluminum and gallium orthophosphates in crystalline and glassy states. The disorder leads to large broadening of the properties of such dynamic localized state. The static localized states of short-range order, related to a material isomorphism, are revealed in wide gap optical glasses relevant to the mentioned crystals. Found essential sensitivity of localized states to history of glass preparation and treatment by light (laser, etc.).

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

Solid state radiation physics laboratory

1. Dr. hab.phys. S.Chernov
2. Dr. hab.phys. L.Grigorjeva
3. Dr. hab.phys. D.Millers
4. Dr. hab.phys. I.Plavin
5. Dr.phys.V.Pankratov
6. Dr.phys I.Hinoverova
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Solid state optics laboratory

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2. Dr.Phys., Dr.Phil. K.Truhins

Technical Staff

1. Eng. A.Sitdikov

Students

1. A.Kalinko
2. T. Dudareva

Scientific Visits Abroad

7. Dr.hab.phys. L.Grigorjeva,. Czech Republic, Charles University,
8. Institute of Physics (7 days).
9. Dr.hab.phys. L.Grigorjeva, Portugal (7 days).
10. Dr.hab.phys. L.Grigorjeva, Hungary (30 days).
11. Dr.hab.phys. L.Grigorjeva, Poland (4 days).
12. Dr.phys.V.Pankratov, Germany (10 month).
13. Dr.hab.phys. L.Grigorjeva, Poland (7 days).
14. Dr.hab.phys.D.Millers, Poland (7 days)
15. Dr.hab.phys.D.Millers, Poland (4 days).
16. Dr.hab.phys.D.Millers, Poland (5 days).
17. Dr.hab.phys. S.Chernov, Poland (7 days)
18. Dr.hab.phys A, Siliņš -Germany (5 days)
19. Dr.hab.phys A.Siliņš Francija, Montpellier, France (6 days)
20. Dr.hab.phys L.Skuja, Italy (14 days)
21. Dr.hab.phys. L.Skuja Japan (1 month).
22. Dr.hab.phys. L.Skuja, Germany (5 days)
23. Dr. Phil., Dr. Phys. K.Truhins, USA, Postdoctoral position at University of Illinois at Chicago, Chicago, Illinois 60607 USA (12 month)
24. Professor, Dr. hab. Phys. A. Trukhin, Italy (10 days)
25. Professor, Dr. hab. Phys. A. Trukhin, St.Petersburg, Russia (2 weeks)
26. Professor, Dr. hab. Phys. A. Trukhin, Germany (15 days).
27. Professor, Dr. hab. Phys. A. Trukhin, Estonia (2 months)

Visits from Abroad

Dr.P.Hlidek (30 days)
Dr.A.Badaljan (14 days)
Mg.P.Potera (40 days)
Mg.K.Lenguel (30 days)
Dr.G.Corradi (30 days)
Dr.A.Watterich (30 days)
Dr. B.Poumellec (7 days)
Dr. B. Guettler (7 days)

Cooperation

Latvia

University of Latvia, (Prof. J.Tiliks).
University of Latvia, Institute of Biology (Dr. O.Mutere).
SIA “Baltic Scientific Instruments” (Dr.V.Gostillo).

USA

Wake Forest University (Prof. R.T. Williams.)
Oak Ridge National Laboratory. Oak-Ridge, (Ph.D. Lynn A. Boatner)
University of Central Florida, CREOL (Professor, Dr.L.B.Glebov)
University of Illinois at Chicago, (Professor, Robert J.Gordon)

Czech Republic

Academy of Sciences, Institute of Physics (Dr. M.Nikl)
Charles University (Dr.M. Zvara, Dr .P.Hlidek, Dr. J.Bok)

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University of Osnabruck, Department of Physics **(**Prof.S.Kapphan, Prof.G.Borstel)
University of Rostock, Germany (Professor, Dr. H.-J. Fitting)

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

Italy

University of Palermo (Prof. R.Boscaino, Dr. M. Cannas, Dr. S.Agnello)
University of Milano (Prof. G. Pacchioni)

Japan
Tokyo Institute of Technology (Prof. H.Hosono, Dr. K.Kajihara, Dr. M. Hirano)

Estonia

Institute of Physics, Tartu (Dr.Sc.R.Kink, Dr.Sc.Ch.Luschik, Dr.J.Maksivov. Dr.V.Nagirnyj)

Hungary

Hungarian Academy of Sciences, Research Inst. for Solid State Physics & Optics, Crystal Physics Laboratory (Dr.G.Corradi, Dr.K.Polgar, Dr.A.Watterich, Ph.D.Stud. K.Lenguel)

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Ioffe Phys.Techn.Inst. RAS, (Dr.V.Trepakov, Dr. A.Badaljan)
GIREDMET, Moskow (Dr.I.S.Listskii)

Ukraine

University of Lviv, (prof. Voloshinovskii)
State University "Lvivska Politechnika" (Prof. A.Matkovskii, Dr.Sugak)

Poland

Polish Academy of Science, UNIPRESS (Prof.W.Łojkowski)
Institute of Physics, University of Rzeszow (Prof.A.Matkovskii, Ph.D.Stud.P.Potera)

The main results

EXPERIMENTAL AND THEORETICAL STUDIES OF OPTICAL PROPERTIES OF POLARONS AND EXCITONS IN $KNbO_3$

L.Grigorjeva, D.Milllers, V.Pankratov, R. T. Williams, R.I. Eglitis, E.A.Kotomin, G.Borstel

Time-resolved absorption and luminescence spectra have been measured in KNbO3 perovskite crystals after irradiation by Xe laser of 200 fs pulses and electron beam 10 ns pulses. Quantum chemical calculations support the interpretation of the observed absorption bands at 0.8 eV and 1.1 eV as free electron polarons and bound hole polarons. Triplet exciton is shown to be a good approximation a pair of nearest Jahn-Teller electron and hole polarons which is very likely responsible for the green luminescence peak observed around 2.2 eV. The calculated activation energy for luminescence quenching (0.06 eV) coincides with the experimental value (0.05 eV). Its small magnitude explains why it is observed only at low temperatures.
In cooperation with: Wake Forest University, USA and University of Osnabruck, Department of Physics

TIME-RESOLVED SPECTROSCOPY IN $ZnWO_4$ AND $ZnWO_4$:Fe

L.Grigorjeva, V.Pankratov, D.Millers, S.Chernov, V.Nagirnyi, A.Kotlov, A.Watterich

Time-resolved luminescence and absorption of a nominally pure $ZnWO_4$ crystal and two crystals with different Fe concentrations (10^{-2} mol% and 10^{-3} mol% have been studied. The fast decaying luminescence at ~1.7 eV is attributed to either Fe^{2+} or a Fe^{3+} related center. Two decay times (~1 μs and ~20 μs) are observed in the STE luminescence decay kinetic and transient absorption relaxation kinetic under electron beam excitation of $ZnWO_4$ at LNT. The two observed stages in luminescence decay kinetics under ionizing radiation are suggested to be due to two types of self-trapped excitons.

In cooperation with: *Hungarian Academy of Science, Research Institute for Solid State Physics &Optics, Budapest, Hungay and Institute of Physics, Tartu, Estonia*

TRANSIENT COLOR CENTRES IN GGG CRYSTALS

P.Potera, A.O.Matkovskii, D.Sugak, L.Grigorjeva, D.Millers, V.Pankratov

The spectra and decay kinetics of transient absorption (TA) induced by pulsed electron beam have been investigated in undoped and Nd doped $Gd_3Ga_5O_{12}$ (GGG) single crystals. It is shown that for all samples there appears a wide (TA) band with two maxima in the region 1.73 eV – 2.1 eV and 2.73 – 3.22 eV.TA decay kinetics measured at 1.73 eV and 2.73 eV are two-exponential (with decay times order several tens and several hundreds ns). Analyzing the obtained results, we can suppose that low energy TA bands are connected with the F^+ -centres and self-trapped O^- centres whereas high-energy TA bands are connected with the F-centres.

In cooperation with: *Insitute of Physics HPS, Rzeszow, Poland,*
State University "Lvivska Politechnika", Lviv, Ukraine

LUMINESCENCE OF NANOSIZE ZrO_2

D.Millers, L.Grigorjeva, W.Łojkowski, A. Opalińska

The time-resolved luminescence from different size (Φ~10-50 nm) ZrO_2 and ZrO_2:Pr nanocrystals was studied. The average grain size (Φ) of nanocrystals was calculated from specific surface area data and density of zirconium oxide (5.6 g/cm^3), assuming that the particles are spherical. The pulsed electron beam was used for luminescence excitation. The luminescence band peaking at 2.8 eV is suggested to be of intrinsic origin. Luminescence intensity and decay kinetics depends on the nanocrystal size. The large size nanocrystals shows more intense luminescence than the small size nanocrystals. This dependence arises due to nonradiative decay of electronic excitations at nanocrystal surface. The luminescence intensity from ZrO_2:Pr nanocrystals is much lower than that from undoped ZrO_2 nanocrystals.

In cooperation with: *High Pressure Research Center of the Polish Academy of Sciences,*
Warsaw, Poland

DIFFUSION AND REACTIONS OF HYDROGEN IN F_2 -LASER-IRRADIATED SiO_2 GLASS

K. Kajihara, L.Skuja, M.Hirano, H.Hosono

The diffusion and reactions of hydrogenous species generated by single-pulsed F_2 laser photolysis of SiO-H bond in SiO_2 glass were studied in situ between 10 and 330 K. Experimental evidence indicates that atomic hydrogen (H^0) becomes mobile even at temperatures as low as 30 K . A sizable number of H^0 dimerize by a diffusion-limited reaction into molecular hydrogen (H_2) that may migrate above ≈200 K. Activation energies for the diffusion, inherently scattered due to the structural disorder in glass, are separated into three bands centered at ≈0.1 eV for free H^0, ≈0.2eV presumably for shallow-trapped
H^0, and ≈0.4eV for H_2 .

In cooperation with: *Tokyo Institute of Technology, Japan.*

THE BEHAVIOR OF INTERSTITIAL OXYGEN ATOMS INDUCED BY F_2 LASER IRRADIATION OF OXYGEN-RICH GLASSY SiO_2.

L.Skuja, K.Kajihara, T.Kinoshita, M.Hirano

Interstitial oxygen atoms in glassy silicon dioxide were created by photolysis of pre-existing interstitial oxygen molecules O_2 with a fluorine excimer laser (7.9 eV). The concentration of atomic oxygen interstitials was indirectly monitored by the disappearance and subsequent recovery of interstitial molecules which were monitored by their 1272 nm photoluminescence band. Most of the oxygen interstitials (>95%) are immobile at room temperature. The onset of their mobility occurs between 200C and 400C where around 95% of them recombine to form O_2 molecules. The high stability of interstitial oxygen atoms is consistent with the theoretical prediction that they are incorporated into silica structure in a form of peroxy linkages Si-O-O-Si. The radiation-induced optical absorption band around 7.1 eV is tentatively assigned to peroxy linkages.
In cooperation with: *Tokyo Institute of Technology, Japan.*

VACUUM ULTRAVIOLET OPTICAL ABSORPTION BAND OF NON-BRIDGING OXYGEN HOLE CENTERS IN SiO_2 GLASS

H.Hosono, K.Kajihara, T.Suzuki, Y.Ikuta, L.Skuja, M.Hirano

An intense broad vacuum ultraviolet (VUV) optical absorption band with peak at 6.8 eV and halfwidth 1.7 eV is identified in irradiated glassy SiO_2 and assigned to dangling oxygen bonds (non-bridging oxygen hole centers, NBOHC). It was selectively created by photolysis of silanol (SiO—H) groups by 7.9 eV photons of F_2 excimer laser at low temperature. Subsequent analysis by VUV absorption, time-resolved luminescence, and electron paramagnetic resonance spectroscopies during thermal annealing showed an exact correlation to the well-known 4.8 and 2 eV absorption and 1.9 eV luminescence bands of NBOHC. The estimated oscillator strength of the 6.8 eV band is f≈0.05. This band may be one of the dominant causes of VUV optical absorption induced by excimer-laser irradiation of silica.
In cooperation with: *Tokyo Institute of Technology, Japan.*

PHOTOLUMINESCENCE AND CATHODOLUMINESCENCE SPECTROSCOPY OF 3.1 AND 4.3 eV BANDS IN H_2 LOADED GERMANOSILICA WAVEGUIDE.

A.N. Trukhin, J. Jansons, V.Cannas, B. Poumellec

We report experimental results on the photoluminescence and cathodoluminescence bands centred at 4.3 and 3.1 eV in germanosilica planar waveguide. The sample was a substrate of silica Tetrasil having a thickness of 1 mm with no absorption at 240 nm; a cladding of B: SiO_2 with thickness about 10 microns; a

core of silica doped with 6% mol GeO_2 having a thickness about 5 microns. Treated with H_2 at 600°C for 5 hours. It has an absorption band at 240 nm.

The blue luminescence life-time under both excitations is 110μs (usual for oxygen deficient germanium luminescence center) and the UV luminescence life time is found to be around 7 ns at room temperature. Also excitation spectra of luminescence bands are similar to "normal" GeODC. Therefore it is obtained that H_2 loading and excitation with low flux does not make difference with GeODC in non-loaded samples.

Germanium dioxide increases the silica refractive index and form a waveguide structure of an optical fibre. however the germano-silicates core of waveguides exhibits photosensitivity itself (as rule, the intensive laser irradiation is used for recording of index changes), the presence of hydrogen enhances photosensitivity. the processes of photosensitivity still not well understood. we assume that attraction of hydrogen in atomic or molecular state to excited center in long living triplet state is elementary process of photosensitivity. many steps photostimulated geometrical reconstruction with involving of a diffusion processes can be proposed as model for total index changes due to photoexcitation.

In cooperation with: Lab. Physico-Chimie des Solides, Orsay, France

WINDOWLESS VUV LIGHT SOURCE AND PHOTOLUMINESCENCE EXCITATION MEASUREMENT EQUIPMENT WITH SEYA-NAMIOKA 0.5 M MONOCHROMATOR CONTAINING TOROIDAL GRATING

A.N. Trukhin

Some luminescence experiments need use of high energy photon above 9 eV a real cut off of MgF_2 and even LiF window light sources. The created equipment contains windowless light source as a duoplasmatron with permanent magnet for concentration of plasma, 0.5 m Seya-Namioka grating vacuum monochromator with sinus mechanism of grating turning, a chamber for toroidal concave mirror made of crystalline quartz and sample vacuum chamber. The monochromator is pumped by two diffusion pumps containing polyphenil ether (can work in different atmosphere without burning) and sample chamber is pumped by one pump. All the pumps possess liquid nitrogen traps. The cathode of the light source is a tungsten wire filament coated with oxide past for higher efficiency of thermo electrons emission. The hydrogen and argon gases could be used in plasmatron. The use of toroidal grating cut on a glass surface as well as quartz mirror both without coating provide filtering of light below 7 eV, where reflection of glass and quartz is small. Then only high energetic photons are really useful. The hydrogen discharge provides light from 7 eV to 13.6 eV (there is some light below 14 eV useful in the case of high luminescence quantum yield or for photoelectron emission). This part of spectra is complemented to the use of storage ring radiation, because could help in second order influence estimation (hydrogen discharge does not provide light above 14 eV). The argon discharge provides several lines above 13.5 eV. The power supply provide 1400 V 0.5 A, then it could be used cold cathode as well. Then, in the case of limited emission ability of hot cathode the discharge could be obtained in cold cathode regime.

The author is thankful to Juris Katkevics for help in mechanic work.

CATHODOLUMINESCENCE DECAY KINETICS IN Ge^+, Si^+, O^+ IMPLANTED SiO_2 LAYERS.

A. N. Trukhin, J.Jansons, H.-J. Fitting, T. Barfels*, B. Schmidt*,*

The use of cathodoexcitation for study of silicon dioxide films on silicon substrate has revealed many interesting properties of luminescence centers. The main luminescent centers in SiO_2 films at room temperature are the red luminescence R (1.85 eV) of the non-bridging oxygen hole center (NBOHC) and the twofold- coordinated (divalent) silicon with a blue B (2.7 eV) and a UV band (4.4 eV). At low temperatures the luminescence of the self-trapped excitons (a band at 2.3 eV) takes place at first few seconds of irradiation. Damage of film during cathodo-irradiation completely destroys STE luminescence.

Morimoto et al. concluded that the blue luminescence (B) is related to interstitial oxygen. That was in contradiction with previous explanation of the blue luminescence of silica glass as oxygen deficient luminescence centers (ODC), possessing specific excitation bands and long duration decay kinetics. Therefore, in the present we compare direct oxygen implantation with direct silicon implantation into SiO_2 layers producing an oxygen surplus, in the first case, and an oxygen deficit, in the second case, respectively. The germanium implanted sample was studied as well, because Ge is creating similar ODC.

The decay of cathodoluminescence in Ge^+, Si^+, O^+ implanted samples was not yet measured for our knowledge and we compare the decay kinetics in implanted and non-implanted samples, that to detect if there are some differences in the nature of blue luminescence in as received samples and implanted samples. The implantation of silicon leads to creation of luminescence center with blue and UV bands. The study of decay kinetics shows that created centers are similar to oxygen deficient luminescence center. The nature of decay kinetics is determined by complex of recombination and intra-center processes. The centers created by silicon implantation could be destroyed during CL measurement. There are no big difference in CL properties with respect to blue and UV bands of oxygen implanted and reference (non-implanted) silicon dioxide film. The corresponding luminescence center concentration growth with excitation dose similarly.

Oxygen implantation stimulates creation of the non-bridging oxygen luminescence center. Therefore study of CL of thin films of silicon dioxide shows different behavior of them with respect to CL of bulk sample of silica. We suspect that different charging of implanted and non-implanted bulk samples could explain observed difference.

**In cooperation with: Physics Department, Rostock University, Institute of Ion Beam Physics, Research Center Rossendorf, Dresden*

STUDY OF THE GERMANIUM LUMINESCENCE IN SILICA: FROM NON-CONTROLLED IMPURITY TO GERMANO-SILICATE CORE OF TELECOMMUNICATION FIBERS PREFORM

Anatoly Trukhin, Bertrand Poumellec, Jérôme Garapon**

We study the luminescence properties of doped silica with different concentration of germanium. The basic luminescence parameters such as spectral

dependencies, decay kinetics and polarization at different temperatures were measured. Three spectral ranges 3.5 – 5.5 eV (I), 5.5 – 7 eV (II), 7 – 8 eV(III) in the optical transparency range of silica could be chosen from these data. The range I possess a weak variation of significant parameters of luminescence such as decay kinetics and polarization of the germanium related oxygen deficient center (GeODC) with the change of luminescence center concentration from extremely low in pure silica to germano-silica core of optical communication fiber preforms. The temperature dependence of luminescence intensity and spectral content including excitation band are more affected by change of concentration. The deviation of those parameters could be explained mainly within framework of inhomogeneous broadening and of center interaction with varying environment. However the influence of multi typicalness of the center structure also takes place in the range I. The changes of decay kinetics and polarization excited in the ranges II and III are also insensitive to the change of concentration but the spectral content is more sensitive to the history of sample preparation there, providing bigger changes in spectral bands relation. That could be explained as multi typicalness of similar centers due to different surrounding. The range III is more affected by host defect (ODC(I) providing an absorption band at 7.6 eV different in different samples by the way that there are in addition to intracenter transitions recombination mechanisms of luminescence excitation.

**In cooperation with: Lab. Physico-Chimie des Solides, Orsay, France*

PHOTOSENSITIVITY OF SILICA GLASS WITH GERMANIUM STUDIED BY PHOTO INDUCING OF THERMALLY STIMULATED LUMINESCENCE WITH VACUUM ULTRAVIOLET RADIATION

*Anatoly Trukhin, Bertrand Poumellec**

Photosensitivity of the germanium-doped silica was studied through kinetics of recombination of the created defects in isothermal and thermally stimulated luminescence (TSL) regimes. The main observed luminescence contains bands mainly due to GeODC (Ge oxygen deficient center) in concentration $N=1.5\times10^{17}$ cm^{-3}. The maximum of photosensitivity corresponds to the high-energy part of the 7.6 eV band. The efficiency of TSL peaks creation increases with increase of the temperature. The growth of TSL intensity is almost linear for the case of excitation through monochromator and growth with saturation in the case of excitation with white light. The result was explained as multi-steps process of photochemical dissociation and products separation by thermally stimulated diffusion.

**In cooperation with: Lab. Physico-Chimie des Solides, Orsay, France*

Scientific Publications

Published in 2002

1. L.Grigorjeva, V.Pankratov, D.Millers, G.Corradi, K.Polgar. *Relaxation of electronic excitations in $LiNbO_3$ crystals*. Ferroelectrics, 2001, vol.**257**, pp.281-292.
2. V.Pankratov, L.Grigorjeva, D.Millers, S.Chernov, and A.,S.Voloshinovskii. *Luminescence center excited state absorption in tungstates.* J. Luminescence, 2001, vol.**94-95**, pp. 427-432.

3. D.Millers, L.Grigorjeva, V.Pankratov, S.Chernov, A.Watterich. *Time-resolved spectroscopy of $ZnWO_4$.* Radiat.Effects and Defects in Solids, 2001, vol.**155**, pp.317-321.
4. R.T.Williams, K.B.Ucer, H.M.Yochum, L.Grigorjeva, D.Millers. G.Corradi. *Self-trapped electron and transient defect absorption in niobate and tungstate crystals*. Ibid, 2001, vol.**155**. pp.265-276.
5. Yong Qiu, K.B.Ucer, R.T.Williams, L.Grigorjeva, D.Millers, V.Pankratov. *Transient absorption of polarons in $KNbO_3$.* Nucl.Instrum.and Methods In Physics Research, B, 2002, vol.**191**, 98-101.
6. L,Grigorjeva, D.Millers. *The model of recombination process in TlBr*. Ibid. 2002, vol.**1912**, pp.131-134.
7. D.Millers, L.Grigorjeva, V,Pankratov, V.A.Trepakov, S.E.Kapphan. *Pulsed electron beam excited transient absorption in $SrTiO_3$.* Nuclear Instruments and Methods in Physical Research B, 2002, vol.**194**, pp 469-473.
8. A.Tale, I.Plavina. *Spatial Correlation of Latent Image Centers in Photostimulable Luminescence of Irradiated Doped Alkali Halides*. In: Smart Optical Inorganic Structures and Devices, Steponas P. Ašmontas, Jonas Gradauskas, Editors, *Proceedings of SPIE,* 2001, **vol**. 4318, pp. 180 – 185.
9. И.К.Плявинь, А.К.Тале, *Возможные механизмы создания фотостимулируемых дефектов и возбуждения люминесценции активатора при облучении щелочно-галоидных кристаллов ионизирующей радиацией*, Автометрия, 2002, том **38**, № **5**, 1 -11. Tulkojums: I.Plavina, and A.Tale, "Possible mechanisms of the photostimulable defect creation and excitation of the activator luminescence in alkali halides under irradiation by ionising radiation"tiks publicēts, *Optoelectronics, Instrumentation and Data Processing*, Allerton Press, USA, 2003.
10. И.К. Плявинь, А.К. Тале, *Пространственное распределение дефектов в фотофотостимулируемых щелочно-галоидных кристаллах*. Автометрия, Изд-ство СО РАН, Новосибирск, 2001, том **37, № 6,** 3 - 23. Tulkojums: I.K.Plavina and A.K.Tale, Spatial correlation of defects in photostimulable alkali halide crystals, Optoelectronics, Instrumentation and Data Processing, Allerton Press, USA, 2002 (accepted).
11. H.Hosono, K.Kajihara, T.Suzuki, Y.Ikuta, L.Skuja, M.Hirano *Vacuum ultraviolet optical absorption band of non-bridging oxygen hole centers in SiO_2 glas*s Solid State Comm. vol.**122**, p.117-120 (2002).
12. L.Skuja, K.Kajihara, T.Kinoshita, M.Hirano *The behavior of interstitial oxygen atoms induced by F_2 laser irradiation of oxygen-rich glassy SiO_2.* Nuclear Instruments and Methods in Physics Research vol**. B191** p.127 –130 (2002).
13. K. Kajihara, L.Skuja, M.Hirano, H.Hosono *Diffusion and reactions of hydrogen in F_2 -laser-irradiated SiO_2 glass*. Phys.Rev. Lett. vol. **89**, No13, p. 135507-1 - 135507-4 (2002).
14. L.Skuja, M.Hirano, K.Kajihara, H.Hosono *Point defect creation by photochemical processes in glassy silica.* Phys. Chem. Glasses, vol. **43C**, p.145–148 (2002).
15. H.-J. Fitting, T.Barfels, A.N. Trukhin, B.Schmidt, *Cathodoluminescence of crystalline and amorphous SiO_2 and GeO_2,* Journal of Non-Crystalline Solids 279 (2001) 51-59.
16. H.-J. Fitting, T.Barfels, A.N. Trukhin, B.Schmidt, A.Gulans, A. von Czarnowski, *Cathodoluminescence of Ge^+, Si^+, and O^+ -implanted SiO2 layers and the role of mobile oxygen in defect transformation,*. Journal of Non-Crystalline Solids, vol.**303** (2002) 218 – 231.

17. Jérôme Garapon, Bertrand Poumellec, S. Vacher, Anatoly Trukhin, *Observation of a new photoluminescence band at 320 nm under 270 nm excitation in Ge-doped silica glass*, Journal of Non-Crystalline Solids, vol **311** (2002), pp 83-88
18. Anatoly Trukhin, Bertrand Poumellec, *Investigation of the photosensitivity of silica glass with germanium by photo inducing of thermally stimulated luminescence with vacuum ultraviolet radiation*, Euro Summer School On Photosensitivity in Optical Waveguides And Glasses. POWAG 2002, St-Petersburg, Russia, 126-133.
19. Anatoly Trukhin, Bertrand Poumellec, Jérôme Garapon *Study of the germanium luminescence in silica: from non-controlled impurity to germano-silicate core of telecommunication fibers perform*, Euro Summer School On Photosensitivity in Optical Waveguides And Glasses. POWAG 2002, St-Petersburg, Russia, 114-125.

In Press

1. L. Grigorjeva, D. K. Milllers, V. Pankratov, R. T. Williams, R.I.Eglitis, E.A.Kotomin, GD.Millers, V.A.Nefedov, V.Pankratov, B.I.Zadneprovski. *Ion-related luminescence ceters in $ZnWO_4$:Fe*. Ibid, (accepted)
2. D.Millers, V.Pankratov, L.Grigorjeva, S.Kapphan, V.Trepakov. *Relaxation of el*. Borstel. *Experimental and theoretical studies of optical properties of polarons and excitons in $KNbO_3$*. Phys.Rev.B, (submitted).
3. D.Millers, L.Grigorjeva, W.Łojkowski, A.Opalińska. Luminescence of Nanosize ZrO_2. Trans.Tech.Publications.(accepted).
4. V.Pankratov, D.Millers, L.Grigorjeva, A.O.Matkovskii, P.Potera, I.Pracka, T.Łukasiewicz. *The role of Fe and Cu dopants in electron-hole trapping and relaxation process in congruent $LiNbO_3$*. Optical Materials. (accepted).
5. P.Potera, A.Matkovskii, D.Sugak, L.Grigorjeva, D.Millers, V.Pankratov. *Transient color centers in GGG crystals*. Radiat.Effects and Defects in Solids (accepted).
6. L.Grigorjeva, N.Pankratov, D.Millers, S.Chernov, V. Nagirnyi, A.Kotlov, A.Watterich. Time-resolved spectroscopy in $ZnWO_4$ and $ZnWO_4$:Fe. Ibid, (accepted).
7. V.Nagirnyi, S.Chernov, L.Grigorjeva, L.Jönsson, M.Kirm, A.Kotlov, A.Lushchik, *ectronic excitations in strontium titanate.* Ibid, (accepted).
8. L.Grigorjeva, D.Millers, V.Pankratov. *Transient absorption of niobium states in photorefractive materials.* Ferroelectrics (accepted).
9. A.Matkovskii, P.Potera, D.Sugak, Ya.Zhydachevskii, V.Pankratov, D.Millers, L.Grigorjeva, I.Pracka, T.Łukasiewicz. *Transient and stable color centers in pure and Cu-doped $LiNbO_3$.* (accepted).
10. L. Skuja, H. Hosono, M. Hirano, K. Kajihara *Advances in silica-based glasses for UV and vacuum-UV laser optics* Proc. SPIE vol. 5122, "Advanced optical materials", 2003 (accepted).
11. A.Silins *Water in fused silica glasses* Glass Science and Technology - Glastechnische Berichte (Accepted, 2003)
12. K. Kajihara, L.Skuja, M.Hirano, H.Hosono *In-situ observation of diffusion of hydrogeneous species in F_2 laser irradiated SiO_2 glass using pump-and-probe technique.* J.Non-Crystalline Solids (submitted).
13. L. Skuja, M. Hirano, H. Hosono, K. Kajihara, A. Silin *UV-induced effects in glassy silica: transformation of peroxy radicals to oxygen dangling bonds* Glass Science and Technology - Glastechnische Berichte (Accepted, 2003)

Lectures in Conferences

18th Scientific Conference, Institute of Solid State Physics, University of Latvia, Riga, 11-13. February, 2002.

1. I.Pļaviņa, A.Tāle. *Components of Activator luminescence induced by ionizing radiation in alkali halides at room temperature.* Abstracts, p.26.
2. V.Pankratov, D.Millers, S.Chernov L.Grigorjeva,.*Luminescence an transient absorption in $ZnWO_4$ and $ZnWO_4$-Fe* . Ibid, p.25.
3. D.Millers, L.Grigorjeva V.Pankratov. *Polarons instrontium titanate.* Ibid, p.24.
4. L.Grigorjeva, D.Millers. OH^- *stretching vibrational absorption in LiNbO3 and* $KNbO_3$. Ibid, p.23
5. A.Siliņš *Intrinsic and impurity molecules in fused silica* Ibid, p.19
6. L.Skuja, H.Hosono *Defect generations in silica glasses by two-step photolysis during* F_2 *laser irradiation.* Ibid, p.18
7. T.Barfels, J.Jansons, H.-J.Fitting, I.A.Tāle, A.N.Truhins, *Influence of oxygen and silicon implantation on silicon dioxide thin film cathodoluminescence*, 17. CFI LU Zinātniskās konferences referātu tēzes, Rīga, Latvija, 19.-23. Februāris 2002, 57.lpp.
8. A.N.Truhins, *Windowless VUV light source and photoluminescence excitation measurement equipment with Seya-Namioka 0.5 m monochromator containing toroidal grating*, 18. CFI LU Zinātniskās konferences referātu tēzes, Rīga, Latvija, 11.-13. Februāris 2002, 20.lpp.
9. A.N.Truhins, J. Jansons, V.Cannas, B. Poumellec, *Photoluminescence and cathodo luminescence spectroscopy of 3.1 and 4.3 eV bands in* H_2 *loaded germanosilicawaveguide*, 18. CFI LU Zinātniskās konferences referātu tēzes, Rīga, Latvija, 11.-13. Februāris 2002, 21.lpp.

The 3th International Conference "Advanced Optical Materials and Devices" (AOMD-3). August 19-22, 2002, Riga, Latvia.

1. D.Millers, L.Grigorjeva, V.Pankratov. *The comparison of short-lived luminescence in* $SrTiO_3$ *and* $LiNbO_3$. Abstracts, p.128.
2. F.Muktupavela, I.Manika, L.Grigorjeva, V.Skvortsova. *Micromechanical properties of AlN and AlN/TiN nanostructured multilayer coatings*. Abstracts, p.157.
3. I. Pļaviņa and A. Tāle, *Possible exciton polariton effects in the creation of spatially-correlated defects in doped alkali halides*. Abstracts, p.128.
4. L.Skuja, H.Hosono *Advances in silica-based glases for UV and vacuum-UV laser optics.* Abstracts, p.104.

The 6th European Conference on Applications of Polar Dielectrics, Aveiro, Portugal, 02-05, September, 2002.

L.Grigorjeva, D.Millers. *Transient absorption of niobium states in photorefractive materials*. Abstracts, p.111.

Europhysical Conference on Defects in Insulating Materials. July 01-05, 2002, Wroclaw, Poland.

P.Potera, A.Matkovskii, D.Sugak, L.Grigorjeva, D.Millers, V.Pankratov. *Transient color centers in GGG crystals*.
L.Grigorjeva, N.Pankratov, D.Millers, S.Chernov, V. Nagirnyi, A.Kotlov, A.Watterich. *Time-resolved spectroscopy in $ZnWO_4$ and $ZnWO_4$:Fe*.
V.Nagirnyi, S.Chernov, L.Grigorjeva, L.Jönsson, M.Kirm, A.Kotlov., A.Lushchik, D.Millers, V.A.Nefedov, V.Pankratov, B.I.Zadneprovski. *Ion-related luminescence centers in $ZnWO_4$:Fe*.
D.Millers, V.Pankratov, L.Grigorjeva, S.Kapphan, V.Trepakov. *Relaxation of electronic excitations in strontium titanate.*

European Material Research Society Fall Meeting (E – MRS), Symposium C, September 14-18, Warsaw, Poland.
D.Millers, L.Grigorjeva, W.Lojkovski, A.Opalinska. *Luminescence of nanosize ZrO_2.*

Workshop of the Network of Centers of Excellence "Nanostructured materials" Warsaw, 15 – 18 September 2002.
D.Millers. *Recent progress in investigation of nanopowders as scintillators.*

Workshop "TlBr Detectors" Baltic Scientific Instruments, 15 January, 2002, Riga, Latvia.
L. Grigorjeva, D.Millers. *The results of investigation of TlBr crystals performance.*

Seminar in Hungarian Academy of Science, Research Institute for Solid State Physics &Optics, Budapest, Hungary, 9 December, 2002.
L.Grigorjeva. *Time resolved luminescence and absorption in tungstate and niobate crystals.*

European Glass Society Meeting (2002 Glass Odyssey) Montpellier, France, June 2-6, 2002
A.Silin *Role of non-metalic molecules in fused silica glasses.*

7th International Otto-Schott Colloquium, Jena, Germany, July 7-11 2002

A.Silin *Water in fused silica glasses*

L.Skuja *UV-induced effects in glassy silica: transformation of peroxy radicals to oxygen dangling bonds*

Euro Summer School On Photosensitivity in Optical Waveguides And Glasses. POWAG 2002, St-Petersburg, Russia, June17, 2002.

A.Trukhin *Localized states of wide gap glasses.*

University of Tartu, Institute of Physics, Tartu, Estonia, 14 November 2002.
Trukhin A., E*lectronic properties of glass-making crystals and localized states of wide gap oxide glasses.*

PHYSICS OF FERROELECTRICS

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

Research Area and Main Problems

The basic research programme of the Department Ferroelectric Physics includes synthesis and structure determination, study of properties and application of functional ferroelectric materials. Chemical coprecipitation and hot pressing technologies have been used for ceramic production, and pulsed laser deposition and sol-gel processing for obtaining of ferroelectric thin films. Phase transitions and ordering effects in conventional ferroelectrics and ferroelectric relaxors are studied along with new relaxor materials, including doped multicomponent systems and thin film heterostructures. A possible applications of "smart" ferroelectric materials in electronics, optoelectronics and microelectromechanics are considered.

The main areas of progress during 2002 are desribed under the following:

- application of field theory methods to structure transformations in ferroelectrics;
- precision X-ray diffractometry studies of polar and centrosymmetric single crystals, ceramics and thin films;
- preparation and study of properties in in lead scandoniobate ceramics doped with rare-earth oxides;
- nature of dielectric dispersion in PLZT ceramics at the diffused phase transition;
- investigation of relaxor and ferroelectric epitaxial thin films by dielectric Fourier spectroscopy;
- study of dielectric and optical properties of multidimentional polar materials for microelectromechanical systems and application in photonics: new compositions of ferroelectric thin films and new non-linear optically active organic molecular layers;
- general applications of Atomic Force Microscopy for surface analysis of functional thin films; detection of local piezodeformation and polarization in ferroelectrics using Scanning Probe Microscopy
- ellipsometry and reflectometry studies and optical second harmonic investigation of properties of thin films;
- antiferroelectric $PbZrO_3$ thin films: structure, properties and neitron irradiation resistance;
- application of PLZT passive and active optical elements in infrared laser systems for bio-optical experiments and medicine;
- use of PLZT ceramics controllable light scattering elements in design of “artificial eye” for vision research experiments.

Scientific staff

1. Dr. Eriks Birks
2. Dr. Karlis Bormanis
3. Dr. Maruta Dambekalne
4. Dr. habil. Vilnis Dimza
5. Dr. Eriks Klotins
6. Dr. habil. Andris Krumins
7. Dr. habil. Maris Ozolins
8. Dr. habil. Leonids Shebanovs
9. Dr. habil. Andris Sternberg
10. Dr. Vismants Zauls
11. Mg. Maija Antonova
12. Mg. Laila Chakare
13. Mg. Maris Kundzins
14. Mg. Maris Livins
15. Mg. Astrida Spule
16. Mg. Inta Brante
17. Mg. Karlis Kundzins

Technical staff

1. Mg. Marite Kalnberga
2. Mg. Anna Kalvane
3. Modris Logins
4. Alberts Tupulis

Students

1. V.Korsaks
2. O.Avotins
3. I.Aulika

Visitors from Abroad

Dr **Jirka Hlinka**, Institute of Physics ASCR, Praha, Czech Republik (1 month);
Dr. **Peter V. Sushko**, University College London, UK, (1 month);
Dr. **Marina Tyunina**, Microelectronics and Materials Physics Laboratories, University of Oulu, Finland (1 month);
Dr. habil. **Juras Banys**, Vilnius University, Lithuania (1 week);
Dr. **Armin Fuith,** Institute for Experimental Physics, University Vienna, Austria (1 month);
Dr. **Stefan Katholy**, University of Potsdam,Germany (1 month);
Dr. **Catalin Harnagea**, Max-Planck-Institute of Microstructure Physics, Halle, Germany (1 month);

Scientific Visits Abroad

Mg. **Maija Antonova**

1. Uzhgorod National University, Uzhgorod-Sinjak, Ukraine (1 week).

B. sc. **Ilze Aulika**

1. 17th International Conference for Physics Students, Budapest, Hungary (2 weeks).

Dr. phys. **Karlis Bormanis**

1. 7th RUSSIA / CIS / BALTIC / JAPAN Symposium on Ferroelectricity, St. Petersburg, Russia (1week).
2. International Conference Electroceramics VIII, Rome, Italy (1week).
3. The 6th European Conference on Applications of Polar Dielectrics, Aveiro, Portugal (1 week).
4. XVI Russian Meeting on Ferroelectricity, Tver, Russia (1 week).

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

1. Pedagogical Academy, Krakow, Poland (1 month).
2. Uzhgorod National University, Uzhgorod-Sinjak, Ukraine (1 week).

Dr. phys. **Eriks Klotins**

1. Institute of Physics, Tartu, Estonia (2 weeks)
2. The 6th European Conference on Applications of Polar Dielectrics, Aveiro, Portugal (1 week).

Dr. habil. phys. **Maris Ozolinsh**

1. Berlin TU, Germany (2 weeks).
2. Vilnius university, Lithuania (2 weeks).
3. Chalmers TH, Lund university, Sweden (2 weeks).
4. University of Murcia, Optics Laboratory, Spain (2 weeks).

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

1. 7th RUSSIA / CIS / BALTIC / JAPAN Symposium on Ferroelectricity, St. Petersburg, Russia (1week).
2. International Conference Electroceramics VIII, Rome, Italy (1week).
3. The 6th European Conference on Applications of Polar Dielectrics, Aveiro, Portugal (1 week).
4. Atomic Institute of Austrian Universities, Vienna, Austria (2 weeks).

Dr. phys. **Vismants Zauls**

1. International Conference Electroceramics VIII, Rome, Italy (1week);
2. The 6th European Conference on Applications of Polar Dielectrics, Aveiro, Portugal (1 week);
3. Conference “Piezoelectric Materials for the End User” Interlaken, Switzerland (1week);
4. Conference "The 4th Nordic Baltic Scanning Probe Microscopy workshop" Tartu, Estonia (3 days);
5. Institute of Condensed Matter, University Potsdam, Germany (1 month);
6. NATO Advanced Study Institute Workshop, Albufeira, Portugal (2 weeks);
7. Vilnius University Laser Research Centre, Vilnius, Lithuania (2 days);

Cooperation

Latvia

1. Daugavpils University (Dr. habil. G.Liberts).
2. Riga Technical University (Dr. habil. M.Knite; Dr. R.Cimdins).

Austria

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

Belarussia

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

Czech Republic

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

Denmark

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

Finland

1. University of Oulu (Prof. S.Leppävuori).

Germany

1. Institute for Solid State and Materials Research, Dresden (Dr. W.Häßler).
2. University of Saarland, Saarbrucken (Dr. H.Schmitt).
3. Institute of Optics, Berlin Technical University (Prof. H.J.Eichler).
4. Institute for Lasertechnology in Medicine, Ulm University (Prof. R.Steiner).
5. Institute of Condensed Matter, University Potsdam, Germany (Prof. L.Brehmer, Dr. S. Schrader, Dr. S. Katholy).

Japan

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2. Vilnius University Laser Research Centre (Prof. Roaldas Gadonas).

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Russia

1. Ural State University, Ekaterinburg (Prof. V.Shur).
2. Volgograd State Architectural and Engineering Academy, Volgograd (Prof. A.Shilnikov).
3. Russian Academy of Science, Moscow (Prof. A.Medovoi).
4. Joint Institute for Nuclear Research, Dubna (Dr. S.Tiutiunnikov);

5. Moscow State University, Moscow (Prof. B.A.Strukov).
6. Research Institute for Complex Testing of Optoelectronic Devices and Systems, (Dr. V. N. Alekseev).
7. Tver State University (Dr O.V.Malyshkina).
8. Institute of Chemistry and Technology of Rare Elements and Minerals, Apatity, (Prof. N.V.Sidorov).

Slovenia

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Spain

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Sweden

1. Liquid crystal group, Chalmers TH, Gotheborg, (Prof. L. Komitov).
2. Medical Laser centre Lund University (Prof. S.Svanberg).
3. Umeå university, Umeå (Dr. B.Eliasson).

Ukraina

1. Institute for Problems of Materials Science, National Academy of Science (Prof. M.D.Glinchuk, Prof. V. Pokropivny).

United Kingdom

1. National Physics Laboratory, London (Dr. Markys G. Cain)

Main results

NONEQUILIBRIUM THERMODYNAMICS OF MULTICOMPONENT DIELECTRICS IN PRESENCE OF PARAELECTRIC-FERROELECTRIC-ANTIFERROELECTRIC PHASE INSTABILITY

E.Klotins and J.Kaupuzs

Subject of this research are advanced dielectric materials undergoing structural rearrangement on various length and time scales on the microscopic level and exhibiting collective paraelectric-ferroelectric-antiferroelectric phase instability. Both the physical background and the mathematical technique describing the behaviour of advanced dielectric materials are at the stage of extensive development steamed by its technological applications.

Main results of the research concern the dielectric response at high driving voltage and the technique of its modelling, namely:

- An extension of the Ginzburg-Landau approach concerns the nonadiabatic behavior of a polar system in case of metastable states not following the reversive external driving field and hence being not in equilibrium. The model analysis yields dynamic hysteresis and nonlinear susceptibility contributed by the amplitude und frequency of the driving field its amplitude far above the validity of the standard approach.

- This technique is addressed to the uniaxial spatial homogeneous materials, namely, a small-size single domain ferroelectrics (for example individual domains in thin-films detected by the scanning probe microscopy technique), as well as a disperse system consisting of microscopic size weakly interacting spontaneous polarized particles.
- In more details the semiadiabatic theory formulated in terms of the Fokker-Planck equations for the Ginzburg-Landau energy functional is extensively applied and the solution for the probability density of polarization is found in terms of Floquet functions with polarization as the instanteneous first moment of the probability density.
- Susceptibility patterns describing main features of relaxor ferroelectrics is an unexpected result encouraging application of the first principle calculated energy functional.

ELECTROMAGNETIC RADIATION IN CERAMICS IN PRESENCE OF PARAELECTRIC-FERROELECTRIC PHASE INSTABILITY

E.Klotins

Early developments of lanthanum doped $PbZrO_3$:$PbTiO_3$ ceramic solid solution (PLZT) based electrooptic devices have been largely concentrated on the electrooptic switches taking advantage from a high rate of electrooptic response and the driving voltage being within limits of standard electronic components.
Intracavity modification of PLZT ceramic based electrooptic switches comprises:

- Application-grade investigations in propagating and scattering of the electromagnetic radiation, the impact of electrodes, its design, and deposition, housing on thermally conducting substrates, and antireflection coatings.
- A compromise between the thickness of PLZT plate minimized by scattering considerations, and the shape and distance of electrodes sufficient for the driving voltage and diffraction restrictions.
- An optimum balance between the energy dissipation growing at shortening the pulses of driving voltage and at increasing the switching frequency as well as electromechanical effects exhibiting itself in a difference between the static and pulsed voltage retardation and coupled optoacoustic oscillations.
- A new class of copper vapor and Nd:YAG spatio-temporal modulated lasers with thin ($300 - 700\ \mu m$) on-off mode intracavity PLZT phase plates provide pulse by pulse spectral, spatial, and temporal control of the radiation.

This work is preceded in collaboraton with Research Institute for Complex Testing of Optoelectronic Devices and Systems, Russia.

POLAR MEDIA WITH NANOSTRUCTURE

J.Kaupuzs and E.Klotins

Polar media in which structural rearrangement taking place on various length and time scales belongs to a class of dynamical heterogeneous materials its scope ranging from

fluids to the structural glasses, relaxors, ferromagnetics and ferroelectrics. A challenge both for the condensed state physics and material science is the correlation between the collective behaviour and the microlevel dynamics. Objective of this programme, focussed on polar media - ferroelectrics and ferroelectric relaxors - is to contribute in the theoretical framework of this problem by calculating multiple-point and multiple-time correlation functions as well as collective effects like polarisation and susceptibility.
Nonmonotonous behaviour of the radial two-point correlation function is found qualitative different from the standard approach and manifests the nucleation as originated by the microscopic-level competitive interaction. Apart from these specific results this analysis allows to address mechanisms, which typically combines different time and size scales with inherent fluctuations.

ANTIFERROELECTRIC $PbZrO_3$ THIN FILMS: STRUCTURE, PROPERTIES AND IRRADIATION EFFECTS

A.Sternberg, K.Kundzins, V.Zauls, I.Aulika, L.Čakare, R.Bittner**, H.Weber**, K.Humer**, D.Lesnyh***, D.Kulikov***, and Y.Trushin****

Lead zirconate $PbZrO_3$ (PZ) is a typical antiferroelectric (AFE) material at room temperature, from which the ferroelectric (FE) state can be induced when subjected to a sufficiently large electric field usually exceeded the material breakdown strength. PZ sol-gel films with a thickness of up to 1.5 μm were deposited on $TiO_2/Pt/TiO_2/SiO_2/Si$ substrates by spin coating technique and heterostructures of the same composition were pulse laser deposited (PLD) on $Pt/Ti/SiO_2/Si$. Observation of a typical AFE double hysteresis loop in obtained PZ heterostructures at room temperature was attributed to the superior dielectric strength in case of thin film materials. The thermal behaviour of dielectric permittivity ε of PZ film reveals a maximum near 225°C on heating and 219°C on cooling.
In contrary, PLD processed Au/PLuN/LSCO thin film heterostructures at room temperature, exhibit FE behaviour (in contrast to typical AFE features of Pb_2LuNbO_6 (PLuN) ceramic) with zero-field dielectric permittivity about 210-260, being three times higher than in ceramics. A diffuse peak was observed around 100^oC, i.e., about 150^oC below the sharp phase transition in bulk ceramics. The lower degree of chemical ordering is considered to be the main factor in the different behaviour of thin films and bulk ceramic material.

The higher resistance of antiferroelectric PZ thin films as compared to ferroelectric (e.g., PZT) heterostructures to neutron irradiation (up to fluence $5x10^{21}m^{-1}$)# is recognized and discussed. Model explaining the shift of Curie-Weiss temperature in PZ thin films, being expected proportional to square of neutron fluence is proposed.

*# Samples were irradiated in the TRIGA MARK II reactor**.*

** In cooperation with Jožef Stefan Institute, Ljubljana, Slovenia;*
*** In cooperation with Atomic Institute of Austrian Universities, Vienna, Austria;*
**** In cooperation with St. Petersburg State Technical University, St. Petersburg, Russia.*

INVESTIGATION OF RELAXOR AND FERROELECTRIC BEHAVIOR OF EPITAXIAL THIN FILMS BY DIELECTRIC FOURIER SPECTROSCOPY

M. Tyunina, K. Kundzinsh, and V. Zauls*

The nonlinear dielectric response of the lead magnesium niobate (PMN) thin-film heterostructures was experimentally studied using digital Fourier analysis of sample current. The amplitudes and the phase angles of the first-, second-, and third-order dielectric harmonics were measured as a function of temperature and amplitude of the applied AC measurement voltage and bias field. The response of the films was reconstructed assuming a linear contribution of the film-electrode interface capacitance.
In our experiment at low ac field, the observed response did not contain the even-order harmonics, the amplitude of the third harmonic increased on cooling below T_m, the third-order nonlinear dielectric permittivity exhibited maximum around the freezing temperature indicating the glassy behavior. With increasing the amplitude of ac field above some threshold, the field dependences of the amplitudes of the odd harmonics deviated from the square low, the phase angle of the third harmonic switched to 90°, and the even-order harmonics appeared in the response indicating the disruption of the glassy state and the onset of a new polar state. The possible mechanism of the observed glass-to-ferroelectric transition is discussed.

** In cooperation with Microelectronics and Materials Physics Laboratories, EMPART research Group of Infotech Oulu, University Of Oulu, Finland.*

DETERMINATION OF THICKNESS AND REFRACTIVE INDEX OF THIN FILMS BY OPTICAL REFLECTOMETRY AND ELLIPSOMETRY

*I. Aulika, V. Zauls, K. Kundzinsh, M. Kundzinsh, and S. Katholy**

Experience and skills in optical spectral reflectometry and multiple angle null-ellipsometry techniques were further improved and combined as an efficient non-destructive tools for measuring thickness and refractive index of transparent or reflective thin films and heterostructures. A miniature “Ocean Optics” CCD spectrometer, model PC1000, designed as a plug-in PC ISA slot with fibre optics input was used for the reflectivity measurements under normal light incidence geometry, while additional refinement of results for helium-neon laser wavelength has been obtained by variable-angle ellipsometr taking measurements at several different incidence angles, thereby increasing the amount of information available for analysis. Optical constants were determined by multiparameter fitting the multilayer model function to the measured data taking into account absorption and dispersion of refractive index. Barium titanate (BT), lead zirconate titanate (PZT) and lead magnesium niobate (PMN) thin films heterostructures deposited on various substrates by laser ablation and sol-gel technique have been investigated. The optical properties related to sample fabrication, structure, dielectric properties and composition was investigated.

** In cooperation with Institute of Physics, University of Potsdam, Potsdam, Germany.*

GENERAL PURPOSE CHARACTERIZATION OF FUNCTIONAL MATERIAL SURFACES BY SCANNING PROBE MICROSCOPE SMENA

C.Harnagea, K.Kundzinsh, V.Losev**, A.Janovs, and M.Kundzinsh*

The Scanning Probe Microscopy (SPM) has been introduced in our laboratory for the first time as a general purpose reseach technique for characterization of surfaces of functional materials. Efficient knowledge transfer both from international workshops and personal visits permit us to gain necessary knowledge and start up measurements quickly. The operation of our brand new Smena NT-MDT instrument has been demonstrated successfully by surace imaging of oxide thin films and holographically recorded high resolution gratings, visualization of local electrostatic fields on poled polymers and results after surface etching and thermal treatment of optical glass fibers.

* *Max-Plank-Institute of Microstructure Physics, Halle, Germany;*
** *NT-MDT Co.Molecular Devices and Tools for NanoTechnology*
State Research Institute of Physical Problems, Moscow, Zelenograd Russia.

DETECTION OF LOCAL PIEZODEFORMATION AND POLARIZATION IN FERROELECTRICS USING SCANNING PROBE MICROSCOPY

C.Harnagea, K.Kundzinsh, A.Janovs, and M.Kundzinsh*

The local piezoresponse and polarization state of ferroelectric thin films can be probed in nanoscale using scanning force microscopy (SFM) combined with lock-in detection technique to enhance sensitivity. In our experiments a small modulation AC voltage along with DC bias voltage has been applied to the sample local area between conductive SFM tip and the bottom electrode. Scanning probe microscope Smena NT-MDT controler was operating in contact mode and combined with external Stanford SR-530 lock-in amplifier to detect both out-of-plane and in-plane surface deformations. Topographic and piezoresponse mapping of c- and a-domains of the barium titanate (100) single crystal surface as model material and measurements of local polarization electric switching hysteresis loops have been demonstreted with estimated lateral resolution limit down to 30 nm.

* *Max-Planck-Institute of Microstructure Physics, Halle, Germany*.

SOLID SOLUTIONS ON THE BASES OF $PbSc_{1/2}Nb_{1/2}O_3$ AND RARE-EARTH NIOBATES

M.Dambekalne, M.Antonova, M.Livins, M.Kalnberga, Cz.Kus, K.Bormanis, A.Sternberg, and L.Shebanovs*

Due to multifunctional properties lead containing perovskites of the general formula $Pb(B'B'')O_3$ (B' - Mg, Zn, Ni, Fe, etc.; B" – Nb, Ta, W) are of special interest. Original binary solid solutions $PbSc_{1/2}Nb_{1/2}O_3$ - $PbLu_{1/2}Nb_{1/2}O_3$ (PSN-PLuN) have been

produced. Presently attempts have been made to obtain ceramic samples of a number of (1-x)$PbSc_{1/2}Nb_{1/2}O_3$ – x$PbLu_{1/2}Nb_{1/2}O_3$ (PSN-PLuN) binary solid solutions and study their structure and properties.

First of all nominally pure PSN and PLuN were synthesized by solid state reaction from oxides and carbonates. These compounds separately were mixed in different proportions to obtain (1-x)PSN-PLuN solid solutions. Differential thermal analysis and X-ray diffraction were used to examine the synthesis and phase constitution.

Triple synthesis of the PSN mixture was used to facilitate the interaction and eliminate the undesired pyrochlore phase. The lutetium niobate PLuN was synthesised through an intermediate volframite phase $LuNbO_4$ at 1250^0C during 1 hour after which PbO was introduced before firing for 2 hours at 800^0C. Ceramic samples were hot pressed under the pressure of 20 MPa, the temperature being adjusted within the 1050^0C-1280^0C interval depending on the particular component ratio. At room temperature PSN has a rhombohedral distortion of the unit cell: a=4.080Å, $\alpha=89.89^0$. Pure PLuN is an antiferroelectric. The values of lattice parameters of PLuN are as follows: a=c=4.150 Å, b=4.119 Å, $\beta=90.43^0$. Pure perovskite PLuN has a long-range ordering of Lu^{3+} and Nb^{5+} in the B sublattice. Transition from the antiferroelectric to paraelectric phase is observed at $T_{max} = 258^0$C.

The value of dielectric permittivity of (1-x)PSN – xPLuN decreases rapidly with the concentration of lutetium: from ε =40000 (PSN) up to ε =600 (PLuN).

* *In cooperation with Institute of Physics, Pedagogical University, Kracow, Poland.*

ELECTRICALLY INDUCED LIGHT SCATTERING IN PLZT CERAMICS MODEL EYE

M.Ozolinsh, R.Paeglis,
P. Artal*, J. M. Bueno*, and E. Berrio*

Applied electrical field ***E*** in PLZT 8.75-9.0/65/35 ceramics induces reversible nucleation of small polar regions, which gives a dominant contribution in the dielectric polarisation ***P*** vs. ***E*** dependence. These polar regions in ceramics have random orientation of crystallographic axes, they are birefringent, thus nucleation creates remarkable light scattering. The submicrone size of these regions determines strong scattering dispersion within the visible spectrum range. The induced birefringence as well the difference in refractive indices (determining light scattering) are proportional to the square of dielectric polarisation, and one can observe scattering at the applied electric field ***E*** > 5-7 kV/cm. Using PLZT ceramics plate with a thickness ***l*** = 1.5 mm we have simulated situation similar to that of a cataract eye. Varying the voltage applied to the plate allows continuously to change scattering efficiency. Decrease of a patient vision acuity ***VS*** by increasing the scattering has been measured psychophysically placing PLZT plate before the human eye.

The PLZT plate together with a +56D lens were used as an electrically controllable eye model to simulate image formation in an eye with cataract [#]. Using the double pass (**DP)** technique the characteristics of the point spread function **PSF** were studied for green He-Ne (λ=543 nm) and near IR laser (λ=780 nm) point sources. The spectral power transfer (**PSF** radial profile) from the eye pupil diffraction restricted low spatial frequencies to the light scattered by PLZT plate at greater angles is more remarkable for shorter wavelength green laser point source. As compared with an human eye the

primary image in the eye model instead of retina is formed on a diffuse reflected glass surface, light does not participate in multiple scattering events and does not loose remarkable its polarisation degree. Thus the balance between the spatial spectral power transfer differs for cases when an analizator in orthogonal directions is used in the second pass.

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**** In cooperation with Laboratorio de Óptica, Dept. de Física, Universidad de Murcia, Spain.***

ELECTRICALLY CONTROLLED EYE OCCLUDERS FOR STEREOVISION EXPERIMENTS

M.Ozolinsh

Some studies in vision science need vision stimuli with dynamically controllable image quality. In the case of stereovision stimuli for both - the left and the right eye must differ. Variations in retinal image quality - contrast, blurring are obtained by either inserting in one eye path an element with controllable optical properties or by displaying the sequence of fast changing visual stimuli on a computer screen that is synchronized with shutters placed before eyes. We have used both of these techniques - a transparent PLZT ceramics plate with electrically controlled light scattering and liquid crystal goggles designed for viewing 3-D images on the PC screen for studies of stereovision threshold dependence on stimuli contrast and blur degree.
In some compositions of PLZT ceramics with a diffuse phase transition close to room temperatures (PLZT 8.5-9.0/65/35) applying the electrical field induces reversible formation of small polar domains leading to remarkable light scattering in visible and diminishing the transmittance of the collimated light. A PLZT plate with semitransparent gold electrodes deposited on both side of such ceramics can be used as an electrically controlled obstacle in order to control the eye image contrast and visual acuity [#]. Inducing of the light scattering domains is much faster as compared with human vision response times, that allows to study dynamically the stereovision.
Two types of liquid crystal (LC) goggles have been approved for dynamic stereovision acuity tests. Both of them are based on nematic twisted LC that does not allow to obtain so high switching speed and also so great ON-OFF contrast ratio as for expensive ferroelectric LC. The tested goggles were synchronized with a PC frame frequency and allowed to operate with a PC frame rate 120 Hz. That corresponds to one eye stimuli 60 Hz - close to the human vision flicker fusion frequency. Using of such controllable eyewear in stereovision experiments allows:

- To ensure eye stimuli phase separation when one eye stimuli undergoes continuous contrast variation or continuous blur procedure for isochromatic stimuli.
- Ensure a parallel way of stimuli separation besides the color filters for isoluminant red-green or blue-yellow stimuli stereotests.

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Q-SWITCHING OF ERBIUM MID-INFRARED SOLID STATE LASERS

M.Ozolinsh, H.J. Eichler*, H. Jelínková** and M. Němec**

The report compares results of Q-switching of the solid state mid-infrared (IR) Er:YAG (wavelength λ = 2.94μm) and Er:Cr:YSGG (λ = 2.78μm) lasers obtained utilizing various materials and techniques. Specific features of transparent PLZT ceramics had allowed to design for these lasers IR polarizing elements, bulk Fabry-Perot etalons as solid state laser interference mirrors using the high surface reflectance of PLZT ceramics, and small size electrooptical modulators. Combining these features with the large electrooptic effect in PLZT that was possible to design a multifunctional electrooptically switchable laser resonator output mirror - that works as the Q-switching element (Er:Cr:YSGG laser single pulse output 13 mJ, pulsewidth 70 ns). Difficulties to obtain high Er:YAG and Er:Cr:YSGG laser output using electrooptical Q-switching are discussed.

** In cooperation with Inst. of Optics, Berlin TU, Germany;*
*** In cooperation with Czech Technical University, Prague, Czech Republic.*

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Published in 2002

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14. E.Tamanis, G.Liberts, and L.Berzina. *Direct Laser Writing of Conductive Patterns in Advanced Ceramic Materials.* AOMD-3 Proceedings (SPIE), "ADVANCED OPTICAL DEVICES".
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19. A.I. Burkhanov, A.V. Shil′nikov, S.A.Satarov, K. Bormanis, A. Sternberg, and A. Kalvane. *Specifics of Polarisation Swtching in $PbNi_{1/3}Nb_{2/3}O_3$ -$PbTiO_3$-$PbZrO_3$ Ferroelectric Ceramics.* Journal of the European Ceramic Society.
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22. A.Sternberg, L.Shebanovs, V.Zauls, K.Kundzins, M.Antonova, M.Livins, L.Cakare, M.Tyunina, J.Levoska, and I.Aulika. *Structure and Properties of Some (A'A")(B'B")O_3 Ceramics and Thin Films*. Ferroelectrics.
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25. J.Kaupužs and E.Klotins. *Spatio-Temporal Correlations of Local Polarization in Ferroelectrics: the Fokker-Planck Approach*. Ferroelectrics.

26. K.Bormanis, M.Kalnberga, A.Patmalnieks, and M.Ozolinsh. *Microscopic Studies of the Crystalline Structure of Ferroelectric and High Temperature Superconductor Layers.* Ferroelectrics.
27. Е.А.Виноградов, В.В.Ефимов, Е.А.Клевцова, В.Ф.Минашкин, Н.Н.Новикова, В.В.Сиколенко, А.В.Скрыпник, С.И.Тютюнников, А.Штернберг, В.А.Яковлев. *Структурные, оптические, диэлектрические исследования релаксорной ЦТСЛ 9,75/65/35 керамики, облучённой импульсным электронным пучком*. Известия Российской академии наук. Серия физическая.
28. К.Борманис, М.Дамбекалне, А. Штернберг, Л.Шебановс, М.Антонова, М.Ливиньш, А.Спуле. *Новые сегнетоэлектрические материалы на основе скандониобата свинца и редкоземельных ниобатов.* Известия Российской академии наук. Серия физическая.
29. А.И. Бурханов, А.В. Шильников, С.А. Сатаров, К. Борманис, А. Штернберг, А. Калване. *Влияние смещающих полей на характер размытого фазового перехода в сегнетопьезокерамике PNN-PT-PZ.* Известия Российской академии наук. Серия физическая.
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Lectures on Conferences (with Abstracts)

Latvijas Universitātes Cietvielu fizikas institūta 18. zinātniskā konference, 2002.gada 11.-13. februāris, Rīga, Latvija.
18th Scientific Conference, Institute of Solid State Physics, University of Latvia, February 11-13, 2002, Riga, Latvia.

1. M.Ozoliņš. *Polarizācijas optiskās metodes acs optiskās sistēmas raksturošanai. Methods of Polarisation Optics for Eye Characterisation.* Referātu tēzes, 8. lpp.
2. D.Rācene, M.Ozoliņš. *Acs monohromatisko aberāciju mērīšana. Measurement of Monochromatic Aberrations of the Eye.* Referātu tēzes, 9. lpp.
3. I.Čipāne, M.Ozoliņš, G.Papelba. *Attēlu kvalitātes ietekme uz stereoredzes asumu. Stereovision Acuity Studies by Disbalanced Eye Image Quality*. Referātu tēzes, 10. lpp.
4. J.Petrova, G.Papelba, M.Ozoliņš. *Krāsu kontrasta maiņas ietekme uz stereoredzes asumu. The Influence of Colour's Contrast to Stereoacuity*. Referātu tēzes, 12. lpp.
5. G.Vāle, A.Krūmiņš, M.Lubāne. *Aktīvās atmiņas vides optiskās informācijas apstrādei. Active Media for Optical Information Processing and Storage.* Referātu tēzes, 28. lpp.
6. Ēriks Klotiņš. *Strukturālas transformācijas senetoelektriķos: ārpus vidējā lauka tuvinājuma. Structure Transformations in Ferroelectrics: Beyond the Mean Field Approach.* Referātu tēzes, 30. lpp.
7. M. Tjuņina, V.Zauls, K. Kundziņš, J. Levoska. *Relaksoru un segnetoelektriķu plānu kārtiņu dielektriskā Furjē spektroskopija. Dielectric Fourier – Spectroscopy of Relaxor and Normal Ferroelectric Thin Films.* Referātu tēzes, 31. lpp.

8. I.Aulika, K.Kundziņš, V.Zauls, L.Čakare. *Metode dielektriskās histerēzes cilpu pētīšanai segnetoelektriskām kārtiņām ar paaugstinātu vadītspēju. A Method of Measuring the Dielectric Hysteresis of Ferroelectric Films with Increased Conductivity.* Referātu tēzes, 32. lpp.
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10. A.Šternbergs, I.Aulika, K.Kundziņš, V.Zauls, L.Čakare, R.Bittner, H.Weber. *Antisegnetoelektriskās $PbZrO_3$ plānās kārtiņas: struktūra, īpašības un apstarošanas iedarbība. Antiferroelectric $PbZrO_3$ Thin Films: Structure, Properties and Irradiation Effects.* Referātu tēzes, 34. lpp.
11. L.Šebanovs. *ABO_3 perovskitu rentgenogrāfisko Debaja temperatūru saistība ar dažiem citiem fizikālajiem parametriem. Relationships Between X-ray Debye Temperature and Some Physical Pararameters of ABO_3 Perovskites.* Referātu tēzes, 36. lpp.
12. L.Šebanovs, A.Šternbergs, M.Antonova, M.Līviņš. *Modifikācijas ietekme uz $Pb(B_{1/2}Nb_{1/2})O_3$ bināro sistēmu fāžu diagrammu un īpašībām morfotropās fāžu robežas tuvumā. Modification Effects on Phase Diagram and Properties of $Pb(B_{1/2}Nb_{1/2})O_3$ - $PbTiO_3$ Binary Systems in Vicinity of Morphotropic Phase Boundary*. Referātu tēzes, 37. lpp.
13. M.Dambekalne, M.Antonova, M.Kalnberga, A.Kalvāne, M.Līviņš, K.Bormanis. *Tehnoloģisko faktoru ietekme uz $PbMg_{1/3}Nb_{2/3}O_3$ sintēzi. The Effects of Technological Factors on the Synthesis of $PbMg_{1/3}Nb_{2/3}O_3$.* Referātu tēzes, 38. lpp.
14. K. Bormanis, A. Šternbergs, A. Kalvāne, J. N. Mamakovs, A. V. Šiļņikovs, A. I. Burhanovs. *Segnetoelektrisko cieto šķīdumu $PbNi_{1/3}Nb_{2/3}O_3$ - $Pb(Zr,Ti)O_3$ dielektrisko parametru nelinearitāte. Nonlinearity of Dielectric Parameters of $PbNi_{1/3}Nb_{2/3}O_3$ - $Pb(Zr,Ti)O_3$ Ferroelectric Solid Solutions*. Referātu tēzes, 44. lpp.
15. M.Knite, G.Mežinskis, L.Šebanovs, I.Pedaja. *Ar CO_2 lāzera starojumu inducētas fāžu pārejas PZT sola-gela kārtās. CO_2-laser Induced Phase Transitions in PZT Sol-Gel Films.* Referātu tēzes, 45. lpp.
16. A.Šternbergs. *Profesors Voldemārs Fricbergs un Latvijas zinātniskā skola segnetoelektriķu fizikā. Professor Voldemar Fritsberg and Latvian School of Ferroelectric Physics*. Referātu tēzes, 47. lpp.
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18. M.Ozoliņš, H.Jelinkova, H.J.Eichlers. *PLZT keramikas izmantošana medicīniskajā IS lāzeru tehnikā. PLZT Ceramics for Medical Applications of Pulsed IR Lasers.* Referātu tēzes, 81. lpp.

International Conference "Piezoelectric Materials for the End User", February 22-28, Interlaken, Switzerland.

1. . L. Shebanovs, A. Sternberg, V. Zauls, K. Kundzins, M. Antonova, M. Livinsh. *Recent Studies on Ferroelectric Ceramics and thin films at the Instutute of Solid State Physics, University of Latvia*. Program and Abstracts Book, Overview poster, p. O-26.

IX International Conference "Laser Applications in Life Sciences", July 7-11, 2002, Vilnius, Lithuania.

1. M. Ozolinsh. *Electrically Controlled Eye Occluders for Vision Science.* Proceedings, Vilnius University, p.117.

European Materials Research Society Spring Meeting (E-MRS 2002 Spring Meeting), June 18-21, 2002, Strasbourg, France.

1. M.Knite, V.Teteris, A.Vītins, and I.Aulika. *Peculiarities of Percolation Transition in Polyizoprene- Carbon Black Nanocomposites – Prospective Deformation Sensormaterials.* Abstracts, p. Q-25.
2. M.Knite, G.Mezinskis, I.Pedaja, and L.Shebanovs. *CO_2-laser Induced Structure Changes in PZT Sol-Gel Films*. Abstracts, p. D-9.

International Joint Conference on the Applications of Ferroelectrics 2002 (IFFF 2002), May 28 - June 1, 2002, Nara, Japan.

1. R.Bittner, K.Humer, H.W.Weber, L.Cakare, A.Sternberg, D.V.Kulikov, and Y.V.Trushin.
   Dielectric Properties of Irradiated Ferroelectric and Antiferroelectric Thin Films. Abstract book, Abstract No. 670, 31H-PP1-6P, p. 370.

7th RUSSIA / CIS / BALTIC / JAPAN Symposium on Ferroelectricity (RCBJSF-7), June 24-28, 2002, St. Petersburg, Russia.

1. L.Shebanovs, K.Bormanis, A.Kalvane, and A.Sternberg. *Recent Trends in Design of Electrocaloric Active Ferroelectric Ceramics.* Book of Abstracts, p. 72.
2. N.V. Sidorov, M.N. Palatnikov, K. Bormanis, and A. Sternberg. *Raman Spectra and Defect Structure of Lithium Niobate Crystals*. Book of Abstracts, p. 116.
3. **M.Dambekalne, M.Antonova, M.Kalnberga, A.Kalvane, M.Livinsh, I.Brante, L.Shebanovs, and K.Bormanis. *The Effects of Technological Factors on the Synthesis of $PbMg_{1/3}Nb_{2/3}O_3$.* Book of Abstracts, p. 150.**
4. E.A.Vinogradov, V.V.Efimov, A.V.Kalmikov, E.A.Klevtsova, V.F.Minashkin, N.N.Novikova, A.Sternberg, V.V.Sikolenko, A.V.Skripnik, S.I.Tiutiunnikov, and V.A.Yakovlev. *Structural, Optical and Dielectric Investigations of the Relaxor PLZT 9.75/65/35 Ceramics Irradiated by High-Current Pulsed Electron Beam.* Book of Abstracts, p. 152.
5. A. Sternberg, L.Shebanovs, V.Zauls, and K.Kundzins. *Ceramics and Thin Films of Som,e New $Pb(B^{3+}, Nb)TiO_3$ - $PbTiO_3$ Systems.* Book of Abstracts, p. 163.
6. M.Knite, L.Shebanovs, G.Mezinskis, I.Pedaja, and A. Sternberg. *CO_2-Laser Induced Structure Changes in PZT Sol-Gel Films.* Book of Abstracts, p. 195.

2002 International Conference on Physics and Chemistry of Molecular and Oxide Superconductors (MOS 2002), August 13-18, 2002, Hsinchu, Taiwan.

1. K. Bormanis, M. Kalnberga, and A. Sternberg. *Microscopic Studies of the Crystalline Structure of High Temperature Superconductor Layers*. Abstract Book, A13.

The 3rd International Conference Advanced Optical Materials and Devices (AOMD-3), August 19-22, 2002, Riga, Latvia.

1. M.Ozolinsh, H.J.Eichler, H.Jelinkova, and M.Nemec. *Q-switching of Erbium Midinfrared Solid State Lasers.* Programme and Abstracts, p. 48.

2. E.Tamanis, G.Liberts, and L.Berzina. *Direct Laser Writing of Conductive Patterns in Advanced Ceramic Materials.* Programme and Abstracts, p. 49.
3. M.Utinans, D.Kaleja, J.Gulbis, V.Zauls, and O.Neilands. *New NLO Polyuretane Polymers Containing N-(INDAN-1,3-DION-2-YL) Pyridinium Betaine Units.* Programme and Abstracts, p. 61.
4. M.Ozolinsh, R.Paeglis, P.Artal, J.M.Bueno, and E.Berrio. *Electrically Induced Light Scattering in PLZT Ceramics Model Eye.* Programme and Abstracts, p. 81.
5. M.Ozolinsh, J.Berzinsh, and K.Pesudovs. *LED Traffic Sign Recognition at Various Retinal Illumination*. Programme and Abstracts, p. 82.
6. M.Ozolinsh, G.Papelba, and G.Andersson. *Spatial and Temporal Transmittance of Liquid crystal Goggles Used in Vision Tests*. Programme and Abstracts, p. 83.
7. G.Papelba, M.Ozolinsh, and J.Petrova. *Method of Determination of Stereopsis Colour Contrast Threshold.* Programme and Abstracts, p. 84.
8. M.Ozolinsh. *Electrically Controlled Eye Occluders for Stereovision Experiments.* Programme and Abstracts, p. 100.
9. G.Papelba, M.Ozolinsh, and I.Cipane. *Evaluation of Image's Quality to Stereovision Acuity.* Programme and Abstracts, p. 102.
10. M.Tyunina, J.Levoska, and S.Leppavuori. *Glass-like Behavior in Relaxor Ferroelectric Thin Films*. Programme and Abstracts, p. 122.
11. A.Sternberg, K.Kundzins, V.Zauls, I.Aulika, L.Cakare, R.Bittner, H.Weber, K.Hummer, D.Lesnyh, D.Kulikov, and Y.Trushin. *Structure, Phase State and Irradiation Effects in $PbZrO_3$ Thin Films.* Programme and Abstracts, p. 123.
12. V.N.Alekseev and E.Klotins. *Benchtop Characteristics of PLZT Based Electrooptic Switches.* Programme and Abstracts, p. 167.
13. M.Tyunina, K.Kundzinsh, V.Zauls, and J.Levoska. *Glass-to-Ferroelectric Phase Transition Induced by AC Electric Field in Lead Magnoniobate Thin Films.* Programme and Abstracts, p. 168.
14. L.Shebanovs, A.Sternberg, K.Bormanis, and A.Kalvane. *Electrocaloric Ferroelectric Ceramics Active in Vicinity of Room Temperature.* Programme and Abstracts, p. 169.
15. K.Bormanis, A.Kalvane, and A.Spule. *Production and Properties of Lanthanum Modified Lead Titanate Ceramics.* Programme and Abstracts, p. 170.
16. A.I. Burkhanov, A.V. Shil′nikov, S.A.Satarov, K. Bormanis, A. Sternberg, and A. Kalvane. *Polarisation Switching in Relaxor PNN-PT-PZ Ceramics.* Programme and Abstracts, p. 171.
17. M. Palatnikov, N. Sidorov, K. Bormanis, and A. Sternberg. *Optical Characteristics of Doped Lithium Niobate Single Crystals.* Programme and Abstracts, p. 172.
18. M. Palatnikov, N. Sidorov, K. Bormanis, and A. Sternberg. *Phase States and Peculiarities of Vibrational Spectra of Oxygen-Octahedral Crystals*. Programme and Abstracts, p. 173.
19. M.N. Palatnikov, N.V. Sidorov, and K. Bormanis. *Phase Transitions in the Ceramics of $Li_XNa_{1-X}Ta_YNb_{1-Y}O_3$ Solid Solutions.* Programme and Abstracts, p. 174.
20. N.V. Sidorov, K. Bormanis, M.N. Palatnikov, and A. Sternberg. *Manifestation of Defect Structure in Raman Spectra of Lithium Niobate Crystals*. Programme and Abstracts, p. 175.
21. S.A.Satarov, A.V. Shil′nikov, A.I. Burkhanov, K. Bormanis, A. Sternberg, and A. Kalvane. *The Effect of Bias Field on the Phase Transition in Relaxor PNN-PT-PZ Ceramics*. Programme and Abstracts, p. 176.
22. G.Liberts, Yu.Mitrofanovs, and A.Cebers. *Electric Field Induced Suppression of Thermal Lensing in Ferrofluids.* Programme and Abstracts, p. 186.

12th General Conference of the European Physical Society (EPS12): Trends in Physics; 17th International Conference for Physics Students (ICPS2002), August 21–26-30, 2002, Budapest, Hungary.

1. I.Aulika. *Study of Transparent Ferroelectrics Thin Films by Optical Reflectometry and Ellipsometry.* Abstracts "Trends in Physics", p.53, p. 133.
2. R. Paeglis, and M. Ozolinsh. *Electro-Optical Solution for Visual Acuity and Contrast Sensitivity Modeling.* Abstracts "Trends in Physics", p.295.

8th International Conference on Electronic Ceramics and Their Applications (ELECTROCERAMICS VIII - 2002), August 25-28, 2002, Rome, Italy.

1. K.Bormanis, M.Dambekalne, M.Antonova, M.Livinsh, L.Shebanovs, and A.Spule. *New Ferroelectric Materials on the Basis of $PbSc_{1/2}Nb_{1/2}O_3$ - $PbLu_{1/2}Nb_{1/2}O_3$ Solid Solutions.* Abstract book, p. 106.
2. K. Bormanis, A. Sternberg, A. Kalvane, A.I. Burkhanov, A.V. Shil′nikov, and S.A.Satarov. *Specifics of Polarisation Swtching in PNN-PT-PZ Ferroelectric Ceramics.* Abstract book, p. 194.
3. K. Bormanis, A. Sternberg, M. Palatnikov, and N. Sidorov. ***Superionic Phase Transitions in the Series of $Li_XNa_{1-X}Ta_YNb_{1-Y}O_3$ Solid Solutions Ceramics.*** **Abstract book, p. 194-195.**
4. *L.Shebanovs, K.Bormanis, A.Kalvane, and A.Sternberg.* Pb(B',B'')O_3 Binary Systems as Electrocaloric Materials for Room Temperature Refrigeration. *Abstract book, p. 205.*
5. A.Sternberg, K.Kundzins, V.Zauls, I.Aulika, L.Cakare, R.Bittner, H.Weber, K.Hummer, D.Lesnyh, D.Kulikov, and Y.Trushin. *Antiferroelectric $PbZrO_3$ Thin Films: Structure, Properties and Irradiation Effects.* Abstract book, p. 239.

The 6th European Conference on Applications of Polar Dielectrics (ECAPD-6), September 2-5, 2002, Aveiro, Portugal.

1. L.Shebanovs, A.Sternberg, K.Bormanis, and A.Kalvane. *Ferroelectric Ceramics Electrocaloric Active in Room Temperature Region.* Program and Abstract Book, p. 76.
2. M. Palatnikov, N. Sidorov, K. Bormanis, and A. Sternberg. *Raman Spectra in Oxygen-Octahedral Crystals.* Program and Abstract Book, p. 120.
3. M.Palatnikov, K.Bormanis, N.Sidorov, and A.Sternberg. *Structural Ordering of Doped Lithium Niobate Single Crystals.* Program and Abstract Book, p. 121.
4. A.Sternberg, L.Shebanovs, V.Zauls, K.Kundzins, M.Antonova, M.Livins, L.Cakare, M.Tyunina, J.Levoska, and I.Aulika. *Structure and Properties of Some (A'A")(B'B")O_3 Ceramics and Thin Films.* Program and Abstract Book, p. 127.
5. E.Klotins. *Polarization Reversal in Ferroelectrics: Stochastic Analysis.* Program and Abstract Book, p. 135.
6. K.Bormanis, A.Kalvane, A.Sternberg, and A.Spule. *Dielectric Properties of Lanthanum Modified Lead Titanate Ceramics*. Program and Abstract Book, p. 141.
7. K. Bormanis, S.A.Satarov, A. Kalvane, A. Sternberg, A.I.Burkhanov, and A.V.Shil'nikov. *Diffused Phase Transitions in Lead Containing Relaxor Ferrroelectrics: Bias Field Effects.* Program and Abstract Book, p. 175.
8. J.Kaupus and E.Klotins. *Spatio-Temporal Correlations of Local Polarization in Ferroelectrics: the Fokker-Planck Approach.* Program and Abstract Book, p. 189.

VI Ukrainian-Polish and II East-European Meeting on Ferroelectrics Physics (UPEMFP' 2002), September 6 - 10, 2002, Uzhgorod-Synjak, Ukraine.

1. M.Dambekalne, M.Antonova, M.Livins, M.Kalnberga, Cz.Kus, K.Bormanis, A.Sternberg, and L.Shebanovs. *Solid Solutions on the Bases of $PbSc_{1/2}Nb_{1/2}O_3$ and Rare-Earth Niobates.* Abstract P-26, p. 71.

7th International Symposium on Ferroic Domains and Mesoscopic Structures (ISFD-7), September 15-19, 2002, Giens, France.

1. K. Bormanis, M. Dambekalne, A. Sternberg, and A. Patmalnieks. *Microstructure Studies of Ferroelectric PLZT and PSN Ceramics*. Abstract Book, Abstract A1P07.
2. K. Bormanis, M. Kalnberga, and A. Patmalnieks. *Microscopic Studies of the Crystalline Structure of Ferroelectric and High Temperature Superconductor Layers*. Abstract Book, Abstract A4P09.
3. M.Ozolinsh, H.J.Eichler, and J.Swartling. *Light Depolarization by Electrically Induced Scattering in PLZT Ceramics*. Abstract Book, Abstract B4P03.

XVI Всероссийская конференция по физике сегнетоэлектриков (ВКС-XVI-2002), 17-21 сентября 2002. года, Тверь, Россия.

1. К.Борманис, А.Штернберг, А.Калване, М.Ливиньш, А.Шильников, А.Бурханов, С.Сатаров, М.Дамбекалне, А.Спуле. *Диэлектрические свойства керамики твердых растворов титаната свинца - лантана.* Тезисы докладов, с. 53.
2. Е.А.Виноградов, В.В.Ефимов, Е.А.Клевцова, В.Ф.Минашкин, Н.Н.Новикова, В.В.Сиколенко, А.В.Скрыпник, С.И.Тютюнников, А.Штернберг, В.А.Яковлев. *Структурные, оптические, диэлектрические исследования релаксорной ЦТСЛ 9,75/65/35 керамики, облучённой импульсным электронным пучком.* Тезисы докладов, с. 98.
3. К.Борманис, М.Дамбекалне, М.Антонова, М.Ливиньш, А.Спуле. *Новые релаксорные материалы на основе скандониобата свинца и редкоземельных ниобатов*. Тезисы докладов, с. 121.
4. А.И. Бурханов, А.В. Шильников, С.А. Сатаров, К. Борманис, А. Штернберг, А. Калване. *Влияние смещающих полей на характер размытого фазового перехода в сегнетопьезокерамике PNN-PT-PZ.* Тезисы докладов, с. 184.

Процессы переключения в сегнетоэлектриках и сегнетоэластиках, семинар, посвященный памяти В.М.Рудяка, 18-20 сентября 2002. года, Тверь, Россия.

1. А.И. Бурханов, А.В. Шильников, С.А. Сатаров, К. Борманис, А. Штернберг, А. Калване. *Особенности переполяризационных процессов в сегнетокерамике PNN-PT-PZ.* Тезисы докладов, с. 39.

NATO Advanced Study Institute Workshop "Scanning Probe Microscopy: Characterization, Nanofabrication and Device Application of Functional Materials" October 1-13, Albufeira, Portugal.

1. K.Kundzins, V. Zauls. *Nanoscale dielectric characterisation and patterning of ferroelectric relaxor thin films.* Abstracts, p.105.

Lectures on Conferences (without abstracts)

Report in the Institute of Physics, April 2002, Tartu, Estonia

1. E.Klotins.
   Spatio-Temporal Polarization Response in Ferroelectrics: Advances & Problems.

Triennial Congress of the International Commission for Optics (ICO-19): "Optics for the Quality of Life", August 25-31, 2002, Florence, Italy

1. Maris Ozolinsh and Dag Hanstorp.
   Photorefraction Demonstrations Using Electrooptic PLZT Ceramics Modulators.
2. M. Ozolinsh, G. Papelba, and G. Andersson.
   Liquid Crystal Goggles for Vision Science.

Rīgas Tehniskās universitātes 43. starptautiskā zinātniskā konference, Rīga, 2002. gada 10. - 14. oktobrī

The 43rd International Scientific Conference of Riga Technical University, Riga, Latvia, October 10-14, 2002

1. M.Dambekalne, M.Antonova, M.Livinsh, I.Brante, and K.Bormanis.
   Tehnoloģisko faktoru ietekme uz $Pb_{1-x}La_x(Zr_{1-y}Ti_y)\ O_3$ caurspīdīgās keramikas parametriem.
   Influence of Technological Factors on $Pb_{1-x}La_x(Zr_{1-y}Ti_y)\ O_3$ Transparent Ceramics Parameters.

Международная научно-техническая конференция «Тонкие пленки и слоистые структуры» (ПЛЕНКИ – 2002) 26-30 ноября 2002 года, г. Москва, Россия.

International Scientific and Technical Conference "INTERPHASE THIN FILMS AND LAYERED STRUCTURES" (FILMS-2002), Moscow, 26-30 November 2002.

1. С.А. Сатаров, А.И. Бурханов, А.В. Шильников, А. Штернберг, К. Борманис, А. Калване.
   Поведение низко- и инфранизккочастотного диэлектрического отклика и токов поляризации (деполяризации) в системе PNN–PT–PZ.

Vilnius University Laser Research Centre, December 10-11, Vilnius, Lithuania

1. V.Zauls. *Investigation of polar polymer films by phase sensitive Optical Second Harmonic Generation.*

SEMICONDUCTOR MATERIALS AND SOLID STATE IONICS

Head of Division Dr.phys. A.Lusis

Research Area and Main Problems

Research areas:

- Electrophysics and electrochemistry of specific semiconductor materials, mixed conductors, ion conductors, high temperature superconductors (transition metal oxides, bronzes, metal hydrates, solid electrolytes, etc.);
- Material preparation methods: thin and thick film technologies, sol-gel process;
- Material characterisation by spectroscopic methods (Raman scattering, optical and X-ray absorption, electrical and electrochemical impedance, magnetic susceptibility, ESR, etc);
- Solid state ionics and optics:
  - electro-, photo-, chemo- or gaso-chromic phenomena,
  - structural changes due to ion intercalation,
  - lattice dynamics and structural and electronic phase transitions,
  - solid state reactions at interfaces electrode – solid electrolyte,
  - solid state reactions in bulk of electrode and solid electrolyte materials,
  - two and three phases electrode reactions,
  - gases and ions sensing phenomena and detection technologies;
- Functional coatings and multi layer electrochemical systems;
- New measurement technologies and instruments with artificial intelligence;
- Miniaturisation of solid state ionic devices:
  - physical and chemical sensors and actuators for microsystems,
  - variable optical coatings for micro optics
- Application specific semiconductor materials and solid-state ionic devices in micro systems for electronic nose.

Research problems and tasks:

1. Stability of materials for electrochemical multi layer systems and electrochromic coatings.
2. Improvements in x-ray absorption spectroscopy methodology and local structural anomalies in the mixed transition metal oxide compounds.
3. Inter-grain activity of solid electrolyte layers based on polymer composites.
4. Ion (H^+, OH^-, Li^+) insertion (extraction) in solid electrolytes and electrodes.
5. Metal hydride electrode for Ni / MH battery.
6. Microwave absorption of high temperature superconductors.
7. Research and development of an electronic nose
   - 7.1. Software Environment for Electronic Nose and Electronic Nose Module;
   - 7.2. Preparation of sensor elements and testing their sensitivity and selectivity;
   - 7.3. Application technologies of electronic nose for food quality.
8. Environmental pollution monitoring methods and instrumentation.
9. Testing and certification of materials and accreditation of testing laboratories.

Scientific staff

1. Dr.chem. G.Bajars
2. Dr.phys. P.Cikmacs
3. Dr.phys. V.Eglitis
4. Dr.phys. J.Gabrusenoks
5. Dr.phys. R.Kalendarjovs
6. Dr.phys. U.Kanders
7. Dr.phys. J.Kleperis
8. Dr.phys. J.Klavins
9. Dr.phys A.Kuzmins
10. Dr.phys. A.Lusis
11. Dr.phys. E.Pentjuss
12. Dr.hab.phys. J.Purans
13. Dr.phys. M.Shirokovs
14. Dr.chem. G.Vaivars
15. Dr.chem. A.Vitins
16. Dr.chem.. Ģ.Vitins

Technical staff

1. A.Kursitis
2. J.Pinnis
3. M.Purane
4. U.Klavins
5. E. Zavickis

Postgraduate students

1. Ģ.Vēveris
2. J.Zubkāns
3. L.Grīnberga
4. K.Paegle

Students

1. L.Jēkabsone
2. J. Gaidelene
3. I. Graudinsh
4. L. Kirmele,
5. J. Hodakovska,
6. G. Mikelsons

Visitors from abroad

1. Prof. E.Lust, Department of Chemistry, Warsaw University (2 month)
2. Prof. A.Orliukas, Department of Physics, Vilnius University (1 month)
3. Prof. B.Conway (2 weeks),
4. Dr. A.Azens, Angstrom Laboratory, Uppsala University (1 month)
5. Dr. S.Strahtman, EC JRS for Food control, Italy (1 month)
6. Eng. D.Pailharey– GPEC, Universite de la Mediterranee (Aix-Marseille II), Marseille, France (1month).
7. Eng. F. Jandard – GPEC, Universite de la Mediterranee (Aix-Marseille II), Marseille, France (1 week).

Scientific visits abroad

1. Dr. P.Cikmacs: University of Roma (Tor Vergata), Italy (1 months.)
2. MS. L. Grinberga –1) Chernogolovka, Russia, Jyne 2002 (4 days),
   2) St. Petersburg, Russia, July 2002, (4 days),
   2) Gotheburg, Sweden, September 2002 (7 days)
3. Dr. J.Kleperis
   1) Graz, Austria, June 2002 (6 days),
   2) Brno, Czech, August 2002 (8 days),
   3) Rome, Italy, Septemebr 2002 (5 days),
   4) Ystad, Sweden, October 2002 (5 days),
   5) Forli, Italy, November 2002 (6 days)
4. Dr.A.Lusis 1) Tallin Technical University, April 3, 2002 (2 days);
   6) ITEK, DI, Copenhagen , Oct.31, 202 (2 days);
   7) NREA, Golden, Colorado, USA, August 5-12, 2002 (1 week).
5. Dr. R.Kalendarevs: LURE, Orsay, France (2 weeks)

6. Dr. A.Kuzmins: 1) CNR CeFSA, Trento, Italy (3 months).
2) GPEC, Universite de la Mediterranee, Marseille, France (2 weeks).
3) LURE, Orsay, France (7 days)
4)The 4th Nordic-Baltic SPM Workshop, Tartu, Estonia (5 days)
7. Dr.hab. J.Purans: 1) GPEC, Universite de la Mediterranee , Marseille, France (1 month);
2) University of Trento, Trento, Italy (1 month) .
3)LURE, Orsay, France (1 month)
4)University of Lausanne, ICMA, Lausanne, Switzerland (2 month)
8. Dr. M.Shirokov: 1) Lab. Inorganic Materials Structural Chemistry, Moscow State University (2 weeks)
2) Laboratory of Spin Tracer Biophysics (prof. A. Tikhonov), Moscow State University(2 weeks).
3) Magnetic Resonance Laboratory (Dr. A. Timoshin), Cardiology Centre, Moscow (2 weeks)

Dr. G.Vaivars: 1) Workshop in Germany, May 2002 (1 week)
2) Cape Town University, South Africa (10 month)

Ph.D. stud. G.Vēveris 1) Warsaw University (7 days)
2) St.Petersburg State University, Russia (7 days)

Dr. A.Vitins:

Dr. G.Vitins: Sauthemton University, UK (10 month)

Cooperation

Latvia

1. University of Latvia - Department of Chemistry (Prof. J.Tīliks, Dr. A.Vīksna)
2. University of Latvia - Laboratory for Mathematical Modelling of Environmental and Technological Processes (Dr.A.Jakovics).
3. University of Latvia - Departament of Information Technology (Doc. H.Bondars).
4. Riga Technical University (RTU) – Faculty of Electronics and telecommunications (Doc. I.Slaidins, Doc. P.Misans)
5. Riga Technical University - Institute of Inorganic Chemistry (Dr. J. Grabis, Dr. I.Zalite, Dr. A. Dindune).
6. Latvian Academy of Science - Institute of Physical Energetics (Prof. N.Zeltins)
7. Certification Centre of Latvian Academy of Science (Prof. J.Matiss).
8. Latvian Electroindustry Business Innovation Centre (LEBIC).
9. Riga City Council - Environmental Department.

Denmark

Technical university of Denmark (Dr. K.West)

Estonia

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

France

1. GPEC, Universite de la Mediterranee (Marseille, France) - Prof. Y.Mathey, Prof. V.I. Safarov.
2. LURE, Lab. of Synchrotron Radiation (Orsay, France) – Dr. J.-P.Itie, Prof. S. Benazeth, Dr. Ph. Parent.
3. Institute of Nuclear Physics (Orsay, France) – Dir. S.Houbert, Dr. F. David

Germany

Tuebingen University -

Great Britain

Southampton University - Department of Chemistry (Prof. Owen)

Italy:

1. University of Roma (Tor Vergata) – Department of Physics (Prof. M.Iannuzi).
2. University of Trento – Department of Physics (Prof. G.Mariotto, Prof. G.Dalba).
3. Universita della Calabria (Arcavacata di Rende, Italy) - Prof. E.Cazzanell
4. CNR CeFSA (Trento, Italy) - Dr. F. Rocca.

Lithuania

1. University of Vilnius - Department of Physics (Prof. A.Orliukas)
2. Semiconductor Physics Institute (Dr. A.Shetkus)

Poland

1. Poznan Central Laboratory of Batteries and Power Sources (Dr. M.Kopczyk, Dr. G.Wojcik)
2. University of Warsaw , Department of Chemistry (Prof. A.Czerwinski)

Russia

1. Moscow State University: Faculty of Physics (Prof. A.Tihonov), Chemistry division (Prof. E.V. Antipov).
2. Joint Instute for Nuclear Research, Dubna (Dr. S.I. Tjutjunnikov)
3. Moscow State Engineering Physics Institute, Moscow (Prof. A.Menushenkov)

Sweden

1. Uppsala University (Prof. C.-G. Granqvist, Dr. A.Azens)
2. Stockholm University, Arrhenius laboratory (Dr. J.Greens)
3. Linkoping University – Laboratory of Applied Physics (Prof. I.Lundstrom)

South Africa

West Cape University - Porous Media Laboratory (Cape Town, Dr. Linkov).

Switzerland

EPFL (Lausanne, Switzerland) - Prof. A.E. Merbach, Dr. L.Helm.

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

NOSE – EC Network of Excellence on Artificial Olfactory Sensing

(Partners from ISSP: Dr.J.Kleperis, Dr.A.Lusis).

Research Projects:

1. **"X-ray Absorption Picoscopy of Advanced Materials"**, Latvian Government Grant, 2001-2004 (Head: Dr.hab. *J. Purans*).
2. **"Reconstruction of Nanocrystals Structure from X-ray Absorption Spectra using Ab Initio Theoretical Methods"**, Latvian Government Grant, 2001-2004 (Head: Dr. *A. Kuzmin*).
3. **"Lanthanide Chemistry for Diagnosis and Therapy"**, European COST Action D18, 1999-2004 (Head: Dr.hab. *J. Purans*).
4. **"In-situ X-ray Absorption Study of Transition Metal Oxides"**, a part of the Project within the framework of the Excellence Centre of Advanced Material Research and Technology (CAMART) at the Institute of Solid State Physics (supported by European Commission 5th Framework Programme), 2001-2003 (Head: Dr.hab. *J. Purans*).
5. EFDA Technology Workprogramme 2002: Field: Tritium Breeding and Materials-Activities task area: HCPB Breeding Blankets.Task title: Development of ceramic breeder pebble beds. Subtask title: Characterisation and development of ceramic breeder materials in high magnetic field for the HCPB blanket.(Prof. J.Tīliks, Dr. A.Vitins)

Didactic work at the University of Latvia

1. Master degree course "Solid State Ionics" (A.Lusis, A.Vitins, G.Vaivars)
2. Master degree course "e-nose and sensors" (J.Klepersi)
3. Master degree course "Structural Methods in Solid State Analysis" (J.Purans, A.Kuzmin).
4. J. Purans was a Supervisor of Doctor Thesis of G. Moreau. Thesis title: “Etude structurale de composes de coordination d’europium(II) et de strontium(II)”, EPFL, Lausanne, Switzerland, 2002.
5. Dr. A.Vitins: Scientific consultant for a term paper of a third-year student Līga Ersta. "Synthesis and properties of a lithium metatitanate doped with niobium ions".

Main results

ION – ELECTRON PROCESSES IN NANO STRUCTURED OR AMOURPHOUSS FILMS AND SYSTEMS BASED ON TUNGSTEN OXIDE

J.Gabrusenoks, A.Lusis, J.Kleperis, E.Pentjuss

The migration of water in the cell and hydration together with ion insertion-extraction reactions of the WO_3 film have main role in formation of new phases, which determine the value of cycling capacity of electrochromic cells. The cycling capacity at constant coloration intensity is limited by initial total number of active tungsten ion sites for induced color centers at inner surface of porous WO_3 film. The more probable transformation of phases in hydrated WO_3 films during cycling, which can be related to loss of active tungsten ion sites, is transformation of octahedral structural units of $H_xWO_3 \cdot nH_2O$ to tetrahedral $H_2WO_4 \cdot mH2O$.

Polymer hybrid electrolytes for fuel cells: Zirconium phosphate containing polymer hybrid electrolytes. Intercalation of organic species in-between zirconium

phosphate layers lead to material delamination. Resulting product is nanodispersion of proton conducting particles suitable for application in electro-optical devices and fuel cells.

The stabilisation of electrical properties of anodically prepared WO_3 electrode and water-acid electrolyte electrochromic cell was studied. The literature sources and presented results indicates that stabilisation processes are mainly directed towards equilibrium between liquid electrolyte and porous tungsten oxide film. The stabilisation associates with water insertion in pores, high increasing of injection and extraction currents and increasing of film thickness. The cycling mainly accelerates the stabilisation process. Proposed explanation for temporary decreasing of injection current at the beginning of stabilisation, based on high "building in" velocity of water molecules in to WO3 structure. There are observed independence of stabilised injected and extracted current values on oxidation charge. It can be determined by high ion conductivity of pores to compare with an electron conductivity of hydrated tungsten oxide fragments of film at the end of stabilisation, that envisage higher coloration of film near the metallic surface.

Infrared reflection and Raman spectroscopy have been applied to study the vibrational modes of tungsten trioxide and cadmium tungstate. Kramers-Kronig relations are employed to yield the refractive index as vell as TO and LO functions of these materials at frequencies from 50 to 1200 cm-1. The tungsten trioxide WO_3 has several polymorphous phases. These WO_3 phases have more or less distorted ReO_3 - type crystal structures. Raman spectra were measured in successive phases of WO_3 zone centre phonons of $CdWO_4$ were determined by the analyses of the Raman and infrared spectra. The modes were identified with respect to their symmetry types and compared to corresponding modes of the wolframite structure

X-RAY ABSORPTION SPECTROSCOPY OF TRANSITION METAL AND RARE-EARTH OXIDE COMPOUNDS

J. Purans, A. Kuzmin, R. Kalendarev

The local electronic and atomic structure around transition metal (TM) and rare-earth (RE) ions was studied by x-ray absorption spectroscopy (XAS) using synchrotron radiation facilities such as LURE DCI (Orsay, France) and ESRF (Grenoble, France). High quality experimental data and top level theoretical analysis allowed us to gain unique information on the local structural and dynamic properties of oxide materials, breaking the pico-metre barrier (10^{-12} m), i.e. conducting research at the picoscopic (10^{-2} Å) and subpicoscopic (10^{-3} Å) scale.

Main directions of our studies are connected with

- research and development of advanced materials for electrochromic applications;
- investigation of the rare-earth ions structure in water and bio-inorganic molecules;
- development of ab initio theoretical methods for the local structure reconstruction from x-ray absorption spectra.

In particular, a set of mixed thin films as WO_3:Ru, MoO_3-NiO WO_3:Cd , WO_3:Cd:Ni, WO_3:Pb, WO_3:Zn, NiO:Re, NiO:Ta, prepared by magnetron co-sputtering, were investigated by XAS to understand the influence of the doping metal on the host structure and microcrystallinity.

We also perfomed a study of local structure instabilities and their role in phase transitions of 5d transition metal oxides. the pressure induced deformations of the

coordination polyhedron (octahedron-type ⇔ tetrahedron-type) around the transition metal ions (rhenium and tungsten) were investigated in ReO_3 and $SrWO_4$ compounds and their relationship with known structural phase transitions by combined EXAFS and XRD techniques.

The local structure of RE aqua ions and bio-inorganic molecules was studied within the framework of the European COST D18 program (W.G. of prof. A. Merbach: "Structure, stability and factors affecting the efficiency of lanthanide chelates relevant to Magnetic Resonance Imaging". The main objectives of our research are to gain further insight into microscopic picture of the water molecules around a Eu(II), Eu(III) and Gd(III) chelate by x-ray absorption fine structure method. The XAFS spectra at the Eu^{2+}, Eu^{3+}, Gd^{3+} L_3-edges and at the Sr^{2+} K-edge have been recorded at ESRF (Grenoble) and LURE (Orsay) synchrotron radiation sources. In-situ XANES measurements of white lines amplitudes (Eu^{2+} and Eu^{3+} separated about 8 eV) have clearly demonstrated that sealed, oxygen free aqueous, DMF, DMSO and CH_3CN solutions of Eu^{2+} ion and Eu^{2+} poly(aminocarboxylates) are stable in the cell at least 3h (Eu^{3+} smaller than 1%). In aqueous solutions, a first coordination shell of Eu^{2+} is formed by 7.2 (3) water molecules at a Eu-O distance of 2.584 (5) Å with a high fluctuation of interatomic distance (Debye-Waller factor) of σ^2=0.0138 (5) $Å^2$ that correlate with the fast rate of water exchange. In the non-aqueous solutions (DMF, DMSO and CH_3CN) the coordination number, the distance and DW factor decrease in comparison with aqueous solutions.

Further development of methods for the analysis of x-ray absorption spectra was performed within the framework of the "EDA" project. A universal EDARMC code was created to perform direct fitting of XANES/EXAFS experimental spectra by Reverse Monte Carlo technique. This is one of the most promising approaches capable to account for both thermal and static disorder and thus overcome many existing problems. The code is currently at testing stage, and its parallel version to be used on Linux-clusters is planned to create in the future.

HIGHEST-T_c MERCURY CUPRATES SUPERCONDUCTORS MICROWAVE MAGNETOABSORPTION: SELFINTERSECTION, REPTATION AND RESONANT PEAKS

V.A. Alyoshin[1)], E.V. Antipov[1)], M.I. Shirokov[2)], A.A. Timoshin[3)]

[1)]Moscow State University, Inorganic Chemistry department, Moscow, 119899, Russia

[2)]Latvian University, Institute of Solid State Physics, Kengaraga 8, Riga, LV-1063, Latvia

[3)]Cardiology Centre, Institute of Experimental Cardiology, Moscow, 121552, Russia

High-T_c superconductors (HTSC) are characterized by irreversibility in magnetic fields up to H~5 T providing high critical current $j_c(H)$. It is shown that highest-T_c mercury cuprates HTSC microwave magnetoapsorption signal is rather sensible to magnetic hysteresis already at H≤0.5 T due to shielding current weak links contours weak superconductivity steep $j_c(H)$ dependence. The current-induced high field hysteresis disappears at h=5÷16 Oe modulation field amplitude alternating by found in Hg-1201 samples hysteresis branches intersection leading to low field hysteresis increase. The reversible signal ~h stands out and gives ΔH-driven forward-back scans intersection effect at steep enough incline ~ $(j_c(H))^2$ low field region. The intersection field $H_i(j)$ increase is explained by critical modulated current state $I+j=j_c$ extension through distributed contours. The inner origin of ΔH is confirmed by the loop self intersection

effect maintenance at maximal scan field diminution. No highly nonlinear in modulation behavior and self intersection effect are observed in Hg-1212 compound. It gives possibility to suppose that different type Josephson junction constitute weak links system in Hg-1201 and Hg-1212 HTSC. It is first observation of principal difference between single conduction plane (Hg-1201) and double conduction plane (Hg-1212) members of mercury cuprares HTSC. Coherence degradation in under doped state leads to τ distribution increase, which promotes current interactions and magnetic energy pumping to long contours containing weak sites, failing superconductivity and leading to the absorption oscillations. Their contents ~ $10^{-4} \div 10^{-3}$ per Cu atom is estimated on the ground of universal critical current state extension tendency. It coincides with ~ 10^{-3} steady concentration of ESR data for paramagnetic centres (PC) found in Hg-1201, Hg-1212 samples. Substitution $Hg^{2+} \rightarrow Cu^{2+}$, dependent on synthesis conditions, is proposed for PC origin. In conclusion, it is shown that magnetic irreversibility, trapped magnetic flux relaxation, deviation from optimal nonstoichiometry and coherence influence on the superconducting state in the highest-T_c mercury cuprates HTSC can be successfully investigated by microwave magnetoabsorption in moderate magnetic fields.

THE LIFE TIME AND PERFORMANCE OF SOLID IONIC DEVICES

A.Lusis, J.Kleperis, E.Pentjuš, G.Vaivars, A.Vitins, G.Vitins,

Now our 20 year experience in electrochromic devices and materials (intercalation oxide electrodes and solid electrolytes) is directed to study the life time and performance of solid-state batteries. The electrochromic devices are functioned as a rechargeable battery and structure of battery cell the same. Such cells can be a good model system for investigating electrochemical processes at electrode / electrolyte interfaces and their products in volume of materials not only by electrochemical methods and impedance spectroscopy, by electro-optical spectroscopy. The value of electrochemical potential is changing for both devices in dependence of charge (colour) – discharge (bleach) state. We used impedance and transient electrochemical methods to determinate the characteristics of electrochemical systems, and all this experience is fully transformable for the rechargeable battery systems. There were elaborated original potential sweeping method in our laboratory, using dc signal perturbed with small ac signal to investigate state -of-charge and state-of-colour of sealed electrochromic systems.

For electrochromic devices the life time (service time) and performance have generally the same dependence from the same physical and chemical processes as for batteries. The degradation of electrochromic devices during cycling and storing was one of the main problem for practical applications. The coloration / bleaching of electrochromic devices are same process as charge / discharge of battery. The cycling capacity of electrochromic device as well as of rechargible battery are connected with unrevesible electrochemical reactions and mechanical streses inside cell and with gradually changes composition of cell components by ion-mass electro-transfere.

POLYMER HYBRID ELECTROLYTES FOR FUEL CELLS

G. Vaivars[1), 2)], V. Linkov[2)]
1) Institute of Solid State Physics of University of Latvia,
2) Western Cape University, RSA, Cape Town, South Africa

Zirconium phosphate containing polymer hybrid electrolytes. Intercalation of organic species in-between zirconium phosphate layers lead to material delamination. Resulting product is nanodispersion of proton conducting particles suitable for application in electrooptical devices and fuel cells.

POSITIVE ELECTRODE MATERIAL FOR LITHIUM BATTERIES

Girts Vitins, J.R.Owen
Institute of Solid State Physics of University of Latvia,
Dep. of Chemistry of University of Southampton,
Highfield, Southampton SO17 1BJ ,ENGLAND

Work on LixCuO2 as a positive electrode material for lithium batteries was prolonged. Particularly Li2CuO2 shows high initial charge capacity, which can be used additive in positive electrodes to partly compensate for the initial charge capacity loss in lithium ion batteries.

Method was develop of combinatorial lithium battery material screening, which involves combinatorial (automated) preparation of large number of electrodes and their simultaneous testing in a single cell.

Structure enhancement of dielectric super capacitors based on Ta/Ta2O5/electronically conductive polymer system was investigated.

HIGH ENERGY CAPACITY POWER SOURCES WITH METAL HYDRIDE, LITHIUM AND CARBON ELECTRODES

J. Kleperis, G. Vaivars, G. Vitins, A. Vitins, A. Lusis
Solid State Physics Institute of University of Latvia
A. Czerwinski, Chemical Department of Warsaw University, Poland
A. Orliukas, Physics Faculty of Vilnius University, Lithuania
E. Lust, Chemical department of Tartu University, Estonia

Metal hydride and lithium power sources broadly are used in different applications with mobile electronic equipment. Nevertheless there are many unsolved problems associated with battery life time and electrode performances. It is necessary to improve the cycling properties and energy capacity for metal hydride electrodes. Experience with impedance measurements for AB_2 electrode materials (synthesised in the Central Laboratory of Batteries and Cells (CLAiO) in Poznan) performed in CLAiO and Riga by G. Vaivars, made excellent basis for the test of “health” of rechargeable batteries. The electrochemical characteristics (charge transfer resistance, exchange current, equilibrium potential) and impedance measured in large frequency region allow interpreting electrode/electrolyte interfaces in sealed battery and determining main blocking layers. New conception is developed how to apply the possibilities of J/S company “Sidrabe” in preparation lithium thin film power sources. First prototype was compiled and

investigated in Southampton University (G. Vitins). Small cycling capacity (3-6 cycles) is connected with limited thickness of Li thin film (6 □m), and will be improved by using thicker Li coatings onto polymer substrate. ITO (indium tin oxide) is an optically transparent semiconductor that finds extensive use in liquid crystal displays, photovoltaic cells, LCD, touch screen displays, smart windows etc. In these applications, the ITO is used as a transparent electrode. As with all such electrode materials, there is a compromise between conductivity and optical transparency. Different substrate materials are playing important role in transparency (better contrast and less absorption, increased brightness), surface morphology (smoothness, homogeneously) and conductivity of the ITO films. We compared optical and electrical properties of ITO films onto polymer substrate, obtained from Company "SIDRABE Inc." (Riga, Latvia) and ITO films onto glass substrate obtained by us. SIDRABE has accumulated significant experience in vacuum coating of polymer films, paper and non-woven materials.

RESEARCHES WITH AN ELECTRONIC NOSE AND SENSORS QUICK AUTHENTICITY TESTING OF FOOD AND GOODS IS IT REAL WITH E/Z – NOSE?

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The development of intelligent sensor instruments as artificial human sense organs shows that it is very important to understand the features of human sense recognition processes. Human odour identification process is multi-dimensional, e.g. many parallel processes proceeds simultaneously. Smell is the special sense of humans and other animals by which odours are perceived. An Electronic Nose is a modular sensor system made for detection of gases and gas mixtures, aromas and odours in an environment. It combines gas sensors for aroma detection and artificial intelligence for treatment of measured data. This instrument isn't an analytical technique but a fingerprint technique analysing the odour as a whole. Some fields of employment of Electronic Nose: quality control or process control in food, medical, perfume, chemical etc., technologies; raw material selection and inspection; manufacturing process monitoring; environmental monitoring.

As Customs authorities on the border of State, as well as customers in markets and food shops – we have a right to expect that the good we inspect or buy matches the description given on the label or in attendant documentation. Nevertheless adulteration and misdescription in itself is nothing new – goods and food fraud has been around for a very long time – probably as long as trading exists. Nowadays electronic nose (e-nose) is trying to permeate between typical quality control instruments (chromatographs, spectrophotometers etc.). As an example for authenticity testing we chose orange juice. The typical ways of juice falsification are artificial mixtures, pulp and peel wash addition, undeclared sugar addition (frequently masked by addition of citric acid), low quality water. Odour recognition with e-nose is based on comparing measured sample with patterns stored in the memory of e-nose as different classes. We collected 30 samples orange juices (from 5 different companies) sold in different places of Riga

(public market, supermarkets, private shops) and compared with fresh-pressed from fruits. In our research we looked for answers on three questions:

- Are the juice samples from same company booked at different places similar?
- Do the juice samples from different companies segregate?
- Do the juice samples from different companies mach with fresh-pressed orange juice?

To make broader application possibilities of electronic nose it is necessary to develop wide selectivity spectra of sensor array. We tested SnO2 thin film sensor made in Vilnius Semiconductor Physics Institute and new potentiometric CO2 sensor made in Physics Department of Vilnius University.

TRAFFIC CAUSED EMISSIONS IN RIGA: INVENTORY, DIRECT MEASUREMENT AND MODELLING/FORECAST

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J. Smeisa, Environmental Department of Riga City Council, Riga, LV-1050, Latvia;
B. Sloka, Euro Faculty Riga Centre, University of Latvia, Riga, LV-1586 Latvia;
E. Vitola, Faculty of Earth Science and Geography of University of Latvia, Riga Latvia

Riga, the capital of the Republic of Latvia, is not only the centre of industry, business, entertainment and tourism, but also the home for 794500 inhabitants (1/3 from all inhabitants in Latvia). Number of inhabitants in Riga is reducing slowly, caused by negative birth rate, immigration and moving people to countryside around city. Nevertheless, the number of traffic in the streets of Riga is increasing from year to year by 8-12%. The most important and famous place in Riga is the Old Town (oldest houses from 16^{th} century), which in 1998 was joined by UNESCO to the heritage of the world culture. Now the Old Town is the place in Riga most crowded by tourists and polluted by cars.

An air quality management system AIRVIRO is used for an inventory of air pollution sources in Riga and their related dispersion calculations (from 1994). DOAS equipment is used for air quality monitoring as on the background level, as well as on the street level in Riga. Inventory results show that traffic on the streets of Riga is responsible for 80% of all NO_x, 78% of all CO and 68% of all VOC emissions in Riga. Calculated dispersion concentrations coincide quit well with directly measured values primarily on main streets with intense traffic.

Latvia is going to associate with European Union in near future, and now is adopting also air quality quid lines accordingly EU legislation. For year 2010 it will be necessary to ensure the annual concentrations of NO_2 and benzene no more as 40 and 5 $\mu g/m^3$ accordingly, but for Riga it will be problems, as it is shown by our dispersion calculations for year 2010. Some suggestions are given how to prevent it.

HEATING ENERGY OPTIMAL UTILIZATION IN THE BUILDING SECTOR

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Thermal energy sector is major area for energy efficiency improvements. The structure of achievable energy efficiency potential consists from 3 parts: 22% - in generation, 31% - in transmission and 47% - in consumption.

Residential and public houses are the major thermal energy consumers. It is estimated that building space heating consumes some 65% of the total delivered heat. The using of the thermal insulation for the building envelope and the improvement of the heating and ventilation systems are an enormous potential for energy savings. One of most important task is increasing of thermal resistance values for various building constructions.

A simple Excel program is developed for calculation heat loses through the buildings envelopes. It calculates the saved heat energy in the residential and public houses depending on the construction of thermal isolation layer on the outside walls. This program calculates saved heat energy during the year and the corresponding payback period of expenses for isolation materials and work. By help of this calculation program it is possible to recommend sequence of energy efficiency measures.

Scientific publications

1. A.Lusis, J.Kleperis, E.Pentjušs. *Model of Electrochromic and Related Phenomena in Tungsten Oxide Thin Films*, J. Solid State Electrochem **7**, 72 (2002)
2. J. Kleperis, D. Danilane, J. Jandulina, E. Vitola. *Inventory, modelling and monitoring of traffic caused air pollution in Riga*. Proceedings of 11th International Symposium "Transport and Air Pollution", vol. **2**, Graz University of Technology (Austria), 19-21 June, 2002, p. 259-266.
3. J. Kleperis, L. Grinberga, P. Misans, A. Lusis, *Quick authenticity testing of food and goods - is it real with e/z – nose?* To be published in IEEE, 2003.
4. J. Kleperis, L. Labane, I. Bartule and J. Smeisa. *Exploration and research of environmental quality in Riga: outdoors air and noise*. Proceedings of International Symposium of World Health Organization "Housing and Health", November 21-23, 2002, Forli (Italy), p. 300-307.
5. V. Linkov, L. Petrik, G. Vaivars, A. Maluleke and G. Gericke. *Ceramic-Based Materials for Electrochemical Applications*, Macromol Symp **178** (2002) p. 153-168.
6. G.Vaivars. *Kurināmā elementa izšķirošā cīņa*, Terra 11 (2001) lpp. 6-9, Terra 12 (2001) lpp. 6-9.
7. G.Vaivars. *Kurināmā elements – nākotnes baterijas*. Enerģija un Pasaule, Nr. 3(14), (2002), lpp. 9-13.
8. G. Moreau, L. Helm, J. Purans and A.E. Merbach, *Structural Investigation of the Aqueous Eu^{2+} Ion: Comparison with Sr^{2+} using the XAFS Technique*, J. Phys. Chem. A. 106 (2002) 3034-3043.
9. J. Purans, G. Moreau, L. Helm, A.E. Merbach, *Eu^{2+} and Eu^{3+} complexes in solid state and solution*, Proc. LURE Users Meeting. Orsay, France, June 6-7, 2002.
10. G. Moreau, L. Helm, J. Purans and A.E. Merbach, *Local structure of Eu(II) complexes: solid state and solution XAFS studies*, Proc. ICCC-35, Heidelberg, Germany, July 21-26, 2002, p. 53.
11. J. Purans, G. Moreau, L. Helm, and A.E. Merbach, *XAFS studies with picometer accuracy: Ln complexes in solid state and solutions*, Proc. ICCC-35, Heidelberg, Germany, July 21-26, 2002, p. 407.
12. G. Moreau, R. Scopelliti, L. Helm, J. Purans and A.E. Merbach, *Solution XAFS Study*

of the Eu2+ and Sr2+ ions: Unexpected Solvent and Metal Ion Dependencies of the Solvation Numbers, J. Phys. Chem. A106 (2002) 9612-9622.

13. F. Rocca, C. Armellini, M. Ferrari, G. Dalba, N. Diab, A. Kuzmin and F. Monti, *X-ray absorption and diffraction studies of Pr3+, Tb3+ and Er3+-activated silica gels,* J.Sol-Gel Sci. Tech. 26 (2002) 267-271.

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1. G. Moreau, L. Burai, L. Helm, J. Purans and A.E. Merbach, Structural XAFS Investigation on Eu^{2+} and Sr^{2+} Poly(amino carboxylates): Consequences for Water Exchange Rates on MRI Relevant Complexes, J. Phys. Chem. A. (2003) [in press].
2. G. Dalba, P. Fornasini, R. Grisenti, A. Sanson, S. A Beccara, F. Rocca and A. Kuzmin, Temperature dependent studies on the short range structure and local dynamics in silver borate glasses, Proc. 4^{th} Int. Conf. on Borate Glasses, Crystals, and Melts, July 14-18, 2002, Cedar Rapids, USA, Phys. Chem. Glasses (2003) (in press).
3. A. Kuzmin, R. Kalendarev, J. Purans, D. Tonneau, A. Houel and D. Pailharey, X-ray absorption spectroscopy, atomic force and scanning tunnelling microscopies of iridium oxide thin films, Appl. Surf. Sci. (2003) (in press).
4. A.Lusis, J.Kleperis, E.Pentjušs *Performance problems of electrochromic coatings*. Proc. SPIE vol. **5123**, "Advanced optical devices", 2003, pages 201-206
5. J. Kleperis, A. Lusis, *Properties of ITO transparent electrode thin films onto different substrates.* SPIE vol. **5123**, "Advanced optical devices", 2003, p. 220-225.
6. G.Vitins, G.Kizane, A.Lusis, J.Tiliks. *Electrical conductivity studies in the system* Li_2TiO_3- $Li_{1.33}Ti_{1.67}O_4$.// J. Solid State Electrochem., 2002, **6**, 311.
7. G.Vitins, E.A.Raekelboom, M.T.Weller, and J.R.*Owen.* Li_2CuO_2 *as an additive for capacity enhancement of lithium ion cells.*// Accepted for publication in J. Power Sources 09.2002. Paper IMLB-034.
8. A.D.Spong, G.Vitins, S.Guerin, B.E.Hayden, A.E.Russell and J.R.Owen. *Combinatorial Arrays and Parallel Screening for Positive Electrode Discovery*.// Accepted for publication in J. Power Sources 10.2002.
9. A.Kuzmin, R. Kalendarev, J. Purans and D. Pailharey, *Iridium L3-edge and oxygen K-edge x-ray absorption spectroscopy of nanocrystalline iridium oxide thin films*, Proc. SPIE (2003)
10. D. Pailharey, D. Tonneau, A. Houel, A. Kuzmin, R. Kalendarev and J. Purans, *Scanning probe microscopy of nanocrystalline iridium oxide thin films*, Proc. SPIE (2003).
11. A.Kuzmin, R. Kalendarev and J. Purans, *Local structure of Ta-Re mixed oxide thin films studied by x-ray absorption spectroscopy*, Proc. SPIE (2003)

Lectures on Conferences

1) 18^{th} Scientific Conference of ISSP UL, Rîga, February 21-23, 2001

1. L. Grinberga, J. Kleperis, A. Lusis. zNOSE^{TM} – revolution in olfactometry., Abstracts, p.14

2. J. Kleperis, L. Grinberga, P. Misans, A. Lusis. Looking for conception of mini-electronic nose., Abstracts, p.41
3. U.Kanders, J.Kļaviņš, B.Petrovs, N.Zeltiņš, Heating energy optimal utilization in the building sector; Abstracts, p.73
4. J.Kļaviņš, U.Kļaviņš, Improvement of the informatization system of the Institute of solid state physics; Abstracts, p.77
5. J.Kļaviņš, J.Maniks, E.Pentjušs, J.Pinnis, Testing laboratory of the Institute of Solid state physics; Abstracts, p.76

2) International conference "EcoBalt 2002", June 7-8, 2002, Riga Technical University

1. L. Grinberga, J. Kleperis, A. Lusis. Superfast gas chromatograph in environmental researches., Abstracts, p. 36
2. J. Kleperis, J. Jandulina, A. Jurkevica, E. Vītola. Is benzene pollution in Riga the air quality problem? Abstracts, p. 30

3) International Conference on Solid State Ionics, June 16-18, 2002, Chernogolovka, Russia

L. Grinberga, J. Kleperis, A. Lusis. Gas sensors and electronic nose.

4) 11th International Symposium "Transport and Air Pollution", Graz University of Technology (Austria), 19-21 June, 2002, Participate - J. Kleperis. Made report

J. Kleperis, D. Danilane, J. Jandulina, E. Vitola. Inventory, modelling and monitoring of traffic caused air pollution in Riga. Abstracts, p.14

5) "WACRA- Europe 2002" World Association on Case Studies Annual Meeting "Systems Theory and Case-Based Approaches", Brno (Czech Republic), August 7-11, 2002

J. Kleperis, B. Sloka. Modeling of traffic caused emissions in Riga: situation today and forecast for 2010. Abstracts, p.23

6) First NORFA summer school " New materials and technologies for low temperature fuel cells", Göteborg, September 5-7, 2002. Participate - L. Grinberga, Made report

G. Vaivars, L. Grinberga and J. Kleperis. Fuel Cell – sketchy about origins and possible applications in Latvia**.** Absracts, p. 15

7) ISOEN| 2002, (International Symposium of Olfaction and Electronic Nose), Rome (Italy), September 30-October 2, 2002. Participate - J. Kleperis. Made report

J. Kleperis, L. Grinberga, P. Misans, A. Lusis, Quick authenticity testing of food and goods - is it real with e/z – nose? Abstracts, pp.134- 137

8) 7th Nordic-Baltic Conference in Regional Science " Regional Integration and Transition in the Baltic Rim", Ystad, (Sweden) October 2-5, 2002.

J. Kleperis, B. Sloka. Survey on air quality in Riga: situation and forecast for 2010, Absracts, p. 19

9) International Symposium of World Health Organization "Housing and Health", November 21-23, 2002, Forli (Italy). Participate - J. Kleperis. Made report

J. Kleperis, L. Labane, I. Bartule and J. Smeisa. Exploration and research of environmental quality in Riga: outdoors air and noise, Absracts, p. 32

10) Nordic Energy Research Meeting, Riga, November, Riga, Ravel Hotel Latvia, November 28-30, 2002. Participate - L. Grinberga, J. Kleperis, A. Lusis. Made report

J. Kleperis, L. Grinberga, A. Lusis, J. Grabis "Review about researches of chemical power sources in Latvia".

11) The 201th Meeting of the Electrochemical Society, Philadelphia (U.S.), 13-17th May 2002

1. G.Vitins, E.A.Raekelboom, M.T.Weller, and J.R.Owen. *Li_2CuO_2 as an additive in lithium ion cells (* Abstract No 108);
2. G.Vitins, E.A.Raekelboom, M.T.Weller, and J.R.Owen. *Li_2CuO_2 as an additive in lithium ion cells (*Abstract No. 236);
3. A.D.Spong, G.Vitins, S.Guerin, B.E.Hayden, A.E.Russell and J.R.Owen. *Combinatorial Arrays and Parallel Screening for Positive Electrode Discovery* (Abstract No. 267. Website for the poster).

12. Scientific Practical Meeting "Thermotechnics of the boundary constructions of buildings II", Riga, March 14-15, 2002

1. U.Kanders, J.Kļaviņš, N.Zeltiņš, Monitoring of energoefficiency of buildings before and after reconstruction: experience of the Institute of solid state physics,
2. J.Kļaviņš, J.Pinnis, Testing of building materials – water permeability, water vapour transmition, moisture content and some other physical properties,

.

13. EFDA Technology Workprogramme. HCPB Blanket Project. "HCPB Task Co-ordinator Group Meeting (2002 / 1). Monitoring 2001." Forschungszentrum Karlsruhe, February 6-7, 2002

J. Tiliks, G. Vitins. "Influence of magnetic field on tritium release in ceramic breeder."

Participation in exhibitions

Presentation E-NOSE technology at international exhibitions:
1. Business days and brokerage events, Delft, March 12-14, 2002.
2. BalTech, Vilnius, May 21-24, 2002.
3. Subcontracting, Tempera, Sept.19-21, 2002.

DIDACTIC SYSTEMS

Head of Division Assoc.Prof.,Dr.J.Kuzmin

Research Area and Main Problems

Investigation of possibility to use “client-server” and “virtual laboratory” technology to create new methods of e-education.

Scientific Staff

Assoc.Prof.,Dr.J.Kuzmin
Dr.A.Kuzmin

Scientific Visits Abroad

A.Kuzmin, Trento University, Physics Department

Research Projects

1. "Client-Server" applications in educational environment", Latvian Government Grant, 2001-2004 (Head: Dr.Phys. J.Kuzmin).
2. "Virtual Physics Laboratory", Latvian Government Grant, 2001-2004 (Head: Dr.Phys. J.Kuzmin).

Didactic work at the University of Latvia

1. course "Structural Methods in Solid State Analysis" - J.Purans, A.Kuzmin.
2. course “Operating Systems” – J.Kuzmin
3. course “System Analysis” – J.Kuzmin
4. course “Modern Education Environment” – J.Kuzmin
5. course “Basics of Informatics for educators” – J.Kuzmin
6. course “Intranet/Internet technology” – J.Kuzmin

Cooperation

Latvia

1. Faculty of Education and Psychology (A.Geske, L.Kuzmina)
2. Latvian schools

Abroad

1. CNR CeFSA, Trento, Italy (Dr. F.Rocca)
2. Marseille University (II), GPEC Lab. (Dr. D.Pailharey)

Main results

CLIENT-SERVER APPROACH TO EDUCATIONAL ENVIRONMENTS AND LATVIAN SUPER CLUSTER

J.Kuzmin, A.Kuzmin

In year 2002 our studies of possibility to use “client-server” and “virtual laboratory” technology to create new methods of e-education were continued with a special focus on widening of system SOLO functions and creating of Latvian SuperCluster. System SOLO was enlarged with new set of dialog and programming functions, which allows to use “peer-to-peer” technology. As a result now is possible to create knowledge tests which can be implemented independently on student workstations, but from central workstation educator can take all test results (on the screen or in the result file). Additionally new parts of e-lectures “System Analysis for nonprofessionals” and “Basics of Operating Systems” are created.

As a part of Virtual Laboratory Project Latvian SuperCluster (LASC) has been installed at the Institute of Solid State Physics (ISSP) of the University of Latvia. LASC is a Beowulf-like cluster, based on reliable Intel multiprocessor servers, interconnected via Fast Ethernet network and running Linux RedHat operating system. After detailed analysis of similar clusters there were found 6 criteria for LASC construction: (1) High Productivity - high speed processing of huge data volumes, (2) High Availability - reliable system, accessible from Internet, Dial-Up and local terminals, (3) Scalability - possibility to increase computational power in the future, (4) Low Cost - for hardware and software (initial, upgrade, repairing), (5) Easy Maintenance - no special personal required, (6) Security - free access on pre-registration basis. LASC is a Beowulf-like Linux PC cluster. It consists of five nodes (one front-end (master) node + four computational nodes), which are Compaq ProLiant ML350 G2 servers. Only the front-end has connection with the rest of the world (Internet) using one of the Network Interface Cards (NICs). The other NICs on all nodes are connected to a HP ProCurve 2312 (12 ports) Fast Ethernet switch. The total resources available to the users are 10 CPUs, having a peak power about 13 GFLOPS, 20 GB memory (RAM) and 336 GB hard disk space (expandable up to 3.3 TB).

The LASC cluster uses mainly open source software. Main components of LASC are: (1) Linux RedHat 7.x operating system and MOSIX software package implementing automatic load-balancing and process migration algorithms, (2) Programming Environment consisting of: GCC 2.96 (GNU set of compilers: C, C++, Fortran 77) ; GNU Pascal 2.1 (compatible with Borland Pascal 7.0 !); Intel Fortran Compiler; Intel C++ Compiler; Borland Kylix 2 Pascal (compatible with Borland Delphi 6); Perl 5.6.1. (3) CLRUN Job Submitting System and (4) Utilities and (5) Communication APIs for Parallel Computations - PVM ("Parallel Virtual Machine") implementation and MPI ("Message Passing Interface") implementation.

All results were tested in educational process at the Faculty of Education and Psychology of University of Latvia and at the Institute of Solid State Physics of University of Latvia. Results were discussed with specialists from Trento University (Italy) and Marseille University (France).

Scientific Publications
Published in 2002

1. J.Kuzmins. *Virtuālās mācību vides*. – Izglītības zinātnes un pedagoģijas mūsdienu pasaulē. Zin.Raksti. **649**.sējums, Rīga, 2002, lpp. 353-363.
2. L. Kuzmina, J. Kuzmins. *Integrēta pieeja Informātikā*. – Izglītības zinātnes un pedagoģijas mūsdienu pasaulē. Zin.Raksti. **649.**sējums, Rīga, 2002, lpp. 363-367.
3. A.Kuzmin, "*Cluster approach to high performance computing*", Computer Modelling and New Technologies, (in press)

NONLINEAR PROCESSES IN SOLIDS

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

Research Area and Main Problems

Our theoretical research is focused on two classes of problems: the kinetics of diffusion-controlled reactions in solids with defects and catalytic surface reactions, and the atomic/electronic structure calculations of defects in non-metallic solids, respectively. We combine many different techniques, including analytical formalisms and large-scale computer simulations (both quantum chemical, semi-empirical and *ab initio* methods and Monte Carlo/cellular automata modelling).

Scientific staff

1. Dr. hab. J.R. Kalnin
2. Dr. hab. E. Kotomin
3. Dr. hab. V. Kuzovkov
4. Dr. A. Popov
5. Dr. Yu. Zhukovskii
6. Dr. R. Eglitis
7. Dr. G. Zvejnieks
8. M.Sc. V. Kashcheyevs

Student

D. Bocharovs

Scientific visits abroad

1. Dr. hab. E. Kotomin, Max Planck Institute for Solid State Researches, Stuttgart, Germany (10 months)
2. Dr. hab. V. Kuzovkov, Braunschweig University, Germany (3 months)
3. Dr. A. Popov, European Molecular Biology Laboratory (EMBL), Grenoblé, France (10 months)
4. Dr. Yu. Zhukovskii, Max Planck Institute for Solid State Researches, Stuttgart, Germany (2 months), Osnabrück University, Germany (1 month)
5. Dr. R. Eglitis, Osnabrück University, Germany (10 months)
6. Dr. G. Zvejnieks, Centre for Researches in Plasma Physics (CRPP), Lausanne, Switzerland (1 month), Eindhoven University, the Netherlands (1 month)
7. M.Sc. V. Kashcheyevs, Tel Aviv University, Israel (4 months)

Main Results

DEFECTS AND SURFACES OF ADVANCES PEROVSKITES

E.A. Kotomin and R.I. Eglitis

Large scale first principles and semi-empirical quantum chemical calculations were performed for a number of materials, including perovskites: $SrTiO_3$, $BaTiO_3$, $KNbO_3$, $KTaO_3$ and their solid solutions, widely used in technological applications.

In collaboration with Osnabrück University and Max Planck Institute for Solid State Researches, Stuttgart (Germany), we perform first principles calculations, according to methods of Hartree-Fock (with electron correlation corrections, HF-CC)

and Density Functional Theory (DFT), as well as semi-empirical INDO calculations. We simulate both (100) and (110) surface relaxation in $SrTiO_3$ and charge-transfer vibronic excitons in $KNbO_3$ and $KTaO_3$ ferroelectric crystals. We suggested interpretation to experimental luminescence energies. One of particular purposes of our study is identification of defects, in particular those responsible for the blue-light-induced-infrared-adsorption devices (BLIIRA) effect which strongly affects eficiency of laser frequency doubling in $KNbO_3$-based devices. In collaboration with Antwerpen University, Belgium we developed a general theory of bound polarons in oxides and illustrated theory with calculations for hole polarons in basic ceramic materials - MgO and Al_2O_3. We performed also computer modeling of self-trapped electrons in perovskite crystals.

THEORETICAL SIMULATION OF REGULAR AND DEFECTIVE METAL-OXIDE INTERFACES

E.A. Kotomin and Yu.F. Zhukovskii

Detailed first principles theoretical studies are performed for the initial stages and mechanisms of the formation of metal coatings on the dense-packed oxide surfaces of alumina and magnesia.

In collaboration with Uppsala University, Sweden, we performed *ab initio* (HF-CC) calculations of silver(111)/corundum(0001) interfaces with different (Al- and O-) substrate terminations emphasizing on the effects of oxide surface coverage by metal, optimal adsorption positions and adhesion energies for metal films of different thickness. In collaboration with Osnabrück University (Germany), we have began (DFT) simulations of copper adhesion onto different oxide substrates. For this aim, we first carefully optimized copper wave functions used in *ab initio* CRYSTAL code. At the same time, available basis sets for MgO and α-Al_2O_3(0001) substrates were found to be quite suitable for DFT calculations and we only slightly re-optimized their external and virtual functions. Using these preliminary calculations, we study adhesive and electronic properties of the flat Cu/MgO(001) interface.

In collaboration with Technion, Haifa, and Ben Gurion University, Beer-Sheva (Israel), we combine results of the electron structure calculations on both regular and defective metal/oxide interface (including interatomic potentials) with novel thermodynamic approach, thus explaining the growth mechanism of metallic films deposited on different metal oxides surfaces.

FIRST PRINCIPLES MODELING OF METAL OXIDATION AND CORROSION

E.A. Kotomin and Yu.F. Zhukovskii

We perform *ab initio* simulations of the initial stages and mechanisms of the formation of metal halogenide coatings on the dense-packed surfaces of alumina and magnesia, which can lead to interfacial conductivity, as well as oxidation of aluminium.

In collaboration with Max Planck Institute for Solid State Researches, Stutttgart (Germany), we began HF-CC calculations of both AgCl(111) surface and AgCl/α-Al_2O_3(0001) interface using procedure of geometry optimization. We found optimal adsorption sites and adhesion energies for silver chloride film on corundum substrate as well as estimated some electronic properties. In collaboration with the University of Western Ontario (Canada) we continue to clarify atomistic mechanism of the initial

stage of aluminium oxidation, using *ab initio* DFT method and procedure of geometry optimization.

EXACT ANALYTIC SOLUTION FOR THE GENERALIZED LYAPUNOV EXPONENT OF THE TWO-DIMENSIONAL ANDERSON LOCALIZATION

V.N. Kuzovkov and V. Kashcheyevs

In collaboration with Braunschweig University, Germany we studied well-known Anderson localization problem in one and two dimensions. The problem is solved analytically via the calculation of the generalized Lyapunov exponents. This is achieved by making use of signal theory. The phase diagram can be analyzed in this way. In the one dimensional case all states are localized for an arbitrarily small disorder, in agreement with existing theories. In the two dimensional case for larger energies and large disorder all states are localized but for certain energies and small disorder extended and localized states coexist. The phase of delocalized states is marginally stable. We demonstrate that the metal-insulator transition should be interpreted as a first-order phase transition. Consequences for perturbation approaches, the problem of self-averaging quantities and numerical scaling are discussed.

SELF-ORGANIZATION IN SURFACE CATALYTIC REACTION

V.N. Kuzovkov and G. Zvejnieks

Modeling of catalytic surface reactions, which are of enormous importance in industrial processes and environmental chemistry, as well as development of new computer codes and new analytical methods are performed.

In collaboration with Braunschweig University, Germany we introduced and studied a microscopic kinetic model for the alpha -> beta [e.g. hex ->1×1 for Pt(100) and 1×2 -> 1×1 for Pt(110)] surface reconstruction, investigated by means of the mean field approximation and Monte Carlo simulations. We consider homogeneous phase nucleation, which induces small surface phase defects. These defects can grow or decline via phase border propagation, depending of the surface coverage by an adsorbate CO. Asymmetry in the adsorbate surface diffusion from one surface phase to the other gives rise to two critical coverages which determine the intervals of stability of the homogeneous alpha phase, the dynamically stable heterogeneous state and the homogeneous beta phase. Both surfaces show a very similar qualitative behavior regarding the phase transitions, which are in both cases of the second order. As a result, the experimentally observed nonlinear island growth rate and the critical coverages can be explained at the quantitative level.

We show the existence of internal stochastic resonance in a microscopic stochastic model for the oscillating $A+B_2$ reaction on a square lattice. This stochastic resonance arises directly from the elementary reaction steps of the system without any external input. The lattice gas model is investigated by means of Monte Carlo simulations. It shows the oscillation phenomena and mesoscopic pattern formation. Stochastic resonance arises as the homogeneous nucleation of the individual lattice site states is considered. This nucleation is modelled as a weak noise. As a result, synchronization of the kinetic oscillations is obtained. We show that all characteristics known from research on stochastic resonance are obtained in our model. We also show that the model explains easily several phenomena observed in real experiments. Internal

stochastic resonance may thus be an internal regulation mechanism of an extreme adaptability.

The A+B->0 reaction model with a surface reconstruction step is analyzed. It is compared with another $A+1/2B_2$->0 model of catalytic reaction with a surface reconstruction (V.N. Kuzovkov et al., *J. Chem. Phys.* **108**, 5571 (1998)) which mimics the CO oxidation on the Pt surfaces. The effect of monomer B adsorption instead of dimer B_2 is in particular examined. The conclusion is drawn that dimer adsorption in the CO oxidation reaction on Pt(100) surfaces could be important from quantitative point of view. However, qualitative system features, like reactant concentration oscillations, are independent on this substitution.

KINETIC MODELING OF METAL FILM GROWTH ON INSULATING MATERIALS

E.A. Kotomin, V.N. Kuzovkov, G. Zvejnieks, and Yu.F. Zhukovskii

We perform kinetic Monte Carlo (kMC) modeling of the thin metallic film growth on insulating substrate. Simulations demonstrate that the key parameter neglected in the standard nucleation theory is the dimensionless attraction energy between the nearest metal atoms, $\omega = E_{ii}/k_BT$. We have shown that for $\omega \geq 2$ pattern formation is observed ("worm"-like metal clusters), whereas for $\omega < 1$ metal atoms are randomly distributed on the surface. *Ab initio* calculations were performed for the particular case of two silver atoms adsorbed on substrate, Ag_2/MgO(001). It is shown that for the pairs silver atoms adsorbed on the nearest and next-nearest regular sites on substrate (NN and NNN) $E_{Ag\text{-}Ag}$(NN) = 1.56 eV and $E_{Ag\text{-}Ag}$(NNN) = 0.87 eV. Thus pattern formation is expected to exist even at high temperatures (≥ 1000 K).

THE KINETICS OF METAL COLLOID FORMATION UNDER IRRADIATION OF PROSPECTIVE MATERIALS

E.A. Kotomin, V.N. Kuzovkov, and V. Kashcheyevs

Theoretical study of the kinetics of metal colloid formation in several important materials (alkali halide, LiF, and metal oxide, MgO) is performed using Monte Carlo simulations and the formalism of many-particle densities.

In collaboration with partners from GSI Institution, Darmstadt, Germany, we developed theory of the kinetics of primary defect aggregation (*F* centers) in tracks of swift heavy ions in ionic solids and suggested interpretation of existing experimental data. We predict metal colloid size to be very small, and thus non-detectable by EPR, in agreement with experiment. We developed also a novel theory predicting the growth mode of thin metallic films on insulating substrates, which is of great technological importance. We discussed joint studies with the Excellence Center in Tartu (Institute of Physics) on radiation defect aggregation in solids.

EFFECTIVE DIFFUSION COEFFICIENT IN HETEROGENEOUS SOLIDS

E.A. Kotomin and J.R. Kalnin

In collaboration with Max Planck Institute for Solid State Researches, Stutttgart (Germany) we suggest a novel method for calculating the effective diffusion coefficient in heterogeneous media (solids with defects and inclusions, two-phase systems).

Analytical theory is well-confirmed using computer simulations on the inclusions of different shapes. It is shown that our theory is in much better agreement with simulations than traditional Maxwell-Garnet theory and it is valid up to very high concentrations of inclusions.

ULTRA-FAST LUMINESCENCE FROM INCIPIENT ION TRACKS OF INSULATOR CRYSTALS

A.I. Popov

A novel ultra fast luminescence was recently found by measuring time-resolved luminescence spectra (resolution of 80 ps) of heavy-ion irradiated in alumina. Further measurements on single crystals of LiF, NaF, NaCl, KCl, KBr, KI, RbI, CsCl, CsBr, CsI, MgO, SiO_2, and diamond revealed the corresponding luminescence except for SiO_2 and diamond. The luminescence showed the following common characteristics:

1) The ultra-short time (<100 ps)
2) The wavelength different from all known bands and unusually broad band widths.
3) The super-linear increase in efficiency with an increase in the excitation density.
4) The decay rate and the efficiency invariant to temperature changes.

The results show that the luminescence does not originate from self-trapped excitons, free excitons, excited defects, and excited impurity centers, that is, is not the localized excited state, but multiply bound states among short-lived excited states (at most 100 ps). The state which suits these characteristics may be the *e-h* plasma or the free exciton complex, considering that almost all energy deposited by ions (as large as a few hundred eV/$Å^3$ along the ion track) goes to electronic system which produces *e-h* pairs.

STORAGE PHOSPHORS FOR NEUTRON IMAGING

A.I. Popov

Storage phosphor imaging plate (IP) are widely used as two-dimensional integrating position-sensitive detector based on the effect of photo-stimulated luminescence (PSL). They consist of a film of finely dispersed storage phosphor crystals (e.g. BaFBr:Eu^{2+}) in an organic binder on a plastic support foil. Under irradiation of the phosphor metastable color centers are created, which can then be excited by visible light to finally emit luminescence light. By scanning the image plate with a focused laser and simultaneous detection of the luminescence light the information stored in the phosphor film can be read out position sensitively. Remaining information can be bleached by exposure to intense light thus making the image plate reusable. By admixture of Gd_2O_3 the storage phosphor can be sensitized to thermal neutrons utilizing the extremely high absorption cross section of gadolinium in this energy range.

In collaboration with EMBL, Grenoblé (France) we have studied neutron sensitive image plates in combination with a suitable scanning system, which exhibit excellent characteristics:

1) High spatial resolution (about 150 µm)
2) Large linear dynamic range (10^3 - 10^6, depending on readout unit)
3) Almost unlimited detector size without reduction of the high spatial resolution
4) High *'detective quantum efficiency'*, (DQE about 30-40 %)

We have performed comparative measurements PSL recorded using a Molecular Dynamics 'Storm' scanner (635 nm) after neutron irradiation of a number of new combinations of converter/storage phosphors. The following materials have been prepared and measured:

1) Eu^{2+} doped BaSrFBr phosphor (which has a higher PSL response than BaFBr) containing varying quantities of Gd_2O_3 or $Li_2B_4O_7$ powder as neutron converter without any binder

2) inorganic borates $Sr_2B_5O_9Br:Ce^{3+}$ /K^+ and $Ca_2B_5O_9Br:Ce^{3+}$ which are intrinsically neutron-sensitive storage phosphors.

Measurements have been made for a number of the above-mentioned materials, in order to characterize the intrinsic fading of the PSL signal with time after neutron irradiation. The X-ray sensitivity and fading of several of these compounds have also been measured.

We have prepared image plates by layering Eu^{2+} doped BaSrFBr phosphor alternately with Gd_2O_3 converter. Prototype image plates have been constructed and tested using a spraying technique for the phosphor/converter. The method has the potential to produce large image plates with good uniformity.

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Master Thesis

V. Kashcheyevs, “**Quantum Pumping in Low-dimensional Nanostructures and Kinetic Phase Transitions in Non-equilibrium Stochastic Systems**”.

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 and electron beam lithography have been performed. Photoinduced changes of optical properties, holographic recording and hologram self-enhancement effects, and relaxation processes in amorphous films were studied. The main task was R&D of high sensitive photoresists in the visible region for holography and electron-beam resists for production of diffractive optical elements. Rainbow hologram production technology based on chalcogenide semiconductor photoresists was developed. R&D of Bragg grating structures for optical communication DWDM systems in planar wavequides based on amorphous chalcogenide semiconductor thin films were performed.

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3. Dr. P.Stradins
4. Dr. J.Teteris

Technical Staff

1. J.Gurovs
2. D.Popele

PhD Students

1. K.Jefimovs

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1. I.Kuzmina
2. I.Pisarevs

Visitors from abroad

1. Dr. A.Peckus, Institute of Physics, Lithuania (20 days).

Scientific visits abroad

1. Mg. K.Jefimovs, University of Joensuu, Finland (12 months).
2. Dr. P.Stradins, Thin Film Silicon Solar Cells Super laboratory, Electrotechnical Laboratory, Japan (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)

Japan

3. Electrotechnical Laboratory, Thin Film Silicon Solar Cells Super Lab. (Dr. P. Stradins).

Main Results

ADVANCED HOLOGRAPHIC STUDIES OF AZOBENZENE OLIGOMERS

A.Ozols and M.Reinfelde

Experimental holographic studies of azobenzene oligomer (ABO) layers brought on the glass substrates which were started last year have been proceeded and widened. The studied ABO samples prepared at Riga Technical University in the group of Professor V.Kampars differed by their chemical composition, matrices and by their connection type of azobenzene oligomers to the matrices (dispersed or covalently bound). Holographic grating recording and their coherent optical erasure have been experimentally investigated. The best holographic parameters (7.9% diffraction efficiency and 86 J/cm^2 specific recording energy) were achieved in the samples with covalent bonding to the matrix. This is much better than for the samples with dispersed ABO groups (0.028% and 1000 J/cm^2). Vector recording is also possible. Recording is unstable and reversible. The coherent optical erasure studies have shown its efficiency dependences on the initial diffraction efficiency, erasing beam intensity and grating period which are different for three groups of ABO samples. The conclusion is made that recording is due to the photoinduced alignment of the azobenzene chromophores followed by refractive index changes. These are the first results and further studies are in progress.

ANGULAR SELECTIVITY OF THIN HOLOGRAMS

A.Ozols and M.Reinfelde

It is widely assumed that thin holograms do not possess angular selectivity, i.e., their diffraction efficiency (DE) does not depend on the readout angle. This conclusion follows from from Kogelnik's coupled-wave theory as well as from rigorous theories of diffraction gratings. However, our experiments with elementary holograms – holographic gratings (HG) in a-As-S-Se films (thickness 2.2 μm, wavelength 0.6328 μm, HG periods 0.45 – 10 μm) have shown a strong and oscillatory DE angular dependence of thin HG.It is found that this angular dependence is caused neither by the angular dependence of reflection coefficient nor by Gaussian intensity distribution in laser beams. Angular selectivity is not predicted also by thin HR theory based on Fresnel – Kirchhof diffraction integral in non-axial Fraunhofer approximation taking into account angular dependences . In our opinion, the observed oscillatory DE angular dependences of thin HG is the result of multiple internal reflections of light waves inside the a-As-S-Se film followed by their interference. Interference conditions depend on optical path which is changing when the readout angle is changing.Angular selectivity of thick HG in a-As_2S_3 films is considered for comparison. The concepts of thin and thick diffraction gratings are analysed.

OPTIMIZATION OF HOLOGRAPHIC RECORDING IN AMORPHOUS CHALCOGENIDE SEMICUNDUCTORS

M.Reinfelde, J.Teteris

The holographic recording parameters of amorphous chalcogenide semiconductor (AChS) thin films under optimization depend on hologram type. The possibility to decrease recording energy by self-enhancement effect during recording and wet etching after recording for multilevel hologram recording was studied. Such necessity arises during embossed hologram formation process. The possibility to manage the holographic parameters through the choice of film thickness and recording wavelength was studied.

HOLOGRAPHIC RECORDING IN AMORPHOUS As-S-Se FILMS

I.Kuzmina and J.Teteris

Thin films of amorphous chalcogenide semiconductors (As-S-Se) have been recently studied as promising materials for optical recording. The essential photoinduced changes of optical refractive index ($\Delta n \leq 0.5$) enable to perform real time phase recording in these materials. Thin films of AChS can be applied both as a medium for direct phase recording and as photoresists where recording is formed by surface modulation.

The phenomenon of photo-stimulated changes of *wet* etching rate in AChS films was studied. The main functional principles and possibilities of the practical application of amorphous As-S-Se photoresists for the production of the embossed *rainbow* holograms and holographic optical elements are discussed.

The self-enhancement of holograms (an increase of diffraction efficiency after holographic recording) was studied. The changes of diffraction efficiency in amorphous AChS films have been measured as a function of ageing time, initial diffraction efficiency and recording light intensity. The possibility of light- and thermo-induced amplification of diffraction efficiency of holograms after their recording was studied.

APPLICATION OF AMORPHOUS CHALCOGENIDE SEMICONDUCTORS IN INFORMATION TECHNOLOGY

J.Teteris

Thin films of amorphous chalcogenide semiconductors (As-S, As-Se, Ge-S, Ge-Se) have been recently studied as promising media for optical recording and processing of information. The essential photoinduced changes of optical properties ($\Delta n \leq 0,8$; $\Delta E_g \leq 0,4$ eV) enable to perform real time phase or amplitude recording in thin films of these materials. The photoinduced changes in amorphous chalcogenide semiconductors are due to transformation of the chemical bonds. Therefore these materials possess extremely high resolution ($\sim 10^4$ mm^{-1}) and they can be successfully used in holography and photolithography. The photoresists with a light sensitivity ~ 10 mJ/cm^2 for visible spectrum ($\lambda \leq 700$ nm) were produced on the base of these compounds. The main functional principles and possibilities of the practical use of these photoresists for the production of embossed holograms and holographic optical elements are discussed. The possibility to apply the thin films of amorphous chalcogenide semiconductors as planar waveguides has been shown.

STUDIES OF PHOTOCARRIER CAPTURE PROPERTIES IN a-Si:H

P.Stradins

In hydrogenated amorphous silicon (a-Si:H) materials we usually observe the various photoconductivity even when the films contain almost the same number of defects. It indicates that ability to capture the photocarrier by the defect is not unique. We have studied the photocarrier capture intothe light induced defects (LIDs) in a-Si:H. The ability of the LID to capture photocarriers would be influenced by microscopic enviroment around it. This microscopic enviroment is determined by several factors, such as hydrogen bonding structure and Si network order. What kind of structure is responsible for the observed photocarrier capture coefficients is the focus of this work. First we studied a-Si:H prepared at various substrate temperatures. Those films were then degraded by the exposure to the nanosecondlaser pulses. After each exposure step, the bandgap photoconductivity, subgap absorption spectra and spin density were measured. We observe a significantly stronger photocarrier capture in the film deposited at 150 ^oC, which is 10 times larger than those of the films deposited at higher temperatures up to 250 ^oC. This indicates that the microscopic structure around the defect, which governs the photocarrier capture ability, is different throughout those films. The film deposited at lower temperatures contains a large amount of hydrogen, whereas the higher temperature deposited films do not. The photocarrier recombination event would have much chance to release the recombination energy to Si-H bond rather than Si-Si bond due to their vibrational energy difference. Therefore, when the Si-H

bond is located close to the defect, the ability to capture photocarriers is likely to become larger. We also studied the photocarrier capture coefficient in thea-Si:H films prepared under various hydrogen dilution ratio including the microcrystalline nucleation threshold regime. The a-Si:H network is modified by the change in deposition precursors due to the hydrogen dilution during the preparation, resulting in different microscopic environment around the defects. We also discuss the photocarrier capture coefficient in these films, as they approoach the transition region for the nucleation of crystallites.

Scientific Publications

1. A.Ozols, M.Reinfelde. *Vector holograms in amorphous chalcogenides*. Scientific Proc. of Riga Technical University. Series: Material Science and Applied Chemistry, 2001, vol.**3**. pp.127-139.
2. J.Teteris. *Holographic recording in amorphous chalcogenide semiconductor thin films*. in Non-Oxide Glasses and New Optical Glasses, University of Pardubice, Czech Republic, 2002, Part 2., p. 621-628.
3. A.Ozols, M.Reinfelde and J.Teteris. *Effect of reflections on phase hologram recording in amorphous As-S-Se films.* Radiation Effects &Defects in Solids, 2002, vol. **157**, p.1167-1171.
4. J.Teteris. *Amorphous As-S-Se semiconductor resists for holography and lithography.* Journ. of Non-Cryst.Solids, 2002, vol. **299&302**, p. 978-982.
5. P.Stradins, S.Shimuzu, M.Kondo and A.Matsuda. *Less-understood phenomena in the light-induced degradation and photocarrier capture in a-Si:H*. Journ. of Non-Cryst.Solids, 2002, vol. **299&302**, p. 460-465.
6. S.Shimuzu, P.Stradins, M.Kondo and A.Matsuda. *Photocarrier capture properties in a-Si:H.* Journ. of Non-Cryst.Solids, 2002, vol. **299&302**, p. 466-470.
7. P.Stradins, M.Kondo and A.Matsuda. *Pump-probe pulse transient photoconductivity study in amorphous and microcrystalline Si:H.* Journ. of Non-Cryst.Solids, 2002, vol. **299&302**, p. 370-374.
8. J.Teteris. *Holographic recording in amorphous chalcogenide semiconductor thin films.* Journ. of Optoelectronics and Advanced Materials, 2002, vol. **4**, p. 687-697.
9. M.Reinfelde, J.Teteris, I.Kuzmina. *Holographic recording optimization in amorphous As-Se-S films.* Proc.SPIE, 2002, vol. **4829**, p. 569-570.
10. K.Jefimovs, V.Kettunen, M.Honkanen, M.Kuitinen, J.Turunen, P.Vahimaa, M.Kaipiainen, S.Nenonen, M.Bavdaz. *Fabrication of inductive grid filters for rejection of infrared radiation.* Proc.SPIE, 2002, vol. **4829**, p. 317-318.

In Press

1. A.Ozols, Ģ.Ivanovs and S.Lazarevs. *Impulse holograms in amorphous semiconductor films. Scientific Proc. of Riga Technical University*, 2003.
2. A.Ozols, V.Kampars, M.Reinfelde, V.Kokars.*Hologram recording in azobenzene oligomers.* Proc. SPIE, 2003, vol. **5123**, p.102 – 109.
3. A.Ozols, M.Reinfelde. *Theoretical and experimental studies of light diffraction anisotropy by holograms in a-As-S-Se films.* Proc.SPIE, 2003, vol. **5123**, p.136 – 141.
4. J.Teteris. *Holographic recording in amorphous chalcogenide semiconductor thin films.* Proc.SPIE, 2003, vol. 5123, p. 110-119.

5. M.Reinfelde, J.Teteris, I.Kuzmina. *Amorphous As-S-Se films for holographic recording.* Proc.SPIE, 2003, vol. 5123, p. 128-135.
6. I.Kuzmina, J.Teteris, M.Reinfelde. *Relief holographic recording in amorphous As-S-Se.* Proc.SPIE, 2003, vol. 5123.
7. J.Teteris. *Holographic recording in amorphous chalcogenide semiconductor thin films.* Journ. of Non-Cryst. Solids, 2003.

Lectures on Conferences

18th Scientific Meeting of Institute of Solid State Physics, University of Latvia, Riga, February 11-13, 2002

1. A.Ozols, M.Reinfelde. *Diffractive anisotropy studies in amorphous As-S-Se films*. Abstracts, p.3.
2. M.Reinfelde, J.Teteris. *Optimization of holographic recording in As-S-Se thin films.* Abstracts, p.4.
3. I.Kuzmina, J.Teteris. *Holographic relief recording in amorphous As-S-Se films.* Abstracts, p.5.
4. J.Teteris. *Application of amorphous chalcogenide semiconductor thin films in optical communication systems.* Abstracts, p.79.

4th International Conference *Photonics Praque 2002* , Czech Republic, Praque, May 26-29, 2002

J.Teteris. *Fabrication of Bragg grating structuries in amorphous chalcogenide semiconductor thin*. Abstracts, p.117 (poster).

7th Conference of the Latvian Physical Society, Daugavpils, Latvia, June 7-8, 2002

A.Ozols.*Zeroth-order light diffraction and the structure of matter* (oral presentation).
Vj.Gerbreders, J.Teteris *Formation and printing of holograms* (oral presentation).

Europhysical Conference on Defects in Insulating Materials,Wroclav, Poland, July 1-5, 2002

5. A.Ozols, M.Reinfelde. *Effect of site on the phase hologram recording in amorphous As-S-Se films.* Program & Abstracts, p.Th-88. (poster presentation).

3rd International Conference on Amorphous and Microcrystalline Semiconductors, Sankt-Peterburgh, Russia, July 2-4, 2002

6. I.Kuzmina, J.Teteris, M.Reinfelde. *Relief holographic recording in amorphous As-S-Se.* Abstracts, p. 237.
7. M.Reinfelde, J.Teteris, I.Kuzmina. *Amorpohous As-S-Se films for holographic recording.* Abstracts, p.10.

The 3rd Int. Conf. *Advanced Optical Materials and Devices,* Riga, Latvia, August 19-22, 2002

8. A.Ozols, V.Kampars, M.Reinfelde, V.Kokars. *Hologram recording in azobenzene oligomers.* Programme and Abstracts, p.10 (oral presentation).
9. A.Ozols, M.Reinfelde. *Theoretical and experimental studies of light diffraction anisotropy by holograms in a-As-S-Se films.* Programme and Abstracts, p.147 (poster presentation).
10. J.Teteris. *Holographic recording in amorphous chalcogenide semiconductor thin films.* Programme and Abstracts, p.112 (oral presentation).

11 .M.Reinfelde, J.Teteris, I.Kuzmina. *Amorphous As-S-Se films for holographic recording.* Programme and Abstracts, p.146 (poster presentation).
12. I.Kuzmina, J.Teteris, M.Reinfelde. *Relief holographic recording in amorphous As-S-Se.* Programme and Abstracts, p.148 (oral presentation).

19th Congress of the International Commission for Optics, Florence, Italy, August 25-30, 2002
13. M.Reinfelde, J.Teteris, I.Kuzmina. *Holographic recording optimization in amorphous As-Se-S films.* Abstracts (poster presentation).
14. K.Jefimovs, V.Kettunen, M.Honkanen, M.Kuitinen, J.Turunen, P.Vahimaa, M.Kaipiainen, S.Nenonen, M.Bavdaz. *Fabrication of inductive grid filters for rejection of infrared radiation.* Abstracts (oral presentation).

The 13th International Symposium on Non-Oxide Glasses and New Optical Glasses, Pardubice, Czech Republic, September 9-13, 2002
15. J.Teteris. *Holographic recording in amorphous chalcogenide semiconductor thin films.* Abstracts, p.4 (invited report)

The 43rd Scientific Conf. of Riga Technical University, Riga, Latvia, October 11-14, 2002
16. A.Ozols, V.Kampars, M.Reinfelde, V.Kokars. *Azobenzene oligomers for holographic information recording* (oral presentation).
17. A.Ozols, S.Lazarevs, B.Berzina. *Millisecond impulse holograms in amorphous As-S-Se films* (poster presentation).

DEFECT PHYSICS IN IONIC MATERIALS

Head of Division Dr. hab. phys., Assoc. prof. B. Berzina

Research Area and Main Problems

The research field is connected with properties of radiation defects and their accumulation in ionic materials such as *alkali earth fluorides* and *III-V group nitrides*. These defects are either created or transformed under irradiation of ultraviolet light. A special attention is paid to the behavior of oxygen-related defects, which are native defects in these materials. Optical research methods based on luminescence are applied.

Scientific Staff
1. Dr.hab.Assoc.prof.B.Berzina
2. Dr.L.Trinklere

Ph. D. Students
1. J.Sils

Students
1. R.Krutohvostov,
2. I.Megnis

Scientific Visits Abroad
1. J.Sils. Ludvigs Maximillian University Munich, Germany (9 month).
2. L.Trinkler. RISOE National Laboratory, Roskilde, Denmark (2 weaks).
3. B.Berzina. Ludvigs Maximillian University Munich, Germany (1 weak).
4. B.Berzina. University of Nice-Sophia Antipolis, Nice, France (1 weak).

Scientific Visitors
1. M.Reichling. Ludvigs Maximillian University Munich, Germany (1 month).

Cooperation

Latvia
Institute of Inorganic Chemistry, Riga TU (Dr. E.Palcevskis)

Denmark
RISO National Laboratory, Roskilde (Dr. A.Botter-Jensen)

Germany
Ludvigs Maximillian University Munich (Prof. M. Reichling)

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

Japan
Naruto University of Education, Department of Physics (Prof. K.Atobe)

Main results

SPECTRAL CHARACTERISTICS OF NATIVE DEFECTS AND ENERGY ACCUMULATION IN AlN AND cBN CERAMICS

B. Berzina and L.Trinkler

Some problems of defect physics of III-V group nitrides were studied. Luminescence mechanisms of native defects and UV light induced energy accumulation in AlN and cBN ceramics were investigated. Two types of AlN ceramics were used: one of them is AlN-Y_2O_3 samples sintered at Institute of Inorganic Chemistry, RTU, and the second one are partly transparent AlN ceramics, which contain no additive and are made in Japan. Partly transparent plates of cBN ceramics are also made in Japan.

The following main results have been obtained. In the case of AlN a problem of defect structure of oxygen-related defects responsible for the UV-visible recombinative luminescence seems to be solved. The luminescence mechanism is proposed and explained in terms of energy level scheme. This mechanism allows not only explain formation of UV-visible photoluminescence having recombinative-tunneling character but also understand the UV-light induced energy accumulation in the crystalline lattice of AlN, which can be released either through photostimulation or thermo-stimulation processes [3]. Studies of other types of luminescence centers, which could also contain oxygen-related defects are in progress.

The second part of our work concerns the studies of the dosimetric characteristics of AlN-Y_2O_3 ceramics after UV irradiation. Results of our research allow consideration of the AlN ceramics as a perspective material for use in UV dosimetry. The studies of dosimetric characteristics of AlN are in progress [1].

Spectral characteristics of cBN were investigated. The results obtained allow us to propose that like AlN also in cBN oxygen-related defects are responsible for photoluminescence forming a broad visible band at room temperature [2]. Further investigations are in progress.

OXYGEN-RELATED NATIVE DEFECTS IN CaF_2 CRYSTAL

J.Sils, B.Berzina, L.Trinkler

CaF_2 is one of perspective materials for developing short wavelength laser optics, because this material is transparent within a wide spectral range of UV light. Therefore, presence of native defects in a crystalline lattice of the material among which oxygen-related defects are the most spread is undesirable. Spectral characteristics of CaF_2 crystals containing different content of oxygen-related defects are investigated. These investigations were performed in terms of collaboration with colleagues from Ludwigs-Maximillian University (Prof. M.Reichling) and will be continued in future.

Scientific Publications published in 2002

1. L.Trinkler, B.Berzina, M.Benabdesselam. *Use of AlN ceramics in ultraviolet radiation dosimetry.* Proc. SPIE vol. **5123**, "Advanced Optical Devices", 2003, pp. 50-55.

2. B.Berzina, L.Trinkler and K.Atobe. *Spectral characteristics of native defects in BN*. Phys. Stat. Solidi (c), **0,** No1, 2002, pp.421-424.

3. B.Berzina, L.Trinkler, J.Sils and K.Atobe. *Luminescence mechanisms of oxygen-related defects in AlN.* Radiation Effects & Defects in Solids, **157**, 2002, pp. 1089-1092.

Lectures on Conferences

International Workshop: Nitride Semiconductors. (Aachen, Germany, July 22-25, 2002).

1. B.Berzina, L.Trinkler, J.Sils and K.Atobe. *Spectral characteristics and structure of native defects in AlN and BN,* (poster presentation).

Europhysical Conference: Defects in Insulating Materials. (Wroclaw, Poland, July 01-05, 2002).

2. B.Berzina, L.Trinkler, J.Sils and K.Atobe. *Native defects and their spectral characteristics in AlN and BN,* (poster presentation).

The 3th International Conference: Advanced Optical Materials and Devices, (AOMD-3). (Riga, Latvia, August 19-22, 2002).

3. B.Berzina, L.Trinkler. *Spectral characteristics of native defects in AlN and BN crystalline lattice,* (poster presentation).
4. L.Trinkler, B.Berzina, M. Benabdessalem. *Use of AlN ceramics in ultraviolet light dosimetry,* (poster presentation).

18. LU CFI Zinātniskā konference (Scientific Conference in Riga): Riga. 11.-13. februāris, 2002.

5. B.Berzna, L.Trinklere, J.Sils un A.Esenvalde. *Native defects and their optical properties in AlN and BN*, (oral presentation).
6. B.Berzina, L.Trinkler. *Spectral characteristics of native defects in AlN and BN crystalline lattice*, (oral presentation).

LABORATORY OF OPTICAL MATERIALS

Head of Division Dr.hab.Phys., Prof. I.Lacis

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 (electrooptic PLZT ceramics, polymer dispersed liquid crystals PDLC);
- 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 (spatial frequency analyse, crosscorrelation of binocular visual stimuli, stereodisparity evaluation);
- evaluation of suppression strength and depth on quality of vision binocular functions and on dominant eye;
- evaluation of accommodation/convergence mechanisms reading print materials and for regular computer users;
- visual perception of different (conventional, luminous, retroreflective) road signs and marks at dazzling conditions during night driving.

Scientific Staff

1. Dr.habil.phys. I.Lacis
2. Dr.habil.phys. M.Ozolinsh
3. Dr. J.Dzenis
4. Dr. V.Grabovskis

PhD Students

1. M.Sc. A.Balgalve
2. M.Sc. G. Papelba
3. M.Sc. J. Fridrihsons
4. M.Sc. A. Švede

Graduate Students

1. B.Sc. D. Rācene
2. B.Sc. R.Paeglis
3. B.Sc. I. Čipāne
4. B.Sc. I. Supe
5. B.Sc. J. Petrova

Each year around 20 bachelor grade and up to 10 master grade students (mainly optometrists) perform their diploma work in the laboratory. Student research works have been appreciated at the national and international level (in 2002 - *B.Sc.* R.Paeglis – ***EPS-10*** *and* ***ICPS*** *joint session student award*).

Visitors from abroad

Prof. S.Villani, Florence University , Italy (4 weeks)

Scientific visits

M. Ozolinsh, R. Paeglis – University of Murcia, Optics Laboratory 12.05.-26.05.2002.
M.Ozolinsh – Chalmers TH, Gőteborg, Sweden, 23.07.-05.08. 2002.
A. Balgalve – City University, London 3.03.-18.03.2002.
V. Grabovskis, P. Cikmacs, S. Purvina, I. Herzoga – Firenze, 22.04.- 22.05. 2002.

Cooperation

Italy	Florence University , Italy, (Prof. S. Villani) Universita` di Roma "Tor Vergata" (Prof. I. Davoli)
Sweden	Lund University (Prof. S.Svanberg) Department of Clinical Science of Karolinska Institute (Dr. H. Richter) Chalmers TH, Sweden (Prof. L.Komitov)
Norway	Buskerud Høgskolan, Institut for optometri (Prof. K. I. Daae).
Great Britain	Bradford University (Prof. D.Whittaker) City University (Dr. W.Thomson)
Spain	Laboratorio de Optica, Universidad de Murcia, Spain (Prof. P. Artal)
Scotland	Psychology Department, University of Glasgow, Scotland (Dr.D.Simmons)
Germany	Electrophysiology Lab, Klinikum der Albert-Ludwigs-Universität, Freiburg (Prof. M. Bach)

Main Results

STEREOACUITY DETERMINATION AT CHANGING CONTRAST OF COLORED STEREOSTIMULI

Gunta Papelba, Maris Ozolinsh, Jelena Petrova, and Inara Cipane
Department of Optometry and Vision Science

Studies are focused on design and appraisal of an objective test for assessment of the stereovision quality in unfavourable conditions. Stereostimuli of different colours are used while the contrast of one of the stimulus being varied. Tests are based on principles of black-and-white and two primary colour random dot stereotests (*B.Julesz, 1974*). Experiments are divided by the method of stimuli display and separation: 1) stereoeffect is obtained haploscopically – by use of spectacles with colour filters (blue and red) or

prisms, 2) stimuli separation is obtained by liquid crystal shutters when both eye stimuli are demonstrated with a different delay. The stereovision threshold is determined at different stimuli disparities simulating the random dot stereotests on a computer monitor with a variable contrast of one-colour stimuli. The applied tests differ by stimuli geometry, separation of vision channels, and by data processing. Tests have been appraised and may be used in stereovision studies.

STEREOVISION STUDIES BY DISBALANCED IMAGES

Gunta Papelba, Inara Cipane, and Maris Ozolinsh
Department of Optometry and Vision Science, University of Latvia, Riga, Latvia

Studies are focused on design and appraisal of an objective test of the quality of stereovision depending on optical stimuli blurring and detecting of the stereovision threshold at various stimuli blur degree. The method is based on the principles of greyscale and colour random dot stereotests. Experiments may be divided with respect to the principle of demonstration: 1) the blur is modelled by defocusing an optical lens – the strength of the optical system is varied at a constant quality of the stimulus, or 2) the blur is simulated on the computer screen – here the quality of the stimulus varies. To obtain an independent description and to measure blurring the experimentally demonstrated images are analysed with regard to modulation depth, Fourier frequencies and by cross-correlation.

COMPUTERIZED DEVICE FOR CRITICAL FLICKER FUSION FREQUENCY DETERMINATION

Diana Racene
Department of Optometry and Vision Science, University of Latvia, Riga, Latvia

The critical fusion flicker frequency of the human visual system is the threshold sensitivity for a sine wave-modulated patch of monochromatic flickering light measured as a function of its temporal frequency and average luminance level. The critical flicker fusion frequency changes in different ocular and non-ocular conditions, for example: high-myopia, AMR, glaucoma, schizophrenia, after alcohol intake, fatigue. A computerized test for critical flicker fusion frequency determination was developed. Visual stimuli are two monochromatic LED light sources that are connected to a microcircuit driven by a computer program. The control of the device is realized through the parallel port of the PC. During the test a patient has to choose which one of two light sources is flickering. The critical flicker fusion frequency is determined by a psychophysical procedure, where the stimulus frequency that showed detection probability 75% is considered as threshold.

SELECTIVE FILTERS FOR IMPROVEMENT OF COLOR DISCRIMINATION

I.Supe and V.Grabovskis
Department of Optometry and Vision Science, University of Latvia, Riga, Latvia

Coloured filters have been used as possible aids for perception in case of congenital colour vision abnormalities. Higher stimulation for L cones in one eye (red filter) and for M cones (green)in other eye acts as a simple method to interfere in human colour vision

processing. Influence on subjective and objective vision performances as binocular functions, fusion, stereopsis and colour vision has been tested. Special coloured glasses have been created, taking into account each subjects ‘ refraction for distance and tested for the 5 months adaptation time. No negative influence on binocular functions, no changes of heterophoria and lowering in fusion ability and stereopsis have been stated due to use of the selective filters. Red/green isoluminant contrast perception ability for distance improved from 0.2 to 0.8m individually. Subjective colour perception improvement has been stated during use in adaptation time for all subjects.

ADDITIONAL USAGE POSSIBILITIES FOR THE COMPUTERIZED HESS SCREEN

Aiga Svede and Janis Dzenis
Department of Optometry and Vision Science, University of Latvia, Riga, Latvia

The purpose of the study was to work out a method how to use the computerized Hess screen in proximal vergence measurements. Proximal vergence or vergence due to knowledge of nearness is one of four independent components making up the total vergence response. Proximal vergence is expressed as a ratio – proximal convergence/test distance (PC/T). The computerized Hess screen is usually used to detect and to measure an ocular misalignment in patients with paralytic strabismus in different directions of gaze. The computerized Hess screen can be used to assess PC/T ratio in different directions of gaze, providing the open-loop disparity vergence and accommodation systems and assuming that tonic vergence is stable. The fusional system loop is opened using red/green filter goggles, objects with different size and colour, a completely darkened room, and vertical dissociation (using a prism). The accommodation system loop is opened using pinhole. The test was performed on 16 neurologically and binocularly normal subjects (14 women, 2 men; average 24 y., 20-38 y.). Average PC/T ratio in a primary position for the whole group was 2.8 pd/D with a standard deviation ±0.8 pd/D, which correlates with results in literature obtained by other methods.

ELECTRICALLY INDUCED LIGHT SCATTERING IN PLZT CERAMICS MODEL EYE

M.Ozolinsh, R.Paeglis
University of Latvia, Riga
P. Artal, J. M. Bueno, E. Berrio
Laboratorio de Óptica, Dept. de Física, Universidad de Murcia

Applying the electrical field $\boldsymbol{E}$ in PLZT 8.75-9.0/65/35 ceramics induces reversible nucleation of small polar regions, which gives a dominant contribution in the dielectric polarization $\boldsymbol{P}$ vs. $\boldsymbol{E}$ dependence. These polar regions in ceramics have random orientation of crystallographic axes, they are birefringent, thus nucleation creates remarkable light scattering. The induced birefringence as well the difference in refractive indices (determining light scattering) are proportional to the square of dielectric polarization, and one can observe scattering at the applied electric field $\boldsymbol{E} > 5$-7 kV/cm. Using PLZT ceramics plate situation similar to that of a cataract eye is simulated. Varying the voltage applied to the plate allows continuously to change

scattering efficiency. Decrease of a patient vision acuity ***VS*** by increasing the scattering has been measured psychophysically placing PLZT plate before the human eye. The PLZT plate together with a +56D lens were used as an electrically controllable eye model to simulate image formation in an eye with cataract [1]. Using the double pass (**DP)** technique [2] the characteristics of the pointspread function **PSF** were studied for green He-Ne (543 nm) and near IR laser (780 nm) point sources. The spectral power transfer (**PSF** radial profile) from the eye pupil diffraction restricted low spatial frequencies to the light scattered by PLZT plate at greater angles is more remarkable for shorter wavelength green laser point source. As compared with an human eye the primary image in the eye model instead of retina is formed on a diffuse reflected glass surface, light does not participate in multiple scattering events and does not loose remarkable its polarization degree. Thus the balance between the spatial spectral power transfer differs for cases when an analysator in orthogonal directions is used in the second pass.

Published and submitted papers

1. M. Ozolinsh, I. Lacis, R. Paeglis, A. Sternberg, S. Svanberg, S. Andersson-Engels, and J. Swartling, *"Electrooptic PLZT Ceramics Devices for Vision Science Applications,"* Ferroelectrics, **273**, 131-136 (2002).
2. G. Papelba, M. Ozolinsh, I. Cipane, and J.Petrova, "*The effect of image blurring degree, luminance, and chromatic contrast in one eye on stereovision*" Perception, **31**, p.156 (2002).
3. M. Ozolinsh, G. Papelba, and G. Andersson, *"Liquid crystal goggles for vision science," Proc.SPIE "Optics for the Quality of Life*", Edit. A. Consortini and G.C. Righini, **4829** (1) , pp.1021-1022, 2002.
4. J. Berzinsh, M. Ozolinsh, P. Cikmacs, and K. Pesudovs, "*Recognition of retroreflective road signs during night driving."* In: Human Factors in Transportation, Communication, Health, and the Workplace, Eds. Dick de Waard, Karel Brookhuis, Jan Moraal, & Antonella Toffetti, Shaker Publishing, Maastricht, pp.155-164 (2002).
5. G. Papelba, I. Cipane, and M. Ozolinsh, *"Stereoacuity studies by disbalanced images,"* Proc.SPIE "Advanced Optical Materials and Devices", **5123**, pp.334-340 (2003).
6. G. Papelba, M. Ozolinsh, J. Petrova, and I. Cipane, *"Stereoacuity determination at changing contrast of colored stereostimuli,"* Proc.SPIE "Advanced Optical Materials and Devices", **5123**, pp.341-349 (2003).
7. I.Supe and V.Grabovskis, *"Selective filters for improvement of color discrimination."* Proc.SPIE "Advanced Optical Materials and Devices", **5123**, pp.350-353 (2003).
8. A. Svede and J, Dzenis, *"Additional usage possibilities for the computerized Hess screen,"* Proc.SPIE "Advanced Optical Materials and Devices", **5123**, pp.354-359 (2003).

9. D. Racene, "*Computerized device for critical flicker fusion frequency determination,"* Proc.SPIE "Advanced Optical Materials and Devices", **5123**, pp.360-365 (2003).
10. M. Ozolinsh, G. Papelba and G. Andersson, *"Spectral and temporal characteristics of liquid crystal goggles for vision research,"* Journal of Optics A: Pure and Applied Optics.

Abstracts of Reports in Int. Conferences

International Meeting of American Academy of Optometrists "Academy in Alps - 2002", April 13-15, Munich, Germany, 2002

I. Supe and V. Grabovskis "Selective filters for improvement of color discrimination." Abstr. International Meeting of American Academy of Optometrists-2002, Muenchen, Germany, p.233.

A. Svede "Changes of proximal convergence in different direction of gaze." Abstr. International Meeting of American Academy of Optometrists-2002, Muenchen, Germany, p.226.

M. Ozolinsh, J. Berzinsh, and K. Pesudovs "LED traffic sign recognition at various retinal illumination," Abstr. International Meeting of American Academy of Optometrists-2002, Muenchen, Germany, p.226.

IXth Int. Conf. "Laser Applications in Life Sciences", Vilnius Univ., July 7-11, Vilnius, 2002

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The 3rd International Conference "Advanced Optical Materials and Devices", August 19-22, Riga, 2002

D. Racene "Computer controled test for critical fusion frequency determination," Proc. of the 3rd International Conference "Advanced Optical Materials and Devices", August 19-22, Riga, Latvia, p.80 (2002).

G. Papelba, M. Ozolinsh, and J. Petrova, "Method of determination of stereopsis colour contrast threshold," Proc. of the 3rd International Conference "Advanced Optical Materials and Devices", August 19-22, 2002, Riga, Latvia, p.84.

M. Ozolinsh, J. Berzinsh, and K.Pesudovs, "LED traffic sign recognition at various retinal illumination," Proc. of the 3rd International Conference "Advanced Optical Materials and Devices", August 19-22, Riga, Latvia, p.82.

M Ozolinsh, G. Papelba, and G. Andersson, "Spectral and temporal transmittance of liquid crystal goggles used in vision tests," Proc. of the 3rd International Conference "Advanced Optical Materials and Devices", August 19-22, Riga, Latvia, p.83.

I. Supe and V. Grabovskis "Selective filters for improvement of color discrimination." Proc. of the 3rd International Conference "Advanced Optical Materials and Devices", August 19-22, Riga, Latvia, p.79.

G. Papelba, M. Ozolinsh, I. Cipane, and J. Petrova, “Evaluation of image’s quality to stereovision acuity,” Proc. of the 3rd International Conference “Advanced Optical Materials and Devices”, August 19-22, Riga, Latvia, p.102.

A. Svede, and J. Dzenis, "Additional usage possibilities for computerized Hess test," Proc. of the 3rd International Conference “Advanced Optical Materials and Devices”, August 19-22, 2002, Riga, Latvia, p.78.

The 12th General Conf. of the European Physical Society “Trends in Physics”, Budapest, August 26-30, 2002.

R. Paeglis and M. Ozolinsh, "Electro-optical solution for visual acuity and contrast sensitivity modeling," Proc. of the 12th General Conf. Of the European Physical Society “Trends in Physics”, Budapest, August 26-30, 2002, p.295.

The XXXV Nordic Congress of Ophthalmology, August 24-27, 2002, Tampere, Finland

G. Papelba, I. Cipane, and J.Petrova, “Stereoacuity studies by disbalanced images,” Abstr. of the XXXV Nordic Congress of Ophthalmology, August 24-27, 2002, Tampere, Finland, p.49.

G.Papelba, J.Petrova, and I. Cipane, “The influence of blue-red colour’s contrast to stereoacuity.” Abstr. of the XXXV Nordic Congress of Ophthalmology, August 24-27, 2002, Tampere, Finland, p.50.

The 25th European Conference on Visual Perception, August 25-29, 2002, Glasgow, UK

G. Papelba, M. Ozolinsh, I. Cipane, and J.Petrova, “The effect of image blurring degree, luminance, and chromatic contrast in one eye on stereovision” *Perception*, 31, p.156 (2002).

ICO-19, Triennial Congress of the International Commission for Optics : "Optics for the Quality of Life," 25-31 August 2002, Florence, Italy

M. Ozolinsh, G. Papelba, and G. Andersson, “Liquid crystal goggles for vision science,” *Proc.SPIE “Optics for the Quality of Life”*, Edit. A. Consortini and G.C. Righini, **4829** (1) , pp.1021-1022, 2002.

SURFACE PHYSICS

Head of Laboratory Dr.hab.phys. J.Maniks

Research Area and Main problems

- Micromechanical properties of solid surfaces and thin films.
- Modifications of the near-surface layers of novel materials by different treatments (e.g. light-, ion- and electron irradiations).
- Strength properties, adhesion and related processes on phase boundaries and interfaces in heterogeneous and nanostructured materials.

Research problems and objects

Photo-, thermo- and atmosphere-induced effects in fullerite C_{60} single crystals and polycrystalline films studied by microindentation, dislocation mobility and AFM methods.

Structural modifications and hardening of ionic crystals under irradiation with energetic (MeV-GeV) heavy (Au, Pb, Bi) and light (S, Ni) ions. The effect of ion-induced long-range stresses.

Mechanical properties of phase boundaries in Al-based eutectic alloys, effects of interfacial diffusion and intercrystalline brittleness.

Scientific staff

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

Students

4. A.Garbuzovs
5. L.Gailīte

Scientific Visits from Abroad

Dr.S.Stolyarova, Tehnion, Haifa, Israel (2 weeks).
Prof.K.Schwartz, GSI, Darmstadt, Germany (1 week).

Scientific Visits Abroad

Dr. I.Manika
GSI, Darmstadt, Germany (2 weeks).

Dr.F.Muktepavela
High Pressure Research Center, Warsaw, Poland (1 week).
International workshop “Diffusion, Segregation and Stresses (DSS-02)”, Moscow, Russia, (1 week).
A.F.Ioffe Physical Technical Institute, Russian Academy of Sciences, St.Petersburg, Russia (1 week).

Dr.J.Maniks
Workshop of the Networks of Centres of Excellence, Warsaw, Poland (1 week).
E-MRS Fall Meeting, Warsaw, Poland (1 week).
7th International Conference on Nanotechnologies and 21.European Conference on Surface Physics (NANO-7/ECOSS-21), Malmo, Sweden (1 week).

Cooperation

Latvia
1. Institute of Physical Energetics, Latvian Academy of Sciences (Dr.J.Kalnacs).
2. Riga Technical University (Prof.V.Mironovs).
3. Daugavpils Pedagogical University (R.Pokulis).
4. Institute of Chemical Physics, University of Latvia (Dr.D.Erts).

Germany
GSI, Darmstadt (Prof.K.Schwartz).

Ukraine
Institute of Metal Physics, Ukrainian Academy of Sciences, Kiev (Prof. M.Vasylyev).

Israel
Technion, Haifa (Dr.S.Stolyarova).

Poland
High Pressure Research Center, Warsaw, Poland (prof.W.Lojkowski).

Participation in the Network of Centres of Excellence "Interfacial effects, novel properties and technologies of nanostructured materials". Working group "Nanostructured metals obtained by severe plastic deformation" (Coordinator W.Lojkowski, Poland)

Participation in the PHANTOMS network (IST Nanoelectronics network)

Main Results

PHOTO-INDUCED POLYMERIZATION OF FULLERITE C_{60}

I.Manika, J.Maniks, R.Pokulis, J.Kalnacs**

The behaviour of photo-induced polymerization of fullerite C_{60} single crystals (99.9 % C_{60}) and nanostructured films has been investigated by microindentation, dislocation mobility, Raman spectroscopy and AFM methods. It has been found that the polymerization of fullerite under visible and ultraviolet light irradiation occurs in the range of 260 – 400 K and leads to significant hardening, lattice contraction and stress generation. Investigations of the kinetics and wavelength dependence show the multiphoton nature of polymerization. Two photo-polymerized phases, which differ by the hardness and thermal stability, were observed. The results confirm the well-known model of photoinduced formation of covalently bonded fullerene dimers or larger linear chains in a molecular lattice of fullerite. Possible volume distribution of the dimers is considered. The results are of interest for applications of fullerite as a photoresist or sensor material.

* *In cooperation with Institute of Physical Energetics, Latvian Academy of Sciences, and Daugavpils Pedagogical University.*

FORMATION OF DISLOCATIONS AND HARDENING OF LIF CRYSTALS IRRADIATED WITH ENERGETIC Au, Bi, Pb, AND S IONS

J. Maniks, I. Manika, K. Schwartz[*]*, M. Toulemonde*[*]*, C. Trautmann*[*]

LiF crystals were irradiated with Au, Pb, Bi, and S ions in the energy range 400-2300 MeV and studied by means of Vickers microindentation. Remarkable hardening effects are observed which depend on the applied fluence and ion species, and correlate with the ion energy loss along the ion path. The effect appears for Au, Bi and Pb ions at fluences above 10^9 ions/cm^2 and for S ions above 10^{10} ions/cm^2. It has been shown that the hardening is due mainly to irradiation-induced formation of defect complexes, clusters and aggregates with nanoscale dimensions, which serve as strong obstacles for dislocations and cause dispersion strengthening. X-ray diffraction measurements of the irradiated crystals show a decrease of the lattice constant indicating the presence of internal stress. Structural investigations reveal irradiation-induced long-range stress extending deep into the adjacent non-irradiated crystal and leading to the formation of dislocations. Close to the implantation zone, the stress exceeds the yield strength and causes microplastic deformation leading to additional hardening. Compared to light S ions, heavy ions (Au, Pb, Bi) cause more severe structural damage, larger hardening effects, and higher internal and long-range stress.

[*]*In cooperation with GSI, Darmstadt, Germany and Laboratory CIRIL, Caen, France.*

STRUCTURE EVOLUTION AND DIFFUSION DURING INTERPHASE BOUNDARY SLIDING IN FINE GRAINED BINARY EUTECTIC BASED ON Sn

F. Muktepavela, J.Maniks

Mechanical behaviour of interphase boundaries (IB), stability of defects and microstucture in heavily deformed binary eutectics (Al-Sn, Zn-Sn, Pb-Sn, Cd-Sn, Bi-Sn) have been investigated. For these eutectics, interphase boundary sliding (IBS) is the main mechanism of plastic deformation at room temperature, but IB energies are significantly different. It has been shown, that for eutectics with high IB energy (Al-Sn, Zn-Sn) IBS occurs by the dislocation gliding, followed by a marked strengthening and accompanied by the formation of IB cracks. Grain size is not changed during deformation and after annealing. For eutectics Pb-Sn, Bi-Sn, Cd-Sn with low IB energy IBS occurs by the viscous flow and is accompanied by matched diffusion along IB. The softening of IB is observed. It has been shown that the heavy deformation of Pb-Sn and Bi-Sn leads to formation of very fine grained (d≈0,05-1μm). IB have certain regular pattern, trading across the sample and representing narrow zones of viscous flow. The formation of pores or cracks in this case is not observed. It could be explained by intensive development of the correlated diffusion-promoted accommodation and dissolution-precipitation processes on IB. This causes the fast healing of defects. The role of IB energy in the stability of defects and development of accommodation processes of the IB of deformed eutectics has been analysed.

Scientific publications

Published in 2002

1. I.Manika, J.Maniks, R.Pokulis, J.Kalnacs. *Wavelength dependence and kinetics of photopolymerization of C_{60} single crystals studied by microhardness and dislocation mobility methods*. Fullerenes, Nanotubes and Carbon Nanostructures, 2002, vol.**10**, p. 69-80.
2. L. Shebanovs, J. Maniks, J. Kalnacs. *X-ray diffraction study of crystallographic parameters and Debye temperature of C_{60} single crystals.* Journal of Crystal Growth, 2002, vol.**234**, p.202-206.
3. I.Manika, J.Maniks, R.Pokulis, J.Kalnacs. *Illumination time-evolution and wavelength dependence of the photoinduced hardening of C_{60} crystals*. Fizika Tverdovo Tela, 2002, vol.**44**, p. 417-418.
4. I.Manika, J.Maniks, K.Schwartz, C.Trautmann. *Hardening and formation of dislocation structures in LiF crystals irradiated with MeV-GeV ions*. Nucl. Instr. and Meth. B 2002, vol.**196,** p.299-307.
5. F.Muktepavela and J.Maniks. *Structure Evolution and Diffusion During Interphase Boundary Sliding in Sn-Based Binary Eutectic. Interface Science*, 2002, vol.**10**, p.21-26.
6. F.Muktepavela, M.Vasylyev. *Hydrogen formation on phase boundaries of Sn/Al. In:"Hydrogen Materials Science and Chemistry of Metal Hydrides"*(Eds.M.D.Hampton, D.V.Schur, S.Y.Zaginaichenko,V.I.Trefilov). NATO Science Series II Mathematics, Physics and Chemistry, Kluwer Academic Publishers. 2002, vol.**71**, p.391-403.
7. F.Muktepavela, M. Vasylyev, V.G.Kostychenko. *Humid atmosphere induced processes of hydrogen formation and embrittlement of Sn-Al eutectic. In. "Hydrogen Materials Science and Chemistry of Metal Hydrides*"(Eds.T.N.Veziroglu, S.Yu.Zaginaichenko, D.V.Schur V.I.Trefilov). *NATO Science Series* II Mathematics, Physics and Chemistry, Kluwer Academic Publishers. 2002, vol.**82**, p.51-58.
8. V.Mironovs, F.Muktepavela. *Properties of AlB powder obtained by crushing Al-B composite presenting industrial waste.* Proceedings of 2nd In.conf." Materials and Coatings for Extreme Performances: Investigations, Applications, Ecologically Safe Technologies for their Production and Utilization", 16-20 September 2002 Katsiveli, Crimea, Ukraine, p.606-607.
9. J.Maniks, I.Manika, J.Kalnacs. *Photo-induced polymerization of fullerite C60 single crystals and nanostructured films"*, In Proceedings of the 7th Int.Conf.on Nanotechnologies and 21.European Conf. on Surface Physics (NANO-7/ECOSS-21), 24-28 June, 2002 Malmo, Sweden, p.40-41.

In Press

10. F.Muktepavela, J.Maniks. *Interface diffusion controlled sintering of atomically clean surfaces of metals.* In:" Diffusion, Segregation and Stresses in Materials". Proceedings of the Int.Conf. on Diffusion, Segregation and Stresses in Materials held in Moscow, Russia, May 27-31,2002. Ed.B.S.Bokstein and B.B.Straumal. Defect and Diffusion Forum, Scitec Publications Ltd.,Switzerland. 2003, vol.**216-217**, pp.169-174.

11. I.Manika, J.Maniks, K.Schwartz, C.Trautmann, M.Toulemonde. *Hardening and long-range stress formation in lithium fluoride induced by energetic ions.* Nucl. Instr. and Meth. B (accepted).
12. J.Maniks, I.Manika, K.Schwartz, M.Toulemonde, C.Trautmann. *Formation of dislocations and hardening of LiF crystals irradiated with energetic Bi, Pb and S ions*. In: Proc.SPIE vol. **5122**, "Advanced optical materials", 2003, pp. 16-23

.

Lectures on conferences

18th Scientific Conference, Institute of Solid State Physics, University of Latvia, Riga, February 11-13, 2002

1. R.Pokulis, I.Manika, J.Maniks, J.Kalnacs. *Influence of temperature on photopolymerization processes in C60 single crystals.* Abstracts, p.39.
2. F.Muktepavela, M.Vasiljev. *Humid atmosphere induced embrittlement of Sn-Al eutectic and hydrogen formation.* Abstracts.p.68.

Workshop of the Network of Centres of Excellence "Nanostructured metals prepared by severe plastic deformation", Warsaw, Poland, April 12, 2002

3. F.Muktepavela. *Obtaining of bimetallic interfaces and their mechanical properties in deformed state.*

Workshop of Network of Centres of Excellence "Nanoparticles and nanotubes in polymers and other matrixes", Warsaw, Poland, May 24-25, 2002

4. J.Maniks.*Polymerization of fullerite C_{60} under laser irradiation.*

7th Conference of Physical Society of Latvia, Daugavpils, June 7-8, 2002

5. R.Pokulis, I.Manika, J.Maniks, J.Kalnacs. *Relaxation of photopolymerization-induced stresses in fullerite C_{60} crystals.* Abstracts.p.27-28.

The 5thInternational Syposium on "Swift Heavy Ions in Matter" (SHIM 2002), Giardini Naxos, Taormina, Italy, May 22-25, 2002

6. I.Manika, J.Maniks, K.Schwartz, M.Toulemonde, C.Trautmann. *Hardening and long-range stress formation in lithium fluoride induced by energetic ions.* Abstracts. p.O5.

International workshop "Diffusion, Segregation and Stresses (DSS-02)", Moscow, Russia, May 27-31, 2002

7. F.Muktepavela, J.Maniks. *Surface diffusion controlled sintering of atomically clean surfaces of metals.* Abstracts.p.59.

7th International Conference on Nanometer-scale Science and Technology and 21st European Conference on Surface Science (NANO-7 and ECOSS-21), Malmo, Sweden, June 24-28, 2002

8. J.Maniks, I.Manika, J.Kalnacs. *Photo-induced polymerization of fullerite C60 single crystals and nanostructured films.* Abstracts.p.113.

The 3rd International Conference "Advanced Optical Materials and Devices", Riga, Latvia, August 19-22, 2002

9. J.Maniks, I.Manika, K.Schwartz, M.Toulemonde, C.Trautmann. *Formation of dislocations and hardening of LiF crystals irradiated with energetic Bi, Pb and S ions.* Abstracts.p105.
10. F.Muktepavela, I.Manika, L.Grigorjeva, V.Skvortsova.*Micromechanical properties of AlN and AlN/TiN nanostructured multilayer coatings.* Abstracts.p.157.

European Materials Research Society Fall Meeting. Symposium C "Interfacial Effects and Novel Properties in Nanomaterials" and Workshop of the Network "NANO-structured Materials",Warshaw, Poland, September 14-18, 2002

11. J.Maniks and F.Muktepavela.*Mechanical peroperties of deformed interfaces in bimetallic joints.* Programme and Abstracts.p.28.

2nd International Conference" Materials and Coatings for Extreme Performances: Investigations, Applications, Ecologically Safe Technologies for their Production and Utilization", Katsiveli, Crimea, Ukraine September 16-20, 2002

12.V.Mironovs, F.Muktepavela. *Properties of AlB powder obtained by crushing Al-B composite presenting industrial waste.*

Participation in exhibitions

Presentation of fullerene C_{60} products at International exhibition Hanovere Messe, Germany, April 15-20, 2002.

LABORATORY OF RADIATION PHYSICS

Head of laboratory Dr. hab. J.Berzins

Research Area and Main Problems

The Laboratory consists of four groups – the nuclear spectroscopy and theory, applied nuclear physics, oxyde physics and high temperature superconductivity. 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 radioactive and nuclear materials in Latvia
- use the nuclear spectral methods for the investigation of forest ecosystem
- investigation of microelement levels and Ca in teeth and whole blood by neutron activation analysis and total reflection X-ray spectrometry.
- the analysis of HANES , EXAFS, optical absorption and luminescence study of MeO - MgO solid solutions. The dependence of the Me-Mg , Me-O and Me-Me distance from the composition and its links with optical properties;
- radiation effects in the dielectric crystals (MgO, $YAlO_3$, $LiNbO_3$);
- the use of the physical methods (MORPHOQUANT, EPR and optical absorption and luminescence) in the medical physics (retrospective medical dosimetry);
- flux pinning in neutron irradiated 123 high temperature superconductors and its relationship to magnetic anisotropy.

Scientific Staff

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

Technical Staff

1. S.Afanasjeva
2. L. Neiburgs
3. A. Sotaks
4. M. Polakovs

Students

1. A. Andrejevs
2. A. Dzalbs

Visitors from abroad

Dr. J. Honzatko Institute of Nuclear Physics, Prague, Czech Republik (7 days).

Scientific visits abroad

Dr. hab. A.Afanasjev Argonne Lational Laboratory, USA (5 months).
Dr. hab. A.Afanasjev Notre Dame University, Notre Dame,USA (2 month).
Dr. hab. J. Berzins European Commisssion Euratom, Brussels,Belgium (10 days).
Dr. hab. V. Bondarenko Institute of Nuclear Physics, Prague, Czech Republik (20 days).
Dr. hab. N.Mironova - Ulmane Institute of Physics, Tartu, Estonia (7 +7days).
Dr. hab. N.Mironova – Ulmane Synchrotron Radiation Laboratory DAΦNE-LIGHT Fraskati Italy (14 days)
Dr A.Kuzmin Synchrotron Radiation Laboratory DAΦNE-LIGHT Fraskati Italy (7 + 7 days)
Mag. A.Pavlenko - IAEA (11 month).

Cooperation

Latvia
1. Medical Academy of Latvia (Dr. hab., prof. M.Eglite, dr.T.Zvagule).
2. Ltd. "RAPA".
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. Instityute of Wood Chemistry (Dr. hab. G. Dobele)

USA
1. Lawrence Livermoor National Laboratory, California (Prof. R. W. Hoff).
2. Brookhaven National Laboratory, Upton (Prof. R.F. Casten).
3. New-York University Stony Brook, Stony Brook (Prof. D. Fossan).
4. Notre Dame University, Notre Dame,USA (Prof. S. Frauendorf).

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

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).

Ukraine
1. State University " Lvivska Politechnika" , Lvov (prof. A.Matkovskii).
2.R&D Institute of Materials RPA " Carat" Lviv (Dr. D.Sugak, Dr. S.Ubizskii).
3.Institue of Physics of the Ukrainian Academy of Science, Kiev (prof. S. Nepijko).

Poland
1. Institute of Pysics, PAS, Warshaw (Dr. A.Suchocki).

Russia
1. Metal Physics Institute, Academy of Science , Ural Division (prof. A.Menshikov).

2..Pedagogical University, Kaluga, (prof.K.Nikiforov), Russia
3. Institute of Chemical Physics, (prof. V.Petinov), Chernogolovka, Russia

Austria
1. Atomic Institute of Austrian Universities, Vienna (Prof. H.Weber).

Croatia
1. Ruder Boškovic Institute, Zagreb (Prof. S.Music).

Main Results

NON-ROTATIONAL STATES OF ^{164}Dy

J.Bērziņš, V.Bondarenko, T.Krasta

The experimental data, obtained in (n,γ), (n,e$^-$) and (n,nγγ) reaction measurements at the high-flux reactor ILL Grenoble as well as the (n,n'γ) reaction data, measured at the IRT reactor in Salaspils, allowed to develop a level scheme of ^{164}Dy nucleus up to about 2.6 MeV excitation energy, including levels with spins <=6. The structure of low-lying level of ^{164}Dy has been interpreted in terms of two-quasiparticle states, interacting with collective excitations of axially-deformed core. Latest experimental data [1], especially those of the nucleon transfer reactions, and the data about structure of neighbouring odd nuclei, were used to assign Nilsson configurations to ^{164}Dy two-qusiparticle levels. The proposed level scheme includes 8 positive parity and 5 negative parity rotational bands, as well as 6 positive parity and 1 negative parity band heads. The effects due to the residual interaction between quasiparticles are analyzed.

[1] B.Singh, Nucl.Data Sheets, Vol.93, No.2 (2001), 243-445.

POSSIBLE EVIDENCE FOR TRIAXIAL SHAPE IN THE ODD-ODD TRANSITIONAL NUCLEUS ^{194}Ir

M. Balodis, T.Krasta, N. Krāmere, J.Bērziņš

The ^{194}Ir nuclear level structure requires an application of several models for its better understanding. This nucleus, being situated in the transitional region A=190-195, allov to use geometric models with an axially symmetric stable deformation. Such approach dominated in the most detailed earlier ^{194}Ir paper [1]. Besides, model interpretation with different algebraic models, namely, IBFFM, supersymmetry is used, e.g. [1,2].
We have evaluated the ^{193}Ir(n,e-)^{194}Ir data for transition energies above 500 keV, and quita reliable multipolarities are obtained in the 500-600 keV interval. Together with the 22-500 keV low-energy data published earlier [1], it has allowed to make a further level scheme analysis. It was possible to use the data from the ^{196}Pt(d,α)^{194}Ir reaction [2], obtained at the Beschleunigerlaboratorium Munich.
Our level scheme development, in ideal case, leads to an almost complete level scheme for low energies, low and medium spins. We can find a level with spin 5 or, probably, even 6, within low energy region of a few hundreds of keV. A recent level scheme work leads to a number of new levels with negative parities, in the interval 400-750 keV. However, for better

model interpretation, most interesting is the a new information on positive parity levels. There are new levels 161.5 keV 5^+, 392.8 keV 3^+,722.7 keV 3^+ , and several levels with corrected or well-confirmed quantum numbers, especially 270.9 keV 3^+,407.0 keV 3^+, 519 .5 keV 4^+.

It is concluded that one cannot interpret in the framework of axially symmetric Nilsson two-particle configurations the 270.918 keV level (being 4+,3+ in [1]), although it was assumed previously[1], that such models is applicable for all known levels below 340 keV.

An attempt to use a model with triaxial deformation indicates another possibility. In a comparatively simple form (compare ref. [3], where ^{193}Ir is studied), it means that somewhere above K_0 band, which follows from the axial shape, one can find a corresponding K_0-1 band, e.g. the 270.9 keV 3^+, 519.5 keV 4^+ band with K=3.

Recently, new 193Ir(d,p)194Ir results have been obtained in the joint work with the Munich colleagues.

1. M. Balodis et al,. Nucl. Phys. A641(1998)133.
2. H. F. Wirth, G. Graw, R. Hertenberg et al., priv.com.(2002).
3. S. E. Drissi, Nucl.Phys., A621(1997)655.

STUDIES OF QUANTUM CHAOS IN NUCLEAR SPECTROSCOPY

J.Tambergs, O.Dumbrājs, T.Krasta, A.Andrejevs

There is no generally acceptable quantum chaos definition in physics yet, hence we believe that the application of existing approaches to various specific physical systems would help to solve this problem. In our approach, we employ the dynamical quantum chaos criterion $\kappa(k)=\Gamma(k)/D_0$, introduced by V.Bunakov. In this criterion, $\Gamma(k)$ is the fragmentation width of the unperturbed quantum state and D_0 is the averaged distance between the levels of unperturbed system. The Bunakov's criterion is associated with physical system symmetries via the conservation laws for corresponding quantum numbers. We consider the application of Bunakov's criterion $\kappa(k)$ both to the traditional (Nilsson single-particle) nuclear model as well as to the algebraic microscopic strictly restricted dynamics nuclear model (SRDM). In the case of SRDM the dynamical criterion $\kappa(k)$ seems to be more sensitive indicator of quantum chaos, in comparison with the statistical one, associated with level spacing distributions.

CRANKED RELATIVISTIC HARTREE-BOGOLIUBOV THEORY: PROBING THE GATEWAY TO SUPERHEAVY NUCLEI

A. V. Afanasjev (1,2,3) , T. L. Khoo (1) , S. Frauendorf (2,4) ,
B. G. A. Lalazissis (5) , I.Ahmad (1)

1 Physics Division, Argonne National Laboratory, Argonne, IL 60439, USA
2 Department of Physics, University of Notre Dame, Notre Dame, Indiana 46556, USA
3 Laboratory of Radiation Physics, Institute of Solid State Physics, University of Latvia, LV 2169 Salaspils, Miera str. 31, Latvia
4 IKH, Research Center Rossendorf, Dresden, Germany
5 Department of Theoretical Physics, Aristotle University of Thessaloniki, GR-54124, Thessaloniki, Greece

The cranked relativistic Hartree+Bogoliubov theory has been applied for a systematic study of the nuclei around 254 No, the heaviest elements for which detailed spectroscopic data are available. The deformation, rotational response, pairing correlations, quasi-particle and other properties of these nuclei have been studied with different parametrizations for the effective mean-field Lagrangian. Pairing correlations are taken into account by a finite range two-body force of Gogny type. While the deformation properties are well reproduced, the calculations reveal some deficiencies of the effective forces both in the particle-hole and particle-particle channels. For the first time, the quasi-particle spectra of odd deformed nuclei have been calculated in a fully self-consistent way within the framework of the relativistic mean field (RMF) theory. The energies of the spherical subshells, from which active deformed states of these nuclei emerge, are described with an accuracy better than 0.5 MeV for most of the subshells with the NL1 and NL3 parametrizations. However, for a few subshells the discrepancies reach 0.7-1.0 MeV. In very heavy systems, where the level density is high, this level of accuracy is not sufficient for reliable predictions of the location of relatively small deformed shell gaps. The calculated moments of inertia reveal only small sensitivity to the RMF parametrization and, thus, to differences in the single-particle structure. However, in contrast to lighter systems, it is necessary to decrease the strength of the D1S Gogny force in the pairing channel in order to reproduce the moments of inertia.

CONCENTRATION LEVELS OF SOME MICROELEMENTS AND CA IN TEETH AND WHOOLE BLOOD OF PERSONAL INVOLVED IN REMEDIATION ACTIONS AFTER CHERNOBYL DISASTER

A. Ludbarzs, A. Viksna, D. Riekstina, M. Leja, T. Zvagule

The results demonstrated that changes of Zn and Ca/Sr content in the teeth samples of Chernobyl clean-up workers are connected with the bones pathology and give the additional information for the diagnosis of diseases. There are no such trends monitored for whole blood samples. The essential elements (Ca, K, Rb) in whole blood show similar trends within both researched groups. Concentrations of the elements vary within the same range at both analysed groups. The elements most often connected with environmental pollution (Pb, Sr, Co) vary among representatives of both target groups. Concentrations of Pb, Co and Sr in teeth and whole blood samples of the personnel involved in clean-up works are slightly higher than those in the teeth and the blood of the reference group. Although, the difference is insufficient to conclude it is connected to work at Chernobyl.

APPLIED OF THE NUCLEAR SPECTRAL METHODS IN THE ANALYSIS OF RADIONUCLIDES

D.Riekstina, O.Veveris, G. Smilskalne

The gamma-nuclear spectroscopy methods for the establishing natural and artificial radionuclides in different objects are elaborated and applied. In the water there were established Cs-137, Cs-134, Co-60, Ce-144, Zn-65, Mn-54; in the forest ecosystem there

were established K-40, U and Th families; as well as Cs-137; in the cement and its additives K-40, U and Th radioactive families; in the construction materials of different configuration – the nuclear fission and activation products.

RAMAN SCATTERING BY PHONONS AND MAGNONS IN $NI_CMG_{1-C}O$ SOLID SOLUTIONS

N.Mironova-Ulmane, A.Kuzmin

We received results of Raman scattering by phonons and magnons in polycrystalline solid solutions $Ni_cMg_{1-c}O$ (c=0.3, 0.4, 0.5, 0.6, 0.7, 0.9) at room temperature (RT).

Solid solutions $Ni_cMg_{1-c}O$ were prepared by solid-state reaction method. The Raman measurements were done in back-scattering geometry using a micro-Raman set-up and the 488.0 nm line of an Argon laser, operated at 20 mW. The spectral resolution was about 3 cm^{-1}.

The experimental Raman spectrum of NiO consists of 6 well resolved bands, According to theoretical phonon spectra calculations the bands in experimental Raman spectrum of NiO are related to the two-phonon scattering. In MgO, having the structure similar to NiO, a close set of bands exists, but they are much weaker and, therefore, were not observed in our experiment. This suggests that the bands found in solid solutions are related to the Ni sublattice. An interesting fact is that the bands in the experimental Raman spectrum of NiO , located above 600 cm^{-1}, disappear with an increase of the Mg content, whereas the bands A and B (disorder-induced one-phonon scattering in pure NiO) are always resolved, but slightly change their shape. We explain this fact by an increasing relative contribution of the one-phonon scattering upon dilution by Mg ions. Finally, the band F in NiO is related to the two-magnon scattering. Its intensity decreases rapidly upon dilution, and the band F becomes invisible, when the antiferromagnetic-to-paramagnetic transition takes place for c ~ 0.6 at RT.

ORIGIN OF PHOTOLUMINESCENCE IN NIO AND $NI_CMG_{1-C}O$ SINGLE-CRYSTALS

N.Mironova-Ulmane, A.Kuzmin

The photoluminescence of NiO and $Ni_cMg_{1-c}O$ (c=0.99, 0.98, 0.95) single-crystals was studied in the range 460-900 nm at the temperatures from 10 to 300 K. The photoluminescence spectra were excited by an Ar (514 and 458 nm, 50 mW) and He-Ne (633 nm, 10 mW) lasers.

The photoluminescence spectra of all samples, excited by the Ar laser, consist of two broad bands, centred at 12500 cm^{-1} and 18000 cm^{-1}, whereas only the first band at 12500 cm^{-1} can be observed under the excitation by the He-Ne laser. The intensity of the two bands decreases when the temperature increases. Besides, the intensities ratio for the two bands depends strongly on the sample composition and the excitation laser wavelength.

We attribute the two bands to the impurity- or defect-perturbed Ni^{2+} states. The band at 12500 cm^{-1} is related to the $^1E_g(D) \rightarrow {}^3A_{2g}(F)$ transition, whereas the band at 18000 cm^{-1} to the $^1T_{2g}(D) \rightarrow {}^3A_{2g}(F)$ transition. The intensity of the bands is determined by the electron-phonon interactions and by the energy transfer between nickel ions.

EFFECT OF ELECTRIC FIELD ON TRANSPORT OF RADIATION DEFECTS IN MgO

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

After irradiation by neutrons the absorption spectra of MgO consists of 250, 357 and 570 nm bands. The accumulation of radiation defects in MgO doped with nickel differs from that in pure MgO. The intensity of the 570 nm absorption band is considerable smaller in MgO:Ni than in pure MgO, besides the relative intensity of the 357 and 570 nm bands is different. The total intensity of the absorption bands from the sample irradiated in electric field is lower than that from those irradiated without electric field. The electric field chenges the rate of annealing. Differences between the anneling curves for pure and nickel-doped MgO indicate that the nature of defects is different. We assume that the 347 nm and 480 nm absorption bands detected after annealing belong to complex Ni.

STRUCTURE AND SUPERCONDUCTING PROPERTIES OF SMALL $YBa_2Cu_3O_{6.82}$ PARTICLES

A.Petrov,I.Kudrenickis, E.Sukhovich, M.Maiorov

The initial ceramics $YBa_2Cu_3O_{7-X}$ was prepared under the usual technology. The $YBa_2Cu_3O_{6.82}$ ceramics particles with various sizes were obtained by (1) mechanical dispersion (for 100-1500 nm) and by (2) electrodispersion (for ~ 100 nm).

The transition temperature T_c value was independent on the particle size within the given size range. Transition width ΔT_c increased and Meissner effect $\Delta\chi$ value decreased significantly with the particle size decreasing.

The dominant reason is being the break-up of current paths in the net of weak links of HTSC producing the obstacles for external field screening. The decreasing of H_{c1} value confirmed this supposition. The another reason of the $\Delta\chi$ decreasing might be the fact that the magnetic field penetration depth (~100 nm) is of order of the investigated samples particles size.

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11.D. Riekstina, O. Veveris, I. Taure, G. Smilskalne *"Distribution of ^{137}Cs in Latvian pine wood"*, Proceedings of IRPA Regional Congress on Radiation Protection in Central Europe, Dubrovnik, Croatia, 2001, May 20-25, 2002, 201-203 pp.

12.A. Ludbarzs, A. Viksna, D. Riekstina, M. Leja, T. Zvagule *"Concentration levels of some microelements and Ca in teeth and whoole blood of personal involved in*

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16.N.Mironova-Ulmane, I.Pavlenko, A.Pavlenko – *Measurement Accuracy for Bone Optical Absorbtion*. Sci. Proc. of Riga Technical University. Riga,2002, **9,** N6, pp. 168-171.

In press

1. A.V.Afanasjev, T.L.Khoo, S.Frauendorf, G.A.Lalazissis, I.Ahmed. *Probing the gateway to superheavy nuclei in cranked relativistic Hartree-Bogoliubov theory*. – Clark Kerr Campus,

2. C.D.O'Leary, C.E.Svensson, S.G.Frauendorf, A.V.Afanasjev et al. *Evidence for Isovector Neutron-Proton Pairing from High-Spin States in N=Z ^{74}Rb*. – submitted to Phys.Rev.Lett.

3. J.Pavan, S.L.Tabor, A.V.Afanasjev et al. *Lifetime Measurements and Terminating Structures in ^{87}Nb*. – submitted to Phys.Rev. C.

4. A.V.Afanasjev, T.L.Khoo, S.Frauendorf, G.A.Lalazissis, I.Ahmad. *Cranked Relativistic Hartree-Bogoliubov Theory: probing the gateway to superheavy nuclei*. – submitted to Phys.Rev. C.

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7. J.A.Castilho Alcaras, J.Tambergs, T.Krasta, J.Ruža, O.Katkevičius. *Classification of Basis States for (p-f) Nuclei (41≤A≤80) with Minimal Configuration Energy*. (Accepted for publication in Brazilian Journal of Physics).

8. A.Andrejevs, J.Tambergs, J.Ruža, J.A.Castilho Alcaras, O.Katkevičius. *Classification of Nuclear States in Unitary Scheme Basis for Strictly Restricted Dynamics Model* (4 pages, submitted for publication in Proc.of 11th Int.Symp.on Capture Gamma-Ray Spectroscopy and Related Topics. Pruhonice, September 20-6, 2002).

9. A.Dzalbs, A.Andrejevs, J.Tambergs, T.Krasta, J.A.Castilho Alcaras, O.Katkevičius. *Strictly Restricted Dynamics Model Calculations with Quadrupole Interaction.* (4 pages, submitted for publication in Proc.of 11th Int.Symp.on Capture Gamma-Ray Spectroscopy and Related Topics. Pruhonice, September 20-6, 2002).

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11. D. Riekstina, A. Ludborzs, I. Taure, O. Veveris, A. Viksna " *Investigation of bioaccumulation of metals in pines sylvestris by INAA, TXRF and ET AAS*", J. Ekologija (accepted).

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13. S.Dolgov, T.Kärner, A.Luschik, A.Maaroos, N.Mironova –Ulmane, S.Nakonechny – *Thermoluminescence Centers Created Selectively in MgO Crystals by Fast Neutrons* Radiation Protection Dosimetry.

Lectures on Conferences

18th Scientific Meeting of Institute of Solid state Physics, University of Latvia, Riga, February 11.-13., 2002

1. M Balodis, T. Krasta, N. Krāmere, J. Bērziņš, New energy levels of ^{194}Ir with high degree of confidence p. 54.

2. J. Bērziņš, V. Bondarenko, T. Krasta, F. Hoyler, K. Fohl, H. Borner , B. Krusche, S. J. Robinson, P. Schillenbeck, Development of ^{164}Dy level scheme, p. 55.

3. J.Tambergs, O.Dumbrājs, T.Krasta. Quantum Chaos and Symmetries in Nuclear Spectroscopy, p. 52.

4.A.Dzalbs, A.Andrejevs, J.Tambergs, T.Krasta, J.Ruža, J.A.Castilho Alcaras, O.Katkevičius. Parameters of the Effective Nucleon-Nucleon Interaction in the Framework of Strictly Restricted Dynamics Model, p. 53.

5.O. Vēveris, D. Riekstiņa, I. Taure, Natural and artificial radionuclides in forest ecosystem, p. 74.

6. V.Skvortsova – Spectroscopy of Defects in Magnesium Oxide Crystals - Abstracts p. 51.
7.A.Petrov, I.Kudrenitskis, M.Maiorov. Exchange anisotropy in cobalt fine particles. – Abstracts p.40.

11th Int.Symp.on Capture Gamma-Ray Spectroscopy and Related Topics. Pruhonice, September 20-6, 2002
1.A.Andrejevs, J.Tambergs, J.Ruža, J.A.Castilho Alcaras, O.Katkevičius. Classification of Nuclear States in Unitary Scheme Basis for Strictly Restricted Dynamics Model.

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2. J.Tambergs, T.Krasta, O.Dumbrājs. Quantum Chaos and Symmetries in Nuclear Spectroscopy.

3. M.Balodis, T.Krasta, N.Kramere, J.Berzins. Possible Evidence for Triaxial Shape in the Odd-Odd Nucleus ^{194}Ir,

5 .J.Berzins, V.Bondarenko, T.Krasta, F.Hoyler, K.Fohl, H.G.Borner, B.Krusche, S.J.Robinson, P.Schillenbeck. Non-Rotational States of ^{164}Dy .

6.J.Honzatko, I.Tomandl, V.Bondarenko, T.von Egidy, H.-F. Wirth, R. Hertenberger, Y. Eisermann, G. Graw, D. Bucurescu, N. Marginean, V. Yu. Ponomarev: Nuclear structure of ^{127}Te studied with (n,γ) and (d,p) reactions and interpreted with IBFM and QPM.

7. P. Alexa, J. Berzins, et al Interplay of Quasiparticle and Vibrational States in W Isotopes.

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J. Berzins, A. Skujina, D. Riekstina, "Identification possibilities of nuclear and radioactive materials in Latvia", Book of Extended Synopses, 89-90 pp.

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1. D. Riekstiņa, O. Vēveris, Ģ. Smilškalne "Applied of the nuclear spectral methods in the analysis of radionuclides", Book of Abstract, 92. pp.

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1. J. Berzins, J. Malnacs, A. Ozols "Radioactive waste managament in Latvia".

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1. E. S. Lindgren, A. Viksna, A. Ludbarzs, D. Riekstina, M. Leja "Concentration levels of metals in whole blood and teeth of Chernobyl clen-up workers", Book of Abstract, 112 pp.

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1. O. Veveris, J. Berzins, D. Riekstina, "Radioactivity in basin's water of halted nuclear reactor.

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1. V.Skvortsova, Nina Mironova-Ulmane, Uldis Ulmanis. Effect of electrical field on radiation defects transport in MgO. Abstracts p.130.

Int.Conf. on Physics of Laser Crystals, ICPLC-2002, Kharkiv, Ukraine, o8.26.02 – 0.9. 02.
1. N.Mironova – Ulmane, U.Ulmanis – Temperature Dependence of Ni^{2+} Luminescencein MgO Single Crystals. Abstracts p. O 18.

LU 60. Sci. Conference. Sci. and Museums History. January 28, 2002
1. U.Ulmanis - LU and the Development of Nuclear Physics in Latvia.

The 3 International Conference Advanced Optical Materials and Devices August 19-22, 2002, Riga Latvia
1. A.Kuzmin, N. Mironova-Ulmane, S.Ronchin. Origin of photoluminescence in NiO and $Ni_cMg_{1-c}O$ single crystals. Abstract p.124.

2. A.Kuzmin, N. Mironova-Ulmane, S.Ronchin. Origin of photoluminescence in NiO and $Ni_cMg_{1-c}O$ single crystals. Abstract p.124.

3.F.Muktepavela, I.Manika, L.Grigorjeva, V.Skvortsova. Micromecanical Properties of AlN and AlN/TiN Nanostructured Multilaayer. Abstract p.157.

European Medical & Biological Engineering Conference 04-08 december 2002
1.N. Mironova-Ulmane. A.Pavlenko, I. Pavlenko Measurement uncertanities for optical analysis of blood cells.

2.N Mironova-Ulmane. A.Pavlenko, I. Pavlenko Human Teeth ESR dosimetry comparison of measurement technologies.

International Scientific Conference Biomedical Engineering and microtechnologies Riga, Latvia October 10-14 2002

1.N.Mironova-Ulmane, I.Pavlenko Measurement Accuracy for Bone Optical Absorbtion., p.15.

Second International Workshop "Nucleation and Non-Linear Problems in First-Order Phase Transitions" (NPT'2002), 1 July – 5 July 2002, St.-Peterburg (Russia)

1.A.Petrov, I.Kudrenitskis, M.Maiorov. Magnetic Phase Transitions in Ni Fine Particles. – Abstracts of the, p. 19-20.

Physics of Electronic Materials, International Conference Proceedings, Kaluga, Russia, October 1-4, 2002

1.A.Petrov, I.Kudrenitskis, E.Sukhovich, M.Maiorov. Structure and superconductive properties of 100-1500 nm $YBa_2Cu_3O_{6.82}$ particles. p.32-35.

2.A.Petrov, I.Kudrenitskis, M.Maiorov. Critical Behaviour of Saturation Magnetization and Initial Susceptibility for Spherical Nickel Particles in Dependence of Their Sizes. p.306-308.

Lectures at Universities, Institutes …

Juris Tambergs

Latvian University, Faculty of Phycis and Mathematics: 1) Basic principles of nuclear and particle physics; 2) Basics principles of general relativity and cosmology

Latvian University, Faculty of Theology: 1) Biblical and scientific conceptions of the Universe; 2) Dialogue between religion and science.

ELECTRONIC ENGINEERING

Head of Department 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).
2. Provide physical measuring and manufacturing process automation.
3. Also solve the other problems, not afore-mentioned.

Scientifical Staff

1. Dr. A.Kristins
2. Dr. Hab. A.Zelenkovs

Technical Staff

1. I.Guza
2. D.Gusevs
3. I.Gvardina
4. J.Melderis
5. J.Tibergs
6. J.Veinbergs
7. S.Zelenkovs
8. I.Zujevs

Cooperation

Latvia

1. Joint-stock company *Latvenergo*
2. *Latvijas Krājbanka*
3. *Kokarde* Ltd
4. Latvia Technology Park
5. Riga Technical University
6. Latvian Environment Agency
7. *Trafik* Ltd
8. IB *Biakss*
9. *GROG* Ltd
10. *DataPro* Ltd
11. *Apollo AS* Ltd
12. *AlarmLat* Ltd
13. *Mikoniks* Ltd
14. *Energoremonts Rīga* Ltd
15. Joint-stock company "Poligons".

Denmark
DanBalt Electronics

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

Estonia
OÜ Terg A&K

The prospects of the instruments look at appendix.

Lectures on Conferences

18th Scientific Meeting of Institute of Solid State physics, University of Latvia, Riga, February, 2002

1. D.Gusevs, I.Gvardina, A.Kristiņš, *Apartment security system.* Abstracts, p.78
2. P.Annus, A.Kristiņš, *Open fieldbus for supervision and control.* Abstracts, p.80.

TESTING LABORATORY

Head of Laboratory Dr.Phys. J.Kļaviņš

ISSP commenced the evaluation of product conformity assurance since 1996, when the Department of Science of the Ministry of Education and Science rendered support from Market demanded research financing resources for the ISSP in Product testing and quality control pursuant to the requirements of the EU. Some of the staff members of the ISSP participated in the number of projects related to the testing and compliance assurance. Among projects was the establishment of the Testing laboratory (TL). The scope of this project includes a lot of activities. (1) TL preliminary measuring equipment has been supplemented by purchasing several new devices - equipment for determination of the waterproofness of building materials, computerized laboratory and analytical balances etc. (2) The already existing equipment has been repaired. (3) The premises of the laboratory have been repaired and equipped accordingly. (4) In the meantime 7 staff members of the ISSP have completed the training course "Preparing the Testing Laboratory Pursuant the Latvian and European Standards", organized by Certification Centre of Latvian Academy of Sciences, some of staff members – courses in Germany and England. (5) The quality system has been implemented in the laboratory. (6) TL is operating and currently performs testing according to 6 standard methods. New methods are being acquired.

On January 12, 2001 Latvian National Accreditation Office (LATAK) completed the accreditation of the Testing Laboratory at the Institute of Solid State Physics. It means that the quality system of one of the Institute units is recognized as comformit to international standard LVS EN 45001.

All the ISSP TL spheres applied for accreditation were accredited. They are: (1) concrete watertightness; (2) adhesion and cohesion of adhesives of ceramic linings; (3) release of lead and cadmium from enemalled metallic ware, (4) from ceramic ware, glass – ceramic ware, glass dinner ware, (5) glass hollow ware and (6) ceramic cookware subjected to heating and as in 3, 4, 5, 6 in contact with food.

In the 2001 TL sphere was extended with (7) the test for determination of breaking strength of glass fiber yarns, (8) the test for determination of breaking strength and alkaline durability of glass fiber mesh, (9) the test for determination of density of hardened concrete, (10) the test for determination of moisture content of building materials.

Test methods and corresponding standards in the scope of accreditation are:

1. Testing hardened concrete. Part 8: Depth of penetration of water under pressure. EN 12390:2000
2. Testing of adhesives for ceramic linings; testing of the deformation of bondings; dispersion adhesives. DIN 53265:1988
3. Ceramic ware, glass-ceramic ware and glass dinnerware in contact with food. Release of lead and cadmium. Part 1: Test method. ISO 6486-1: 1999
4. Vitreous and porcelain enamels. Release of lead and cadmium from enamelled ware in contact with food. Part 1: Method of test. ISO 4531-1: 1998
5. Glass hollowware in contact with food. Release of lead and cadmium. Part 1: Test method. ISO 7086-1: 2000
6. Ceramic cookware in contact with food. Release of lead and cadmium. Part 1: Method of test. ISO 8391/1 – 1986
7. Textile glass - Yarns - Determination of breaking force and breaking elongation. ISO 3341: 2000

8.Standard Test Method for Determining Tensile Breaking Strength of Glass Fiber Reinforcing Mesh for Use in Class PB Exterior Insulation and Finish Systems (EIFS), after Exposure to a Sodium Hydroxide Solution. ASTM E2098: 2000
9.Testing hardened concrete - Part 7: Density of hardened concrete. EN 12390-7: 2000
10.Hygrothermal performance of building materials and products - Determination of moisture content by drying at elevated temperature. EN ISO 12570: 2000

Currently not accreditated test methods:

1.Floorings. Testing of watertightness. SIS 923511:1974
2.Ceramic tiles - Part 3: Determination of water absorption, apparent porosity, apparent relative density and bulk density. ISO 10545-3: 1995

Staff

1. Dr. J.Kļaviņš
2. Dr.hab. J.Maniks
3. Dr. E.Pentjušs
4. J.Pinnis

Support Staff

1. Dr. V.Eglītis
2. Dr.hab. M.Spriņģis

Cooperation

1. Latvian National Accreditation Bureau LATAK
2. Latvian Association of Testing Laboratories
3. Certification Center of Latvian Academy of Sciences
4. Testing Laboratory of fresh and hardened concrete of "Kalnozols Building", Ltd

Lectures on Conferences and Seminars

1.J.Kļaviņš, J.Maniks, E.Pentjušs, J.Pinnis, *Testing Laboratory of the Institute of Solid State Physics*, 18th Scientific Conference of the Institute of Solid State Physics, University of Latvia, Rīga, February 11-13, 2002.

2.J.Kļaviņš, U.Kļaviņš, *Improvement of the informatization system of the Institute of Solid State Physics*, 18th Scientific Conference of the Institute of Solid State Physics, University of Latvia, Rīga, February 11-13, 2002.

3.J.Kļaviņš, J.Pinnis, *Testing of building materials – water permeability, water vapour transmition, moisture content and some other physical properties*, Scientific Practical Meeting "Thermotechnics of the boundary constructions of buildings II", Riga, March 14-15, 2002.

ORGANIZED CONFERENCES

18th Scientific Conference of the Institute of Solid State Physics, University of Latvia

Riga, February 11 – 13, 2002

The anual Scientific Conferences of the ISSP are held at the Institute of Solid State Physics in February the 11 – 13 and is a part of Scientific Conference of University of Latvia (UL).

The 18th Conference worked in 6 sections:
- structure and phase transitions (14 reports),
- non – linear optical properties and problems of optometry (13 reports),
- optical spectroscopy and luminescence (11 reports),
- materials and applications (10 reports),
- nuclear reactions and radiation physics (9 reports),
- solid state electronics and ionics (14 reports).

Alltogether 71 reports of 15 – 30 minutes were presented. Apart from staff members of ISSP and the Department of Optometry, represesantives of the Faculty of Physics and Mathematics UL, the Riga Technical University, and of the Institute of Inorganic Chemistry participated in the Conference.

The aim of the Conference was to inform the physicists community of Latvia about the most important results obtained in the previous year.

Abstracts of the scientific reports presented at the Conference were published in Latvian and English and were available to participants before the meeting.

Conference chairman
Prof. A.Krumins

The 3rd International Conference "Advanced Optical Materials and Devices", AOMD – 3
Riga, August 19-22, 2002

The Conference was organized by the Institute of Solid State Physics in collaboratorion with the Baltic Chapter of SPIE and Institute of Physical Energetics LAS. 130 participants alltogether from 21 countries come together to discuss the main results in this field. Latest develpoments and new results were reported in 57 oral and 88 poster presentations, as well as in many discussions trough out the meetings.

The main sections covered during the Conference were:

- theory of optical materials;
- organic optical materials;
- inorganic optical materials and radiation effects;
- semiconductor optical materials, nanostructures and SPM technique;
- ferroelectric optical materials and applications;
- holographic materials and optical recording;
- electrochromic devices, wavequides, sensors and laser technoloqies;
- optical devices and methods for vision science and medicine

The Conference abstracts were published before the meeting. Manuscripts of the prepared reports were edited during the Conference and will be published in 2003 in two special issues of International journal "Proceedings SPIE":

- vol. 5122 "Advanced optical materials"; editors A.Krumins, D.Millers, I.Muzikante, A.Sternbergs, V.Zauls.
- vol. 5123 "Advanced optical devices", editors J.Spigulis, J.Teteris, M.Ozolinsh, A.Lusis.

The sponsors of the Conference were European Community (5th Framework programme), SPIE – The Internacional Society for Optical Engineering, European Office of Aerospece Research and Development, Latvian Council of Sciences, Stora Enso Packaging SIA

Conference Chairman
Prof. A.Krumins

Radioelectronic Department
Institute of Solid State Physics
University of Latvia

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 or Windows 2000.

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

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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 ∅17.35 x 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. 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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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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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: ВВШ-110; ВВБ-110; ВВУ-110; ВВН-110/6; ВВ-330Б; ВВН-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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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™ 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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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:	$2{,}8 \bullet 10^{14}$
User keys:	? 56 pcs.
Dimensions:	83x55x35 mm

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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 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 (∅ 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°C.

Touch Memories can accommodate over one million data changes.

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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:	$2{,}8 \bullet 10^{14}$
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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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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