

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, University of Latvia (ISSP UL) was established in 1978 on the basis of two Laboratories: Semiconductor Physics and Ferro- and Piezoelectric Physics. From 1986 until 2006 the ISSP UL had the legal status of an independent scientific institution. In 2006 the institute was reorganized as part of the University of Latvia.

The Institutes attributes are scientific expertise, quality of performance, and original interdisciplinary approach. At the same time the Institute is involved with the popularization of science and modern technology, and discussions with society. These activities are among the priorities of ISSP UL and will make a career in exact sciences more attractive for young, talented students.

The ISSP UL is an internationally recognized institution, a leader in the field of materials sciences and cross-disciplinary fields in Latvia, and it should be considered as an extremely valuable national asset for Latvia. The ISSP UL is the coordinator and leader in a number R&D cooperative projects: the National Research Programme on “Materials Science”, projects on functional materials and nanotechnologies, the National Research Centre (NRC) functional and construction materials and their technologies, incl. development of the “Latvian Nanostructured Material Center (LATNANO-C)”, EURATOM and Fusion for Energy (F4E) projects by Association EURATOM – the University of Latvia (AEUL) etc. The main research objective of these cooperative projects is to create a domestic research potential in the fields of materials science and solid state physics and chemistry with an emphasis on nanoscience. This is necessary for future high-tech industrial developments in the country. This task will be implemented by maintaining and developing both human resources and the research infrastructure in Latvia, including instrumentation, experimental know-how, technologies, human work force and educational potential. These initiatives will create an attractive and modern research environment that will attract young and as well as experienced researchers from Latvia and foreign countries.

Presently the main directions of research at the ISSP UL are:

- ✓ Electron and ion processes in wide-gap materials with different degree of ordering;
- ✓ Functional organic molecules and polymers for photonics and organic electronics;
- ✓ Multifunctional and hybrid materials for energy applications: light emitting diodes, photovoltaic elements and coatings for solar batteries, storage of hydrogen for fuel cell devices;
- ✓ Electrodes and plasma technologies for hydrogen production, polymer membranes with ionic conduction for fuel cells and gas separations;
- ✓ Inorganic single crystals, ceramics, glasses, thin films, and nano-structured surfaces for applications in optics, electronics, photonics and energetics;
- ✓ Studies of novel vision technologies and development of sight-care equipment.

The highest decision-making body of the ISSP is the Scientific Council of 22 members elected by the employees of the Institute. The International Supervisory Board of ISSP LU was established in 1999. Presently the board has 17 members representing Europe, Russia, USA and Japan consisting of distinguished scientists in the field of materials science.

The ISSP UL staff consists of 92 researchers with Doctor Habilitatus of Sciences and PhD degrees, 28 PhD students and 21 bachelor and master students. Compared to the previous reporting period the total number of staff members of the institute has decreased by 25 (258 in year 2007), but the number of academic personnel has increased by 14.

ISSP UL has expertise in the following technologies:

- ✓ High temperature crystal growth;
- ✓ Sintering and hot pressing of transparent electro-optic ceramics and nanostructured oxide materials;
- ✓ Pulsed laser deposition (PLD);
- ✓ Metal – organic chemical vapour deposition (MOCVD);
- ✓ Organic thin film deposition;
- ✓ Technology for producing of chalcogenide films for holographic recording;
- ✓ Modification of materials by laser radiation from infrared to vacuum ultraviolet range.

Several analysis, characterisation simulation methods are used by the ISSP UL:

- ✓ Theoretical calculations and computer simulations using *Latvian SuperCluster (LASC)*;
- ✓ X-ray structural and X-ray absorption fine structure analysis;
- ✓ Scanning electron microscopy (SEM), confocal optical microscopy in conjunction with Raman and luminescence spectroscopy techniques as well as various scanning probe microscopy techniques (AFM, STM, NSOM);
- ✓ Fourier-transform infrared absorption spectroscopy, Raman spectroscopy, optical absorption spectroscopy in the visible, ultraviolet and vacuum-ultraviolet ranges, several different luminescence spectroscopy techniques and time resolved spectroscopy in the picosecond time range under pulsed electron or laser excitation;
- ✓ Electron paramagnetic resonance techniques;
- ✓ Electro-optic and non-linear optic methods and ellipsometry;
- ✓ Holographic recording techniques;
- ✓ Dielectric and photoconductivity measurements;
- ✓ Cryogenic equipment within 10-600 K for experiments at different temperatures.

Applied research is likely to succeed in well equipped laboratories staffed by skilled, highly competent scientists. A number of RTD projects is carried out in close co-operation with technology-oriented Latvian enterprises. The cooperation partners are companies like Sidrabe, Alfa, Alfa Pro, Baltic Scientific Instruments, Valmieras Stikla Skiedra (Valmiera glass fibres). Two SMEs (Hologramma Ltd., Dardedze Holografija Ltd.) - spin-off companies have resulted from research projects of the Institute.

The strategy of the ISSP UL 2010 – 2020

ISSP UL has developed a strategy that incorporates the objectives of the national Latvian R&D strategies for shorter and longer terms (Latvia Council of Ministers’ Guidelines for Development of S&T for 2009 – 2013” and Latvian sustainable development strategy 2030) and that of the European Research Area (A *New Renaissance* strategic view and the Plan Europe 2020) and Horizon 2020.

Future development steps were selected based on past success, future needs and trends in the R&D of ISSP UL. The following activities are planned:

- ✓ Active R&D work within the National Research Programme on “Materials Science”, which is successful continuation of ISSP UL activities based on Programme of EC Excellence Centre of Advanced Materials Research and Technology (*CAMART*) – being launched in year 2000;

- ✓ Realisation of the “Latvian Nanostructured Material Centre (LATNANO-C)” is proposed (2011-2020) as the world scale European (EU) Large research facility equipped with advanced technological facilities and research equipment for processing and study of nanostructure materials. The research efforts will consist of five fundamental parts: i) nanotechnologies and processing; ii) composition and structure control; iii) morphology and structuring/lithography; iv) properties and characterization; v) application assessment.
- ✓ Active involvement in organization and consolidation of Latvian science: formation of the Latvian National Research Centres (NRC) with the goal of becoming an essential player/leader of NRC working on *nanostructured multifunctional materials*;
- ✓ Enhanced cooperation with industrial partners on preparation of the Competence centre programme to be developed in cooperation with the Latvian Ministry of Economics and funded by EU Structural funds under their governance;
- ✓ Increasing the number of grant applications in the EC 7FP programme and preparation for participation in the Horizon 2020 activities;
- ✓ Extending international cooperation by entering into various European scientific and technology networks and increased access to “*large scale facilities*” of EU including development of regional partner facilities (e.g., in the frame of Baltic Science Link project- BSL). A network like the BSL would help and strengthen the already strong areas in life sciences and materials science, and enhance cooperation with industry.

The sections below summarise major development since the latest evaluation report (April 3, 2007) by the International Supervisory Board.

Achievements

1. During reporting period the ISSP UL has progressed well, which is evidenced by excellent quality of research resulting in numerous publications in well-known international journals, participation in conferences and international research projects, etc. Success is due to increased international cooperation (FP7 projects, e.g. “*Catherine* - Carbon Nanotube Technology for High-Speed Next-Generation Nano-Interconnects, ERANET MATERA projects, participation in EURATOM and Fusion for Energy Programme, etc) as well as improved research infrastructure, which enable to carry out investigations on qualitatively new level and more efficiently.
2. During the period 2007 – 2010 in the ISSP UL 13 PhD thesis were completed. Scientific staff has attended more than 230 international conferences and has published more than 340 scientific articles in the reviewed and internationally recognized journals.
3. Major support from the European Structural Funds along with Latvian national contribution has enabled ISSP UL to make significant improvement (1 mil. LVL) of scientific research infrastructure. New scientific and technical equipment for sample preparation was obtained, e.g., MOVCD AIX200 system and PLD reactors, technology for organic thin film deposition; characterisation equipment – SEM with EDX, Kelvin probe, set of optical spectrometers, lasers, etc; computing facility LASC and others. This creates good conditions for the ISSP UL to be competitive in European Research Area and worldwide.
4. ISSP UL has continued its excellent traditions in active organization of international scientific events. Since 2003 the international conference series “Functional materials and nanotechnologies - FM&NT”, regularly organized at a high level by the initiative of the ISSP UL staff, has grown very attractive event among researchers of functional materials and nanotechnology coming together from nearly all continents. A typical

size of the conference is more than 200 participants. Well selected invited speakers and a good balance between topics ensure a growing popularity. There are also other international events organized, for example “International Symposium on Systems with Fast Ion Transport”, “Developments in Optics and Communication” and others.

5. In 2009 the Society of Students and Young Scientists of ISSP UL was founded, organizing students in all study levels incl. young scientists up to the age of 35. The main goal is to assist them in their studies (scholarships) and in professional development (regular information and training of presentation skills, writing scientific papers, etc.) and organizing popularization activities among schoolchildren and others.
6. The ISSP UL contribution to the higher education has increased at Latvian universities (e.g. at UL the staff is responsible for teaching of experimental and solid state physics in all study levels).
7. The science popularization is becoming important activity of the ISSP UL. The scientific staff writes popular science articles in Latvian, regularly presents news in TV and radio, organizes annual events such as “Sun Cup” for school children, where vehicles moving on solar power are competing. Also, the professional movie “E=hu“ on DVD, released in 2009, describes the present and future prospects of the ISSP UL.

Critical Issues


1. The 2008 economic crisis has caused a lot of turbulences setting many countries in serious difficulties all around world. Latvia was one of the countries hit really hard, which has been reflected by severe cuts of financing in all fields of Latvian society incl. science and higher education. After excellent 2007 and 2008 years financial wise, the Latvian state funding for science has been decreased by 62 % in year 2010 down to 16,49 mil. LVL, which is comparable the level in 2005. This is a serious threat for sustainable future development of the Institute and diminishes the effect of progress made during the previous year. One of the consequences for the institute, being under funded, is a prohibited access to European Structural Funding, where compulsory co-financing is required according to programme regulations. Finally, under such funding conditions it would be a serious challenge to keep world-class scientists as well as to employ young and talented researchers either from Latvia or abroad.
2. Another important issue is the renewal of academic personnel of ISSP LU, which at the present is not optimal. A prognosis based on the present personnel situation of ISSP LU shows, that in order to maintain the same performance of the Institute as before, at least 3 new scientists with PhD degrees has to be recruited every year. Although the number of master and PhD students has increased in recent years, systematic measures should be encouraged to further increase the number of professionals coming from other institutes and from other countries.
3. Presently, according to the Latvian S&T development policy (like in other Baltic countries), there are special measures directed to increase the number of PhD students using funding of European Social Fund. This has created favourable economical conditions for doctoral studies. However, after the completing PhD theses a career model should be developed (with the respective funding) to motivate a continued professional life in science and technology (postdoctoral studies in other countries, and programs for return to the home country). This is not just an institutional problem, but rather an issue for and a challenge to the Latvian S&T policy as a whole.
4. The significant growth in project based funding has increased the administrative load of scientists diverting them from their main task, research.

Recommendations

1. ISSP LU is internationally well recognized research and development institute with the highest success rate in Latvian for obtaining grants from European programmes. Considering the present Latvian economical situation, which affects future prospects of ISSP LU as well as any other institute in Latvia, it is necessary to address issues of S&T programmes (implementation of competence centres, national research programmes, funding issues, etc.) at national governmental level and among politicians considering the high reputation of ISSP. Efforts should be directed towards the use of European Structural Funds (e.g. their co financing and VAT coverage issues), which will play a crucial role in overall development of research and technological infrastructures. These decisions will be very important for future Latvian economical development. The International Advisory Board will assist in formulating **the foresight strategy document**, so that it can be convincingly used in discussions with various stakeholders in Latvia and in foreign countries.
2. ISSP LU has to review its human and all other resources in order to consolidate R&D activities in directions which are the strongest and follow the goals of the National Research Programs “Materials Science” and the European Initiatives.
3. The institute shall increase cooperation with other Baltic Countries at political and scientific levels in order to influence European Science policies more along the particular needs of smaller EU member states.
4. Timely corrections should be made of the ISSP LU strategy, which should alleviate the present difficult financial situation, but without making compromises with the long term goals.
5. ISSP LU must have strong collaboration with large scale materials research centres (synchrotron radiation, laser and neutron research centres) in order to improve the quality of research and to facilitate scientific contacts, and to develop own experiments/end stations in upcoming modern facilities (MAX-IV, ESS, XFEL, etc.) together with other Baltic countries. Increased participation in international scientific and technology networks is desirable to facilitate knowledge transfer needed for efficient using of modern equipment and access to experimental methods not available at the home institute.
6. The ISSP should more actively participate in education at highly specialized levels in materials science and nanotechnology in Latvia as well as internationally by participating in joint international curricula, in particular with countries in the Baltic Sea region.
7. Renewal of academic personnel is issue to be addressed in a complex way. On one hand it must be concerned with efficiency and volume of PhD studies at the home institute and sending doctoral students and postdoctoral researchers to other countries. On other hand, a recruitment plan for research staff should include return of researchers of Latvian origin to their home country, attraction of foreign PhD students, postdocs and experienced researchers.

Chairman of the meeting,
Director of the Institute of Physics, Tartu University,
Dr. Phys. Marco Kirm

3 May 2011, Tartu, updated in September 2011 in order to account recent developments.

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