INSTITUTE OF SOLID STATE PHYSICS
UNIVERSITY OF LATVIA

ACTION PLAN

2022

Riga 2022

Action Plan 2022, Institute of Solid State Physics, University of Latvia

29 pages

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INTRODUCTORY REMARKS

The research direction of ISSP UL is described in the long-term Strategy and Research Programme 2021-2023-2027 document. The program must be continuously corrected and the changes must be reflected in the Action Plan in order to adjust these to the changing research environment and emerging applications or societal challenges.

One of the most recent significant developments during 2021 is "Europe Green Deal 2050" initiative. It is a set of policy initiatives by the European Commission with the overarching aim of making the European Union (EU) climate-neutral in 2050.

Another outstanding development in 2021 are "EU Missions" that represent a novelty of the Horizon Europe research and innovation programme for the years 2021-2027:

1. Adaptation to Climate Change: support at least 150 European regions and communities to become climate resilient by 2030
2. Cancer: working with Europe's Beating Cancer Plan to improve the lives of more than 3 million people by 2030 through prevention, cure and solutions to live longer and better
3. Restore our Ocean and Waters by 2030
4. 100 Climate-Neutral and Smart Cities by 2030
5. A Soil Deal for Europe: 100 living labs and lighthouses to lead the transition towards healthy soils by 2030

In this relation, ISSP UL plans activities mainly in Missions 1, 2, 4.

The Action Plan for the current year (2022) defines the short-term research directions and adjustments to them, caused by a number of variable factors, like funding, staff, partners, infrastructure. One of the most important factors, which largely defines the short-term research topics, is the set of actually funded projects. Hence, a major part of the planned work is related to the already funded projects, described below in the section "Current activities". The activities of ISSP UL can be roughly divided in four major application-oriented strategic directions:

- Photonics;
- Thin films, low dimensional (0D, 1D, 2D) structures and sensors;
- Energetics;
- Medical technologies (diagnostics); Microfluidics.

On the other hand, the structure of the laboratories of ISSP UL outlines 25 Research & Innovation domains:

1. Theoretical material science and modelling
2. X-ray absorption spectroscopy
3. Opticaly active defects in silicon dioxide
4. Analysis of paramagnetic defect structure in functional materials
5. Electronic processes and charge transfer mechanisms in luminescent materials
6. Third order non-linear optical effects, materials and devices
7. Radiation damage studies in functional materials for fusion and particle physics
8. Thin film and coating technologies
9. 0D, 1D, 2D and mixed-dimensional nanomaterials
10. Prototyping of microfluidic devices (new initiative)
11. Polymer photonics technology platform (new initiative)

12. Morphology and structure
13. Synchrotron radiation spectroscopy of scintillators
14. Spectroscopic ellipsometry of advanced materials
15. Electroluminescence and organic light-emitting diodes
16. Light amplification and organic solid-state lasers
17. Visual perception and image processing in adaptive optics and augmented reality
18. Transparent glass-ceramics, glasses, composites.
19. Novel materials for ionizing radiation and UV light dosimetry
20. Utilising up-conversion luminescence properties in nanoparticles for various applications
21. Persistent luminescence mechanisms and applications in wide bandgap materials
22. Materials for batteries
23. Hydrogen energy
24. Thermoelectrics and hybrid photovoltaics
25. Ferroelectric materials for electromechanical and electrocaloric application

The research conducted in these 25 research domains is generally relevant to more than one application group or strategic direction. The following matrix illustrates the relation between the research domains, the 16 presently actual applications and 4 general, strategic directions.

Table: Relation between the current 25 research domains of ISSP UL (top row), the relevant applications, and the 4 outlined strategic directions (the left column).

	Domain # and names	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Strategic directions	**Applications, related to the strategic directions**	Theoretical material science and modelling	X-ray absorption spectroscopy	Opticaly active defects in silicon dioxide	Analysis of paramagnetic defect structure in functional materials	Electronic processes and charge transfer mechanisms in luminescent materials	Third order nonlinear optical effects, materials and devices	Radiation damage studies in functional materials for fusion and particle physics	Thin film and coating technologies	0D, 1D, 2D and mixed-dimensional nanomaterials	Prototyping of microfluidic devices	Polymer photonics technology platform	Morphology and structure	Synchrotron radiation spectroscopy of scintillators	Spectroscopic ellipsometry of advanced materials	Electroluminescence and organic light-emitting diodes	Light amplification and organic solid-state lasers	Visual perception and image processing in adaptive optics and augmented reality	Transparent glass ceramics, glasses, components	Novel materials for ionizing radiation and UV light dosimetry	Upconversion luminescence properties in nanoparticles for various	Persistent luminescence mechanisms and applications in wide bandgap	Materials for batteries	Hydrogen energy	Thermoelectrics and hybrid photovoltaics	Ferroelectric materials for electromechanical and electrocaloric
PHOTO-NICS	Photonics devices	x	x	x	x	x	x		x	x		x	x		x	x	x	x	x	x	x					x
	Optical materials	x		x	x	x	x	x	x			x	x	x	x	x			x	x					x	
	Optical fibers			x	x								x							x						
	Scintilators	x			x	x		x					x	x					x	x		x				
	Light sources				x	x			x			x	x			x	x					x				
	Displays					x			x			x	x		x	x	x	x								
LOWDIM	Nanoelectronics	x	x		x					x			x													
	Coatings			x		x			x				x		x											
	Sensors	x	x	x	x	x	x		x	x		x	x						x	x	x	x			x	x
	Actuators									x			x													x
ENERGY	Nuclear energy	x	x	x	x	x		x					x	x												
	H_2 energy	x											x										x	x		
	Photovoltaics	x	x		x	x			x	x		x	x		x				x		x					
	Batteries	x							x				x										x	x		
MEDTECH	Medical technologies			x		x			x	x	x	x	x					x	x	x	x	x				
	Microfluidics										x		x													

The research is primarily valued by two criteria: excellence and impact. Excellence is assessed by the academic community within a particular field of specialisation and can be roughly measured by bibliometric indicators including publications, patents. The impact of applied research on society in turn is assessed by: new innovative, potentially disruptive technologies, which have been developed and introduced in production, new commercial products, devices, instruments or services, which have been designed, or spin-off companies, which have been set up.

One of the cornerstones of scientific progress is international cooperation to achieve common goals, focusing on the challenges defined in the Horizon Europe Programme, in the "European Green Deal" - the Commission's blueprint and roadmap to make Europe a climate-neutral continent by 2050, by response to the twin climate and biodiversity crises while accelerating a fair and sustainable recovery from coronavirus pandemic. International cooperation is essential in order to provide access to Large European Infrastructures. It helps to increase the mobility of researchers and academic staff, leading to an important flow of knowledge and an open science system.

ACTIVITIES AND MEASURES 2022

CURRENT ACTIVITIES

For the development of new competitive ideas, it is essential to provide research activities within: the interdisciplinary cross-laboratory collaboration; inter-institutional (with scientific Institutes in Latvia); and international cooperation (with scientific Institutions in EU and beyond, including CAMART^2 Swedish partners) to promote new initiatives and motivation for the future speed-up of regular scientific collaboration, to facilitate internships and education activities.

Sustainable Human Resources (HR) Plan is being developed, however, given the general demographic situation in Latvia, it needs to be further improved in order to attract more students to STEM studies and to ISSP UL. An efficient management of HR is a must in order to increase the scientific capacity. Further improvement can be expected due to more resources for hiring scientific staff becoming available with the implementation of our research projects.

Training and motivation of both research staff and university students to develop their professional skills across Institute's research-innovation ecosystem will be continuously promoted.

The young researchers will be continuously supported by Institute's grants, providing as well opportunities to participate in summer-winter schools, workshops and conferences. In the current reality of COVID constraints, it is not possible to develop a realistic longer-term event planning, even in the cases of events in an online remote format. So, we will keep a close eye on all the opportunities that will open up.

For intensifying project proposal's writing, an adequate service is provided, and extra personnel has been hired to offer an everyday support to project proposal developers.

An increase in the quality of the research results measured by the distribution of papers relative to journal's quality (SNIP, Quartile, Impact Factor) in the next years will be further stimulated by the new merit-based budget distribution scheme and by the requirements included within the new research projects. Scientific paper writing workshops will be provided by Learning & Development team.

During 2021 Institute's research team started preliminaries for the International FM&NT-2022 conference scheduled for June-July 2022 in Riga. We hope that it will be possible to hold the conference in the normal, "in-person" format.

In November-December 2021, six extended thematic scientific Seminars were organized in order to evaluate the present state of the research in Institute laboratories, to assess the most promising future trends, their alignment with the previously elaborated long-term (2021-2027) plan and to determine the necessary corrections in short- and mid-term planning.

As a result, four strategic directions of Scientific Activity were identified (see also the domain-application- strategic direction table on the page 6 above:

- Photonics;
- Thin films, low dimensional (0D, 1D, 2D) structures and sensors;
- Energetics;
- Medical technologies (diagnostics); Microfluidics.

In the last decade, there has been an increasing tendency to integrate smart materials with nanotechnology to develop novel materials or structures for the applications in sensors, actuators, biomaterials, multifunctional materials, structural health monitoring, etc. The combination of smart materials and nanotechnology provides many advantages, realizes novel designs that could not be achieved in traditional engineering, and offers greater opportunities as well as challenges.

PHOTONICS

The key laboratories of ISSP UL involved in development of this direction are:

- **Laboratory of Organic Materials** (fundamental and applied research of organic molecules, materials and their structures with the main goal to develop knowledge about the relationship between structure and properties in organic materials for next generation electronics and photonics. Using the concepts derived from the studies, new materials with improved properties are designed in close cooperation with Latvian and foreign chemists. Assessment and demonstration of the possible applications of novel materials, light emitting diodes, solar cells, solid state lasers, electro-optical and optical-optical modulators and field effect transistors. Persistently improved scientific skills, generated knowledge and technology within the Laboratory are the key elements for the development of organic the electronics and photonics in Latvia.

- **Micro and Nanodevices Laboratory** R&D and fabrication of various micro-devices and nanostructures: sensors, transistors etc. Industrial experience in fields of photonics, semiconductors and microfluidics. It provides state of the art electron beam lithography

(Raith) and direct laser writing lithography for photonic device fabrication. The laboratory maintains cleanroom tools and provide cleanroom operator training.

- **Laboratory of Visual Perception** (research areas include: the optical quality of different optical systems including a human; adaptive optics, wave-front phase retrieval; various light sources and their influence on visual perception, various visual stimuli for studies on visual psychophysics are designed. The laboratory connects materials science, wave optics, vision science and optometry).

- **Optical Materials Laboratory.** Research of various optical phenomena in solid state materials. Areas of interest include studies of persistent luminescence, interaction of ionizing radiation with crystalline, ceramic and glass-like structures, research of optical fibres and ultraviolet optics. Laboratory includes sample synthesis division focusing on crystalline, glassy and ceramic materials, and coatings of different compositions for mechanoluminescence devices, lighting, various sensors, scintillators and other applications.

Publications 2021	**27**
Active national projects	5 (ERDF) + 6 (LCS-FARP)+4 (PostDoc) =**15**
Active international projects	1(LV-LT-Taiwan)=2
Funded new national projects starting 2022	2 (1 FARP)+(1 ERDF)+ 1(EU Space Agency)
Submitted international and Horizon Europe projects	Excellence Hub European DEEPTECH Laboratory for Smart Urban Development (A. Anspoks)

Highlights

NEW PROJECTS

- Interstitial molecules and point defects in silicon dioxide-based materials for photonics, radiation-related and photochemical applications (Latvian Science Council Fundamental and Applied Research Projects (FARP) - L. Skuja).

- Enhancing transparency and efficiency of scalable thin film electroluminescent protective panels using anti-reflective layers and advanced materials (ERDF, K. Šmits): display technology.

- Feasibility of phase retrieval adaptive optics for satellite-ground optical communication (European Space Agency –ESA- S. Fomins)

CONTINUED PROJECTS

- Functional ultrawide bandgap gallium oxide and zinc gallate thin films and novel deposition technologies (ERDF, J. Purans): Transparent semiconductors for display technology.
- Development of efficient clad-pumped fiber optical amplifiers for telecommunication systems (ERDF, J. Grube)
- Next generation aggregation induced emission luminogens for artificial lighting sources (ERDF, A. Vembris)
- Development of holographic recording materials based on azo-benzene and epoxy compounds (ERDF, J. Teteris)
- Enabling a commercially viable long lifespan and high-efficiency omni-friendly OLED lighting source with G2 and G3 emitters (Latvia-Lithuania-Taiwan project, A. Vembris)
- Up-conversion luminescence photolithography in organic compounds using nanoparticles/photoresist composition (FARP, J. Grube)
- Structural modification of carbene-metal-amide complexes towards acquisition of thermally activated delayed fluorescence blue light OLED emitters (FARP, A. Vembris)
- Development of X-ray sensitive hybrid organic-inorganic systems (FARP, A. Kalinko)
- Epitaxial Ga_2O_3 thin films as wide band-gap topologic transparent electrodes for ultraviolet optoelectronics (FARP, J. Purans)
- Thin films of rare-earth oxy-hydrides for photochromic applications (FARP, M. Zubkins)
- Improvement of the optical properties of complex oxide ceramic materials showing persistent luminescence (Post doc projects, V. Vitola)
- Effect of synthesis on the structure and properties of NBT-based solid solutions (Post doc projects, M. Dunce)
- Modern glass and glass-ceramic temperature-resistant luminophores with different rare-earth and 3d-ion-activated garnets for high-power LEDs (Post-doc. projects, M. Skruodiene)
- Organic light-emitting diodes based on heavy metal-free emissive materials (post-doc, A. Pidluzna)

THIN FILMS AND LOW DIMENSIONAL (0D, 1D, 2D) STRUCTURES AND SENSORS

Dimensional scaling of materials dramatically modifies their electrical, thermal, mechanical, and magnetic properties, as well as their material-property relationship, which in turn alters the physical behavior of nanoscale photonic and electronic devices. There are also significant challenges related to understanding and controlling material properties at the nanoscale and integration of nanomaterials into hybrid systems at advanced technology nodes.

The key laboratories of ISSP UL involved in development of this direction are:

- **Thin Films Laboratory** - provides thin film deposition service of a wide variety of inorganic materials, using different deposition techniques, including the PVD vacuum multifunctional R&D cluster SAF25/50, the magnetron sputtering G500M cluster including High Power Impulse Magnetron Sputtering (HiPIMS), as well as PLD, MOCVD and ALD. Laboratory collaborates with the largest vacuum technology industry among the Baltic countries: SIDRABE VACUUM, Ltd., SCHAEFFLER BALTIC, Ltd., GROGLASS, Ltd., ALFA, Inc.. The thin film deposition techniques developed at ISSP UL during the recent years are extensively used in the framework of multiple projects by this and other laboratories of ISSP UL and by external customers.

- **EXAFS laboratory**. EXAFS Spectroscopy Laboratory (Extended X-ray Absorption Fine Structure Lab) focuses on the study of materials structure using synchrotron radiation X-ray absorption spectroscopy. Its aim is to develop the various advanced methods of X-ray absorption spectroscopy and their application in material science; to maintain and further expand the ISSP UL cooperation with the existing and new European Union synchrotron radiation centres. Additional experimental capabilities include confocal spectromicroscopy; X-ray diffraction and other. The laboratory uses advanced theoretical calculations and simulations of experimental data to gain insight on the structure-property relationships in materials. In particular, it uses synchrotron radiation X-ray absorption spectroscopy to study the local atomic structure and lattice dynamics in thin films and two-dimensional layered materials to elucidate structure-property relationships with a special focus on phenomena associated with local structural instabilities, distortions and relaxations. The obtained experimental information also provides an opportunity for validating theoretical atomistic simulations.

- **Laboratory of Spectroscopy** – is one of the largest and presently best equipped laboratories at the ISSP UL. It combines a variety of research techniques related to optical, magnetic and electron spectroscopy. Its staff has extensive experience in the spectroscopic characterization of materials and apart from its own research provides services to academic and industrial partners. The range of materials includes crystals, glasses, glass-ceramics, thin films, nanomaterials. The available techniques include optical spectroscopy (absorption, luminescence excitation/emission, steady-state and time-resolved luminescence) over a wide temperature range (6 K to 700 K), as well as vibrational (Raman and Fourier infrared) spectroscopy, ellipsometry, electron paramagnetic resonance, optically detectable magnetic resonance, subnanosecond luminescence characterization, thermostimulated luminescence measurement, ablation spectroscopy and X-ray photoelectron spectroscopy. The laboratory performs in-house synthesis of rare-earth doped fluoride and oxyfluoride glass ceramics and nanocomposites. Spectroscopic properties of rare-earth activated bulk materials are extensively studied for many years. Based on these studies, novel lasers, colour displays, light

emitters and etc. are developed. Nanocomposites possess many intriguing properties, which are not present in the corresponding bulk materials;

- **Laboratory of Materials Morphology and Structure Investigations** - focuses on the study of materials structure, morphology and composition using modern experimental and theoretical methods. This is to a significant degree a method-based laboratory providing services to other research laboratories. These include: electron microscopy methods (SEM, TEM, HRTEM); X-ray and electron diffraction; microhardness and nano-indention; atomic force microscopy.

- **Laboratory of Computer Modelling of Electronic Structure of Solids**. Laboratory of Computer Modelling of Electronic Structure of Solids performs large-scale *ab initio* computer simulations on advanced materials, their surfaces, interfaces and nanostructures. It performs state-of-the-art massive parallel computer modelling using commercially available first principles quantum mechanical computer codes combined with home-made advanced thermodynamic analysis, pair potential approach, molecular dynamics, kinetic Monte Carlo and simpler formalisms. Such approach yields reliable atomic and electronic structure of complex advanced nanomaterials (nanoparticles, nanorods, nanotubes etc.), as well as a multi-scale picture of physical-chemical processes in a large variety of materials important for technological applications.

Publications 2021	**46**
Active national projects	4 (ERDF) + 4(FARP) +2(rural support)+3(PostDoc) =**13**
Active international projects	**1** (ERA-NET)
Funded new national projects starting 2022	**2** (FARP)
Submitted international and Horizon Europe projects	ERC DIAMENA (A. Kuzmins) Twinning project: Development of Research Capacity of Thin Film Nanotechnologies and Multifunctional Applications (“ ARENA”) - (J. Purans) Excellence Hub European DEEPTECH Laboratory for Smart Urban Development (A. Anspoks)

	Horizon Europe project: SESTO SENSO (I. Aulika) 2 COST Actions (A.Kuzmins)

Highlights

NEW PROJECTS

- Computer modelling, synthesis and characterization of modified TiO_2 nanoparticles for disinfection applications (FARP, D. Bocharov)
- Topological semimetals towards low-dissipation electronics (FARP, G. Mozolevskis – as partner of project coordinator UL Chemical Physics Institute)

CONTINUED PROJECTS

- Development of mechanoluminescent thin films for real time stress detectors (ERDF, D.Millers): photonic stress sensors
- Core-shell nanowire heterostructures of Charge Density Wave materials for optoelectronic applications (FARP, B. Polyakov)
- Smart Metal Oxide Nanocoatings and HIPIMS Technology (ERDF, J. Purans)
- Development of technologies for determination of carbon concentration in soil (Latvian Rural Support Projects, K. Smits)
- Winter wheat monitoring using spectroscopic methods (Latvian Rural Support Projects, D. Millers)
- Optical gas sensor (ERDF, G. Mozolevskis)
- ZnMgO materials with tunable band gap for solar-blind UV sensors (M-ERANET, L. Trinklere)
- Surface plasmon resonance enhanced light amplification and modulation in organic thin films (FARP, A. Vembris)
- Effect of the crystallite size and composition on formation of polarons in nanocrystalline tungstates (PostDoc, G. Bakradze)
- Elaboration and characterization of Ga_2O_3 and ZnMgO thin film detectors of ultraviolet radiation (PostDoc R. Nedzinskas)
- Towards universal lab-on-chip single graphene sheet-based sensor: from photodetection to biosensing (PostDoc., T. Yager)
- Novel materials for development of all-optical temperature sensor (OPTSEN) (ERDF, U. Rogulis)

ENERGETICS

The laboratories of ISSP UL focused on development of this direction are:

- **Laboratory of Materials for Energy Harvesting and Storage**. It studies cathode materials and anode materials for Li-ion and Na-ion batteries, materials and technologies for producing hydrogen in electrolysis or photoelectrolysis, in biomass dark fermentation processes, for its storage in metal hydrides and nanostructured composite materials. Additional focus points are CO_2 processing into synthetic hydrocarbons (COEXIDE) and development of functional coating technologies for the functionalization of glass and natural fiber textiles.

- **Laboratory of Chemical Technologies** – provides chemical synthesis infrastructure and services for other laboratories and performs its own research. Topics handled in the laboratory include ion conducting polymer materials and membranes for batteries - synthesis and characterization; chlorosulphonated polyetheretherketone membranes with different sulphonation degrees, including the sulphonation degrees influence on membrane physical properties and composite formation, as well as process kinetics; resolution of problems extensively investigated in the field of luminescent up-converting nanomaterials, as: stabilization, modification and (bio)functionalization; design and preparation of multifunctional up-converting nanomaterials and core-shell hybrid structures with improved performances – the development of synthetic methods, structural, morphological and optical characterization, other.

- **Laboratory of Ferroelectric Materials** - comprehensive research of ferroelectric solid solutions of perovskite structure, technology of transparent ceramics and its application in electronic and photonic devices. Laboratory is focused on R&D of lead-free ferroelectric ceramics. NBT-based solid solutions are prepared and studied in respect of structure, dielectric, electromechanical, electrocaloric and other properties. The aim of the research is to get a deeper insight in the complicated nature of the polar state in this family of materials and to develop compositions with properties prospective for applications.

- **Laboratory of Computer Modelling of Electronic Structure of Solids** Laboratory performs *ab initio* computer calculations on materials for photovoltaic energy sources and novel materials for efficient electrolysis cells.

Publications 2021	**49**
Active national projects	4(ERDF) + 4(FARP) + 1(post doc) + 1(Ntnl. Res. Prog.) =**10**

Active international projects	1(Horizon) + 3(COST) + 1(ERA-NET) + 1 (EUROfusion) +2(EEA-Norway) +2(LV-LT-TW)+1(LV-Ukraine)= 10
Funded new national projects starting 2022	2(FARP)
Submitted international and Horizon Europe projects	Horizon Europe project: NOVOC (G. Kucinskis) Horizon Europe project: High performance batteries (G. Kucinskis) Horizon Europe project: HEROECO (M. Rutkis) ERA Chair: Advanced Laboratory of Ferroelectric Materials (E. Birks) EURATOM-2021-NRT: (A.Kuzmins) M-ERA.NET Call 2021: (A.Kuzmins)

Highlights

NEW PROJECTS

- Large-scale computer modelling of defective ternary chalcopyrites for photovoltaic applications (FARP, S. Piskunov)
- Advanced atomistic studies on Ruddlesden-Popper phases for protonic ceramic electrolysis cells (FARP, D. Gryaznov)

CONTINUING PROJECTS

- Functional ink-jet printing of wireless energy systems (A. Kuzmin, ERDF): elaborating of a prototype of ink-jet printed antenna-fed wireless electroluminescent display
- Development of sustainable recycling technology of electronic scrap for precious and non-ferrous metals extraction (V. Pankratovs, ERDF)
- Modern materials for sodium-ion batteries (PostDoc Project, G. Kucinskis)
- Engineering of perovskite photocatalysts for sunlight-driven hydrogen evolution from water splitting (M-ERANET, E. Kotomin)
- Towards understanding and modelling intense electronic excitation (COST, A. Popov)
- Mechanochemistry for Sustainable Industry (COST E. Elsts)

- Computational materials sciences for efficient water splitting with nanocrystals from abundant elements (COST, J. Kotomin)
- Research of the Top Quark and Higgs Boson in the CMS Experiment, Development of Crystal Scintillators, CMS Sub-Detectors and Particle Accelerator Technologies for Applied Applications in Collaboration With CERN (Latvian National Res. Program “High Energy Physics and Accelerator Technologies”, A. Popov)
- Comparative analysis of radiation-induced processes in complex oxide crystals and ceramics for their application in fusion devices (Latvia-Ukraine cooperation project, R. Eglitis)
- Multiscale computer modelling, synthesis and rational design of photo(electro)catalysts for efficient visible-light-driven seawater splitting (CatWatSplit) (Latvia-Lithuania-Taiwan cooperation projects, S. Piskunov)
- Aluminum in circle economy - from waste through hydrogen energy to alumina" – AliCE-Why (EEA-NO/LV/LT/IC project)
- Development of Semi-Transparent Bifacial Thin Film Solar Cells for Innovative Applications (EEA-Norway project, A. Vembris)
- Implementation of activities described in the Roadmap to Fusion during Horizon 2020 through a Joint programme of the members of the EUROfusion consortium (Eurofusion)
- Novel polymer and ionic liquid composites for sodium polymer batteries (FARP, G. Vaivars)
- Life-cycles prognosis of electrodes and cells of lithium ion batteries based on current-voltage measurements (FARP, G. Kucinskis)

MEDICAL TECHNOLOGIES (DIAGNOSTICS); MICROFLUIDICS

The laboratories of ISSP UL focused on development of this direction are:

Micro and Nanodevices Laboratory The laboratory performs R&D and fabrication of various microdevices and nanostructures: microfluidic devices, sensors, transistors etc. Microdevices and structures are used to study new materials, biological processes and physical phenomena. Lab staff has industrial experience in photonics, semiconductors and microfluidics. The laboratory maintains tools in cleanroom, is responsible for process development and user training.

Thin Films Laboratory is focused on development of antiviral, antifungal, anti-COVID coatings development, materials for deep-UV LEDs. There is also an inter-institutional cooperation in medicine-related projects with University of Latvia and Riga Technical University.

Laboratory of Spectroscopy- Synthesis and study of luminescent particles for medical applications: persistent luminescence materials for in situ diagnostics, up-conversion luminescence for therapy

applications and infrared visualisation and X-ray visualisation and dosimetry. Development of fiber-optic SERS-based sensing of virus proteins.

Laboratory of Computer Modelling of Electronic Structure of Solids - Computer modelling of modified TiO_2 nanoparticles for disinfection applications.

Publications 2021	**10**
Active national projects	5(ERDF) + 5(FARP) + 2(post doc) = **12**
Active international projects	**1** (LV-LT-TW project)
Funded new national projects starting 2022	3(FARP)+2(ERDF)=**5**
Submitted international and Horizon Europe projects	NOVOTACT (I. Auļika, J.Purāns) BIOCONNECT (A. Anspoks) AQUAMUNDA (A. Šarakovskis+ partners from RISE) Excellence Hub European DEEPTECH Laboratory for Smart Urban Development (A. Anspoks)

Highlights

NEW PROJECTS

- Development of carbonic anhydrase IX test biosensor for cancer screening (FARP, A. Anspoks)
- Computer modelling, synthesis and characterization of modified TiO_2 nanoparticles for disinfection applications (FARP, D. Bocharov)
- The development of a novel-designed optical fiber-based system for ultra-sensitive point-of-care viral protein detection by SERS (ERDF, K. Šmits)
- Technologies for deposition of large-area multifunctional antibacterial and antiviral nanocoatings (ERDF, J. Purans)
- Research of microbiota derived extracellular vesicle role on breast cancer by using gut-breast cancer axis on a chip (FARP, R. Rimsa as a partner of project coordinator - Latvian Biomedical Research and Study Centre)

- Cellbox Labs

CONTINUING PROJECTS

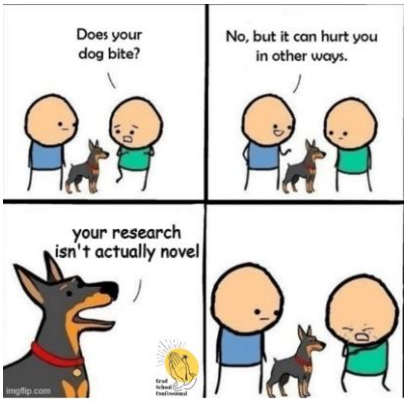
- Large area deposition technologies of multifunctional antibacterial and antiviral nanocoatings (ERDF, J. Purans)
- Investigation and optimization of cutting-edge lead-free PMUT platform: from materials to devices (Latvia-Lithuania-Taiwan cooperation projects, E. Birks)
- Mass-manufacturable gut on a chip device (ERDF, R. Rimsa)
- Microfluidic field flow fractionation for high throughput extra-cellular vesicle separation (FARP, R. Rimsa)
- Novel persistent luminescent material – red light emitter (FARP, B. Berzina)
- Portable diagnostic device based on a biosensor array of 2D material sensing elements (Post-doc, A. Ogurcovs)
- Microfluidic chip with multidetection module for evaluation of nPEF-induced gene expression (PostDoc, Arunas Stirke)

ACTIVITIES FOR FUTURE DEVELOPMENT

In 2022 we plan to further develop all three components of the scientific-innovation ecosystem:

- Human resources;
- Infrastructure;
- Budget.

HR development is more detailed described in Scientist to Scientist activities section of this document and particularly in WP6 deliverable "D6.3 – New HR management system". Infrastructure development is more concerned with WP4 "D4.11 - Infrastructure Development and Investment Plan".



Apart from these local infrastructure development activities, ISSP UL plans to increase participation in the new European Large Infrastructure facilities, such as European Spallation Source (ESS), X-Ray Free Electron Laser Facility (XFEL) and Max-IV synchrotron, which can drive innovative solutions thanks to their unique analytical techniques and expertise of the supporting teams.

In 2022 the focus will be continued on securing funding for scientific research as the funding received from Ministry of Education and Science in 2021 was 13% from the total funding of the ISSP UL, and it should be taken into account that the principles of financing of scientific institutions in Latvia will be changed in 2022. For the purpose of intensifying project application and improving their quality the newly created Project support team consisting of specialists with competencies in project call selection, project partner consortium building, project application planning, writing and Learning@Development will be involved.

Seven Horizon Europe projects have been submitted during 2021 jointly with partners with a considerable ISSP UL contribution both in the proposal preparation and in the planned implementation of the project tasks:

1. Eliminating VOC from Battery Manufacturing through Dry or Wet Processing (NoVOC)
2. Market-near Next-generation High Voltage Lithium-Ion Batteries (NEXTHIGH)
3. Physical Intelligence for Smart and Safe Human-Robot Interaction (SestoSenso)
4. Next Generation Thermoelectric Innovation Excellence: A Collaboration To Success (HEROECO)
5. Thermal Energy Harvesting Coatings through Organic-Inorganic Multilayer Hybrid Materials (Coat-4-TEH)
6. Graphene Flagship & Human Brain Project (GRA-SENSE)
7. AQUAMUNDA: Screening, control and abatement of water pollutants to promote circular economy, improving human and environmental health.

More details on them are given below in Scientist-to-Scientist section. This section gives also an extended outlook on possible targets for joint Horizon Europe project submission for years 2022-2023.

Participation in relevant project calls for 2022 is planned in the following directions:

Local project calls:

- Latvian Science Council projects FARP (Fundamental and Applied Research Projects)
- Application-oriented projects (ERDF projects managed by the Investment and Development agency of Latvia);
- Sectorial Research Programs (SRP) - National Mission-Oriented Research Programs (MORP) (according to RIS3);
- Commercialization projects with entrepreneurs;

International project calls:

- Horizon Europe Programme, with emphasis on Widening Projects (Twinning, ERAChair, Excellence Hubs);
- M-ERAnet's, various bilateral projects, etc.
- European Large Infrastructures projects:
  - Synchrotron radiation centres, MAX-4 – FinEstBeamline; XFEL,
  - ESS, CERN, ESA.

To prepare high quality project applications for the annual Latvian Science Council FARP project call and international project calls (Horizon Europe, ERANET) in the summer of 2022, there will be Project

writing workshops organized to develop project application writing competencies at ISSP UL – to better develop the project structure, formulations of its objectives and the overall quality.

SCIENTIST TO SCIENTIST (S2S) ACTIVITIES

In 2022 much focus will be devoted to Scientist to Scientist (S2S) activities that contribute significantly to new research ideas, cooperation in scientific publications and project applications.

KEY ACHIEVEMENTS

The main achievement of S2S activities is the submission of 7 Horizon Europe projects, already listed in the preceding section above, which were all prepared together with Swedish partners from RISE or KTH. In case of funding they will be started to implement in 2022. Here follows a brief description of these projects.

1) **HORIZON-CL5-2021-D2-01-04**: Environmentally sustainable processing techniques applied to large scale electrode and cell component manufacturing for Li ion batteries. Project coordinator: RISE. ISSP UL role in the project is to study the production of electrodes with water-based binders, to assist in the development of a prototype and to participate in its testing.

2) **HORIZON-CL5-2021-D2-01-02**: Advanced high-performance Generation 3b (high capacity / high voltage) Li-ion batteries supporting electro mobility and other applications. Project coordinator : RISE. ISSP UL role: to optimize the application of the protective coating on the surface of the cathode material (HV spinel) by chemical methods, to assist RISE in large-scale synthesis, to study the possibilities of recycling the coated material.

3) **HORIZON-CL4-2021-DIGITAL-EMERGING-01-11**: Pushing the limit of robotics cognition. ISSP UL role: thin film coatings for improved optical performances for ToF signal transmittance, organic material deposition with AM technologies, optical and morphological characterization needed for the 2D, 3D and 6D printed samples for robot sensory skin development, basic ToF tests and optical modelling (light interaction with the material - issues related to ToF efficiency, precision). RISE role: hybrid printed electronics technology, capacitive sensor printing, WP2 lead.

4) **HORIZON-CL4-2021-DIGITAL-EMERGING-01**: Functional electronics for green and circular economy (RIA). ISSP UL role: printable thermoelectric material development and characterization.

5) 2nd phase of **M-ERA.NET 2021** project on thermal energy harvesting organic coatings. KTH role: project coordination. ISSP UL role: Characterization of TE (thermoelectric) materials and hybrid films, lead of WP3 "Materials and Functional Characterization".

6) **FLAG-ERA JTC 2021** connected to Graphene flagship/Human brain project. Project coordinator: KTH, RISE/ISSP together would work on material engineering of graphene and its hybrids to enable new sensing mechanisms including large area monolayer graphene and graphene-based quantum structures

7) **H2020-LC-GD-8-1-2020**: Building a low-carbon, climate resilient future: Research and innovation in support of the European Green Deal (RIA). Project coordinator: RISE. ISSP UL role: engineering of

conventional nanoscale oxides (e.g. ZnO, TiO_2) and their 2D/3D nano/microstructures to provide innovative nanomaterial platform for the detection/treatment.

The efficiency of S2S activities with Swedish partners, implemented up to now, is illustrated by 3 joint papers (two papers with RISE and one paper with KTH), which are already submitted and published: (Note: Latvian partners marked by blue, Swedish partners by red)

- Ying Fu, Tom Yager, Georg Chikvaidze, Srinivasan Iyer and Qin Wang, Time-Resolved FDTD and Experimental FTIR Study of Gold Micropatch Arrays for Wavelength-Selective Mid-Infrared Optical Coupling, Sensors 21 (2021) 5203, https://doi.org/10.3390/s21155203
- Martins Zubkins, Janis Timoshenko, Jevgenijs Gabrusenoks, Kaspars Pudzs, Andris Azens, Qin Wang, and Juris Purans, Amorphous p-Type Conducting Zn–xIr Oxide (x > 0.13) Thin Films Deposited by Reactive Magnetron Co-sputtering, Phys. Status Solidi B (2021) 2100374, https://doi.org/10.1002/pssb.202100374
- Sergiy Khartsev, Mattias Hammar, Nils Nordell, Aleksejs Zolotarjovs, Juris Purans, Anders Hallén, Reverse bias electroluminescence in Er-doped β-Ga_2O_3 Schottky barrier diodes manufactured by pulsed laser deposition, pss(a) (2021) https://doi.org/10.1002/pssa.202100610

The focus in 2022 will be on growing the number of joint scientific publications as one of the results of scientist-to-scientist (S2S) co-operation. S2S activities will be intensified as they contribute significantly to new research ideas and cooperation in project applications.

In 2022 Cooperation with RISE Nano-Technology Unit including ProNano Lund, NanoLund, Fiber Optics Unit, , Electrum Kista (KTH/RISE) will be continued on relevant R&D topics of ISSP UL Internships trainings planned on relevant R&D topics of ISSP UL are:

- n-type Ga_2O_3/GaN heterostructures
- Raman and XPS spectroscopy
- Organic materials
- Fiber optics sensing and up-conversion luminescence
- Process development of graphene-based IR detectors by nano fabrications
- Graphene quantum dots for drug detection

Internships and trainings implemented at

- RISE Norrköping about analysis of inks behavior and optimization of inks jetting from nozzles
- KTH about design of phonic devices using COMSOL
- RISE-ISSP UL webinar on graphene, organized by SIO graphene program in Sweden
- ProNano (RISE): vacuum sputtering technologies and epitaxial Ga_2O_3
- Electrum (KTH): ALD, cleanroom and oxidation processes

S2S PLANS FOR 2022

1. TRAININGS / INTERNSHIPS

Topic	Duration/period	RISE	KTH	ISSP UL
Fiber optics	2-3 weeks	K. H. Tow		A. Sarakovskis P. Lesnicenoks
Energy harvesting and storage	1 week	A. Ahniyaz	G. Lindbergh	G. Kucinskis P. Lesnicenoks G. Bojars A. Knoks
Sensors (CVD graphene-based IR detectors/sensors, Graphene quantum dots for drug detection)	1 week	Q. Wang		T. Yager G. Kucinskis P. Lesnicenoks G. Mozolevskis A. Sarakovskis
Adaptive optics	1 week		L. Lundstrom	S. Fomins V. Karitans
Flexible electronics	1 week	V. Beni P.A. Ersman M. Sandberg P. Andersson S. Majee	J. Li	B. Polakovs P. Lesnicenoks R. Olins
Ga_2O_3/GaN and related topics on vacuum deposition technologies				
HR-XRD for thin film characterization	First week of February (3 days)		A. Hallen M. Hammar	G. Strikis L. Bikse
PLD: visit of ISSP UL at KTH	mid-February (2-3 days)		M. Hammar A. Hallen S. Khartsev	E. Butanovs K. Kadiwala
Thin film, (production of Ga_2O_3 power electronics devices, etc.)	April (2 days)		S. Khartsev A. Hallen	E. Butanovs L. Dimitricenko J. Purāns
PLD: visit of KTH at ISSP UL	2-3 days		S. Khartsev	E. Butanovs K. Kadiwala

2. JOINT PROPOSAL SUBMISSION

Currently more than 20 Horizon Europe calls are considered for the 2022 and 2023. The list of the targeted calls:

Programme	Call	Topic	Deadline	ID
Horizon Europe	CSA	Excellence Hubs	15-Mar-22	HORIZON-WIDERA-2022-ACCESS-04-01
Horizon Europe	CSA	Twinning	18-Jan-22	HORIZON-WIDERA-2021-ACCESS-03-01
Horizon Europe	CSA	ERA Chairs	15-Mar-22	HORIZON-WIDERA-2022-TALENTS-01-01

Horizon Europe	RIA	Products with complex functional surfaces (Made in Europe Partnership)		HORIZON-CL4-2022-TWIN-TRANSITION-01-02
Horizon Europe	RIA	Functional multi-material components and structures		HORIZON-CL4-2022-RESILIENCE-01-12
Horizon Europe	RIA	Advanced materials modelling and characterisation		HORIZON-CL4-2022-RESILIENCE-01-19
Horizon Europe	RIA	Safe- and sustainable-by-design organic and hybrid coatings		HORIZON-CL4-2022-RESILIENCE-01-23
Horizon Europe	RIA	Novel materials for supercapacitor energy storage (RIA)	30-Mar-22	HORIZON-CL4-2022-RESILIENCE-01-24
Horizon Europe	RIA	Innovative materials for advanced (nano)electronic components and systems	30-Mar-22	HORIZON-CL4-2022-RESILIENCE-01-10
Horizon Europe	RIA	Pushing the limit of physical intelligence and performance	05-Apr-22	HORIZON-CL4-2022-DIGITAL-EMERGING-01-06
Horizon Europe	RIA	Basic Science for Quantum Technologies	05-Apr-22	HORIZON-CL4-2022-DIGITAL-EMERGING-01-16
Horizon Europe	RIA	Advanced multi-sensing systems	05-Apr-22	HORIZON-CL4-2022-DIGITAL-EMERGING-01-03
Horizon Europe	RIA	R&D for the next generation of scientific instrumentation, tools and methods	20-Apr-22	HORIZON-INFRA-2022-TECH-01-01
Horizon Europe	RIA	Digitalisation of battery testing, from cell to system level, including lifetime assessment (Batteries Partnership)	06-Sep-22	HORIZON-CL5-2022-D2-01-07
Horizon Europe	RIA	Embedding smart functionalities into battery cells (embedding sensing and self-healing functionalities to monitor and self-repair battery cells)	06-Sep-22	HORIZON-CL5-2022-D2-01-06
Horizon Europe	RIA	Next generation technologies for High-performance and safe-by-design battery systems for transport and mobile applications	06-Sep-22	HORIZON-CL5-2022-D2-01-05
Horizon Europe	RIA	Physics and data-based battery management for optimised battery utilisation	06-Sep-22	HORIZON-CL5-2022-D2-01-09
Horizon Europe	RIA	Development of high temperature thermal storage for industrial applications	06-Sep-22	HORIZON-CL5-2022-D4-01-05
Horizon Europe	RIA	Direct renewable energy integration into process energy demands of the chemical industry	27-Oct-22	HORIZON-CL5-2022-D3-02-06
Horizon Europe	RIA	2D materials-based devices and systems for biomedical applications	16-Nov-22	HORIZON-CL4-2022-DIGITAL-EMERGING-02-19
Horizon Europe	RIA	2D materials-based devices and systems for energy storage and/or harvesting (RIA)	16-Nov-22	HORIZON-CL4-2022-DIGITAL-EMERGING-02-18
Horizon Europe	IA	2D-material-based composites, coatings and foams (IA)	16-Nov-22	HORIZON-CL4-2022-DIGITAL-EMERGING-02-20
Horizon Europe	CSA	Supporting the coordination of the Graphene Flagship projects (CSA)	16-Nov-22	HORIZON-CL4-2022-DIGITAL-EMERGING-02-22
Horizon Europe	RIA	Novel Thin Film (TF) technologies targeting high efficiencies	10-Jan-23	HORIZON-CL5-2022-D3-03-05

3. S2S PHOTONICS TOPICS DURING 2022

Topic	Sub-topic	Scientists	
		ISSP UL	KTH
Organic materials	Structural and emission spectra modelling for thiazole-based carbene-copper-amide complexes for an application as TADF-active OLED emitters	A. Vembris	M. Hammar K. Gylfason S. Popov G. Baryshnikov
	Optical gas sensors, ring resonators	A. Bundulis G. Mozolevskis	K. Gylfason
Nanophotonic structures	Optical investigation of nanophotonic structures	A. Sarakovskis	A. Srinivasan
SiO_2	Semiconductor interphases	I. Aulika J. Butikova	A. Hallen M. Hammar
Piezoelectric Crystals	EXAFS and optical anisotropy studies in periodically polled $LiNbO_3$ thin films and crystals	A. Kuzmins I. Aulika J. Butikova	K. Gallo
Adaptive optics	Adaptive optics for broad application High- speed phase retrieval based on advanced microoptics	S. Fomins V. Karitans	K. Gylfason S. Popov M. Hammar
	Coordination of activities, research coordination, definition of adaptive optics requirements		L. Lundstrom

4. SEARCH FOR NEW S2S OPPORTUNITIES

New opportunities will emerge during joint meetings, trainings and internships, where reflection on experience and new ideas will be organized. Directions for new opportunities at the beginning of 2022 are the following:

- Spectroscopy and nanomaterials: A. Sarakovskis (ISSP UL) and Prof. Jerker Widengren (KTH)
- Biomed: G. Mozolevskis (ISSP UL) and Hjalmar Brismar (KTH)

For eliciting new directions and opportunities Agile planning principles will applied with regular assessment of results and planning of new activities.

One of the main objectives of the S2S is to develop cooperation for joint research, new publications and project applications. S2S activities planned are visits for exchange of experience, visits for widening RDI network, visiting professors, mini- ERA Chairs, participation in conferences / workshops and summer schools. S2S activities will be planned strategically to reflect the priorities of the ISSP UL and laboratories. New S2S opportunities will be actively explored both with CAMART^2 partners KTH and RISE and with other international partners where the collaboration already exists and where it needs yet to be built. The successful S2S collaboration model developed with RISE and KTH will be applied in S2S cooperation with other international partners, which is expected to lead to new joint projects and exchange.

APPENDIX: LIST OF ISSP UL RESEARCH PROJECTS ONGOING IN 2022

#	Project	Project leader	End date	Type
1	Smart Metal Oxide Nanocoatings and HIPIMS Technology	J. Purans	2022-02-28	ERDF
2	Development of technologies for determination of carbon concentration in soil	K. Smits	2022-02-28	Rural support
3	Winter wheat monitoring using spectroscopic methods	D. Millers	2022-02-28	Rural support
4	Modern materials for sodium-ion batteries	G. Kucinskis	2022-03-31	PostDoc
5	Development of efficient clad-pumped fiber optical amplifiers for telecommunication systems (DOPAnT)	J. Grube	2022-05-31	ERDF
6	Next generation aggregation induced emission luminogens for artificial lighting sources	A. Vembris	2022-05-31	ERDF
7	"Engineering of perovskite photocatalysts for sunlight-driven hydrogen evolution from water splitting", SunToChem	J. Kotomins	2022-05-31	M-Eranet
8	Development of holographic recording materials based on azo-benzene and epoxy compounds	J. Teteris	2022-06-30	ERDF
9	Mass-manufacturable gut on a chip device	R. Rimša	2022-06-30	ERDF
10	Optical gas sensor	G. Mozo-levskis	2022-06-30	ERDF
11	ZnMgO materials with tunable band gap for solar-blind UV sensors	L. Trinklere	2022-08-31	M-ERANET
12	Towards understanding and modelling intense electronic excitation	A. Popov	2022-09-11	COST
13	Innovative student grants	A. Anspoks	2022-10-01	UL/industry

#	Project	Project leader	End date	Type
14	Research of the Top Quark and Higgs Boson in the CMS Experiment, Development of Crystal Scintillators, CMS Sub-Detectors and Particle Accelerator Technologies for Applied Applications in Collaboration With CERN	A. Popov	2022-10-11	Latvian National. Res.Prg. NRP-CERN
15	Feasibility of phase retrieval adaptive optics for Satellite-Ground optical communication	S. Fomins	2022-11-30	ESA
16	Microfluidic field flow fractionation for high throughput extra-cellular vesicle separation	R. Rimša	2022-12-31	FARP
17	Up-conversion luminescence photo-lithography in organic compounds using nanoparticles/photoresist composition	J. Grube	2022-12-31	FARP
18	Novel persistent luminescent material – red light emitter	B. Berzina	2022-12-31	FARP
19	Structural Modification of Carbene-Metal-Amide Complexes Towards Acquisition of Thermally Activated Delayed Fluorescence Blue Light OLED Emitters	A. Vembris	2022-12-31	FARP
20	Development of X-ray sensitive hybrid organic-inorganic systems	A. Kalinko	2022-12-31	FARP
21	Surface plasmon resonance enhanced light amplification and modulation in organic thin films	A. Vembris	2022-12-31	FARP
22	Comparative analysis of radiation-induced processes in complex oxide crystals and ceramics for their application in fusion devices	R. Eglitis	2022-12-31	LV-Ukraine
23	Investigation and optimization of cutting-edge lead-free PMUT platform: from materials to devices	E. Birks	2022-12-31	M-ERANET
24	Improvement of the optical properties of complex oxide ceramic materials showing persistent luminescence	V. Vitola	2022-12-31	PostDoc
25	Effect of synthesis on the structure and properties of NBT-based solid solutions	M. Dunce	2022-12-31	PostDoc
26	Effect of the crystallite size and composition on formation of polarons in nanocrystalline tungstates	G. Bakradze	2022-12-31	PostDoc
27	Mechanochemistry for Sustainable Industry	E.Elsts	2023-02-26	COST

#	Project	Project leader	End date	Type
28	Elaboration and characterization of Ga_2O_3 and ZnMgO thin film detectors of ultraviolet radiation	R. Nedzinskas	2023-05-31	PostDoc
29	Modern glass and glass-ceramic temperature-resistant luminophores with different rare-earth and 3d-ion-activated garnets for high-power LEDs	M. Skruodiene	2023-05-31	PostDoc
30	Functional ultrawide bandgap gallium oxide and zinc gallate thin films and novel deposition technologies	J. Purans	2023-06-30	ERDF
31	Portable diagnostic device based on a biosensor array of 2D material sensing elements	A. Ogurcovs	2023-06-30	PostDoc
32	Towards universal lab-on-chip single graphene sheet-based sensor: from photodetection to biosensing.	T. Yager	2023-06-30	PostDoc
33	Microfluidic chip with multidetection module for evaluation of nPEF-induced gene expression	Arunas Stirke	2023-06-30	PostDoc
34	Organic light-emitting diodes based on heavy metal free emissive materials	A. Pidlužna	2023-06-30	PostDoc
35	Enabling a Commercially Viable Long Lifespan and High-Efficiency Omni-Friendly OLED Lighting Source with G2 and G3 Emitters (Eco-OLED)	A.Vembris	2023-08-31	M-ERA-NET
36	Novel materials for development of all-optical temperature sensor (OPTSEN)	U.Rogulis	2023-09-30	ERDF
37	Functional ink-jet printing of wireless energy systems	A. Kuzmins	2023-09-30	ERDF
38	Development of mechanoluminescent thin films for real time stress detectors	D. Millers	2023-09-30	ERDF
39	Development of sustainable recycling technology of electronic scrap for precious and non-ferrous metals extraction (es-retech)	V. Pankratovs	2023-11-30	ERDF
40	Enhancing transparency and efficiency of scalable thin film electroluminescent protective panels using anti-reflective layers and advanced materials	K. Šmits	2023-12-22	ERDF

#	Project	Project leader	End date	Type
41	The development of a novel-designed optical fiber-based system for ultra-sensitive point-of-care viral protein detection by SERS	K. Šmits	2023-12-22	ERDF
42	Large area deposition technologies of multifunctional antibacterial and antiviral nanocoatings	J. Purans	2023-12-22	ERDF
43	Computational materials sciences for efficient water splitting with nanocrystals from abundant elements (2019-2023)	J. Kotomins	2023-12-31	ERDF
44	Development of Semi-Transparent Bifacial Thin Film Solar Cells for Innovative Applications	A.Vembris	2023-12-31	EEA-Norway
45	Epitaxial Ga_2O_3 thin films as wide band-gap topologic transparent electrodes for ultraviolet optoelectronics	J. Purans	2023-12-31	EEA-Norway
46	Thin Films Of Rare-Earth Oxy-Hydrides For Photochromic Applications	M. Zubkins	2023-12-31	FARP
47	Novel polymer and ionic liquid composites for sodium polymer batteries	G. Vaivars	2023-12-31	FARP
48	Life-cycles prognosis of electrodes and cells of lithium ion batteries based on current-voltage measurements	G. Kučinskis	2023-12-31	FARP
49	Core-shell nanowire heterostructures of Charge Density Wave materials for optoelectronic applications	B. Poļakovs	2023-12-31	FARP
50	Aluminum in circle economy - from waste through hydrogen energy to alumina" – AliCE-Why	J. Kleperis	2024-04-30	EEA-LV-LT-IC
51	Multiscale computer modelling, synthesis and rational design of photo(electro)catalysts for efficient visible-light-driven seawater splitting (CatWatSplit)	S. Piskunov	2024-05-02	EEA-Norway
52	Large-scale computer modelling of defective ternary chalcopyrites for photovoltaic applications	S. Piskunov	2024-12-31	M-ERANET
53	Development of carbonic anhydrase IX test biosensor for cancer screening	A. Anspoks	2024-12-31	FARP
54	Computer modelling, synthesis and characterization of modified TiO_2 nano-particles for disinfection applications	D. Bocharov	2024-12-31	FARP

#	Project	Project leader	End date	Type
55	Advanced atomistic studies on Ruddlesden-Popper phases for protonic ceramic electrolysis cells	D. Grjaznovs	2024-12-31	FARP
56	Interstitial molecules and point defects in silicon dioxide-based materials for photonics, radiation-related and photochemical applications.	L. Skuja	2024-12-31	FARP
57	Topological semimetals towards low-dissipation electronics	G. Mozo-levskis	2024-12-31	FARP
58	Research of microbiota derived extracellular vesicle role on breast cancer by using gut-breast cancer axis on a chip (GBA-OC)	R. Rimša	2024-12-31	FARP
59	WP07-ENR	A. Popov	2025-12-31	EUROfusion
60	WP18-MAT	E. Kotomin	2025-12-31	EUROfusion
61	WP05-PWIE	E. Butikova	2025-12-31	EUROfusion

Note: New projects acquired in 2021 and starting in 2022 are denoted by blue-colored font