Wrocławskie Centrum Badań EIT+

The Department of Nanotechnology Wrocław Research Centre EIT+

The Department of Nanotechnology

Wrocław Research Centre EIT+

INNOVATIVE ECONOMY
NATIONAL COHESION STRATEGY

Wrocławskie Centrum Badań EIT+
NanoMat, DCMiB

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND

Projects co-financed by the European Union through the European Regional Development Fund

1. Lower Silesia, Wrocław

Lower Silesia, a province in the South-West of Poland, borders the Czech Republic to the South and Germany to the West. Due to its unique location, at the intersection of important transport routes leading from the North to the South and from the East to the West, Lower Silesia is the fastest growing region in Poland. Its dynamic economic development is based on the close cooperation with the European economy. Global leading corporations, including: LG, Hewlett-Packard, Allied Irish Banks, VOLVO, Toyota, Volkswagen, WABCO, Crédit Agricole, Bosch, 3M, Faurecia, Whirlpool, MacoPharma and many others, have invested in this region and established their branches there. Furthermore, numerous business development institutions, special economic zones and investment stimulating programs have created an investor-friendly climate and have encouraged some economic initiatives. Dynamic growth has been reported in the traditional branches of the industry and new technologies as well. The province's other advantages include its natural resources (including copper and rare earth metals), excellent soil and the climate favorable to the agriculture development, vast cultural heritage and wonderful touristic landscapes (Karkonosze and Sudetes Highlands).

Lower Silesia owes its economic success also to its young, highly educated, dynamic population, open to the world and its challenges. There are several dozen higher education institutions, both state and private. The most important science and research centres include: University of Wrocław, Wrocław University of Technology, Medical University, University of Life Sciences, University of Economics and University of Physical Education.

Wrocław Research Centre EIT+ Ltd.

www.eitplus.pl

Wrocławskie Centrum Badań EIT+
NanoMat, DCMiB

Wrocław Research Centre EIT + Ltd. was founded in 2007 as a joint initiative of the city authorities, local government and Wrocław's institutes of higher education. The company's shareholders are: Wrocław University of Technology, University of Wrocław, Medical University, Wrocław City Hall, Lower Silesia Marshall's Office and Governor's Office, University of Life Sciences, University of Economics. The company's mission is to create and develop a new cooperative strategy linking the science and higher education sector, local authorities and innovative business. Wrocław Research Centre EIT+ has its headquarters in the Pracze Odrzańskie area of Wrocław, wihtin a 27 hectare plot, covered with historic buildings and a beautiful park complex. Financing in excess of EUR 200 million, provided for the center's construction and interior furnishing, was based on European Union funds. In this respect, Wrocław Research Centre EIT+ may be considered one of the largest and most significant projects on the Polish scientific map.

Since 2008, the company has been implementing two large research programs (in the fields of biotechnology and nanotechnology), one of the country's largest infrastructure projects in the area of R&D and several research projects in the area of ICT, financed from 7th Framework Program resources. Company's activities in these fields aim to collect a significant scientific potential (in cooperation with the best researchers in the Lower Silesia region), access to world class specialists and commercialize the intellectual property as well.

The priority project of Wrocław Research Centre EIT+, entitled „Lower Silesia Centre for Materials and Biomaterials Wrocław Research Centre EIT+ (DCMiB)", aims at constructing and furnishing of a cutting edge research and development Campus in Wrocław. Under this project, buildings that are already located within the Campus and dated from the 1920s, will be adapted and refurbished, and one brand new facility will be erected. The area of approximately 24 000 m^2 will house above 50 specialist research and technology laboratories, equipped with the top class devices, holding appropriate certification. Core activities will comprise research of an applicative nature, focused on cooperation with research and implementation Centres of industrial clients. Furthermore, the laboratory structure will include modern „open-space" laboratories intended for micro, small-scale and semi-technical research. The objective of the Campus is to stir up cooperation between scientists from different fields and the business environment, which is meant to set up a unique society involved in the development of state-of-the-art technologies.

The Strategy of the Wrocław Research Centre EIT+

Wrocław Research Centre EIT+ is involved in the comprehensive creation and implementation of innovative solutions, through the combination of management and execution of scientific research, codification of knowledge, protection of intellectual property, technology brokering, commercialization and product development. Wrocław Research Centre EIT+ is the first and most active Research and Technology Organization (RTO) in Poland. Research results with significant market potential obtained in the course of projects implemented by the company will be protected by intellectual property rights, patented and commercialized in established companies and created spin-offs.

Wrocław Research Centre EIT+ is implementing its own commercialization method provided for research work results, based on capital investment in technological companies, entry of created companies into the market and their continued development. The next step to be made encompass establishing of an investment fund intended for financing of technological ventures at early stages of development, i.e. those that feature a high level of market risk.

The Department of Nanotechnology

Wrocławskie Centrum Badań EIT+

NanoMat, DCMiB

The Department of Nanotechnology at Wrocław Research Centre EIT+ was established in 2010. It conducts activities associated with the active search for breakthrough scientific topics, performing research and commercialization of results in direct cooperation with the business environment. The Department's main fields are photonics, material engineering and issues concerning rare earth metals.

<u>The Department is divided into four sections which cooperate closely with one another:</u>

- Promotion and cooperation with Industry and Scientific Centres,
- Intellectual Property Management,
- Organization and Management of Research Projects,
- Research Infrastructure.

<u>Key operating objectives of the Department include:</u>

- efficient execution of research projects, completed with best possible results and their commercialization,
- start-up of new research projects with high IP potential,
- designing, planning, constructing, furnishing and performing start-up and maintenance of operations of nanotechnology research laboratories,
- establishing of a cooperation network within the scope of developed competences and knowledge base in Wrocław Research Centre EIT+ activities, and defining new and strategic areas of activity as well.

The Department of Nanotechnology is involved in research projects co-financed by European Union funds, primarily under the European Regional Development Fund. The most important of these projects include: „The Application of nanotechnologies in modern materials – NanoMat" and „Lower Silesia Centre for Materials and Biomaterials Wrocław Research Centre EIT+ (DCMiB)".

The Department also conducts activities focused on supporting of enterprises in the Lower Silesia region through the creation and development of business clusters. At present there are two clusters operating within the Department: Polish Nanotechnology in Business and Science Cluster and Lower Silesia Photonic Technologies Cluster.

Staff

Detlef Hommel, Prof.

Coordinator of the Research Program NanoMat

Prof. Detlef Hommel, Ph.D. has been a Coordinator of the Research Program NanoMat in the Wrocław Research Centre EIT+ since April 2010. His expertise comprises: solid-state physics, optoelectronics and semiconductor physics. Until 1991 he had been working in the Academy of Sciences in Berlin and then in the University of Würzburg. In the latter, within the Ph.D. follow-up internship, he was working on the first ZnSe-based green semiconductor laser in Germany. His achievements also include: contribution to the first university GaN-based blue laser in Europe and the first single photon source worldwide, based on quantum dots. Since 1994 he has been a full professor on the University of Bremen. Currently, he has been managing the Semiconductor Epitaxy Team. He is an author of more than 550 scientific publications, an advisor to over 20 Ph.D. theses and an inventor of numerous patents. Prof. Hommel is a member of many Advisory Committees and an organizer of the cyclic international conferences. He was awarded the Aleksander von Humboldt scholarship granted by the Foundation for Polish Science. He has two times been a visiting professor to Japan and, currently, he holds this title at Wrocław University.

Łukasz Nieradko, Ph.D., Eng.

Head of Nanotechnology Department

Łukasz Nieradko, Ph.D., is a Head of Nanotechnology Department. He is in charge of research development, strategy development, coordination of the research infrastructure expansion in the Pracze Campus and cooperation between scientific and business environments in the area of nanotechnology. He is a graduate of the Wrocław University of Technology and a scholarship holder of Marie Curie Individual Fellowship and the Foundation for Polish Science. He worked for the French National Scientific Research Centre, participating in various projects of General Directorate for Armament (DGA), National Research of Space Research and National Research Agency at elaborating on integrated on-chip components provided for the atomic clock as well as MOEMS systems. He has undergone trainings on management of R&D and IPR Centres, IBM in Switzerland and Watson Research Centre in the US. Numerous honorable mentions have been granted to him, including an award of the Polish Electrician Association, the President of the Warsaw University of Technology, distinctions at international and national conferences. He is an author of a large number of scientific publications and the European patent. Doctor Nieradko is a member of the Polish Sensor Technology Association, Marie Curie Fellow Association and the Technological Committee for Nanotechnology of the Polish Committee for Standardization.

Anna Szajdak, M.Sc.

NanoMat Project Manager

A graduate of the Wrocław University, also finished Project Management studies at the Wrocław University of Technology and the Banking University. She has been the NanoMat Project Manager in the Wrocław Research Centre EIT+ since 2008. She coordinates and supervises all administrative procedures related to project implementation. In the past she worked for the Grant Office and European Funds in the Wrocław University of Technology, dealing with advisory on preparation of applications for frame programs and structural funds and management of the project database, performed within the university. She has participated in preparation of applications for university projects (e.g. an investment project "Construction of the Academic Campus – Integrated Student Centre PWr in Wrocław) and worked in teams managing the following projects: "TWIPSA" – Transfer of Knowledge to Enterprises from the Lower Silesia Province through Internships for Graduates PWr", "Innovative Macroregion. Technological Foresight for the Lower Silesia Province until 2020", "Strategic Policy Intelligence Tools for Better Science and Technology Investment Strategies in Europe's Regions – REGSTRAT"

Filip Granek, Ph.D.

Head of Photonics Project Division

Filip Granek, Ph.D., is the Head of the Project Division of the photonics scientific area, the Department of Nanotechnology of the Wrocław Research Centre EIT+. He is an expert in cutting edge photovoltaic cells technology and is currently starting off scientific works in this field. In 2004-2005 doctor Granek was working for the Energy Research Centre of the Netherlands (ECN), Holland. In 2005-2011 he was hired by the Fraunhofer Institute for Solar Energy Systems (ISE), Germany, where, since 2009, he headed the research team, handling state-of-the-art processes related to laser and chemical treatment applied in cutting edge photoelectric cells. Filip Granek has been managing several research projects with the total budget of approx. EUR 3 million. His research activities, conducted in leading European scientific institutions, have been run in tight cooperation with representatives of the international photovoltaic industry. He is an author of over 50 articles released in scientific magazines and presented on international conferences and 8 international patent applications.

2. NanoMat Research Project

www.nanomat.eitplus.pl

Wrocławskie Centrum Badań EIT+
NanoMat

„NanoMat – The Application of Nanotechnology in Advanced Materials" involves interdisciplinary research aimed at manufacturing of technologically advanced materials, developing of nanotechnology and its application in such fields as: nanoelectronics, photonics, power engineering, medicine, construction materials, polymer industry and many others. The goal of the research is to obtain materials featuring new or improved properties, determine their potential in terms of practical application and also develop selected technologies provided for their manufacture. Results obtained in the course of the project are supposed to be patented and implemented in technology companies and spin-offs.

Works are conducted within the following research topics:

- Nanomaterials for photonic and biomedical application
- Nanomaterials for optoelectronic and sensory application
- Lasers and fiber optic amplifiers
- Microstructural polymer fiber optics
- Functional polymer materials
- SMART materials and nanocomposites
- Electromagnetic radiation detectors and converters for digital medical diagnostics and document and banknote security systems
- Intermetallic alloys absorbing hydrogen and permanent magnets based on lanthanides – development of magnetically hard nanocomposite materials based on domestic raw materials
- Materials and technologies for advanced energy conservation and storage systems
- Development of modern biodetection and cellular bioimaging methods with the use of luminescent nanotags
- Biosystems for detection of microbiological hazards
- Technologies associated with laser micromachining and their application
- Nanomaterials manufactured through sol-gel technology, intended for medical and sensory application
- Polymer and ceramic nanocomposites for electrotechnical application

Project data:

Period	**2008 – 2014**
Financing	31,1 mln €
Indicators	Number of commercialized R&D research results: 5 Number of patent applications as a result of the project: 16 Number of scientific publications as a result of research conducted: 150 Number of academic titles awarded in direct association with project implementation: 35
Research tasks	14

2.1. NanoMat Project Tasks

Wrocławskie Centrum Badań NanoMat

2.1.1. Nanomaterials for photonic and biomedical application

The aim of the task is to create, determine and apply luminescent nanocrystals using metal oxide matrices doped with ions from transition group elements or lanthanides and semi-conducting nanocrystals. The structures obtained are characterized in terms of optic properties (such as band structure parameters) as well as mechanical properties (material sensitivity to external factors e.g. temperature, magnetic fields, atmosphere) and their possible practical applications. The goal of the work is to obtain a substance with high emission efficiency with low level of agglomeration, in the form of powder or solid solution (particle size < 30 nm). The task will also cover an examination and development of techniques for surface modification of nanoparticles obtained in order to achieve complex arrangements, for example, with binding of biological particles, core-shell (luminescent core and bioactive coating), multilayer structures and others.

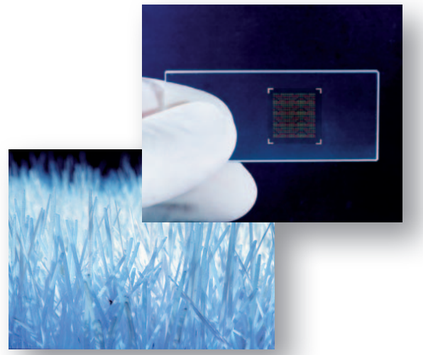
The materials and techniques developed may find application in optoelectronic equipment (sinters, thin film, colloids, fibers for use in detectors, emitters, scintillation screens, etc. with narrow spectral parameters). They may also be used to mark objects and securities with doping of polymers in their manufacture, the ink or in the form of nanofibers. Furthermore, the obtained luminophores may be used as luminescent markers in the form of a thin coating of silicon oxide, whose surface has been modified (e.g. with functional groups, antibodies etc.) to facilitate the adhesion process of tissue and cellular components.

Executor
Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław

Potential areas of cooperation with a business partner:
- Nanocrystalline phosphors with efficient emission and characteristic spectrum
- Nanopowders, nanocrystals, thin films, sinters and nanoceramics of various optical properties for application in photonics
- Phosphors in the form of nanopowders with modified and functionalized surfaces (for coating or encapsulation)
- Luminescent markers for biological applications, in new types of paints and fibers, for marking of objects and documents at risk of counterfeiting
- Bioactive particle carriers, biomarkers, e.g. for fast detection of a given strain of bacteria
- Narrow-band detectors / emitters, scintillation screens, etc.

2.1.2. Nanomaterials for optoelectronic and sensory application

The scope of the project works comprise creation, characterization and application of complex nanostructures (wells, quantum dots), that are an element of a new generation of photonic systems, sensor systems and a new type of an optoelectronic instrument. Works on semi-conductor structures include production and application of such composite materials as (Al, In, Ga)N on various bases. Materials are developed in such a way as to facilitate their use in medical imaging biodetection and in semi-conductor equipment.



Potential areas of cooperation with a business partner:
- Super luminescent diodes with optical output 30mW operating in a spectrum of 385-400nm
- Coherent light source for chemical and biological analysis for sensory applications in the blue-purple spectrum
- Light source using nanocolumns and quantum drops, operating in the blue-yellow spectrum, source of single photon emissions for application in quantum cryptography and as coherent emitters in the green spectrum
- Hybrid systems facilitating the coupling/collection of several semiconductor lasers into one fiber optic, which allows a wide choice of emission wavelength in the 395-425-nm range
- Emitters based on InGaN quantum dots in the green-orange spectrum
- Cultures of GaN nanocolumn groups containing quantum wells and quantum drops emitting under current injection
- Production of monolithic sources of single photons on demand in equipment working at close to room temperature

2.1.3. Lasers and fiber optic amplifiers

The project concerns construction and optimization of fiber optic amplifiers and sources of medium and high output radiation for application in the area of fiber optic telecommunications, free space telecommunications or micromachining of specific materials. Technical solutions developed in the course of the task will facilitate safe application of constructed high optical output equipment without the dangers currently present in this area.

The scope of the task includes construction design of medium and high output fiber optic amplifiers operating at wavelengths safe for the eye. This type of amplifier will then serve the construction of fiber optic radiation sources in the so-called MOPA (Master Oscillator Power Amplifier) configuration. The radiation source in this case is a low output signal laser, whose parameters may be easily controlled, and high output radiation is gained through cascade amplifier (most commonly two or three stage).

Executor
Wrocław University of Technology

Potential areas of cooperation with a business partner:
- New type of highly efficient and stable fiber optic amplifiers for high power light sources
- High power fiber optic amplifiers with improved output beam parameters
- New high power radiation source system, operating in continuous or pulse mode (nano- and pico-/femtosecond), with distortion compression and pulse shape force system
- High power amplifier control systems (automatic monitoring systems)
- New type of low power laser with improved parameters (lower pulse time, higher repetition frequency, improved operations stability)
- Measurement systems to measure length of ultra short pulses

2.1.4. Microstructural polymer fiber optics

This project involves development of technologies for production of microstructural polymer fiber optics, and also design and production of fiber optics with new transmission and metrological properties. The new fiber optic materials will be characterized by one or several selected features: low temperature of material preparation and fiber optic drawing, facility to dope with easily degrading materials such as organic an biological, as early as the preform stage, biological compatibility (possible medical application), compatibility and easy integration with polymer photonic elements produced in planar technology, greater distortion scope (to 30%) in comparison with quartz fiber optics (max. 4%) (possibility for application in sensor role in ranges unattainable for quartz fiber), smaller Young modulus (approximately 3 GPa) when compared to fused quartz (72 GPa), which ensures high elasticity of polymer fibers, better surface tension to viscosity ration (at fiber drawing temperature), which facilitates production of more complex structures in comparison to quartz fibers, ease of doping polymer fiber optics (through diffusion into a chemically softened polymer) with various materials (dyes, materials increasing photosensitivity, electrooptic properties, etc.) immediately after manufacture, which is not possible in the case of quartz fiber optics.

Executor
Wrocław University of Technology
Maria Skłodowska-Curie University, Lublin

Potential areas of cooperation with a business partner:
- New types of microstructural polymer fiber optics and their production technologies
- Birefringent fiber optics for polarimetric and interference sensors
- Technology for recording fiber Bragg grating and long term mesh in microstructural polymer fiber optics
- Polymer fiber optics for use in sensors (sensitivity to physical and chemical conditions)
- Production of index-guided type microstructural polymer fiber optics with photonic gap complex structure

2.1.5. Functional polymer materials

Research works in this task are directed at achievement and application of specific functional one-, two- and three-dimensional polymer nanomaterials of defined properties. Research works are conducted within three independent topics.

The first topic concerns polymer nanolayers used as intelligent surfaces, whose properties change depending on an external stimulus. Such structures may be used as nanomechanisms, sensors, semi-conducting layers, selective membranes or membrane catalysts.

The second topic is focused on composite materials of various properties and preparation of initial assumptions for development of technologies to produce them. Furthermore, the scope of the task includes achievement and examination of functional polymers presenting characteristic properties in the face of specific external conditions. These materials will comprise thermoplastic composites made up of a polymer coating and functional nanofilling. Depending on the type of filler used, the new materials will be active in a magnetic field, constitute a sensory material with selective action, intended for the detection of specific liquids, gases, light or change in dimensions.

The third topic, involving work on the border between nanotechnology and biotechnology, focuses on development of nanostructure carriers through adsorption of polyelectrolyte layers on the surface of solid body particles of colloidal size. The scope of works includes definition of physical and chemical conditions for the synthesis of carriers, and development of carrier production technologies using adsorption, layer by layer. Moreover, polymeric nanospheres, capable of carrying, targeted delivery and controlled release of cytostatic drugs, will be produced. Furthermore, research works focus on functionalization of nanoparticle surfaces to attach cystatin molecules, responsible for recognition of tumor cells.

Executor
Wrocław University of Technology

Potential areas of cooperation with a business partner:

- Polymers with modified surfaces
- New generation of separating membranes
- New types of protein carriers, bio-inspired materials, controlled drug release systems
- Sensor materials
- Conducting nanocomposites
- Biocompatible materials and composites
- Functional nanostructure layers, surface modification techniques
- New materials for fuel cells
- Polymer nanolayers with assigned properties
- Polymer composites for sensor applications

2.1.6. SMART materials and nanocomposites

The scope of this task is based on three independent, interdisciplinary projects.

The first topic is focused on the research into new polymer ceramic composites. Works cover production, optimization and examination of the properties and application possibilities of new nanofillers for various polymers, including: thermoplasts, chemically hardened resins, organic compound absorbers and coatings. Therefore, polymer composites with lowered combustibility, increased fire resistance and improved barrier properties, is to be developed. Research also includes polymer nanocomposites which, in addition to superior mechanical properties, also present ferroelectric and piezoelectric properties for sensor applications.

The second topic, entitled „ SMART magnetic materials", involves works on production of new magnetorheological and ferrorheological fluids (MRF and FRF) and ferromagnetic nanopowders, as well as a range of composites and their participation as key components in semi-active dampers in military and civilian constructions and intelligent drug carriers. There are also indications of new applications in the area of various mechanical constructions.

The third topic is SMART polymers in nanometer structures on fixed surfaces. The objective of this sub-task is achievement of functionalized SMART polymers in nanometer structures on fixed surfaces and functional polymer nanolayers. Furthermore, the works on development of ways to fix polymer photochromic film to a fixed surface (glass, silicon chip, and polymer) and examine and optimize the growth and culture conditions (technologies) of neuron cells with the use of the above-mentioned photochromic films are underway. Research is also addressed to production of intelligent dyes (SMART dyes) for coatings and thin films, and methods for encapsulation of organic chromophores in nanometer structures. Furthermore, methods referring to modification of natural polymers – chitin, aimed at producing of nanometer films with photochromic properties, are currently developed.

Executor
Wrocław University of Technology
University of Bielsko-Biała

Potential areas of cooperation with a business partner:

- Nanofillers for modification of montmoillonite
- SMART magnetic materials
- Ferromagnetic nanopowders
- Materials absorbing electromagnetic radiation
- Magnetovision – a new system for non-destructive testing
- Electromagnetic screens for telecommunication and electrotechnics
- Liquid cores
- Nanolayers from photochromic polymers
- Intelligent photochromic and thermochromic dyes

2.1.7. Electromagnetic radiation detectors and converters for digital medical diagnostics and document and banknote security systems

Research works performed within this task are focused on the use of rare earth metal elements (lanthanides) in production of advanced materials of cutting edge material engineering. The scope of works include, in particular, production technologies and characterization of new luminescent materials for digital imaging techniques (medical: planar imaging, PET, computed tomography and thermal: conversion of infrared to visible light) and luminescent markers for security of documents. The materials obtained are in the form of transparent, high-density ceramic sinters, meeting the requirements for digital imaging and nanopowders of very low particle size range. The scope of works to be performed also include ceramics production technologies and examination of their application possibilities.

The research results will be used in production of electromagnetic radiation converters and detectors for digital medical diagnostics and security systems provided for documents and banknotes. Additionally, the output may also be used in modern industrial sectors such as nucleonics, electronics, optoelectronics, powder metallurgy and in modern raw material doping techniques (co precipitation, sol-gel techniques) and finished materials (implantation, diffusion). The output using metallic lanthanides and their compounds will be used in ceramics as materials of high thermal resistance, in lasers as luminophores, (also for diodes), scintillation screens and others.

Executor
University of Wrocław

Potential areas of cooperation with a business partner:
- New X and gamma ray detectors (in the form of high efficiency, low-scatter nanopowders or ceramic sinters)
- Materials for converters of IR and UV into visible light
- Powder materials (crystallites with narrow grain size range)
- Nanosize phosphors with characteristic spectrum for security of sensitive documents (e.g. as an additive in inks, etc.)

2.1.8. Intermetallic alloys absorbing hydrogen and permanent magnets based on lanthanides – development of magnetically hard nanocomposite materials based on domestic raw materials

Due to its extended scope, this research task has been divided into eight areas of research covering:

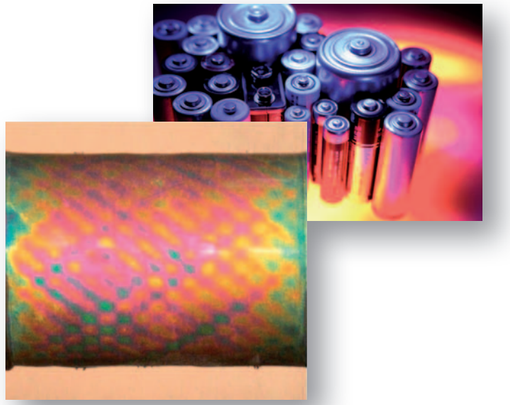
1. Determination of effectiveness applicable technologies for capturing lanthanides from existing domestic raw materials using modern chemical metallurgy techniques.
2. Development of technologies for obtaining high-purity lanthanide halides.
3. Determination of the electrical conductivity and thermodynamic properties of selected lanthanide halide – alkali halide systems.
4. Development of technologies to obtain neodymium and Nd-Fe and Nd-Fe-B alloys for the production of permanent magnets and the production technology of intermetallic hydrogen-absorbing lanthanide alloys.
5. Development of nanocomposite magnetic materials based on rare earth elements.
6. Assessment of the potential for application of ores, concentrates, intermediate products and waste and the development of technologies to obtain selected non-ferrous and rare metals with hydrometallurgical and biometallurgical methods.
7. Synthesis and examination of the physical and chemical properties of titanium dioxide nanofibers obtained through hydrometallurgic methods.
8. Application of biometallurgic methods to process polymetallic sulphide raw materials.

Executor
Institute of Non-ferrous Metals, Gliwice
Institute of Non-ferrous Metals, Poznań
Wrocław University of Technology

Potential areas of cooperation with a business partner:
- Modern methods for the recovery of rare earth metals from waste
- Magnetic nanocomposites
- Recovery of gypsum from waste
- Technologies for obtaining new alloys for production of permanent magnets and hydrogen-absorbing systems
- New materials based on rare earth elements
- Titanium dioxide nanofibers and nanopowders
- New materials for lithium batteries with improved parameters

2.1.9. Materials and technologies for advanced energy conservation and storage systems

This task comprises development of new technologies addressed to production of light composite containers for collection of hydrogen and methane, necessary to supply fuel cells and combustion engines. New, innovative materials shall will also be manufactured, including chemical compounds absorbing hydrogen gas in direct hydrogen reactions or in the process of an electrochemical reaction. Furthermore, technology for production of Ni-MeH hydride battery electrodes will be developed. The obtained electrode will be used in production of hydrogen and will act as a chemical hydrogen gas container to supply of low temperature fuel cells.



Executor
Wrocław University of Technology
Częstochowa University of Technology
Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław
Jan Długosz University, Częstochowa

Potential areas of cooperation with a business partner:
- New techniques and materials for hydrogen pressure storage (light composite containers with sensor system)
- Metal hydride systems and equipment to produce and store hydrogen
- Carbon materials and composites for energy storage systems:
  - New anode materials for lithium-ion cells
  - electrode materials for electrochemical super capacitors
- Ultra nanoporous carbon and hybrid materials with improved hydrogen storage capacity (in cryo and elevated pressure conditions)

2.1.10. Use of electric, spectroscopic and optic methods in biodetection and bioimaging

The research task covers two complementary topics.

BioSens – biosystems for detection of biological hazards – concentrates on development of new luminescent techniques for detection of bacteria cells and toxins derived from bacteria, including endotoxins. Detection systems are based on the application of specially adapted in vitro cultures of eukaryotic cells and the use of modified glass, silicon and polymer matrices (in cooperation with NAOMIS).

NAOMIS – development of modern methods of cell biodetection and bioimaging with the use of nanosize luminescent markers, within the scope of which work is being conducted on the construction of new biosensors, imaging methods, techniques and protocols for cellular biology. Taking into account the above-mentioned objective and in order to meet the reuirements of the task, new nanosize luminophores, including biofunctionalized, are being applied. The scope of this task also includes development of new imaging techniques (and modification of techniques currently applied) and work on their application in the examination of biological systems (in cooperation with BioSens).

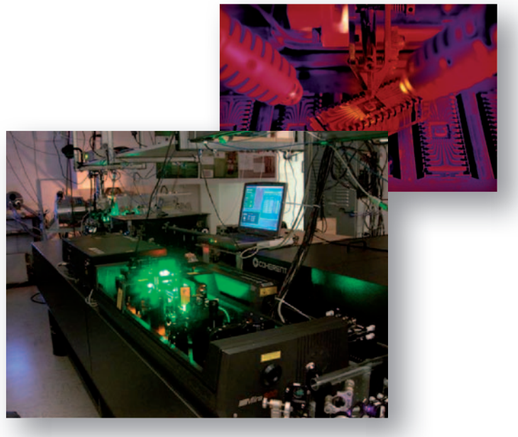
Executor
Institute of Immunology and Experimental Therapy, Polish Academy of Sciences, Wrocław
Institute of Low Temperature and Structure Research, Polish Academy of Sciences, Wrocław

Potential areas of cooperation with a business partner:
- Competitive techniques for detection of bacteria / toxins / pyrogens
- New optical methods for application in biodetection and bioimaging
- New luminescent markers: nanocrystallites, quantum dots, polymeric nanospheres, and others (including biofunctionalized), to track signal pathways, cell interior imaging, potential therapeutic tool for photodynamic therapies
- Nanomaterial biofunction protocols
- Micromatrices functionalized with monoclonal antibodies
- Competitive systems for detection of bacteria / bacterial toxins (particularly Gram-negative)
- Quick (automatic) selection system of clone cells for introduction into desired cell lines

2.1.11. Technologies associated with laser micromachining and their application

Modern lasers provide ultimately accurate material modification, usually unattainable for other technologies. The aim of this task is to develop 2D and 2.5D (microdrilling, microcutting, micromarking etc.) laser micromachining of semi-conductor materials, metals, glass, ceramics and plastics. It is the first project of its kind performed in Poland.

Laser micromachining has a very important applicative aspect. With the use of laser technology it is possible to cut, mark or print texts and graphics on materials such as glass, metal or plastic. It can also be used in the automotive industry, in the manufacturing of domestic appliances or in marking of glass or steel.



Executor
Wrocław University of Technology

Potential areas of cooperation with a business partner:
- 2D, 2.5D and 3D micromachining of various materials
- New techniques in laser marking and micromarking
- Safety systems for work stations with high power lasers
- Database of material susceptibility to treatment with lasers of different wavelength
- Techniques for quick prototyping of single-layer printed circuits with the use of laser micromachining
- Laser techniques for modification of surface properties, surface treatment, selective removal of coating
- Removal system for gaseous products of laser machining
- Creation of microstructures

2.1.12. Nanomaterials manufactured through sol-gel technology, intended for medical and sensory applications

The aim of the research is to develop materials and technologies to be used in industries such as: construction, textiles, pharmacy, medicine and veterinary medicine. The scope of works undertaken includes the achievement of amorphous nanostructures, nanopowders with low particle distribution and nanolayers, through surface and volume modification of the most commonly used oxides in nanotechnology: titanium, zirconium and silicon. Doping allows for change in physical properties (conductivity, magnetism, hydrophobicity, oleophobicity), chemical properties (e.g. photocatalysis) and biological properties (bactericidal, fungicidal, surface biofinction etc.). Furthermore, the materials are examined in terms of their usefulness as additives to anticorrosive coatings, sensory elements in gas and liquid optical sensors (also at high temperatures) and in biocompatible materials (for application in implantology).

Executor
Electrotechnical Institute, Wrocław
Institute of Low Temperatures and Structure Research, Polish Academy of Sciences, Wrocław

Potential areas of cooperation with a business partner:
- New materials and their production technologies (sol-gel method), in the form of nanopowders of low particle distribution and nanocrystallites and/or amorphous thin films and coats (thickness to 1 mm)
- New materials (layers and powders) surface of volume doped with ions and/or metal atoms
- Oxide materials in the form of nanopowders and thin films
- Oxide materials functionalized with organic compounds, with modified hydrophyllic / hydrophobic properties (for application as protective coatings, anti-corrosion materials, self-cleaning surfaces for products (e.g. wooden, metallic, plastic)
- Multilayer barrier composite materials (conductive or magnetic layers on dielectric substrates)
- Thin films with antibacterial and/or mycological properties
- Oxide materials with improved photocatalytic properties
- Materials for application in textiles, as anti-corrosion materials, in medicine (implant-bone connections), sensors

2.1.13. Polymer and ceramic nanocomposites for electrotechnical applications

This task concerns development of new polymer, ceramic and composite materials (including nanocomposites) and their application in selected electrotechnical solutions (varistors, surge arresters, composite insulators, insulating varnishes, fuel cells). The scope of work includes manufacturing of high-voltage insulators with improved operating parameters (increased electrical resistance, resistance to flammability, moisture, dirt and UV radiation) and developing and implementing of nanocomposite, electrical insulation impregnating varnish technologies for converter-controlled energy-efficient motors. Furthermore, an objective of works is to obtain the production technology allowing for manufacturing of oxide varistor nanoceramics to be applied in high-voltage surge arresters and materials and technologies for SOFC and PEMFC fuel cells.

Executor
Electrotechnical Institute, Wrocław

Potential areas of cooperation with a business partner:

- New polymer, ceramic and composite materials for electrotechnical applications
- Materials and production technologies for high-voltage nanocomposite insulators
- Materials and technologies for production of cables for overhead medium-voltage transmission lines
- Materials and production technology for electrical insulation nanocomposite varnishes
- Materials and production technology for new, cheap varistor ceramics for high-voltage surge arresters for electronic appliances and power networks
- Prototype surge arresters with composite screens
- Materials and technologies for SOFC and PEMFC fuel cells
- Prototype SOFC fuel cell (solid oxide) working at low temperatures (in comparison to existing solutions)
- Prototype PEMFC fuel cells (polymer) working at temperatures higher than existing cells

3. Nanotechnology laboratories on the Pracze Campus – Lower Silesia Centre for Materials and Biomaterials Wrocław Research Centre EIT+ (DCMiB)

Wrocławskie Centrum Badań EIT+
DCMiB

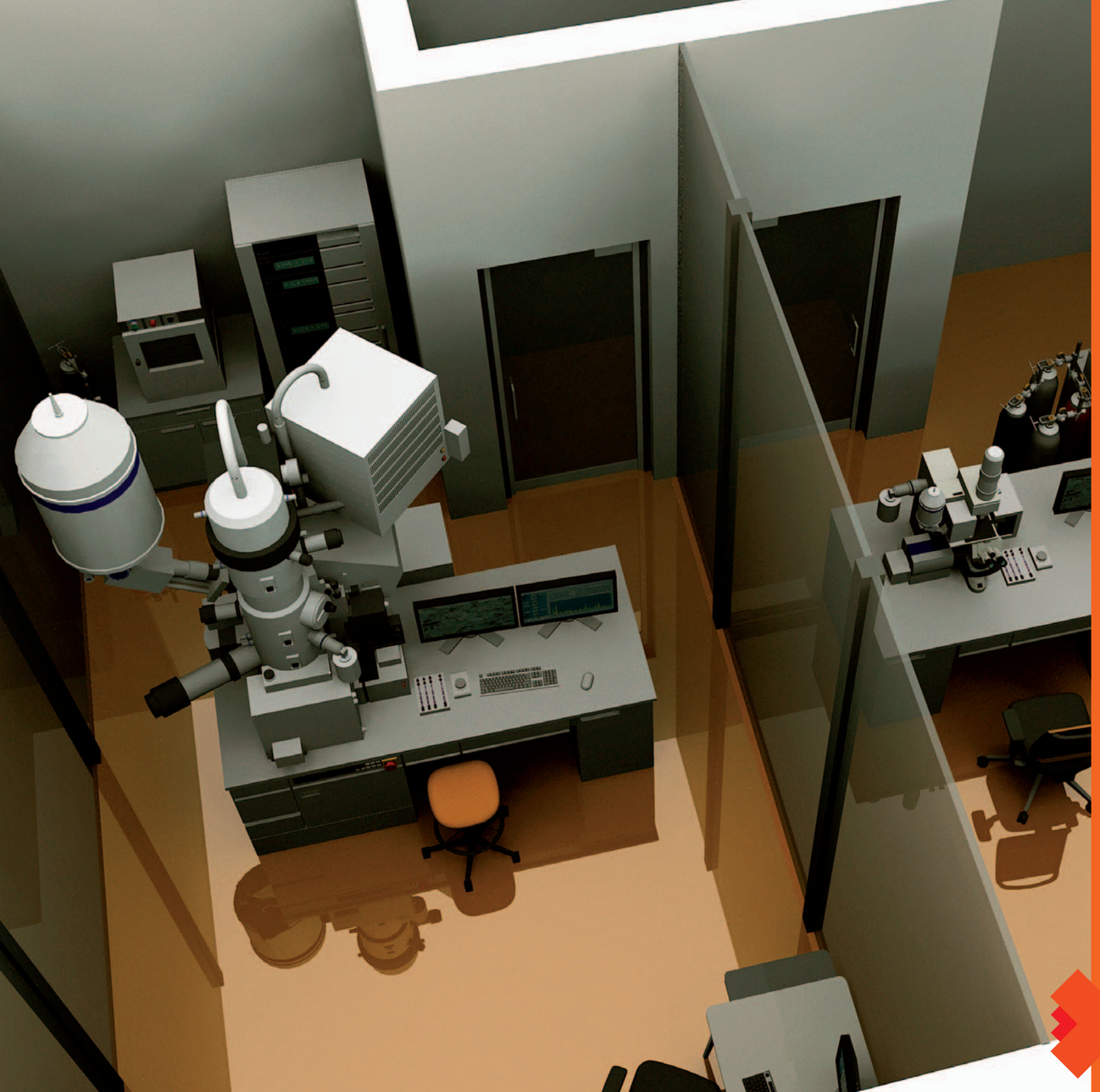
The scope of „Lower Silesia Centre for Materials and Biomaterials Wrocław Research Centre EIT+ (DCMiB)" covers construction of a scientific research complex – Pracze Campus. The investment has been underway since 2010, encompassing construction of new buildings and renovation of existing facilities so to adapt the current infrastructure to new purposes. Three existing buildings (Bud. 1BC, Bud. 7 and Bud. 9) are to be refurbished and equipped with devices, whilst the fourth facility, (Bud. 9A) will be made out of scratch. The complex will house above 50 interdisciplinary laboratories, both biotechnological (primarily in Bud. 9) and nanotechnological (primarily in Bud. 9A).

The nanotechnology technology laboratories have been functionally divided between the buildings as follows: Building 1BC – material characterization laboratory, Building 7 – laboratories concerned with energy storage, Building 9A – specialist laboratories facilitating complementary research, from basic tests to creation of new materials. Building 9A will also house an „open-space" laboratory, unique on the domestic scale, in which external bodies will be able to work as tenants. Part of the laboratory facilities will be certified to PN-EN ISO/IEC 17025.

Project data:

Period	**2008 – 2014**
Financing	503 mln PLN
Number of nanotechnology laboratories sin the project	22
Total are of buildings	~24 000 m^2
Are of nanotechnology laboratories (net*)	>4500 m^2

*rooms with the laboratory equipment, excluding quiet study rooms and the office space.



3.1. Laboratory list

Wrocławskie Centrum Badań EIT+
DCMiB

Building 1 B-C:

- Crystallography laboratory
- Optical spectroscopy laboratory

Building 7:

- Material strength test laboratory
- Energy storage laboratory:
- Research results documentation and visualization laboratory

Building 9a:

- Clean-room laboratories (MEMS, MOEMS, on-chip, photovoltaic)
- Electron microscope laboratories
- Surface and composition examination laboratories
- LEEM microscopy laboratory
- Open-space laboratories
- Synthesis and characterization of organic, organometallic compounds, rare elements and nanocrystalline laboratory
- Lab-on-a-chip
- Naomis-Biosens laboratory
- Fiber optic applications laboratory
- Laser micromachining laboratory
- Fiber optic lasers and amplifiers laboratory
- Laser ablation laboratory
- Solar energy conversation nanostructures laboratory
- Material laser ablation laboratory
- Laboratory for achievement of high dispersed materials in the form of micro- and nanogranules
- Polymer materials and technologies laboratory

4. Sector clusters

Except for supporting of technological development within the region, Wrocław Research Centre EIT+ also tries to stimulate Lower Silesian commerce through bolstering of the clusters. The joint objective of all clusters is to establish links between different types of institutions, such as companies (particularly SME), research and development Centres, and organizations in the business environment. Cluster activity, above all, serves improved communications, resulting in strengthened cooperation and development of cluster members. It brings tangible economic benefit, not only to the sector, but to the whole region. The following clusters operate under Wrocław Research Centre EIT+, the Nanotechnology Department: Polish Nanotechnology in Business and Science Cluster NANOKLASTER.PL and Lower Silesia Phototechnical Technologies Cluster.

Lower Silesia Phototechnical Technologies Cluster

The mission of the cluster is to shape Lower Silesia as an innovative region supporting development of photonics, becoming recognizable domestically and overseas. There are over 70 companies in the Lower Silesia region involved in photonics, comprising such competences as: light and image sources (LED, monitors, elements, equipment), security technologies (holography, markers), medical technologies (phototherapy) telecommunications (fiber optics, information processing) and energetics (photovoltaic). Lower Silesia is also a powerful scientific Centre with 40 research groups holding laboratory facilities at their disposal.

The aims of the clusters are: establishing of meeting places, increased access to resources (financial, personnel, technological, clients) and improved communications and development of cluster member competences. These goals are achieved through workshops, a Polish-language service dedicated to photonics, participation in conferences and fairs, but, above all, through facilitating internal and external contacts. The cluster activities have received the support from the Lower Silesia Marshal's Office under the project "Promotion of Lower Silesia Phototechnical Technologies Cluster on the International Stage", performed from June 1 to December 15, 2011.

www.dktf.eitplus.pl

Polish Nanotechnology in Business and Science Cluster

The primary objectives of the cluster are: initiation of cooperation between companies and scientists as well as promotion and support of the Polish nanotechnology through exchange of contacts and information, and organization of conferences, workshops and seminars for businesses and scientists involved in nanotechnology. The cluster was established in cooperation between Wrocław Research Centre EIT+ and NANONET Foundation for the Support of Nanoscience and Nanotechnology, which runs nanonet.pl, the largest Polish language portal dedicated to nanotechnology. The cluster is to constitute support for organizations involved in nanotechnologies, operating in the area of modern construction materials, medicine, material engineering, nanoelectronics and the chemical industry.

www.nanoklaster.pl

ASPICE - Action to Support Photonic Innovation Clusters In Europe

The ASPICE project is conducted within the scope of 7 Framework Program in the task of Coordination and Support Action, by a consortium comprising: OptoNet e.V. Competence Network for OpticalTechnologies [Germany], Foundation for Research & Technology – Hellas [Greece], National University of Ireland, Galway [Ireland], OPTICSVALLEY – The Network in Optics, Electronics and Software in the Paris Region [France], Southern European Cluster in Photonics and Optics (Spain) and Wrocław Research Centre EIT+.

The project is a supportive activity of development of links between clusters, market and industrial entities, for propagation and implementation of innovative photonic technologies in Europe. Propagation and popularization of photonic applications for healthcare and security in civil and military applications are of particular concern. The result of the project will be an integrated plan for promotion and partnerships in: services, technologies and products. The project has been ongoing since September 2011 and will last for 36 months.

www.fp7-aspice.eu

The Team of the Nanotechnology Department

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Photography of people and the Pracze Campus: Wojciech Dobrut.
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