# TECHNET_NANO
ACCESS HIGH TECHNOLOGIES


# TECHNET_NANO NETWORK
## AN INTERNATIONAL ALLIANCE OF HIGH TECH FACILITIES

Baltic Sea Region
Programme 2007–2013

Part-financed by the European Union
(European Regional Development Fund)

# WELCOME

With the financial support of the European Commission, twelve partner organisations from seven countries in the Baltic Sea Region have joined forces to build a strong network within the field of micro- and nanotechnology. Technet_nano (www.technet-nano.eu) which was created in autumn of 2011 aims to connect small and medium enterprises (SMEs) to high technology facilities and innovation resources across the Baltic Sea Region.

Today, Technet_nano is a strong alliance with eight cleanrooms and numerous researchers. With the help of a transnational web data base, ten Technet_nano Innovation Agents assist enterprises with the identification of appropriate partners, competences and technical facilities, all of which tailor to their individual needs and support their innovation activities.

Technet_nano is open to all interested in exploiting the new opportunities offered by high technologies. Make use of this emerging potential and become part of our unique transnational network!

Professor Horst-Günter Rubahn,
University of Southern Denmark
Technet_nano Secretariat

# ENABLING THE FUTURE: FROM MICRO- TO NANO-TECHNOLOGY

Present daily life is dictated and enabled by modern micro- and nanotechnologies. Both technologies can be applied to numerous fields and lead to novel, smart and radical innovations. These include intelligent drugs and non-invasive medical treatments, smart food, smartphones and solar cells as well as non-chemical cosmetics and IT security.

Whereas microtechnology dates back to the invention of the transistor in the 1950s, nanotechnology emerged in the 1980s and focuses of processes that take place at a scale of a tenth of a millionth of a millimeter.

## SMALL DIMENSIONS – BIG IMPACT

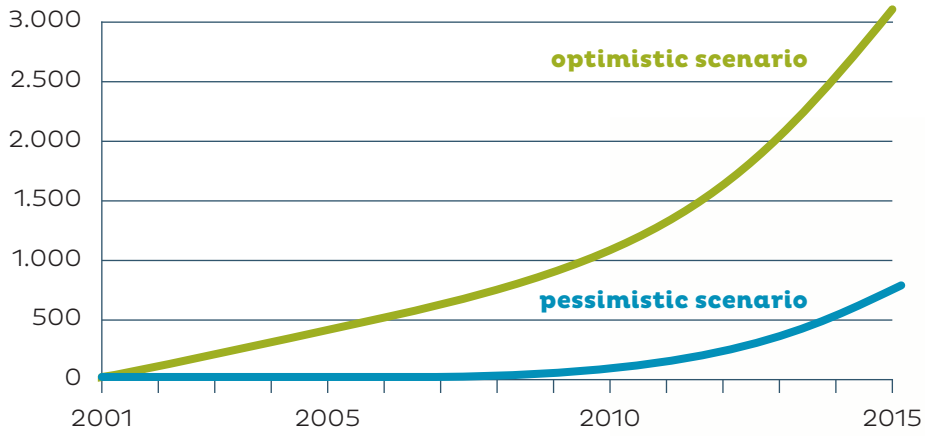
Within the European Community, "Key Enabling Technologies" (KETs) such as nanotechnologies and advanced manufacturing are key drivers of future growth. The global market volume of KETs will amount to over a trillion Euros by 2015. Consequently, the number of jobs related to nanotechnology will increase substantially by 2020.

## TOMORROW STARTS TODAY

The figure shows the expected development of the nanotechnology market, both in a pessimistic and an optimistic scenario.

To speed up this process, the European Commission strives to support nano- and microtechnologies with almost a hundred billion Euros worth of funding as part of the industry and production related research and innovation programme Horizon 2020 from 2014 to 2020.

Especially small- and medium- enterprises (SMEs) are encouraged to engage with micro- and nanotechnology to support their innovation activities.




**Estimates of nanotechnology market size in billion US$ (IEC, 2013)**

# THE BALTIC SEA REGION – COMBINING STRENGTHS

The Baltic Sea Region (BSR) is home to numerous high profile research institutions active in the field of nano- and microtechnology. The excellence of fundamental research conducted in European research facilities and universities has influenced technological progress significantly. However, the integration of this research into industry and competitive products often occurs in other parts of the world.

Odense

Sønderborg

Flensburg

Kiel

Itzehoe

## INNOVATION PERFORMANCE

According to the Innovation Union Scoreboard, some Baltic Sea regions are among the top countries in terms of innovation performance. Regions in Denmark, Estonia, Germany, Sweden and Finland are leaders or strong followers of innovation. The key to their success resides in a comprehensive focus on the entire value chain from research to product development and economic growth.

Although other regions in the BSR have the opportunity to catch up with their neighbouring innovation leaders, many are still underperforming.

## COMBINING STRENGTHS

A competitive advantage of the Baltic Sea Region resides in the diversity of technological strengths in each of the countries. This provides for a sufficient degree of complementarity which is particularly beneficial to small and medium enterprises. Combining strengths and providing mutual access to innovation resources is the key to success in the Baltic Sea Region.

Kista / Stockholm

Tartu

Riga

Technet_nano is an alliance of twelve research and development facilities with eight cleanrooms and numerous researchers. Together, they provide small and medium enterprises with access to innovation resources in the field of micro- and nanotechnology.

**www.technet-nano.eu**

Kaunas

Vilnius

Czechowice-Dziedzice

# ROADMAP TO INNOVATION LEADERSHIP

Innovation based on micro- and nanotechnology is a key part of the political agendas in the Baltic Sea Regions. The main challenge facing regional policy is to bridge the gap from research to product development and commercialisation.

## GOOD POLICY PRACTICE

Some regions in the Baltic Sea Region (BSR) have already started to focus their regional innovation policy on the Key Enabling Technologies (KET). Some good practice examples are [1]:

- Green Labs, Denmark
- Comptetence Centre Programme, Estonia
- Functional Materials, Finland
- Photonics Research, Germany
- Comptetence Centre Programme, Latvia
- High Technologies Development Programme, Lithuania
- Life Science Cluster, Poland
- ProViking, Sweden

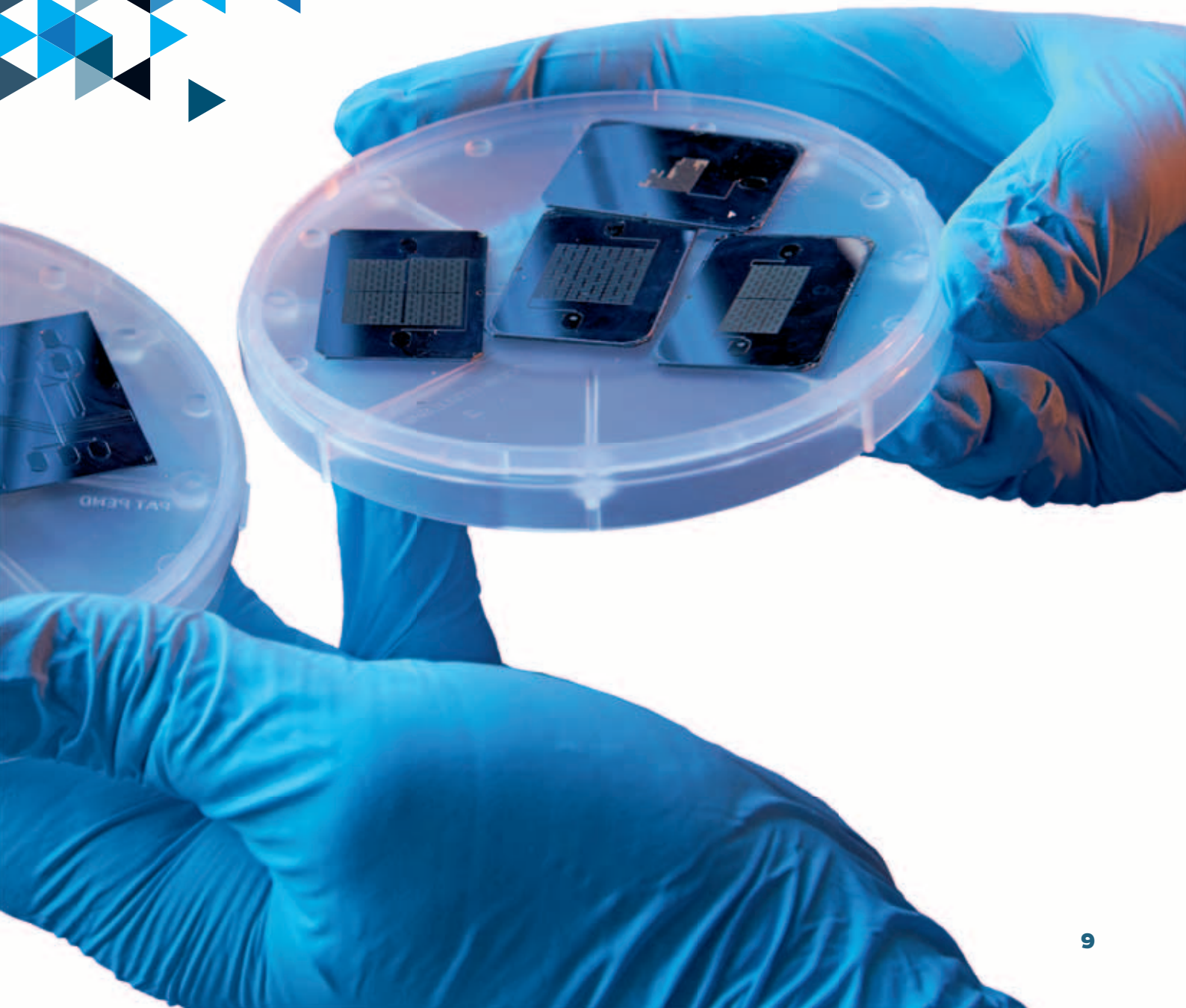
These initiatives focus on a specific field of technology and strengthen technology transfer to industry as a whole.


Key challenges to regional innovation leadership [2]

## FACILITATING THE REGIONAL ROADMAP TO INNOVATION

Technet_nano can play a strategic role for the Baltic Sea Regions on their way towards innovation leadership.

Technet_nano links the technological strengths of twelve R&D institutions and highly reputable researchers across the BSR. Technet-nano primarily aims to provide small and medium-sized companies with access to high technology facilities. Vice versa, the BSR R&D institutions gain  better access to regional companies. Together, both aim to ensure for the future of the Baltic Sea Regions based on  world-class innovation and growth.



# NANO- AND MICROTECHNOLOGY FROM DENMARK

### UNIVERSITY OF SOUTHERN DENMARK, NANOCAN

NanoCAN (www.nanocan.org) utilises large-scale integrated robotics which are used to screen the effects of nano-formulations on living cells. NanoCAN provides an adaptation and innovation of methods needed for large scale analyses, screening and post-screen analyses. This includes, for example, drug testing as well as toxicity/efficacy testing of nanodrug formulations.

**Services & Competences**

Assay/method development and optimization, High Throughput Screening, Ribonucleic Acid Interference (RNAi) libraries, downstream validation, biotechnology, robotics, nanoparticles, consultancy

**Project example**

NanoCAN tests the differential killing efficacy of agents by performing High Throughput Screenings of RNAi libraries. In this way, NanoCAN identifies cancer cells and differentiates them from normal cells. This allows for the exclusion of agents that exert unspecific toxicity.

**Contact**

Jan Mollenhauer, University of Southern Denmark
5000 Odense C, Denmark
+45 65 50 39 70
jmollenhauer@health.sdu.dk

### UNIVERSITY OF SOUTHERN DENMARK, NANOSYD / MCI

NanoSYD (www.nanosyd.dk) provides R&D activities including bottom-up atomic and molecular growth methods as well as top-down surface technology, material science, optical spectroscopy and laser treatment. The centre boasts a wide range of ultrahigh vacuum and laser equipment, electron and helium ion microscopes as well as processing and device packaging technologies.

**Services & Competences**

Device development and prototyping, organic electronics and photonics, nanoparticles, nanosurfaces, optics and optoelectronics, sensors, thin films and coatings, micro/nanofluidics

**Project example**

NanoSYD launched an initiative on the development of advanced materials for high-temperature strain gauges for aerospace, industrial processing, and power generation. The materials are deposited by a reactive sputtering process, whereby the composition and morphology of the deposited films over a wide range may vary depending on the industrial application.

**Contact**

Horst-Günter Rubahn, University of Southern Denmark
6400 Sønderborg, Denmark
+45 6011 3517
rubahn@mci.sdu.dk

# NANO- AND MICROTECHNOLOGY FROM ESTONIA

**INSTITUTE OF PHYSICS, UNIVERSITY OF TARTU (IPUT)**

Together with its 165 scientists, IPUT (www.encc.ee) specializes in material science as well as theoretical-, laser-, plasma-, environmental- and biophysics. Particular focus is placed on low-dimensional structures and their interdisciplinary application in thin and ultra-thin solid films as well as on wide-gap materials and the prospects for their application.

**Services & Competences**

Development of devices and prototyping, micro/nanoelectronics, nanoparticles, optics and optoelectronics, sensors, thin films and coatings

**Project example**

IPUT has developed a new type of electro-optical film that is based on liquid crystal dispersion in a sol-gel derived matrix and is used for windows that can alternate between transparency and opaqueness. In this project, IPUT also developed new technologies and coatings designed to achieve low cost and transparent conduction layers that are required in these structures.

**Contact**

Toomas Plank, IPUT
51014 Tartu, Estonia
+37 27 37 46 03
Toomas.Plank@ut.ee

## SOME QUESTIONS FOR THE EU-COMMISSION ...

**Carlo Corazza is the spokesperson of Vice President Tajani of the European (EU) Commission. The Commission promotes policies that support micro- and nanotechnology as a set of innovative technologies that contribute to growth and jobs, whilst ensuring for their safe use and the prevention of negative health and environmental effects. Nanotechnology is one of the six Key Enabling Technologies (KETs) identified as being of strategic importance to Europe's future competitiveness.**

**Which potential does the EU Commission see in micro- and nanotechnology now and in the future?**

Nanotechnologies have a huge potential for growth and will have a strong impact on the competitiveness in many industrial sectors. Due to their cross-cutting nature and systemic relevance, nanotechnologies are instrumental in modernising Europe's industrial base and in driving the development of entirely new industries. Their direct economic impact is considerable. The global market for nanotechnology was valued at EUR 14.9 bn in 2012 with a growth potential between 15 and 20% in the coming years. Total sales are expected to reach EUR 35.3 bn in 2017 after increasing at a five-year compound annual growth rate of 18.7 %.

**What are the strategies of the EU Commission to tap the full potential?**

Many actions to boost the deployment of KETs into KET-based products have already been launched. For example, adapting and aligning different European instruments in support of KETs: KETs are now a priority in Horizon 2020, for the European Structural and Investment Funds (ESIF) and also for the European Investment Bank. Furthermore, a significant increase of EIB lending to industrial KETs projects (+60%) has been realised since the signature of a Memorandum of Understanding with the EIB (February 2013). Lastly, the Commission promotes risk assessment of nanomaterials with a view to better understanding and controlling risks. This should ensure their safety and create the market confidence for the full acceptance and use of the innovation potential of micro- and nanotechnologies.

**Carlo Corazza**

**"Nanotechnology has many applications in a broad range of industries."**

# NANO- AND MICROTECHNOLOGY FROM GERMANY

## CHRISTIAN-ALBRECHTS-UNIVERSITÄT ZU KIEL (CAU)

The CAU (www.tf.uni-kiel.de) comprises the research groups "Inorganic Functional Materials" and "Functional Nanomaterials". Whereas the former develops thin films and their applications such as micro-actuators or -sensors, the latter focuses on the synthesis of nanostructures within application fields, nanomedicine or composite materials.

### Services & Competences

Biotechnology, device development and prototyping, medical technology, micro/nanoelectronics, nanoparticles, nanosurfaces, optics and optoelectronics, sensors, thin films and coatings.

### Project example

Inspired by geckos' and insects' ability to walk on walls, the CAU adopts a biomimetic approach to developing an ideal structural shape. This is done by adjusting the mechanical properties using flexible nano ceramics.

### Contact

Rainer Adelung, CAU zu Kiel
24143 Kiel, Germany
+49 431 880 61 16
ra@tf.uni-kiel.de

## FLENSBURG UNIVERSITY OF APPLIED SCIENCES

In cooperation with SMEs, the University (www.fh-flensburg.de) focuses on R&D based all-day business activities. Topics include the use of DNA based methods and flow through techniques (FACS) for quality control and process optimisation in the food industry, the pharmaceutical industry as well as the risk assessment of genetically modified organisms and the impact of nano particles on cell cultures.

### Services & Competences

Bioanalysis, device development and prototyping, micro/nanofluidics, lab on chip, risk analysis, bioprocess engineering.

### Project example

Using flow cytometry, the University is able to detect bacterial DNA of microbial contaminants. In collaboration with the University of Southern Denmark, the Flensburg University develops a lab-on-chip system for the identification of perturbing contaminants in foods, feeds and pharmaceutical products.

### Contact

Helmut Erdmann, FH Flensburg
24943 Flensburg, Germany
+49 461 805 14 11
helmut.erdmann@fh-flensburg.de

## FRAUNHOFER ISIT

Together with its 150 scientists and industrial cooperation partners, Fraunhofer ISIT (www.isit.fraunhofer.de) specializes in the development, manufacturing and integration of components in the field of microelectronics and microsystems technology. These components are intended for use in medicine, environmental and traffic engineering,

communication technology, the automotive industry and mechanical engineering.

### Services & Competences

Device development and prototyping, micro/nanoelectronics, optics and optoelectronics, sensors, thin films and coatings, micro/nanofluidics

### Project example

In Schleswig-Holstein, the innovation cluster "Power Electronics for Renewable Energy" was established by Fraunhofer in 2013. An additional part of the cluster will be created in Niedersachsen in 2014. The cluster aims to improve the electronic power components of wind power plants in the MW range and focuses on increasing efficiency, reliability and durability.

### Contact

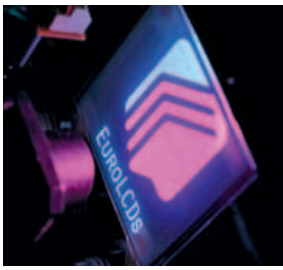
Ralf Dudde, Fraunhofer ISIT
25524 Itzehoe, Germany
+49 4821 17 42 12
dudde@isit.fraunhofer.de

# NANO- AND MICROTECHNOLOGY FROM LATVIA

**INSTITUTE OF CHEMICAL PHYSICS (ICP), UNIVERSITY OF LATVIA**
In cooperation with the Institute of Solid State Physics and the Laboratory of Bioanalytical and Biodosimetry Methods, ICP (www.lu.lv) focuses on materials intended for application in optics, electronics, energetics and the medical industry. The technologies that have been developed are used for the production of thin film coatings, solar cells, sensors and nano-electromechanical devices.

**Services & Competences**
Solar cells, holography, thin films and coatings, sensors and actuators, bioanalytics on cells, device development, nanosurfaces, optics and optoelectronics, nanoelectromechanics

**Project example**
ICP has designed a new generation display: A high speed video projector sends a series of 3D image depth slices into a 3D image volume composed of a physically deep stack of various electrically switchable liquid crystal scattering shutters. The display produces 3D images which are perceivable at a wide viewing angle and do not require the use of special glasses.




**Contact**
Donats Erts,
University of Latvia
1586 Riga, Latvia
+371 670 33 875
Donats.Erts@lu.lv

## 3 QUESTIONS TO THE MANUFACTURER ...

**Dr Frank Osterwald is responsible for research in the field of power semiconductor packaging and cooling at Danfoss Silicon Power – a manufacturer of power electronic modules. He makes use of packaging and interconnection materials which involve micro- and nano particles and applies micro technologies in the module factory.**

**Which potential do you see in micro- and nanotechnology? How can it help to "make a better world"?**
Power electronics is a key technology for the "Energiewende". Power Electronics components and devices will involve micro- and nanotechnologies. Thus, micro- and nanotechnologies will help to facilitate the change from atomic- and coal fired power plants towards renewable energies.

**What are the current research trends in micro- and nanotechnology? Which research fields should be strengthened in the future?**
On the one hand, the trend in semiconductor manufacturing is leading towards even smaller structures (in the nano range) and thinner layers. On the other hand, packaging and interconnection technologies seek for more reliable material combinations and functional surfaces. Micro- and nanotechnologies are believed to play a big role here.

**How can we strengthen the technology transfer? What are the roles of industry, researchers and policy?**
Technology transfer is not to be understood as one-way, being directed from the universities to the industry. In order to be able to conduct applied research work, the industry should have clearly expressed their needs to the researchers. Entering into research work together with the universities typically involves high risks which can be mitigated by public funding of joint research programmes and research networks.

**Dr Frank Osterwald**
**"Micro- and nano-materials development is a key to future power electronic module concepts and solutions."**

# NANO- AND MICROTECHNOLOGY FROM LITHUANIA

### APPLIED RESEARCH INSTITUTE FOR PROSPECTIVE TECHNOLOGIES (PROTECH)

ProTech (www.protechnology.lt) specialises in photovoltaic technologies. Particular focus is placed on silicon solar cells for photovoltaic modules, the development of new materials, electronics and microelectronics, plastics and bioplastics technology.

**Services & Competences**

Device development and prototyping, optics and optoelectronics, thin films and coatings

**Project example**

ProTech has proposed an industrially feasible si nanostructuring process based on the application of nanoparticles of various metals. This process has been integrated into IBC (Interdigitated Back Contact) solar cells and has resulted in good absorption properties at the high energy end of the solar spectrum.

**Contact**

Algirdas Galdikas,
Applied Research Institute for Prospective Technologies
10224 Vilnius, Lithuania
+370 5 25 00 610
algis.galdikas@protechnology.lt

### BALTFAB

BALTFAB (www.baltfab.lt) focuses on the development of new nano-scale materials and structures for life sciences and industrial application. BALTFAB also develops advanced optical coatings for bandpass filters, anti-reflective and highly reflective molecular surfaces.

**Services & Competences**

Functional patterning, nanolithography, protein and cell micro/nanoarrays, device development and prototyping, plasmonics, surface analysis, scanning probe technology, laser micromachining.

**Project example**

BALTFAB and Capstone Turbine Corporation (CPST) have used laser beam interference ablation as a rapid micromachining method to create periodic subwavelength patterns on the surface of photovoltaic cells. The patterned surface reduces reflection and facilitates better light absorption, thus increasing  cell efficiency.

**Contact**

Ramūnas Valiokas,
Center for Physical Sciences and Technology
02300 Vilnius, Lithuania
+370 5 26418 18
valiokas@ftmc.lt

### KAUNAS UNIVERSITY OF TECHNOLOGY, INSTITUTE OF MATERIALS SCIENCE

The Institute (www.fei.lt) specialises in micro- and nanotechnologies, thin film nano-composite coatings and optical document security. Scientists research on the application of ion, plasma and laser technology methods for micro and nanostructures and have experience in the formation and modification of diamond like carbon (DLC) films and DLC based nano-composites which are used as piezo-resistive sensors or in optical sensor platforms.

**Services & Competences**

Device development and prototyping, micro/nanoelectronics, sensors, micro/nanofluidics

**Project example**

The Institute developed a complex refractive index sensor based on leaky waves which are excited at a subwavelength diffraction grating and interact with the analyte.  In this way, processes in the liquid can be detected with a sensitivity of 80 nm/RIU (Refractive Index Unit) and changes in the refractive index in the order of 0.1 permille observed. This method can be applied to in-situ monitoring studies in solutions, including bacterial responses to antimicrobial agents.

**Contact**

Sigitas Tamulevicius, Kaunas University of Technology
50131 Kaunas, Lithuania
+370 37 31 34 32
sigitas.tamulevicius@ktu.lt

# NANO- AND MICROTECHNOLOGY FROM POLAND

### ILESIAN SCIENCE AND TECHNOLOGY CENTRE OF AVIATION INDUSTRY LTD.

The Silesian Science and Technology Centre of Aviation Industry Ltd. (www.scntpl.pl) works on manufacturing composite structures along with a research laboratory to provide services to the aviation industry. The centre also introduces this high technology into other areas, such as the marine, automotive, railway and wind power industry.

**Services & Competences**

Manufacturing of composite structures by autoclave technology, materials research and testing, composite components development and prototyping.

**Project example**

The Silesian Science and Technology Centre of Aviation Industry validates the Controlled Free Radical Polymerization (CFRP) substrates manufacturing process for spacecraft structures to perform a complete cycle of manufacturing and testing on samples and on a "full scale" carbon-fibre-reinforced polymer panel based on the Thales Alenia Space standard structural platform design.

**Contact**

Bartlomiej Plonka,
Silesian Science and Technology Centre of Aviation Industry Ltd.
43502 Czechowice-Dziedzice, Poland
+48 32 777 60 00
b.plonka@scntpl.pl

## 3 QUESTIONS TO THE RESEARCHER ...

**Prof. Dr Franz Faupel occupies the Chair for Multicomponent Materials at the Christian-Albrechts-Universität zu Kiel. Among other subjects, his research focuses on functional nanocomposites. Since 2005, he has functioned as the coordinator of the North German Initiative on Nanomaterials (NINa).**

**Which potential do you see in micro- and nanotechnology? How can it help to "make a better world"?**

Particularly nanotechnology is one of the key technologies, perhaps the key technology, to make this world better. Nanotechnology not only plays a key role in microelectronics but also in important fields such as life science and energy. In general, almost all new technologies more or less directly depend on innovative materials which are developed at the nano-scale.

**What are the current research trends in micro- and nanotechnology? Which research fields should be strengthened in the future?**

In microelectronics, for instance, many new functionalities are currently transferred to a chip, an approach know as "more than Moore". Much research effort is also put into organic electronics, graphene, plasmonics, materials for energy harvesting, and nanomaterials for medical diagnostics and therapy. All these fields certainly deserve much attention.

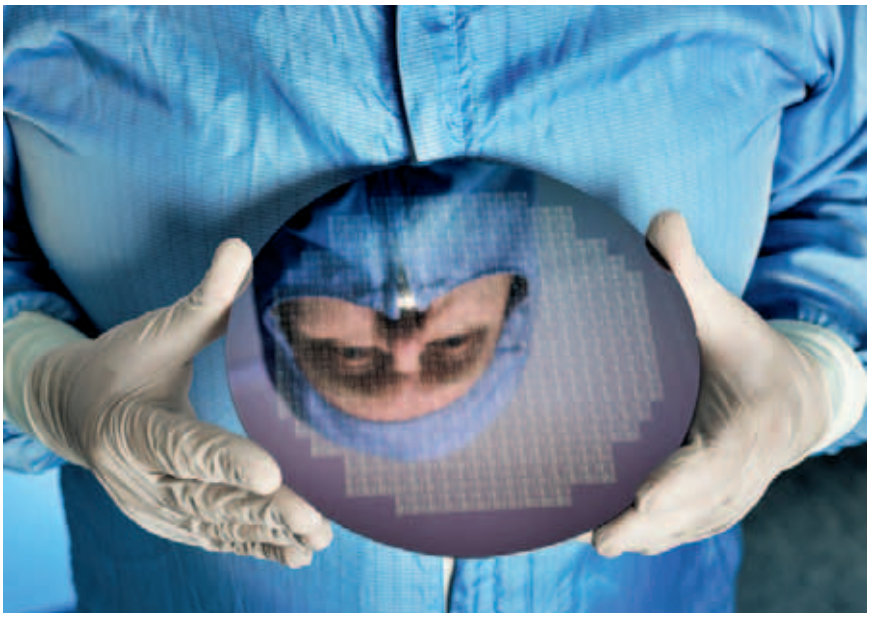
**How can we strengthen the technology transfer? What are the roles of industry, researchers and policy?**

One important obstacle to technology transfer, at least at universities, is that it often only plays a minor role in determining the reputation of a professor. In addition, universities and industry often do not interact sufficiently and tend to have cut and dried opinions about each other. Additional factors which require attention are administrative barriers and problems related to intellectual property.

**Prof. Dr Franz Faupel**

**"Nanotechnology is perhaps the key technology to make this world better."**

# NANO- AND MICROTECHNOLOGY FROM SWEDEN



## ACREO SWEDISH ICT (ACREO)

Acreo (www.acreo.se) offers innovative and value-adding information and communication technology (ICT) solutions for sustainable growth and competitiveness in industry and society. Acreo provides cutting edge resources and technologies for sensors and actuators, power electronics, digital communication and life science, new semiconductor materials and electronics for harsh environments as well as electronic devices and systems with new functionalities.

**Services & Competences**

Biotechnology, device development and prototyping, microelectromechanical systems (MEMS), micro/nanoelectronics, nanoparticles, nanosurfaces, optics and optoelectronics, sensors, thin films and coatings, ,micro/nanofluidics

**Project example**

There is a strong need for miniaturised biomedical tools with integrated lab-on-chip solutions. Acreo not only has expertise in microfluidic solutions integrated sensor technologies, but can also speed up the analysis and reduce the sample volume through chip manufacturing.

**Contact**

Teresita Quarnström,
Acreo Swedish ICT AB
164 25 Kista, Stockholm,
Sweden
+46 707 87 77 39
teresita.quarnstrom@acreo.se

## ELECTRUM LABORATORY, KTH

KTH (www.electrumlab.se) is an outstanding resource for the fabrication and characterisation of materials at the nano and micro scale and supports the entire value chain from education, research and development to prototyping and production. KTH provides access to a cleanroom and state-of-the-art laboratories which can be used for the manufacturing and implementation of characterisation technologies. Topics include micro and nano electromechanical systems, micro and nanoscale materials as well as electronic and photonic components and devices in silicon and compound semiconductor materials.

**Services & Competences**

Device development and prototyping, microelectromechanical systems (MEMS), micro/nanoelectronics, nanoparticles, nanosurfaces, optics and optoelectronics, sensors, thin films and coatings, micro/nanofluidics

**Project example**

To reduce the amount of active substance needed and the risk of side effects, KTH has developed multifunctional nanoparticles. These are not only targetable and biodegradable, but also traceable in vivo and equipped with controlled drug release. The particles could function as a vehicle to deliver medicines to specifically defined cells and tissue.

**Contact**

Nils Nordell, KTH
164 40 Kista, Stockholm,
Sweden
+46 87 90 43 88
nordell@kth.se

# HOW TO ACCESS HIGH TECHNOLOGY

You are a modern and innovative company. You imagine that micro- and nanotechnology could make your research and development activities fit for the future. Or you have a concrete problem which could be solved with micro- and nanotechnology, but you don't know exactly how. **Get in touch with us:**

**START YOUR INNOVATION!**

**Get in touch with our researchers to match your specific needs.**

**... with a local Technet_nano innovation Agent who supports you in**
- **identifying innovation potential,**
- **learning about funding possibilities and**
- **contacting the right network partner.**

**YOU HAVE AN IDEA AND NEED SUPPORT?**

**Browse our website www.technet-nano.eu and get in touch ...**

TECHNET_NANO
ACCESS HIGH TECHNOLOGIES

Technet_nano consists of twelve network partners in seven countries and provides high technology research and ten Technet_nano Innovation Agents who help SMEs to identify suitable network partners for their innovation activities.

**Your contact:** **www.technet-nano.eu**
**rubahn@mci.sdu.dk (Technet_nano secretariat)**

## IMPRINT

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**Editor**

Technet_nano secretariat
University of Southern Denmark
Mads Clausen Institute
Alsion 2, 6400 Sønderborg, Denmark
Internet: www.sdu.dk/mci

**Realisation**

DSN – Connecting Knowledge, Kiel

**References**

Page 4-5: Figure "Nanotechnology in the sectors of solar energy and energy storage" (Technology Report) of the International Electrotechnical Commission (IEC), Geneva, Switzerland, 2013
Page 6-7: Pictures of Acreo Swedish ICT AB, Fraunhofer ISIT, Kaunas University of Technology, SSTCAI Poland, University of Latvia, University of Southern Denmark, University of Tartu
Page 8-9:
[1] Exchange of good policy practices promoting the industrial uptake and deployment of Key Enabling Technologies, European Commission, 2012
[2] Cross-sectoral Analysis of the Impact of International Industrial Policy on Key Enabling Technologies, European Commission, 2011
Page 12: Picture of Fraunhofer ISIT
Page 13: Picture of University of Latvia and picture of Dr Frank Osterwald, Danfoss
Page 14: Picture of Kaunas University of Technology
Page 15: Picture of SSTCAI Poland and picture of Prof. Franz Faupel, Christian-Albrechts-Universität zu Kiel
Page 16: Picture of KTH Sweden

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