iNANO - Interdisciplinary Nanoscience Center

The Interdisciplinary Nanoscience Center (iNANO) at Aarhus University (www.inano.au.dk) was inaugurated in 2002 and has undergone rapid development ever since. The aim of iNANO is to foster interdisciplinary research within the fields of nanoscience and nanotechnology, and actively promote synergistic interactions that cross traditional scientific boundaries. In essence, iNANO provides an interdisciplinary framework in which expertise in physics, chemistry, molecular biology, engineering and medicine is combined to create cutting-edge science of international stature.

Mission

The overall mission of iNANO focuses on three equally important pillars:

1. *education of the next generation of scientists in nanoscience from bachelor to postdoctoral level*
2. *interdisciplinary research, at the highest international level*
3. *provision of an innovative interface for technology transfer, to facilitate the creation of spin-off companies and catalyse innovative projects in existing companies.*

Interdisciplinarity

iNANO is highly interdisciplinary and works within a matrix organizational structure in which all scientific staff have dual appointments – each being associated with a University department. Furthermore iNANO has also very close connections with many leading professors and groups at the Faculty of Health Sciences and at Aarhus University Hospital, resulting in an extensive resource of people and equipment. iNANO has fruitful collaborations with more than 60 Danish companies and is committed to several projects funded by the Danish National Advanced Technology Foundation as well as 15 projects funded by the Danish Strategic Research Council and five innovation consortia projects funded by the Danish Council for Technology and Innovation - all with strong industrial involvement.

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Infrastructure

Currently a new 10.000 m2 laboratory complex to house the iNANO Center is being constructed, with anticipated completion in 2012, and as a first phase of this work, a new clean room facility has recently been completed.

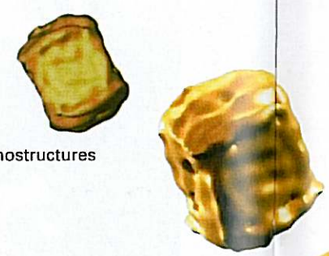
People and funding

Today 60 senior researchers, 55 post docs, 135 PhD students and about 220 undergraduate students are associated with iNANO. Ever since its inauguration in 2002, iNANO scientists have attracted a large number of research grants from various national and international sources, amounting to a total funding budget of more than 415 million Danish kroner (ca. 55 M euros). Among the grants obtained from international sources are several EU related grants, Marie Curie stipends and most recently three prestigious ERC grants.

Research

Research activities at iNANO are wide ranging and cover the following areas:

- functional nanomaterials
- nanoenergy materials
- nanomedicine
- nano-biotechnology
- self-assembled molecular nanostructures
- interdisciplinary nanofood
- nanophotonics/electronics
- nanotoxicology



Centres of Excellence

The iNANO Centre houses a substantial number of Centres of Excellence, financed by the Danish National Research Foundation, as follows:

The Centre for DNA Nanotechnology *(CDNA)* is a truly interdisciplinary centre dedicated to explore DNA as a programmable tool for assembling molecules and nanostructures *(www.cdna.dk)*.

The Centre for Insoluble Protein Structures deals with development and application of new methods for analysis of proteins in insoluble biological structures *(www.inspin.dk)*.

Other centres associated with iNANO are:

- *The Centre of Functionally Integrative Neuroscience (CFIN), (www.cfin.dk)*
- *The Centre for Membrane Pumps in Cells and Disease (PUMPKIN), (www.pumpkin.au.dk)*
- *The Centre for Materials Crystallography (CMC), (www.chem.au.dk)*
- *The Centre for Oxygen Microscopy and Imaging (COMI), (www.chem.au.dk/~comi)*

Recently, at iNANO, a Danish-Chinese Centre for Molecular Nanostructures on Surfaces was founded to conduct research in self-organisation and self-assembly of molecular nanostructures on surfaces using the unique Scanning Probe Microscopy activities. There is also the Centre for Energy Materials *(CEM)* funded by the Danish National Strategic Research Council to conduct research in materials promoting environmentally friendly forms of energy *(www.chem.au.dk /~uorg/cem/)*. iNANO also coordinates the activities within the interdisciplinary NanoFood project *(www.inano.dk/ research/research-areas/nanofood/)*, a consortium with the objective of providing new innovative nanoscience based solutions on food safety, health and nutrition and disease prevention.

Selected research at iNANO in more detail

At iNANO the Drug Delivery Group combines expertise in nucleic acid function and technology with expertise in pharmaceutics and polymer design and function. The group has successfully developed novel nanoparticles for the delivery of small interfering RNA *(siRNA)*. The team at iNANO is focusing on respiratory diseases such as influenza and inflammatory diseases such as rheumatoid arthritis. Impressive results have already been achieved with various publications and patents attracting interest from the pharmaceutical industry *(Howard K. et al. Molecular Therapy 14:476-84 (2006), Howard K. et al. Molecular Therapy 17:162-8 (2009))*.

DNA and Nanostructure Design:

By using DNA it is now possible to design nanostructures of almost any shape that efficiently self-assemble in a test tube. This has been made possible by the introduction of the 'DNA origami' method, where a long DNA strand is folded into shape by multiple short DNA strands. In addition to adopting almost any designed shape, the 'DNA origami' structures have the additional feature of uniquely positioning more than 200 nanoparticles with nanometre resolution, and thus provide an enhanced control of nanoparticles for the construction of complex devices. Scientists from iNANO have now as the first succeeded in the assembly of three-dimensional DNA 'nano-boxes'. These lockable nano-boxes are made entirely from DNA that can be opened by externally supplied DNA 'keys'. They offer great potential as diagnostic sensors for viral diseases, cancer, for controlled drug delivery or even for molecular computers. *(Andersen ES. et al. Nature 459:73-6 (2009))*.

Nanoparticles for energy applications

At the Centre for Energy Materials *(CEM)*, activities focus on synthesizing, characterizing and implementing a range of novel nanoparticles with emphasis on thermoelectric materials, lithium batteries, photo-catalysis and energy (hydrogen) storage. Robust design principles for reactors utilising a revolutionary new technology called Supercritical Synthesis are being developed. This research may lead to new improved hydrogen storage materials. Another important activity is the development of thermoelectric nanomaterials for conversion of waste heat to electricity *(Christensen M. et al. Nature Materials 7:811-15 (2008))*. CEM is collaborating with several industrial partners, e.g. SCF Technologies, Dantherm A/S, PANCO, Grundfos A/S, and German Aerospace Centre.

Control of catalytic reactions

When materials are reduced to the nanoscale, new interesting structural and electronic phenomena often occur, and the SPM group at iNANO recently revealed a novel size-dependent morphology of MoS_2 nanoclusters, the active species of the environmentally highly important desulphurization catalyst. Using STM, iNANO scientists in 2007 discovered that the morphology of MoS_2 nanoparticles changed profoundly with size for particles containing less than 100 atoms in total *(Lauritsen JV. et al. Nature Nanotechnology 2:53-8 (2007))*. Such discoveries, through a fruitful collaboration with Haldor Topsøe A/S, have helped to improve industrial catalysts, and a new industrial BRIM™ hydrodesulphurization catalyst has been developed as a result by the Topsøe company – of increasing importance in meeting the requirements of environmentally friendly burn-off of fossil fuels. The SPM group also collaborates with SCF Technologies and Image Metrology A/S in a project financed by the Danish Strategic Research Council.

RadiSurf

Today, coatings on consumer goods and industrial tools often cannot withstand the environment for which the product is intended. The goal of the RadiSurf project at iNANO, funded by the Danish Strategic Research Council is to develop methods to generate strong chemical bonds between two otherwise incompatible materials by using polymer coatings. This is particularly important for items made of industrial metals such as iron and stainless steel, as well as for commodity and engineering plastics. The research will contribute significantly to the development of future coating solutions for corrosion protection, reduction of wear and cheaper maintenance. The RadiSurf project is conducted in collaboration with the SP Group A/S and Grundfos A/S.

For further information about the iNANO Center, visit ***www.inano.au.dk***

Annual reports can be downloaded at ***www.inano.dk/research/annual-reports***

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