NINa-News

North German Initiative Nanotechnology SH

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Dear Reader

Prof. Dr. Horst Weller

it is my great pleasure to introduce the Fraunhofer Center for Applied Nanotechnology (CAN) in this issue of the NINa Newsletter.

CAN and NINa share a common history: in the early 2000s, the state governments of Hamburg and Schleswig-Holstein decided to make better use of the opportunities offered by nanotechnology in the north as well. To this end, they conducted a joint study, which concluded that the activities in Schleswig-Holstein should be more closely networked and that Hamburg should establish a new application institute around research on colloidal nanoparticles. And so NINa SH and CAN GmbH were founded at the same time.

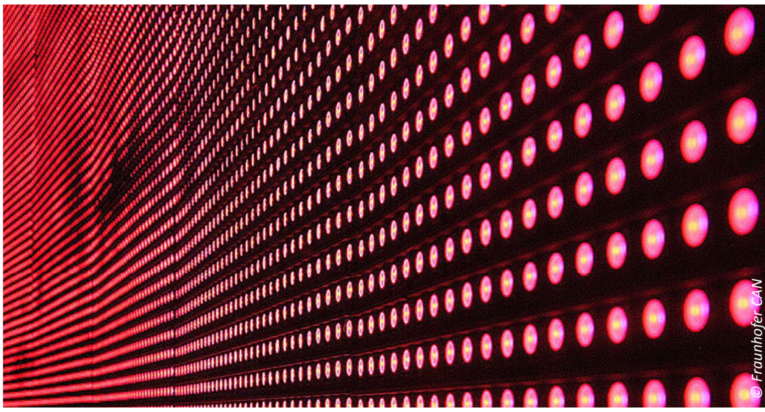
When planning CAN together with a management consultancy, we deliberately decided on the organizational form of a GmbH (limited liability company) in order to be able to respond flexibly to the needs of commercial enterprises on the one hand, and on the other hand to obtain SME status, which is advantageous for applying for funding. Parallel to CAN GmbH, an association for the promotion of nanotechnology was founded, to which well-known industrial companies and other public institutions belonged and which acted as the largest shareholder alongside the city and the University of Hamburg.

Wir fördern Wirtschaft

EU.SH

Landesprogramm Wirtschaft: Gefördert durch die Europäische Union - Europäischer Fonds für regionale Entwicklung (EFRE), den Bund und das Land Schleswig-Holstein

Schleswig-Holstein. Der echte Norden.



Semiconductor nanoparticles with intense fluorescence can be precisely manufactured at Fraunhofer CAN for a wide range of applications. Quantum dots serve, for example, as customized light sources for displays.

The city of Hamburg was the last federal state to join the Fraunhofer-Gesellschaft e.V. and as part of the venture two research institutes were integrated into the Fraunhofer-Gesellschaft, the CAN and the IAPT. While the IAPT was already large enough to assume an independent institute status, the CAN was integrated into the Fraunhofer IAP in Potsdam-Golm as the 7th research area with great independence. The goal was and is to grow to the point where another independent Fraunhofer Institute can be founded in Hamburg. After three and a half years, we are now well on our way and have been able, not least due to the good cooperation with the rest of the IAP, to further expand our network and research activities (for more details, see page 2).

We are looking forward to further developments, also with regard to Hamburg's ambitious goals of the "Science City Bahrenfeld", which is planned as CAN's future location, and are pleased to be part of NINa.

Prof. Dr. Horst Weller

Fraunhofer Center for Applied Nanotechnology CAN,

Institute for Physical Chemistry at the University of Hamburg

Highly functional nanoparticles from the Fraunhofer Center for Applied Nanotechnology (CAN)

At the Fraunhofer Center for Applied Nanotechnology CAN in Hamburg, inorganic nanoparticle systems are developed for new or improved products. The focus is primarily on the application areas of functional materials, life science, and home and personal care.

Production of nanoparticles in a mixing chamber capable of producing about one ton of pure quantum dots per year.

© CAN

Quantum physics has long since arrived in our living rooms. For example, fluorescent nanoparticles made of semiconductor materials, so-called quantum dots, are used for particularly true-color backlighting in displays and televisions.

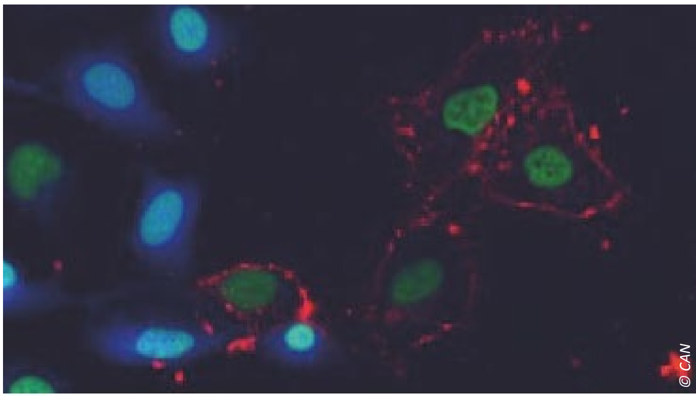
In many other areas, too, nanoparticles produced by wet chemistry have made the leap from academic research to industrial application in the last decade: quantum dots have found their way into the field of NIR detectors and multispectral cameras, which are used for example in automobiles or for “smart farming“ in drones, as well as in the field of forgery-proof product labels and for labeling biological molecules.

CAN has a patented automated manufacturing process in flow reactors that is far superior to the batch processes commonly used. Important in all areas of application is the targeted chemical surface modification in order to be able to integrate the particles into the device in a suitable manner. Here, too, as in the characterization of the particles, CAN occupies a leading position in an international comparison.

© CAN

Quantum dots filled in bottles that emit light of specific wavelengths.

The development of efficient electrocatalysts for fuel cells and electrolysers is of great importance, especially against the background of the energy turnaround and activities on green hydrogen. A promising alternative to conventional catalysts are alloy and core-shell nanoparticles that contain only a small amount of expensive precious metals such as platinum. CAN is developing corresponding particles and using them to produce practical fuel cells in the size of laboratory samples. In the field of medical diagnostics, activities are focused on fluorescence-based methods with quantum dots and rare-earth-doped nanoparticles, but magnetic and plasmonic particles are also used.



© CAN

Image of functionalized quantum dots with antibodies (red) bound to the receptors of cell surfaces.

Among other things, a novel platform technology is being developed for high-throughput and point-of-care diagnostics based on single-molecule detection, which should come close to PCR-based methods in terms of sensitivity and specificity. The research is rounded off by the successful collaboration with a pharmaceutical company from Hamburg in the field of the treatment of autoimmune diseases by means of targeted drug delivery.

CheckNano for the safe use of nanoparticles in industrial products

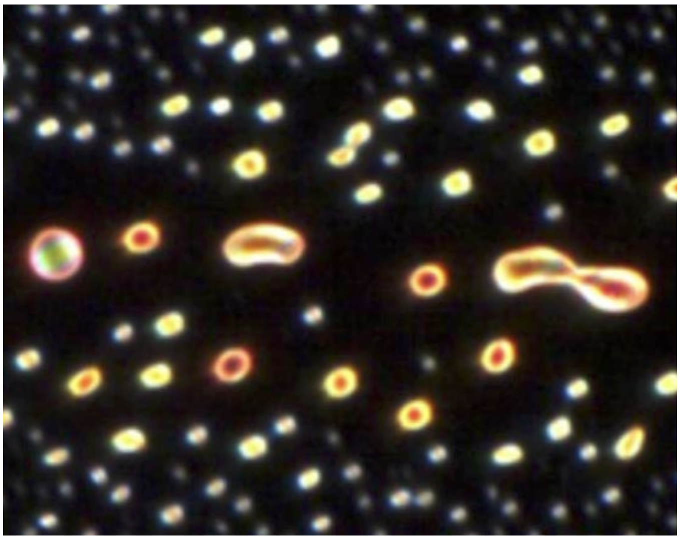
The properties of nanoscale materials promise technological breakthroughs in industrial and medical applications. However, it is problematic that the corresponding substances can enter the human organism and possibly have a high toxic potential there.

Nanoparticles are nowadays contained in a wide variety of products such as cosmetics and food. Individually small amounts can accumulate in living organisms over time.

Silver particles with diameters well below 50 nm penetrate the cell membrane and react within it, which can lead to cell death - if they are twice this size, cell wall penetration is not possible. Particles with diameters smaller than 20 nm in particular have a high hazardous potential. Therefore, it is necessary to regulate the direct or indirect use of micro- and nanoscale substances, and this is only possible if the interaction mechanisms with organisms and the toxicological potential are well known.

The Interreg project "CheckNano" has the task to identify methods to detect very small nanoparticles. The toxicity problem is thus reduced to a problem of accurate size determination at the nanometer scale. The project team is led by SDU with members from Kiel UAS and Flensburg UAS. The companies Coherent Laser-systems in Lübeck and CCM Electronics in Sønderborg are also partners.

In industrial processes, nanoparticles are produced in many ways as "by-products". Even if the goal is actually to produce relatively large silver nanoparticles, industrial processes produce a large number of particles with very small diameters that can be dangerous. These particles are usually only discovered when they are specifically searched for, since the exact identification of very small particles in complex media, e.g. in a food product with embedded fat, is difficult. Even if these particles do not have an immediate toxic effect due to their relatively small number, they pose a high risk potential. On the one hand, because their toxic potency can be significantly increased in interaction with other enriched substances. On the other hand, because they accumulate and more and more of them will be in circulation - a potentially dangerous development when transferred to the human organism. EU regulation of the number density of small nanoparticles allowed is imperative here.



Detection of small nanoparticles in particular is difficult. For this reason, the project partners are using various methods for capturing, preparing and detection of the particles.

"We are developing various tests that should have matured into a prototype within the next two years," says Horst-Günter Rubahn of SDU. "After that, it will be up to the authorities to decide when these tests will be introduced as a standard to detect the occurrence of hazardous particles in the industrial production of silver nanoparticles. Our goal is also to produce a similar test for consumers, such as companies that put the nanoparticles in their creams and lotions. This would allow companies to reassure their customers that only harmless nanoparticles are present in their products."

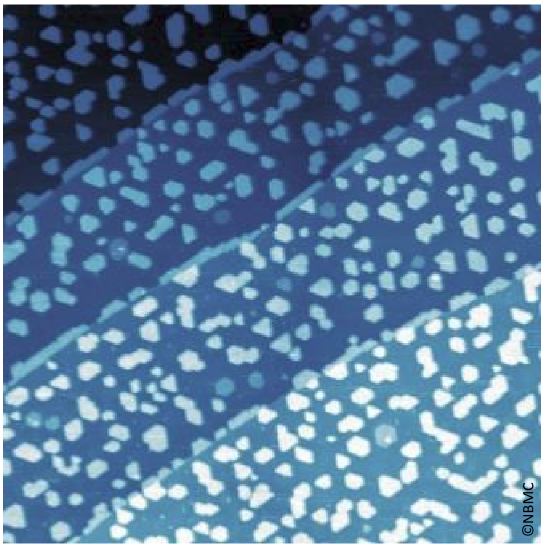
Nanoparticles will not be avoidable today or in the future. The main task is therefore to find out what these particles do to (or for) our organism and to avoid the production of dangerous particles - through testing and personal responsibility or through regulations.

Interdisciplinary Nanotechnology at the NanoBioMedical Centre of the Adam Mickiewicz University in Poznan

At the NanoBioMedical Centre (NBMC), an interdisciplinary team of around 100 experienced scientists, students and PhD students work on innovative solutions for biosensors, tissue engineering, diagnosis and targeted therapy, energy conversion and storage, catalysis and nanoelectronics. Numerous projects funded by Polish authorities and the European Union are carried out in collaboration with top research institutes worldwide.

Professor Stefan Jurga is the director of the NBMC and conducts interdisciplinary research in the field of nanotechnology.

The NBMC was established in 2011 by Adam Mickiewicz University in Poznan, Poland, together with Poznan University of Medical Sciences, Poznan University of Life Sciences and Poznan University of Technology. The center houses laboratories with state-of-the-art research equipment for characterization, lithography and deposition, including a class 100 clean room facility, as well as chemical and biological laboratories with cell growth facilities.



Two-dimensional nanostructured materials possess unique properties for nanotechnology applications.

Research at NBMC focuses on the development of novel nanomaterials used in the fields of materials science and biomedicine:

Supported 2D materials, such as ultrathin films, epitaxial graphene, or block copolymer assemblies, are one of the interesting groups of nanomaterials studied at NBMC. They exhibit unique structural, electronic, catalytic, and magnetic properties resulting from their low dimensionality and interaction with the underlying substrate. In addition, they represent suitable substrates for bottom-up fabrication of ordered arrays of nanoparticles through self-assembly phenomena.

Other important research topics at NBMC are bioimaging and drug delivery. Of particular interest for this are cubosomes, so-called lipid liquid crystal nanoparticles (LLC NPs). The NBMC aims to develop novel LLC NPs and exploit their application potential in optical and magnetic resonance imaging and in cancer drug delivery systems.

Biosensors are being investigated as part of the M-Era.net project, a joint research project with research groups from Lithuania, Germany and Japan. The studies focus on the collective optical behavior of arrays of self-assembled metal nanoparticles (known as collective surface plasmon resonance). The goal is to explore the potential of nanostructures fabricated using top-down (lithography) and bottom-up (self-assembly) approaches for nanolaser and biosensor applications.

At NBMC, we are always open to collaboration and look forward to future partnerships, including international ones.

At the NBMC, interdisciplinary and internationally connected research is conducted in the field of nanotechnology.

DLR establishes the Institute for Maritime Energy Systems in Geesthacht

Ships carry more than 80 percent of the world's freight. Most ships use heavy oil as fuel, generating about three percent of the world's CO_2 emissions. Added to this are cruise ships, which also contribute to climate-damaging CO_2 emissions. That is set to change: The new Institute for Maritime Energy Systems at the German Aerospace Center (DLR) is developing technologies for decarbonizing shipping.

A "digital twin" enables simulated experiments to be carried out on a virtual ship. This allows testing at the limits and reduces the number of real tests required.

©DLR

"In our new institute in Geesthacht, we are setting the course for the maritime transport of the future. This should cause as few emissions as possible and have a closed material cycle," explains Prof. Anke Kaysser-Pyzalla, Chair of the DLR Executive Board. With the new institute, DLR is expanding its research to shipping.

Minister President Daniel Günther commented: "Freight traffic at sea, cruises and ferry traffic are increasing. More and more, the focus is on how renewable energies can be used sensibly and efficiently on ships and how emissions can be reduced towards zero. In Geesthacht, you will develop answers to some of the most pressing questions facing our economy and environment. That's why the state government is supporting the establishment of the institute with 15 million euros and providing part of the annual funding."

The new DLR institute is located in the Innovation and Technology Center (GITZ) on the premises of the Helmholtz Center Hereon. The institute is building a large-scale infrastructure in Geesthacht to test the new energy systems to be developed, initially in standardized laboratory environments and later under real conditions on a research vessel. In the long term, the institute is expected to employ 250 people in four departments: Energy Converters and Systems, Energy Infrastructures, Virtual Ship and System Demonstration.

In its work, the institute will also take advantage of synergies with the existing Helmholtz Research Center in Geesthacht. At the DLR site, for example, efficiency technologies such as fuel cell systems for ships or application and storage options for alternative fuels at sea and on land are being developed. In cooperation with industry, application-oriented solutions are developed and transferred into practice.

"In shipping, we want to become emission-free well before 2050. The German government's goal here is for the first emission-free cruise ship "Made in Germany" to be realized as a beacon as early as 2030. In all of this, the new DLR Institute for Maritime Energy Systems will make an important, application-oriented contribution to implementing the German government's ambitious climate targets in the transport sector," says Norbert Brackmann, the German government's coordinator for the maritime industry.

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Dr. Alexander Dyck heads the institute commissionally.

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