NINa-News

North German Initiative Nanotechnology SH

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Dear Reader

Prof. Dr. Michael Fröba researches and teaches at the University of Hamburg

The current energy crisis and the increasingly dramatic climate change prove that new answers to the major challenges of mankind are needed more urgently than ever. Nanotechnological approaches will provide key solutions in countless applications.

At the University of Hamburg, for example, we are working on innovative nanomaterials that can lead to a significant increase in performance in future energy storage systems. Read more about our research on nano-confinement on page 2.

Due to the technical and regulatory complexity, however, an interdisciplinary approach is required to successfully bring developments into application. On page 3, Stühff Maschinen- und Anlagenbau GmbH from Geesthacht demonstrates how northern German industry is working with research institutions and international partners to establish new technologies for green hydrogen.

While nanotechnology offers broad technological potential on the one hand due to its interdisciplinary nature, the diversity of players on the other hand requires focused networking of competencies and needs. The funding of NINa SH started with this mission in 2015. At the end of this funding period, you can read a summary by the association's chairman Professor Franz Faupel on page 5.

We firmly believe that the field of nanotechnology will continue to enable important innovations in the years to come. Stay fascinated!

Prof. Dr. Michael Fröba
Institute for Inorganic and Applied Chemistry
University of Hamburg

Save the date - Workshop

„Exploring the clinical translational of Nanotechnology for diagnosis and therapeutics“

August 18, 2022, 9 - 17 CET
Fraunhofer IAP, Center for Applied Nanotechnology CAN
Grindelallee 117, 20146 Hamburg

Information & Registration:
can.nina-sh.de

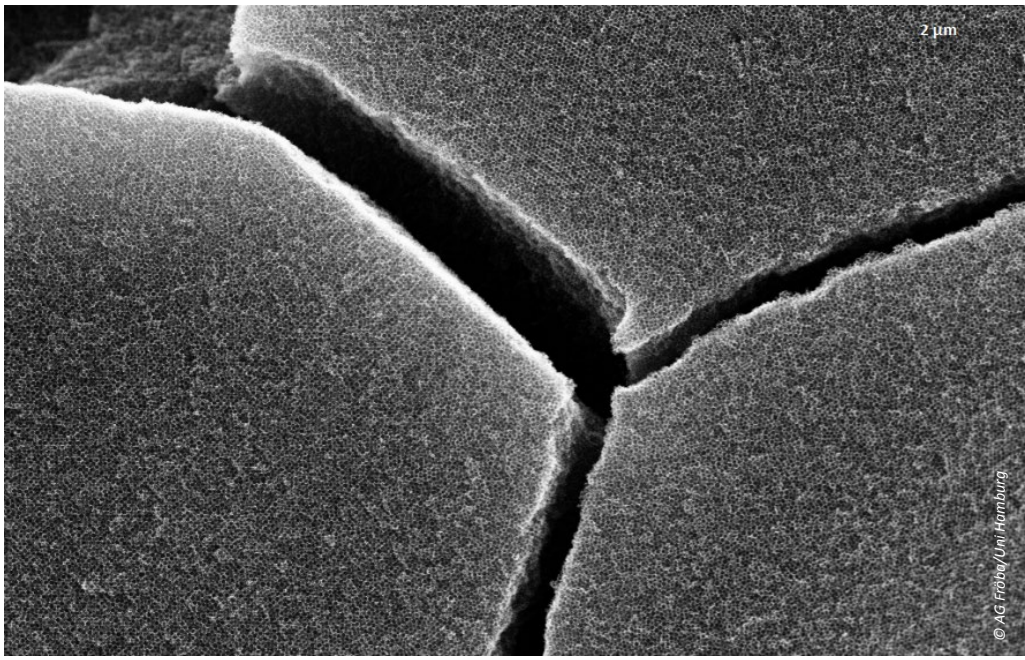
Nanopores: shaping and controlling space at the nanometer scale

Porosity is ubiquitous and plays an important role in a wide range of materials, as chemical and physical processes can be tailored at the large surfaces. If one moves into the world of nanopores, then these processes are further modifiable. Controlling nanoporosity and surface chemistry on the nanoscale makes it possible to develop new materials with special properties and adapt them to specific requirements. The research group led by Professor Michael Fröba at the University of Hamburg is investigating an important adjusting screw for this purpose, the so-called „confinement effect".

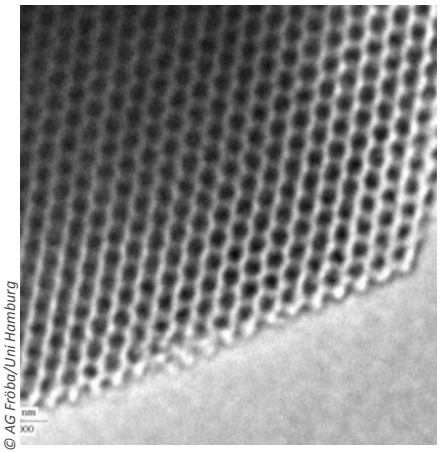
If one controls the size, shape and chemical composition of a material on the nanometer scale, one also controls its properties. This understanding has led to an incredible boom in nanoscience over the past 25 years, which is still ongoing and has enabled a wide variety of new materials and, in turn, new technologies.

„Numerous methods for the controlled production of nanoparticles are now state of the art. We are going the other way and creating nano-holes, so-called nanopores," explains Professor Michael Fröba. In this process, the nanoporous materials achieve an internal surface area of up to 6000 m² per gram, which corresponds to about the area of a soccer field. The pores can each be created with very uniform diameters in the range of 0.5-100 nanometers.

„If you bring other substances into these nanopores, their properties change significantly. We use this „confinement effect" to specifically control material properties and store substances," Professor Fröba said. The group is conducting more basic research on the nanoconfinement of water. This freezes, for example, in pores 3 nanometers in size only at a temperature of -60 °C.



Scanning electron microscope image of pure carbon with uniform spherical nanopores.



Transmission electron microscope image of pure SiO_2 with uniform cylindrical nanopores.

Efficient storage systems are a key component of a successful energy transition. Hydrogen storage is needed for the „power-to-H2" approach. In addition to physical forms of storage under high pressure (up to 700 bar) and in liquid form (at -252 °C), there is also the possibility of storing hydrogen chemically in various types of materials. For this application, the Fröba group made an important observation: nanopores in the range of 0.8-2.5 nanometers have a strong attractive effect on hydrogen molecules. Nanoconfinement thus leads to enhanced and faster gas absorption, which is necessary for efficient hydrogen storage.

Porosity also plays a crucial role for storing electrical energy through supercapacitors and batteries. „By optimizing the individual capacitor and battery components with respect to their nanoporous properties, we expect to increase their charge density. Thus, our research on nanopores also contributes to a successful energy transition," Professor Fröba sums up.

Hope in the Energy Crisis: Metal Hydride Storage for Green Hydrogen

Two years ago, Stühff GmbH from Geesthacht presented in NINa-News 12 how northern German SMEs are contributing to the hydrogen-based energy turnaround and creating jobs at the same time. Against the backdrop of the current energy policy crisis, it is time for an update from the now renamed Stühff Maschinen- und Anlagenbau GmbH.

Holger Stühff with staff and partners of the EU-project HyCARE standing in front of a demonstrator for the integrated conversion, storage und utilization of hydrogen.

„Politicians must now have the courage to take a step forward and use the developed hydrogen technology so that we do not fall from one dependency to the next when it comes to energy supply," says Managing Director Holger Stühff, referring to the current state of energy policy. „In order to be independent of autocratic regimes, we need a massive expansion of offshore wind power," Stühff continues. With the help of offshore platforms, the necessary fresh water could be provided directly on site and electrolysis of hydrogen could take place using generated electricity. This hydrogen would then be transported through pipelines to land, according to Stühff's vision.

This is where the system co-developed and manufactured by Stühff GmbH from the EU HyCARE project comes into play, which is currently housed in a test container. The system demonstrates the combination of hydrogen production by means of an electrolyzer, the storage of up to 50 kg of hydrogen in metal hydrides at moderate pressure and temperatures below 100 °C, and the generation of electrical energy by means of an integrated fuel cell. At the same time, the heat generated during the absorption of the hydrogen in the metal hydrides is retained in latent heat storage units for later use. „The system is almost ready for use. For industrial implementation, it has to be scaled up to application size, which is technically comparatively simple," Stühff explains. He sees a greater challenge in the regulatory requirements, since many decision-makers are not familiar with the technology of storing hydrogen in metal hydrides: „Conventional gas storage tanks, for example, must be visitable for inspection. This is simply not possible with a tank filled with metal hydride. We will have to take the regulatory requirements into account in terms of design as soon as there is more clarity."

In the mobility sector, the Geesthacht-based company is developing hydrogen storage systems for automobiles and ships. „The vehicle industry is currently focusing heavily on purely electric mobility. However, commercial vehicles in particular require more energy than can currently be provided electrically with batteries," Stühff describes.

In the H2Hybrid project, the company completed a first hydrogen storage system for mobile use based on metal hydrides. The hydrogen system is expected to demonstrate a range of about 600 km with a refueling time of only 10 minutes. Stühff Maschinen- und Anlagenbau GmbH also developed and manufactured two storage systems for an industrial customer to test the operation of a hydrogen electric drive under maritime conditions on a research vessel. In each case, 20 kg of hydrogen in metal hydride storage tanks are to enable pure hydrogen-electric operation for approximately eight hours. „Whether on water or on land, a sufficient tank infrastructure for hydrogen vehicles is crucial for the success of the technology," Stühff is certain.

Currently, metal hydrides for hydrogen storage are being intensively studied in the field of nanotechnology, for example at the Helmholtz Center Hereon in Geesthacht, where the new DLR Institute for Maritime Energy Systems will also be located. Stühff hopes the research will improve storage capacity, at low operating temperatures and pressures. And he would like to see a stronger link between local wind farm operators and hydrogen technology, because, „We can't justify our hydrogen production by splitting drinking water in regions of the world where people don't even have enough water to live or for agriculture."

NORDZENTREN bundle innovative capabilities: state invests 700,000 euros for start-up support

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For more than 30 years, the 17 innovation, technology and start-up centers in Schleswig-Holstein have made a significant contribution to economic development by supporting founders, start-ups and young companies in their initial steps and subsequent growth. „The technology and start-up centers in Schleswig-Holstein are often the crystallization point for innovations. That's why we want to interlink the regional ecosystems in Schleswig-Holstein even more closely," says Dr. Frank Schröder-Oeynhausen, Chairman of NORDZENTREN e.V. and Managing Director of the Lübeck Technology Center.

The NORDZENTREN e.V. is therefore joining efforts to further strengthen Schleswig-Holstein as a start-up state. The aim of the association of innovation, technology and start-up centers in Schleswig-Holstein is to promote the exchange of knowledge between established and young companies more intensively in order to sustainably increase innovation and competitiveness. For this purpose, the project LINA was launched: Lean Innovation Nordic Approach. The state government approved a funding amount of 700,000 euros on May 10, 2022. The project duration extends until June 2023.

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Dr. Frank Schröder-Oeynhausen, Chairman of NORDZENTREN e.V. and Managing Director of the Lübeck Technology Center TZL

„The acting stakeholders are now moving closer together. Coordinating activities, intensifying cooperation, benefiting from synergies - these are the major goals of the LINA project," says Schröder-Oeynhausen.

Nanotechnology and new materials for the Hydrogen turnaround made in Northern Germany

The decarbonization of the energy industry is considered a central challenge of the 21st century. In particular, green hydrogen as an energy carrier is considered a significant contributor to the energy turnaround. Schleswig-Holstein offers very good conditions for the production, distribution and use of green hydrogen.

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The Geesthacht Innovation and Technology Center GITZ provided the premises for the workshop.

Thus, the North can play a pioneering role on a national and even European level.

Since hydrogen technology poses major technological challenges, the energy turnaround will not be possible without nanotechnology and new materials. To inform about the topic „hydrogen energy" from the technological-scientific and political point of view of Northern Germany, NINa SH invited to the event „Hydrogen as an energy carrier - what can nanotechnology and new materials contribute?" on May 12, 2022.

The 50 participant places available at the GITZ site in Geesthacht, limited to due to COVID restrictions, were quickly booked up in advance. For this reason, NINa, together with the GITZ, the Helmholtz Center Hereon and the University of Hamburg additionally enabled a hybrid participation.

Dr. Ohrt from NINa SH is satisfied: „The number of 80 participants in total shows the current relevance of the hydrogen topic in Northern Germany and the importance of networking the different actors from politics, science and industry."

Innovation driver nanotechnology: on the future of Schleswig-Holstein

Prof. Dr. Franz Faupel, Chairman of NINa SH

As a key technology, nanotechnology is an important innovation driver for Schleswig-Holstein. Although it is not an independent branch of industry, nanotechnology is an essential cross-sectional technology for all central future fields, from alternative energies and clean environment to health and the digital revolution. It is a particularly important factor for the innovative capacity of the regional SMEs.

Local companies find globally recognized experts at Schleswig-Holstein's universities. At Kiel University (CAU) in particular, nanoscience has been a central research focus for many years and has established itself as „KINSIS" (Kiel Nano Surface and Interface Science). Nanotechnology also plays an important role at the Universities of Applied Sciences in Kiel and Lübeck and the University of Lübeck. This also applies to the Fraunhofer Institute for Silicon Technology (ISIT) in Itzehoe, the Helmholtz Center Hereon in Geesthacht (HZG), the Technical Center Lübeck (TZL), the Geesthacht Innovation and Technology Center (GITZ) and the Itzehoe Innovation Center (IZET).

Since 2005, the „North German Initiative Nanotechnology Schleswig-Holstein e.V." (NINa SH e.V.) has built up a very active nanotechnology network that now includes universities, research institutes and companies throughout the Baltic Sea region. With the support of the Schleswig-Holstein Ministry of Economics and the European Union, the „Nanotechnology Coordination Office" was established with a full-time network coordinator - whose funding, however, will soon expire. The above-mentioned measures have in the meantime not only raised public awareness of nanotechnology in Schleswig-Holstein, but have also noticeably sensitized SMEs to the potential of nanotechnology. At the same time, the focusing of technology transfer in the science sector has led to successful spin-offs in the field of nanotechnology.

In the future, too, close networking with partners in the entire Baltic Sea region will be indispensable for the further development of nanotechnology in the comparatively small state of Schleswig-Holstein with its industrial landscape predominantly characterized by SMEs. The association NINa SH e.V. will continue to play a leading role in this. To take into account the ever stronger connection between nanotechnology and innovative materials, it should expand its activities accordingly and rename itself „North German Initiative Nanotechnology and New Materials Schleswig-Holstein e.V.". However, the current dimension of the network can no longer be managed on a purely voluntary basis and continues to require professional network management that is not dependent on temporary projects. A complete financing by the association itself or the economy, which is rather financially engaged in its core areas due to the cross-sectional character of nanotechnology, is not to be expected.

Here, the use of synergy effects with the CAU and other partners offers an opportunity to make even better use of the knowledge available at the universities and research institutes for the economy. This would also be in line with the state's higher education law, in which technology transfer is listed as a mission of the universities on eye level with research and teaching. Against this background, the permanent location of the network management at the CAU, together with the great commitment of the nano stakeholders, could make the NINa network an even more significant innovation driver in the entire Baltic Sea region and beyond. The ball is now in the politicians' court to achieve these goals.

Franz Faupel

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