in2science

The Magazine about People with Ideas

#5

Searching for pollutants in the Baltic Sea • The gold expert
Industry and science closely intertwined • The adaptation
toolkit for cities • Strong Connections • Hydrogen on the march

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

That's why I chose science

Studying science, engineering or technology opens many doors in industry or research. We asked scientists at the HZG, "In all honestly – why did you choose science?"

Dr. Josephin Enz,
(WMF Group Leader, Materials Research)

To progress in science, in my opinion, you must be passionate about your work and your subject. You are always facing new challenges and must constantly continue to develop. This is also thrilling! And of course, it's even more fun when you then discover something completely new or achieve research results that others may not have believed possible!

Prof. Dr. Florian Pyczak,
(Head of Department WPM, Materials Research)

It is fascinating to work with things that no individual has ever seen or investigated yet. Every day my work in science offers me the opportunity to glance over the brink into the unknown. I can't imagine following a different job or a different career path with the same passion and fascination.

Michael Streßer,
(KOR PhD Student, Coastal Research)

While I was studying civil engineering, I already noticed that I had trouble motivating myself to solve problems "by the book". I found a suitable alternative in coastal research. The questions we are facing here are usually so varied and complex that it is practically impossible to use an already existing formula. Furthermore, I find it stimulating that a detailed understanding of the physical processes within the coastal ecosystem is necessary to facilitate sustainable building and residential development in the coastal regions. To improve this understanding, field measurements must be compared with computer simulations and large-area remote-sensing data (from satellites, zeppelins or airplanes, for example). The measurement technologies as well as the evaluation methods are still unavailable, so a high degree of creativity is necessary to conduct certain experiments. As a scientist, I therefore always have a new job in a way: sometimes as a measurement technician, sometimes a programmer, sometimes a physicist, manager or inventor. It never gets boring!

Dear Readers,

The environmental state of the coastal sea, adaptation to climate change and alternatives to conventional fuels – this issue delves into important topics concerning the future.

There was a real spirit of optimism at this year's climate summit in Bonn. In particular, the phasing out of coal has gained unstoppable momentum. Staff at the Climate Service Center Germany (GERICS), a branch of the HZG, returned with some very positive news, which you can read about here in the magazine. It would be desirable if this new dynamic, which can be felt globally, would also spread to Germany.

Phasing out coal means regenerative energies enter the picture: scientists at the HZG developed a hydrogen storage tank that could be used in the future to power mass market vehicles. Fuel cells and electric motors are paving the way for the future. The scientists are also researching the climate-neutral production of hydrogen using solar cells. An additional benefit here is that cars powered by hydrogen merely emit clean water rather than toxic exhaust gases.

Our polymer researchers are looking into issues of clean water. Lara Grünig has been part of a cooperation in developing a method in which wastewater can be treated more efficiently – a method that could soon be used in sewage treatment plants.

Come along on a measurement campaign in the Baltic Sea – our Photo Feature demonstrates how coastal researchers search for pollutants in water and sediment.

We'll also introduce you to an institute director and a scientist in the field of materials research engaged in work on lightweight materials and nanoporous gold.

We hope you enjoy perusing the magazine!

Your Editorial Team

We are pleased to present the fifth issue of in2science

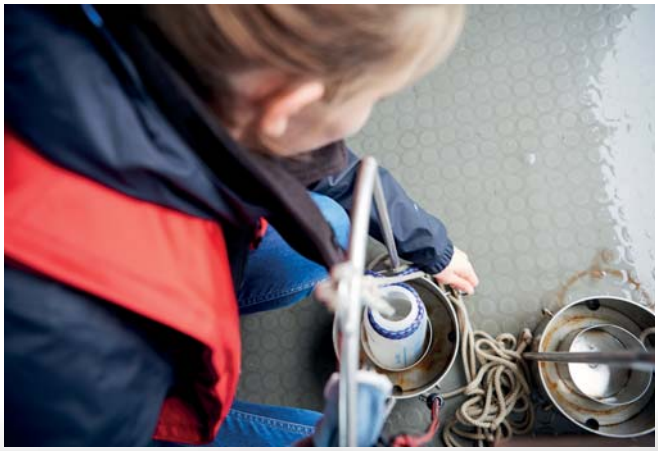
A call for submissions:
Employed at the HZG and have an exciting story or outstanding collaboration you'd like to share? Then please get in touch with our editors. We look forward to your ideas, praise and criticism. Simply write to us at in2science@hzg.de

Mission: searching for pollutants in the Baltic Sea

44 stations, eight ports and one ship:
Scientists from the Department for Environmental Chemistry at the Institute of Coastal Research are on a ten-day sampling campaign from Peenemünde to Flensburg – on the HZG research ship LUDWIG PRANDTL. The researchers are taking samples along the coast of the Baltic Sea and the important riverine inflows to investigate levels and distribution of pollutants.

On board

On this trip, the coastal researchers are particularly interested in UV filters and stabilisers, as well as per- and polyfluoroalkyl substances (PFASs). Water and sediment samples are taken for this purpose. Freya Debler is collecting water samples from the Baltic Sea with a ladle and labelling the bottles.



At sea

The team collects sediment samples with a box corer. The sampling points are selected in advance with the help of a sediment distribution map, as only particular locations are suitable for taking samples. Detlef Heinze, Christina Apel and Jürgen Gandraß (from left to right) are preparing the box corer to pull up the sediment from the sea floor.

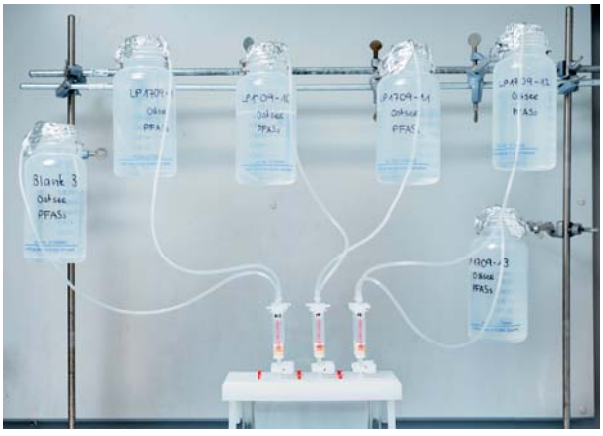
Ready for transport

The sediment samples are put into pre-cleaned aluminium boxes and frozen at -20°C in the laboratory container on deck of the PRANDTL. The water samples are stored in the refrigerator. Every two to three days, samples are taken to the HZG.

Laboratory analyses

The water samples are analysed by the PhD student Hanna Joerss for per- and polyfluoroalkyl substances. To start with, suspended matter is filtered out (image above).

By using solid phase extraction, the substances are concentrated, and undesired components such as salts are removed. In the final step, the sample is reduced in volume. The pollutants remain in the solution.



The PhD student Christina Apel is investigating UV filters and stabilisers in the sediment. Initially, a desiccant is rubbed into the thawed samples. Then, the dry mixture is put into steel cells and an accelerated solvent extraction is performed.

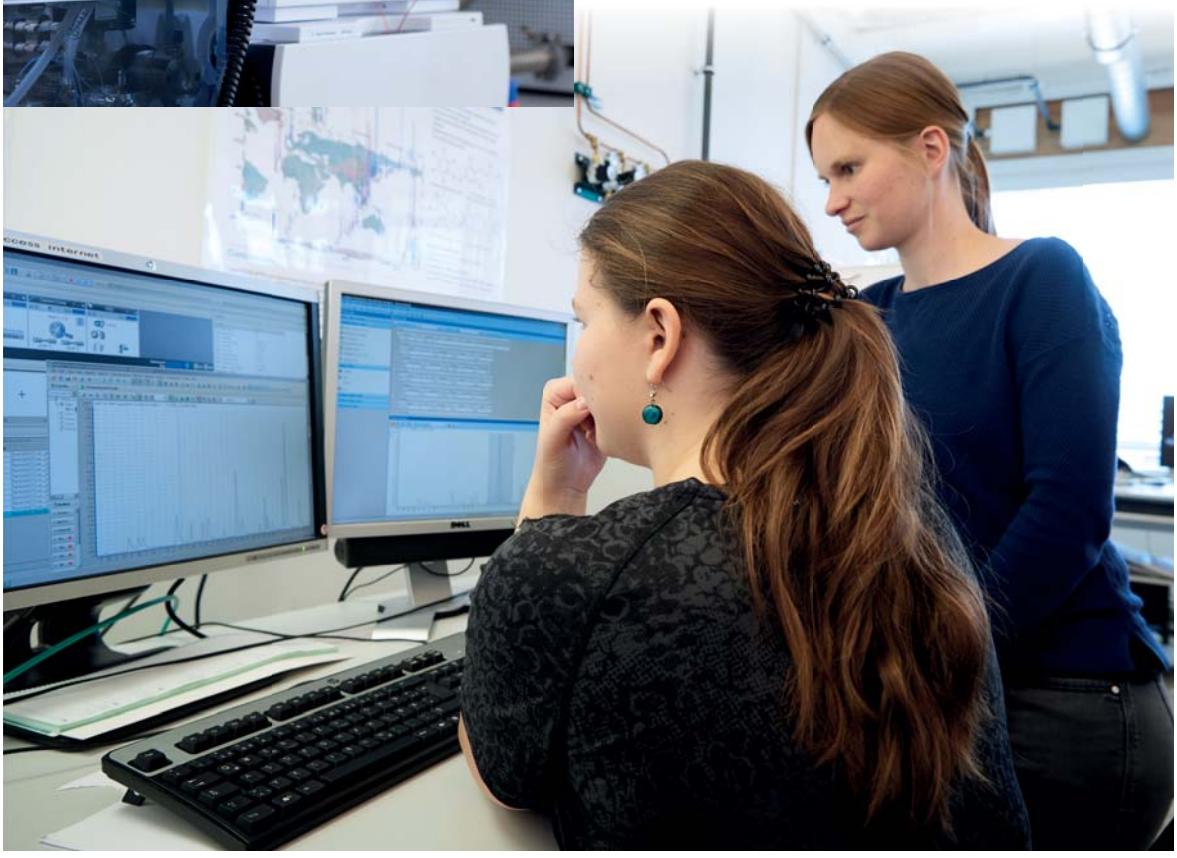
The rotary evaporator is used to reduce the sample volume.

Alternative and Legacy Perfluoroalkyl Substances: Differences between European and Chinese River/Estuary Systems
F. Heydebreck et. al, Environmental Science & Technology, 2015, 49 (14), pp 8386–8395
DOI: 10.1021/acs.est.5b01648

In fluoropolymer manufacturing, hazardous long-chain PFASs are replaced by short-chain PFASs and structurally similar fluorinated alternatives. In this publication, the substitute HFPO-DA was first detected in the German Bight, and point sources and transport pathways were identified. The current campaign will provide information about the status of the Baltic Sea.

Measurement and evaluation

The various contaminants in the samples are separated by high-performance liquid chromatography. A mass spectrometer is coupled to this system to identify the substances and determine their concentrations. “The devices are so sensitive that a lump of sugar could be identified in Lake Constance,” explains Hanna Joerss. Then the measurements are evaluated and attributed to the sample stations in the Baltic Sea. Consequently, sources, transport pathways, and distribution patterns can be identified.



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www.hzg.de/media_library

Fighting bacteria, viruses & more

More than ten billion cubic meters of wastewater run through the German sewer system every year. In the last stage of water treatment, known as ultrafiltration, hollow fibre membranes can be used to filter out impurities. However, the membranes are already full of organic substances and must be cleaned after a short while. To make this step unnecessary in the future, an extra component with a dirt-repellent effect is added to the membranes. Lara Grünig has joined the fight against "bacteria & more". She is a doctoral researcher at the Institute of Polymer Research in Geesthacht.

For many years, hollow fibre membranes have been well established in wastewater treatment. Pore sizes of ultrafiltration membranes range from one to twenty-five nanometres. Thus, due to size exclusion, even bacteria and viruses are retained by the membranes. The wastewater thereby flows through the module in which the hollow fibres are located. The water that passes through the separation layer of the membranes is cleaned and purified; it is called "the permeate".

However, after only a few days, a filter cake that contains the retained impurities, blocks the open pores. Organic material and microorganisms – that is, viruses and macromolecules such as sugar – attach themselves to the porous structure. This process is called fouling.

Lara Grünig explains: "Until now, there have been two standard possibilities for cleaning the fibres: One of them is to run the membrane backwards. In this step, water is pressed through the membrane from the outside, and hopefully the filtration cake is removed by the pressure of incoming water. However, this process can only remove the substances attached to the very inner surface of the hollow fibres. Those particles that are deeply stucked into the pore structure, remain in the membrane. Therefore, additional chemical cleaners are needed to clean the membranes entirely. The chemical cleaners that commonly contain chlorine can reduce the polymer matrix of the membranes. As a result, the material turns brittle. Additionally, the chemical treatment is also harmful to the environment. Membranes with a lower tendency for fouling are more economical, as fewer membranes are necessary for the same amount of cleaned water. The modules are thus smaller and cheaper. Therefore, we must find another solution."

We have shown in numerous tests that this principle works. We must now investigate "the perfect additive".

ABOUT:
Lara Elena Grünig, twenty-nine years old, has already spun more than ten kilometres of hollow fibre membranes for her dissertation. The doctoral researcher was born in Hamburg and completed her bachelor's and master's degrees at the University of Hamburg in the fields of nanoscience and nanotechnology. During her master's program, she participated in a University of Bayreuth project using artificial spider silk. "It was there that I realised that I wanted to do my research in an application and industry-oriented field. The project with Prof Volker Abetz suited me well", explains the nanoscientist. "The overall topic of water is of great significance in all fields – everyone needs and should have access to clean water." Lara Grünig has a son and lives with her family in Hamburg.

Plastic additives prevent deposits

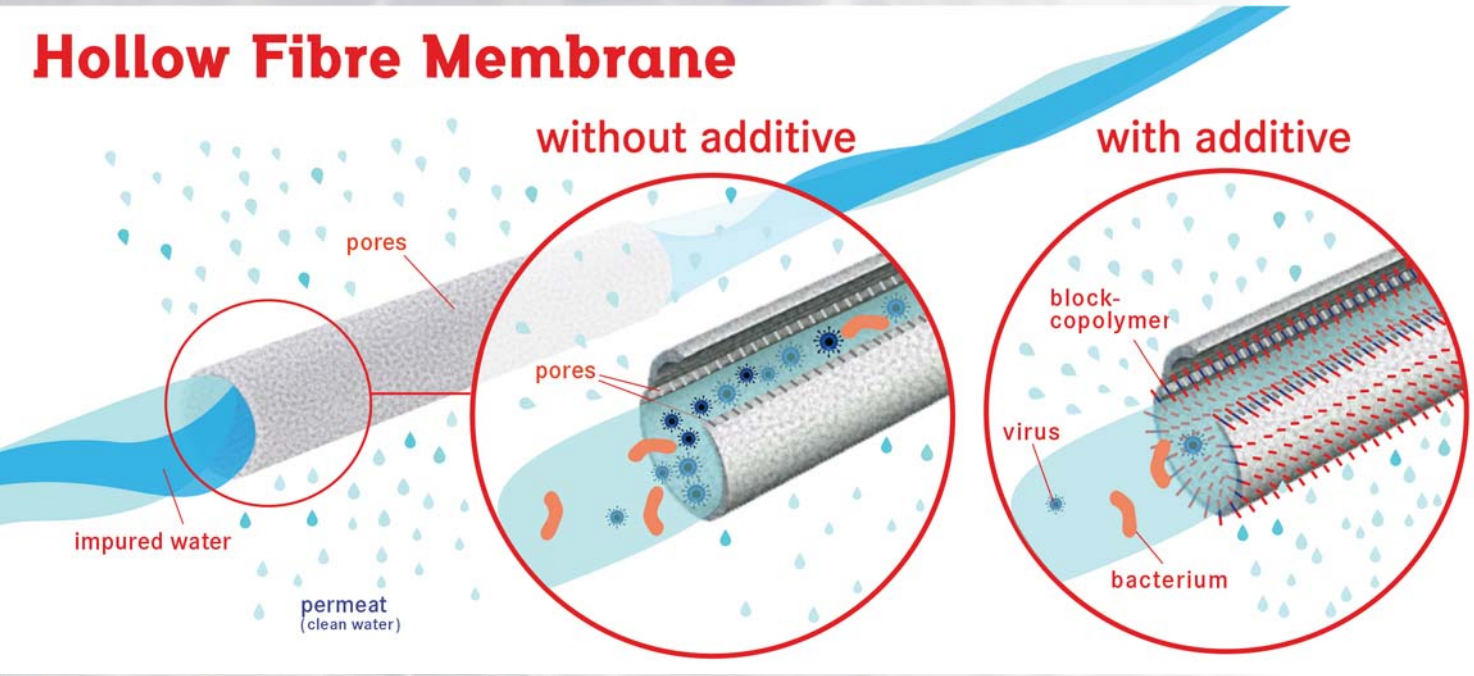
In the context of her PhD work in the Department of Material Characterization and Processing (PMM) at HZG, Lara Grünig cooperates with BASF SE, the University of Duisburg-Essen, inge GmbH and the IWW Water Centre to improve the antifouling properties of the membrane. The overall objective is to avoid agglomeration of organisms such as viruses on the membrane separation layer. The project "MABMEM" ("Material-Auswahl-Box für Hochleistungsmembranen", i.e., a materials toolbox for high-performance membranes), funded by the German Federal Ministry of Education and Research, has been running since May 2016.

Until now, the standard hollow fibre membranes, such as those studied in the project, consist of two components: a matrix polymer and a "pore former", which is a polymer additive that interconnects the pores of the membrane. The matrix polymer forms the support structure; the pore former creates, as the name indicates, the interconnected pores and provides the membrane with a spongy structure. In the project, the scientists are adding a second additive to the standard mixture. This is what is known as the dope solution: An antifouling additive or, more precisely, an amphiphilic block copolymer. This additive polymer consists of hydrophobic (water-repellent) as well as hydrophilic (water-attracting) components. The hydrophobic anchor is built into the actual fibres; the hydrophilic group sticks out of the surface of the membrane, similar to bristles of a brush. Hence, the surface of the membrane has a hydrophilic function and prevents viruses and other microorganisms from attaching themselves to the membrane structure.

"We have shown in numerous tests that this principle works. We must now investigate "the perfect additive" that repels the organic components in the most efficient way," says Grünig. Therefore, she is testing different variants in the laboratory, trying various types of additives or changing the block length of the polymers.

She has already produced fifty different kinds of membranes. This requires approximately three hours of "spinning" time in the laboratory for each of them. She then ends up with two hundred metres of hollow fibres, that are cut into 50-centimetre pieces. As soon as the fibres are produced, they are characterised with the utmost precision.

www.machwas-material.de/MABMEM



The basic principle of wastewater treatment using hollow fibre membranes is represented in the diagram on the left. The middle section shows that viruses and bacteria are deposited in a hollow fibre membrane without additives (fouling). Less water therefore flows through the pores of the membrane. The diagram on the right shows a hollow fibre membrane with the additive, a block copolymer. This custom-made polymer prevents bacteria and viruses from clogging the pores, whereby increasing permeate flow.

First implementation tests planned for 2018

Each type of membrane is integrated by inge GmbH into one hollow fibre module. A module looks like a large tube that contains all hollow fibre membranes affixed inside. The modules are then subjected to laboratory tests at the University of Duisburg-Essen, where they are examined under extreme conditions. When all additive variants are analysed, four of the best performing membranes with the least observed fouling will then be subjected to a practical test. In April 2018, these pilot modules shall be implemented by the project partner IWW in at least two locations: one wastewater treatment plant and one reservoir, where they will be tested under real conditions for several months.

Water treatment in developing countries

If the membranes pass the tests, they can be implemented in professional water treatment modules in the future. “This would be a major step, particularly for developing countries who suffer from water shortages.” says Grünig. “Generally, the problem is not that there’s too little water available; it is that there is not enough access to the drinking water. Drinking water can be extracted from saltwater by a process called reverse osmosis. But this step can only take place before the saltwater was ultrafiltrated with, for example, hollow fibre membranes for ultrafiltration. In this way, only salt remains to be extracted from the particle-free water.”

Author: Gesa Seidel (HZG)

Wastewater in Germany – figures & facts

- More than 96% of the total population is connected to the public sewer system.
- There are 10,000 public sewage treatment plants in Germany.
- 10.07 billion cubic metres of wastewater flow through the sewer system: from households, from industry and the economic sector, but also from rain and other influences. For comparison: Germany’s largest reservoir, “Bleiloch” in Thuringia, contains 215 million cubic metres of water.

Source: German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Hydrogen on the march! New laboratories at the Institute for Materials Research

The steel cylinder is mounted on a green painted block, metal corrugated hoses as thick as a human arm function as supply lines. “This is our new high-energy mill,” describes Martin Dornheim, department head at the HZG Institute for Materials Research. “A stirring rod in the cylinder makes small steel balls move. They crash into each other and grind the milled substance.” This creates an extremely fine, nanostructured powder with a remarkable property: it absorbs hydrogen like a sponge and thus constitutes an efficient energy storage medium.

The Helmholtz-Zentrum Geesthacht has been working on these “metal hydrides” for two decades. Now, the experts are taking the next step: in a new experiment hall, where the high-energy mill is located, they will be manufacturing and testing larger quantities of this innovative hydrogen storage medium – a major step towards implementation.

“Hydrogen is the ideal energy carrier for our sustainable energy supply,” says Thomas Klassen, director of the Materials Technology Division. “Hydrogen can be used to store both wind power and solar energy and to power climate-friendly fuel cell cars.” A challenge thereby is storing the gas.

Until now, either pressure tanks were used, storing the hydrogen at seven hundred bars, or cold storage tanks, storing it as a liquid at temperatures of minus 250 degrees Celsius. Both procedures are established, but they both have their disadvantages: the storage capacity of pressure tanks is not very large, while liquid tanks are relatively difficult to handle and are expensive.

Metal hydrides promise an interesting alternative: they are metals that can absorb and bind hydrogen in astonishing quantities. “A hydrogen

Mauricio Schieda

Thomas Klassen

Martin Dornheim

storage tank based on metal hydrides can hold about twice as much hydrogen as a 700-bar pressure tank of the same size," says Klassen. "This means that one could reduce the tank size of a fuel cell car by half."

To ensure the tank doesn't become too heavy, the use of lighter metals is recommended – alloys in lithium, magnesium or boron, for example. The problem is that these alloys are eager to absorb hydrogen, but they release it with difficulty. To get at the gas, relatively high temperatures are required – which made using light metal hydrides difficult for a long time.

A few years ago, the HZG researchers found a suitable solution: the combination of two different hydrides made it possible to significantly reduce the release temperatures. In this process, one metal atom is offered to the other as a reaction partner, both then willingly release the hydrogen.

Recently, this "partner exchange" has even made it possible to release the hydrogen from the storage medium at ninety degrees Celsius. "This means the waste heat of a fuel cell could be used," explains Thomas Klassen. "Therefore, no extra energy needs to be spent to get at the hydrogen." Another challenge is that at every charging and discharging, the reaction partners must separate or find each other again. So that they don't drift too far apart over the course of time, the hydrides can be enclosed in porous polymer membranes, which then only let the hydrogen pass unhindered. The material and polymer researchers at the HZG, together with industry partners, are working on this aspect in a project funded by the German Federal Ministry of Education and Research.

Until now, however, the Geesthacht researchers were only able to create and test these new hydrides in small quantities – in the gram or milligram range. For larger quantities, there are additional challenges: the hydrides must reliably demonstrate the same quality and desired storage behaviour. This is the purpose of the new experiment hall.

The researchers want to use it to create promising metal hydrides in larger quantities with the new high-energy mill. With its volume of one hundred litres, it is significantly larger than the devices the size of coffee grinders the scientists were working with until now.

The initial substance is mostly a coarse metal powder. Inexpensive recycling material can also be processed. Through the milling process, which can sometimes take hours, a nanopowder is created – tiny powder particles consisting of even tinier grains with a diameter between ten and sixty nanometres.

The F-Cell: The hydrogen-powered car in the HZG vehicle fleet.

"There are many pores and channels between the powder particles," explains Martin Dornheim. "Even inside the particle, between the even tinier grains, there are areas that are less densely packed with atoms." These pores, channels and microscopic areas allow the hydrogen to spread rapidly, to be chemically bound to the metal. In order for this to occur, the hydrogen molecule on the particle

Finely ground metal powder is to absorb the hydrogen and release it as easily as possible.

surface must first be split into atoms – which is helped by a special catalyser mixed into the metal in the high-energy mill. Other additives are there to prevent the coarsening of the grains within a particle.

"We can monitor the particle size during milling," says Dornheim. "This helps us to understand and systematically optimise the creation process." The nanopowder thus created is then pressed into pellets. They can take the shape, for example, of an ice hockey puck that can be stacked in flexible configurations in a tank.

To put the prototypes through their paces, the hall also has a new testing device – a large white tank next to two solid concrete walls. Here, the storage pellets can be repeatedly charged and discharged. The experts can thus determine how large their storage capacity is and whether they can keep their properties for the entire service life of a car.

The experiments are to start at the beginning of 2018. In one of the projects, the HZG researchers are teaming up with a large car manufacturer. The goal is to create a fuel cell test vehicle with a metal hydride storage tank on board.

"In the long term, we want to make a tank that only weighs one hundred kilograms and that can store five kilograms of hydrogen," hopes Dornheim.

"A fuel cell car could thus drive five hundred kilometres in a climate-friendly and environmentally friendly manner." The exhaust would namely give off neither CO_2, nor nitrogen oxide, nor fine particles – instead only pure water.

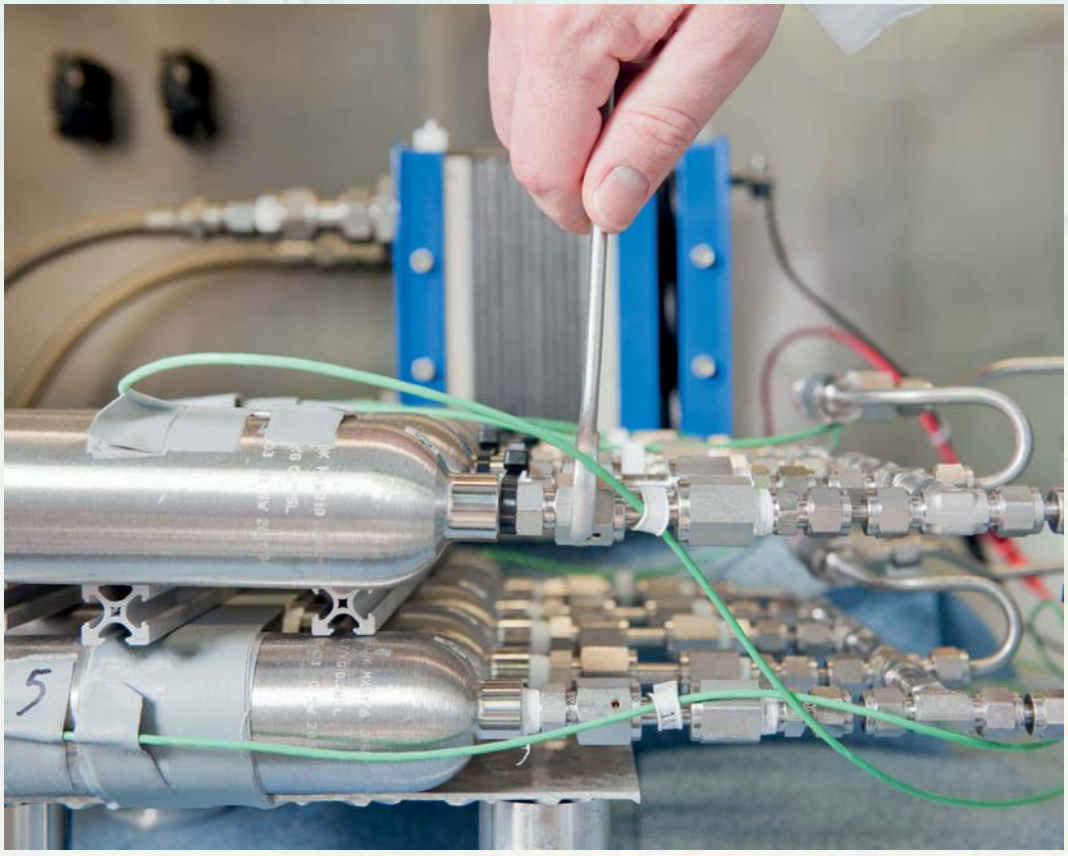
For a good climate footprint, however, CO_2-neutral generation of the hydrogen is necessary. This can be currently performed in what are known as electrolysers. These are devices that split water molecules into their components, hydrogen and oxygen, with the help of electricity. "If solar cells are used to run the electrolysers, the hydrogen is created climate-neutrally," says Mauricio Schieda, group manager at the HZG.

"We are working on a more elegant method, whereby the sunlight is used directly to split the water." The vision is a new type of solar module for the home roof that generates enough hydrogen to cover the inhabitants' needs.

This test equipment contains a hydrogen storage unit based on sodium alanate.

The new technology is based on semiconductor materials that absorb light – just like a normal solar cell – whereupon charge carrier pairs are generated in the material. But the difference from a solar cell is that these semiconductors are immersed in an electrolyte – an electrically conducting liquid, such as a salt or an acid. "In the semiconductor, at the interface with an electrolyte, an electric field arises, which separates the created charges apart from each other," explains Schieda. "We use these charges to split water molecules and generate hydrogen."

The researchers are currently experimenting with semiconductors such as titanium dioxide, iron oxide or tungsten oxide. Schieda



The HZG hydrogen laboratory is used to research solid fuel tanks and fuel cells.More information on the hydrogen research can be found online:

More about the research on hydrogen:

www.hzg.de/h2

points to a stamp-sized piece of metal. “That is a titanium plate on which a thin layer of tungsten oxide, measuring only a few micrometres, is applied through a special spraying procedure, in cooperation with the Helmut-Schmidt University of Hamburg. ” The scientists then test these electrodes in a measurement cell and see how much hydrogen they generate under the influence of light.

“Electrodes based on such metal oxides have much potential, and the materials are inexpensive and stable,” explains Schieda. In the long term, even more efficient semiconductors and photo-catalysers are planned for use to significantly accelerate the splitting of the water molecule. In addition, the HZG scientists are investigating the possibilities of new types of metamaterials, in cooperation with the TU Hamburg, to make even better use of sunlight.

“The field is still very young,” says Mauricio Schieda. “There is still much to learn and research before this technology can be implemented in practice.” The research possibilities in Geesthacht have been significantly increased: Schieda’s group has recently been provided facilities in a brand-new laboratory building. This offers much more space to manufacture, structure and closely analyse the electrodes.

The prospects are promising, according to the institute director Thomas Klassen. “With a photo-electrochemical cell, up to forty percent efficiency is possible in theory,” he explains.

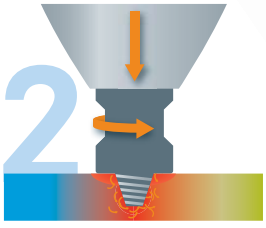
If the researchers truly achieve such efficiency, a house roof equipped with modules should be sufficient in providing an entire family with hydrogen – stored solar energy for household electricity as well as for sustainable electro-mobility with fuel cell cars.

Author: Frank Grotelüschen

Forming Strong Connections

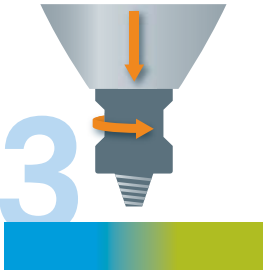
Friction stir welding – this is the method with which the most varying materials can be joined together by stirring. Scientists at the Helmholtz-Zentrum Geesthacht have developed additional methods based on this technology. Today, for example, they're joining carbon fiber reinforced polymer to metal or aluminium to steel. No melting, no adhesive, no difficulty. This infographic presents some of these methods.

STEP 1
The material is firmly clamped, then a tool with 8 to 40 kilonewtons pressure (depending on the type of metal) penetrates into the material joint.



STEP 2

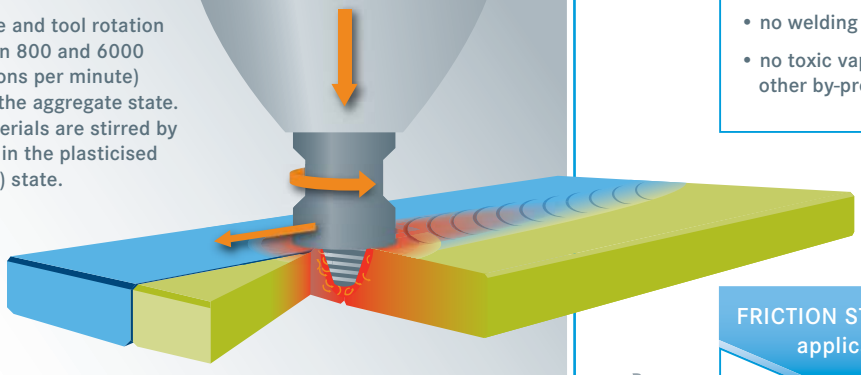
Pressure and tool rotation (between 800 and 6000 revolutions per minute) change the aggregate state. The materials are stirred by the tool in the plasticised (doughy) state.



STEP 3
Mixing the materials results in a stable joint. Only faint friction rings on the surface bear witness to the weld seam.

FRICTION STIR WELDING (FSW)

Friction stir welding is a method for joining various metals. Stirring the materials under little heat, no melt is produced. Thus a joint develops that is exceptionally strong and is barely visible.



FRICTION STIR WELDING advantages

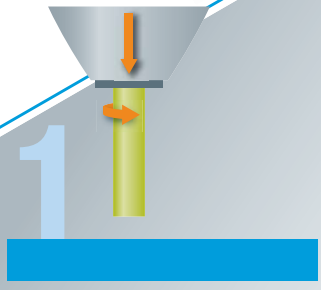
- little heat development
- the most varying materials can be joined
- no preparation or post-processing of the joint is necessary
- no welding filler necessary
- no toxic vapours or other by-products

FRICTION STIR WELDING applications

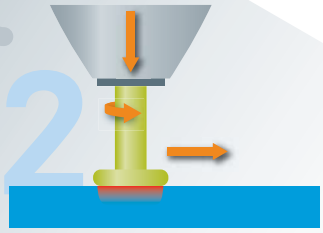
- Automotive industry
- Aerospace Engineering
- Railway vehicle construction
- Naval engineering

FRICTION SURFACING

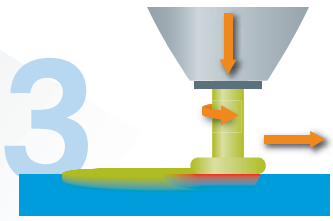
A metallic material is applied to another material, such as for local corrosion and wear protection, or for repair.



STEP 1
The material to be applied is pressed onto the other material in cylindrical form.



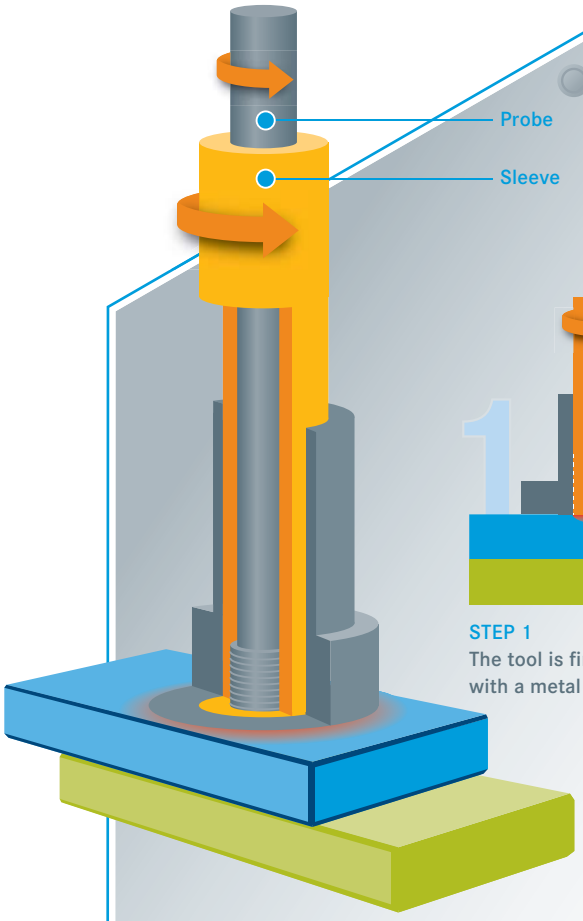
STEP 2
Through rotation and pressure, the applied material begins to plasticise (into a doughy consistency).

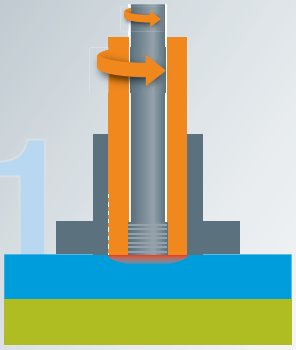


STEP 3
The plasticised material is applied. The two materials are stirred and cling together. A strong joint develops.

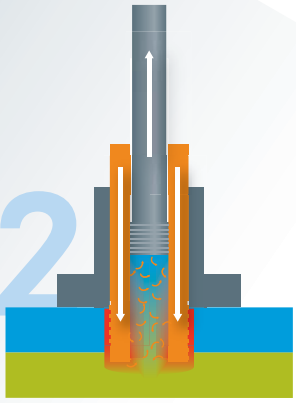
REFILL FRICTION STIR SPOT WELDING (refillFSSW)

The punctiform joint results from employing a tool consisting of multiple parts. Rotating individual parts stir the materials to be joined together without an outlet hole.

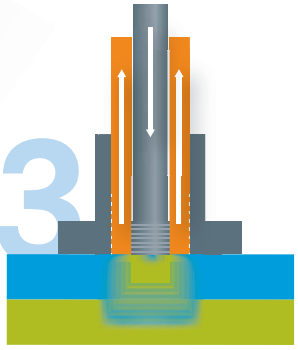




STEP 1
The tool is firmly attached with a metal clamping ring.



STEP 2
The sleeve rotates and plunges downwards into the workpiece. The pin, also rotating, is pulled upwards and makes room for the material displaced by the sleeve.

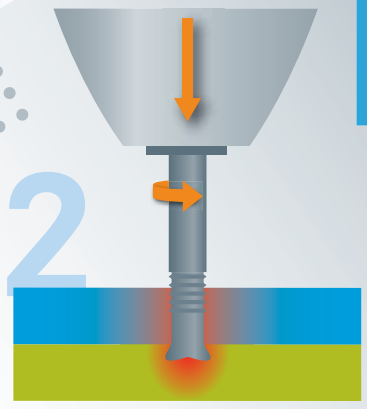


STEP 3
The sleeve retracts while the pin presses the mixed material back into the weld spot. The procedure leaves a stirred interface between the upper and lower material.

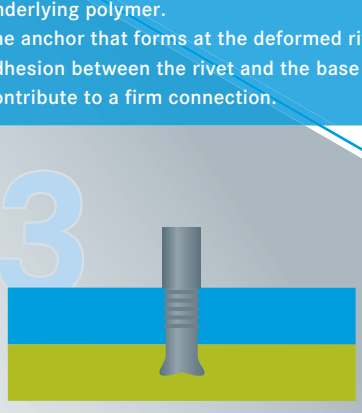
FRICTION RIVETING FOR METAL-POLYMER JOINTS (FricRiveting)

A cylindrical, metallic rivet penetrates through the upper material under rotation and pressure into the underlying polymer.
The anchor that forms at the deformed rivet tip and adhesion between the rivet and the base material contribute to a firm connection.

STEP 1
A rotating rivet is placed on the base material with 3 to 20 kilonewtons pressure and up to 10.000 revolutions per minute.

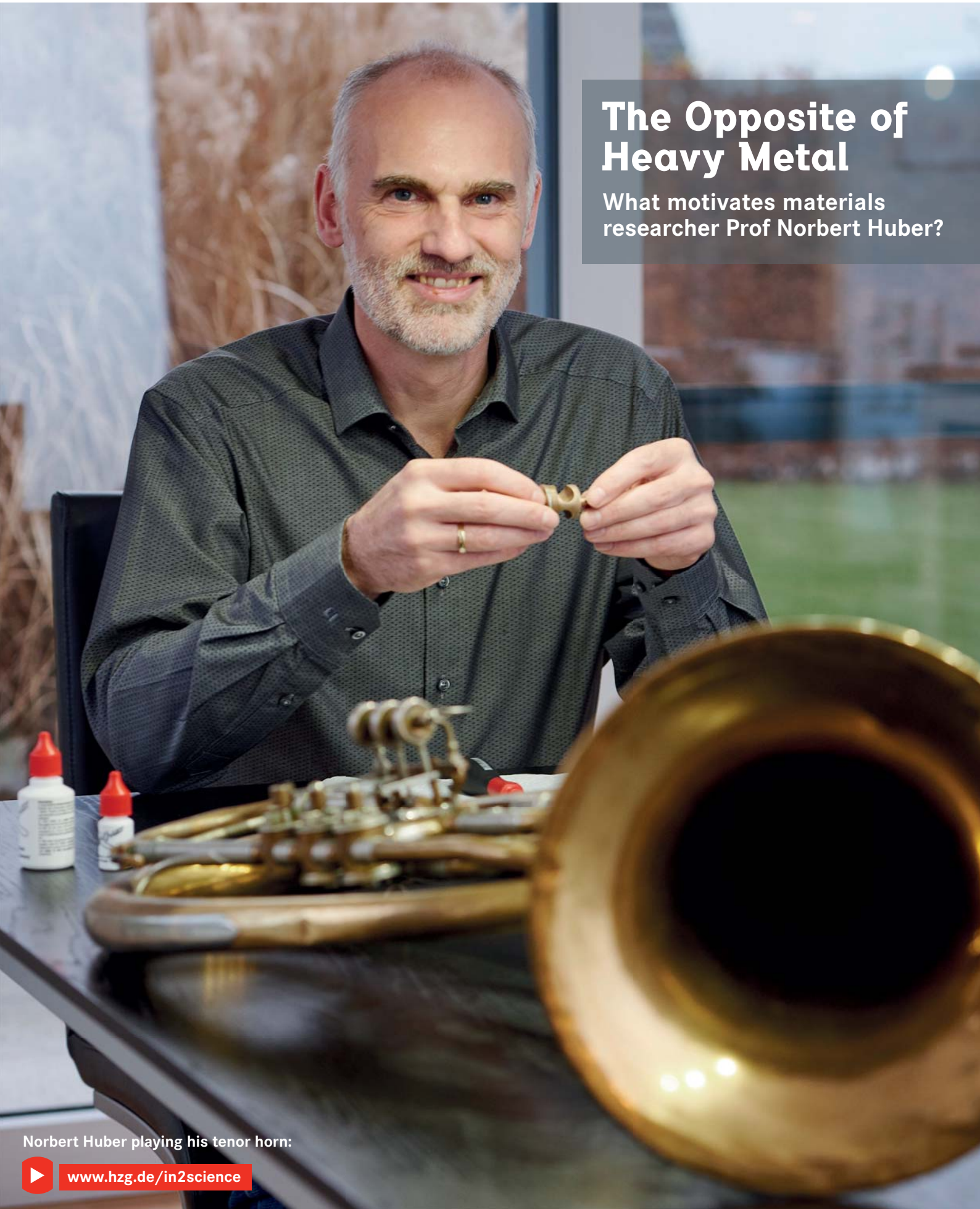


STEP 2
The rivet penetrates through the upper and into the lower material. The displaced material is thereby pushed upwards and out of the joint.



STEP 3
The pressure causes the front side of the rivet to spread like an anchor. Adhesion between the rivet and the materials further increases the strength of the joint.

www.hzg.de/solid-state-joining



The Opposite of Heavy Metal

What motivates materials researcher Prof Norbert Huber?

Norbert Huber playing his tenor horn:

www.hzg.de/in2science

Prof. Norbert Huber

Professor Norbert Huber is a director at the Institute for Materials Research

He attributes a few factors to his career path: southern German industriousness, a passion for technology and an impressive capacity to seize and develop at least seven random opportunities in his life. When talking with Norbert Huber (49), it quickly becomes obvious in his intonations that he does not come from Hamburg. His original home is a village close to Baden-Baden. Even early on, he was interested in technology. He crafted little machines and his own radio with building blocks that his uncle gave him—this is when opportunity number one opened up for him. Huber attended secondary school and had a promise of an apprenticeship as an electrician. Everything that followed he ascribes to random opportunity number two: Norbert Huber played tenor horn in a music club. His instrument teacher Fridolin Boos said to him: "You must make more of yourself!" In his last year of high school, he discovered a new passion for mechanical devices, for "things that were visibly interlocked and worked together" so he decides to study mechanical engineering.

Before that, Norbert Huber still needed to perform his military service, where he, opportunity number three, joins the music corps. "I was able to play music every day for an entire year there; it was a dream." When he returned he became the vice conductor of his original music club. "And this taught me early on how to organise and lead a large group. That is something that one is rarely taught in science."

His plan was actually to find a job in industry. However, Huber's girlfriend, now wife, recommended a lecture on materials research to him – thus opening up opportunity number four. "I liked it so much that I chose it for my optional subject obligatory exam. After the exam, the professor asked me directly if I wanted to do my doctorate with him."

Norbert Huber accepted. Even the subject of his doctorate was already set: his professor had just obtained a new device for his institute, which no-one had explored in depth yet – opportunity number five. It was a nanoindenter. With the help of an extremely sharp diamond tip, he needed to measure the hardness and stiffness of thin layers, a procedure that Huber's research and that of his institute still support today.

For his postdoctoral qualification at the research centre in Karlsruhe, it was a chance that helped him – this was the sixth one: at a guest lecture he heard of machine learning, which was a new procedure at the time.

> **I immediately knew that this method had a place in the future.**

Since that day, Norbert Huber has combined his experimental research with theoretical models and artificial intelligence.

After an intermediate position in Stanford and a position as department head in Karlsruhe in 2006, Norbert Huber arrived in Geesthacht – opportunity number seven. Because when he applies, he already has an offer from the University of Siegen. What was his quickly developed concept? "I wanted to closely link experimentation as well as modelling together. The reciprocal fertilisation of experiment and theory – I find it incredibly rewarding. Above all, I believe that new ideas tend to appear where different disciplines meet each other." The institute also follows a well-defined principle:

> **We want to develop – especially in the field of aviation – innovative, lightweight structures that weigh at least twenty percent less than the current average.**

Materials such as aluminium, magnesium or titanium play an important role. Weight is saved, in the way components are connected to each other. An example of this is friction stir welding, which is researched at his institute. This process does not require rivets or overlapping structures or sealants. It also avoids rivet holes, which often lead to cracks.

How can damage to the fuselage of an aircraft be detected more effectively? The answer is something similar to his lifelong project: since the 90s, his colleagues – especially the department head Jörg Weißmüller – have been researching a very special material: nanoporous gold. "It is an open-pore material, like a sponge, that creates an electrical signal when it is deformed," Huber explains. The vision is that nanoporous gold – or equivalent titanium – could cover the surface of an airplane in ten or fifteen years' time and thereby give very precise indications of when cracks appear on the airplane. "To see this idea of structural health monitoring actually take off one day would make me very proud."

Alongside his work as institute director and professor, Norbert Huber is also a member of the board for a collaborative research centre he co-founded and is the director of the Centre for High-Performance Materials. The tinkerer from the edge of the Black Forest has become a manager of science. How does this fit in with his earlier passion – his fascination for gears? "When a cogwheel interlocks with another, I find it fascinating whether it happens in a machine or in an organisation. Making complex structures work together, that is its own type of science and what I am intensely involved in."

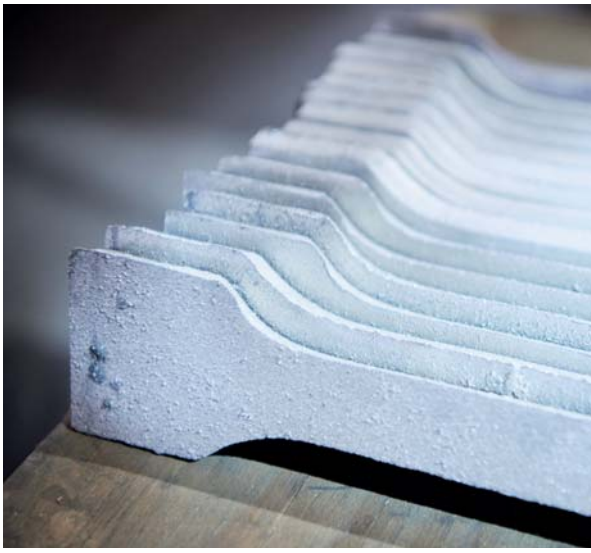
Today he is not quite without any concrete tinkering: Norbert Huber got an old tenor horn working again. "I said to myself: let's see if I can get it going again. I took it apart completely, soldered the holes and polished it. Now it can be played again. And you know what? It sounds really good."

Author: Jochen Metzger

Industry and science closely intertwined

Interview with Henning Fehrmann, director of the metalworking company Fehrmann Metallverarbeitung GmbH

Henning Fehrmann's company manufactures high-strength aluminium – and works in close cooperation with the Helmholtz-Zentrum Geesthacht. The experts from the Centre for High-Performance Materials (ZHM) examine the alloys with sensitive analysis methods and microscope technologies. After two and a half years, the joint project resulted in an aluminium alloy that is nearly as strong as steel.



Scientists at the HZG test such sample specimens made of aluminium alloy.

Aluminium – compared to steel, for example – is limited in its mechanical properties. A two-and-a-half-year long project together with the Helmholtz-Zentrum Geesthacht has made it possible to develop a new type of alloy, the strength of which is in the same range as normal steel.

Mr Fehrmann, your company produces high-performance aluminium alloys. What is special about these materials?

Aluminium is light and relatively inexpensive. This is why components that require reduced weight are increasingly produced in aluminium, such as in the automotive sector as well as for constructing industrial plants. However, aluminium – compared to steel, for example – is limited in its mechanical properties. With our alloys, we are trying to improve these properties. We were able to develop an aluminium alloy quite some time ago, which stretches up to twelve percent when stressed and can thus be used in areas with high explosion risk, such as for tankers or grain transporters. And now, together with the Helmholtz-Zentrum Geesthacht, a two-and-a-half-year long project has made it possible to develop a new type of alloy, the strength of which is in the same range as normal steel. In comparison, standard aluminium alloys are only about half as strong as steel.

How was the cooperation with the Helmholtz-Zentrum Geesthacht established?

The plans for a new high-performance alloy had already been in the pipeline for quite some time. At the beginning of 2014, we started looking for a partner. The Innovation Contact Point (IKS) of Hamburg helped us here. The IKS visits companies in the region, inquiring about their requirements in matters of research and development. It then offers to find the companies a suitable scientific partner, free of charge. It was the IKS that gave us the contact information for the HZG scientists and Prof Norbert Huber. Right from the start of discussions, we noticed the chemistry: we sat at the table with people of conviction, who are looking forward to the project and are one hundred percent committed. At the end of 2014, we applied to the Hamburg Investment and Development Bank (IFB). Its PROFI program supports innovative research and development projects undertaken by companies in Hamburg. We have been working with the Helmholtz-Zentrum Geesthacht since then, and this cooperation has proven excellent.

We developed the alloys in our company, the special formula – sometimes we call it our Coca-Cola formula.

How was the work divided? What was performed by your company and what was performed at the Centre for High-Performance Materials in Geesthacht?

We developed the alloys in our company, the special formula – sometimes we call it our Coca-Cola formula. Such alloys consist of aluminium, offset with other materials, especially metals, of which six to eight are decisive for the mechanical properties. We must know precisely the interactions between all these components and control the manufacturing process in all its details. This is only possible with decades of experience. We then sent samples of these new alloys to Geesthacht. There, the samples were examined in detail using many different methods: What influence do different melting processes have? What does the material fabric structure look like? What role do heat treatments have? How weldable is the material? The HZG has the necessary analysis devices as well as the staff familiar with these methods. This was the ideal addition to our skills.

What were the concrete benefits for you of the work undertaken by the HZG researchers?

The results of the HZG analyses formed the basis of new optimisation steps. To start with, we thought about which combination of metals could provide the desired properties. Then we created samples and had them examined in Geesthacht. Based on the results, we were able to improve the formula, to then have it examined by the researchers again. We thus moved closer to the best alloy, step by step. Together, we discussed many intermediate results and went to forums and conferences to exchange and gather information. It was a fruitful and productive cooperation – without the research at the Centre for High-Performance Materials in Geesthacht, we would never have been able to develop the new material in such a targeted way.

ABOUT
Henning Fehrmann:
Industrial engineer Henning Fehrmann (42) is a managing partner of Fehrmann Metallverarbeitung GmbH. The family company was founded back in 1895 as a metal foundry for the shipping industry. It also soon began producing ship windows and doors. The foundations of the company remain the same today: it offers special pressure-tight windows – ship windows, for example – that can even resist a monster wave, but also hinged windows for the exterior facade of the Elbe Philharmonic Hall. The company has also specialised in manufacturing high-performance alloys in aluminium. These alloys can be used anywhere that requires high strength and elasticity. Innovation has always played a significant role in this field. In 2011, Henning Fehrmann was designated the Hamburg entrepreneur of the year, together with his father Uwe. As a regional board member of the Familienunternehmer e.V., he combines industry and science. He also provides his knowledge to innovative company founders and to start-ups as a mentor. Fehrmann has been working with the Centre for High-Performance Materials (ZHM) at the Helmholtz-Zentrum Geesthacht since 2014.

And what did the result look like?

After two and a half years, the alloy has now been finished, and it is better than we imagined at the beginning of the project. At the beginning, our goal was to develop a corrosion-resistant aluminium alloy with a strength comparable to steel. We actually exceeded this goal because we also succeeded in achieving a twenty percent elongation at break – the material can stretch up to twenty percent before breaking. We are also very satisfied with the weldability. The initial goal has thus been exceeded and, in the meantime, we have applied for a patent for the new alloy.

Where could the new high-strength aluminium alloy be utilised?

Especially in areas that require reduced weight – and this is the case for nearly seventy percent of the aluminium market. Because our alloy is clearly more stretch-resistant than standard aluminium, many components can be made leaner and therefore lighter. Compared to standard alloys, we are anticipating a weight reduction of up to fifty percent. In the automotive sector, for example, this would make it possible to reduce the weight of cars and therefore also the amount of fuel consumption and CO_2 emissions. Electric cars could be made lighter, which would improve their range. Wind power plants could be made to be more efficient. Some steel components could even be replaced, as our alloy is as strong as steel. This could even provide weight advantages of over sixty percent. Another positive aspect is that our aluminium alloy is corrosion-resistant and therefore does not require a corrosion protection coating as many other alloys do.

I believe that joint projects in which we can combine our respective strengths are incredibly important for the future.

Do you believe that such cooperative projects between companies and research facilities could become the norm in the future?

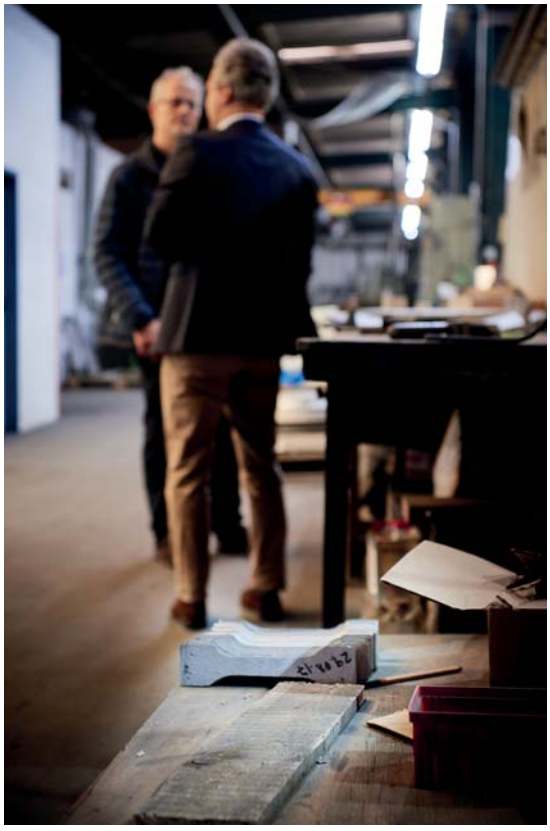
I see the need for industry and science to be better linked. And I hope that our project will be visible as a best-practise example that shows how well such a cooperation can work. The scientific community complains that small and mid-sized companies in northern Germany are not aware enough of research and that it is difficult to introduce their methods and skills into the industry. I hope that our project will serve as a beacon in helping dismantle the fear of contact on both sides because trust can only be built when people get to know each other. And co-

operation is only possible when trust has been built. The goal is linking science and industry more tightly together. The strength of industry is that it is very close to the market and therefore able to identify its demands. The strength of research facilities, on the other hand, is developing new solutions on a scientific basis. I believe that joint projects in which we can combine our respective strengths are incredibly important for the future.

Encouraged by the success of the first project, a new cooperation with the Centre for High-Performance Materials is already underway. What is the subject of this collaboration?

My company has entered into a strategic alliance with the Helmholtz-Zentrum Geesthacht to further develop the cooperation. Our new joint project concerns a high-performance aluminium for 3D printing – we are talking about additive manufacturing. The basic material is aluminium powder, which is then melted into components by laser. I am convinced that this production method will have an enormous market in the future. The reason for this is that when building a component, one has much more freedom than with conventional manufacturing methods. It also saves material and therefore weight. Currently, however, there are not many aluminium alloys that are suitable for additive manufacturing. This is why we now want to make a high-performance alloy that is suitable for 3D printing. We have submitted an application for a research project to the German Federal Ministry for Research and Development, together with the HZG, the Laser Centre North and the TÜV North. In the project, planned for a two-year period, we want to optimise several alloys for 3D printing as well as compare different laser processes. In the end, we should have created new aluminium powders that are already approved by the TÜV. The initial tests have already provided excellent results. This is why we are optimistic that this joint project will also be a success.

www.tuhh.de/zhm



We now want to make a high-performance alloy that is suitable for 3D printing. That is why my company has formed a strategic alliance with the Helmholtz-Zentrum Geesthacht.

The interview was conducted by science journalist and physicist Frank Grotelüschen in the manufacturing hall of Henning Fehrmann in Hamburg.

The gold expert

About high-performance materials and love of her motherland

Dr. Nadiia Mameka

is conducting research in the field of hybrid material systems at the Institute of Materials Research

Born in Ukraine, this scientist had never planned to move abroad – today she is glad that she took that step: Nadiia Mameka completed her bachelor's and master's degree in physics in Kiev. Motivated by the positive experiences of her friends and colleagues, she applied for a scholarship in Germany. Her stay at the Ruhr-University Bochum changed her life: "Since then I knew that I wanted to do my doctoral studies in Germany. Here, scientists have excellent research opportunities. Unfortunately, in my home country, the prospects for young scientists are currently limited." It was for this reason that Nadiia Mameka moved to Grünhof-Tesperhude and started her doctoral thesis at the HZG, in the Institute of Materials Research.

"I am excited about how freely and independently research can be conducted in Germany."

In the "Hybrid Material Systems" group, the scientists investigate phenomena that act on surfaces to better understand their properties. One of the research objectives is to develop intelligent materials with unique functional properties through controllable surface modification." We use nanoporous metals, as they posses an extremely large internal surface area: For instance, one gram of nanoporous gold has an internal surface area of more than ten square metres!" Nanoporous gold was the subject of Mameka's PhD. She studied how the metal's surface state can be changed electrochemically and through an electric voltage, and what effect this has on the mechanical properties." It is a kind of metal muscle: The metal can change its length, for example, through electrical signals. This process is even reversible; this means that we can completely control the material's behaviour," she says, her eyes gleaming. "In one experiment, we observed up to about ten percent change in the stiffness of the material. And that is without structural changes, only by variations of the surface state," explains the materials scientist, who earned a doctorate in 2015. Currently, it is still fundamental research, but at some point, these structures can be integrated as sensor elements in various devices.

"Luckily, I was offered a post-doctorate position at the HZG – when I saw the results of my research, I really wanted to continue working on the subject," says Mameka. "It is an indescribable feeling to observe something that no one has seen before and that no one yet understands. At first, it seems like magic, although we know that there must be logic behind it. It really motivates me.

The next step consists of developing new approaches towards surface modification in these materials. For example, right now we are working on combining the nanoporous metals with electrically conductive polymers to discover new functions."

Her next main goal is to propose her own research project. She was particularly inspired by the 2017 Nobel Laureate Meeting in Lindau, in which she participated as a young scientist. There young researchers meet renowned scientists, Nobel Prize winners. "People from different countries and cultures took part – it was a great honour for me to have been selected among the many applicants all over the word. It shows that our research has been recognised in the scientific community." Through discussions with leading as well as emerging researchers, she learned a simple but important truth:

"A key to success is to love what you do and work hard for it. They told me I should fight for my dream, and that is what I will do."

As well as all the work, experiments, conferences and publications, there is also a counterweight for her; work-life-balance is not just a theoretical construct for Nadiia Mameka. She especially needs a physical counterweight; she likes hiking, cycling and going to the fitness studio. "When I am surrounded by nature, I can switch off properly" – that was the main reason for living in Geesthacht Grünhof instead of moving to Hamburg.

Through the international environment in which she researches, the physicist has become acquainted with many cultures over the years and built many friendships. She likes travelling and enjoys cooking and baking, especially Ukrainian dishes. Her favourite dish is borscht, the well-known soup with meat, beetroot and other vegetables.

"Baking is a bit like materials science – mixing various ingredients together and achieving a completely different product at the end."

The 31-year-old hopes that her home country, Ukraine, will overcome its political and economic problems: "Then we could return and give back to the country what we have received. Later, I would like to teach at a university and pass on my knowledge and encourage young people. Investing in one's own country is the best one can do."

Author: Gesa Seidel (HZG)

“Swamped” in Bleckede: GERICS scientists flood city

After heavy rains in May 2017, the Bleckede Fire Department pumped out cellars and subterranean parking garages. The drains were opened in order to make the streets accessible again.

Global warming of up to two degrees Celsius will change natural spaces, economic sectors and living environments in Germany. For example, the book "Klimawandel in Deutschland", published by the Climate Service Center Germany (GERICS), points out that heavy rainfall has increased during the winter months. The amount of rain is pushing the urban drainage infrastructure to its limits.

GERICS scientist Dr. Markus Groth provides advice on climate-adapted municipal development so that cities and communities don't increasingly find themselves "swamped". He turns to the GERICS-adaptation toolkit for cities for his work (see information box). This modular system is based on the current state of research knowledge and can be used flexibly while remaining focused on a specific city.

Bleckede, a city on the Elbe, is one of the first cities to be counselled by GERICS specialists on the topic of "water in the city". Jens Böther, the mayor of this community, comprised of approximately ten thousand inhabitants in the Elbtalaue in Lower Saxony, speaks with Markus Groth about the results.

Climate change, with is impacts for the environment, economic sectors and society, presents various challenges for cities and communities in Germany. What challenges does Bleckede face?

Jens Böther: Climate change impacts affect us in different areas. On the one hand, we are located directly on the Elbe, where we have experienced floods in 2002, 2006, 2011 and 2013, which have triggered disaster alarm here in the region. We have built new dykes between 2007 and 2014 in answer to this situation. We didn't have these floods before this for decades. It's clear to us that something has changed. Heavy rainfall has also become a topic. There were two heavy rain events in 2016 and three already in 2017 with overloaded sewage systems together with flooded cellars and streets.

Markus Groth: There are regional climate projections for the Elbtalaue which show that summers are becoming dryer and that fall, winter and spring will see rather more precipitation. The total amount of precipitation remains about the same in terms of the yearly average. We cannot make clear statements on future changes in frequency and intensity of heavy rain events. Initial observations and calculations show, nevertheless, that the amount of precipitation is increasing during heavy summer rainfall. This is expected to lead to an increased risk of damage from heavy rains.

What exactly happens during such a severe rain event and how has this been dealt with so far?

Jens Böther: We had two focus areas: the "Industriestraße" and the "Nindorfer Moorweg" both in the city centre. That is the drainage axis for the small Bruchwetter Creek. The roads were flooded, the fire brigade was on its way and the cellars pumped out. The water wasn't retreating. In part, the pipes were completely filled with sediments because, for example, the top soil was swept away and wound up in our rainwater drainage system. We're now looking closely at this issue because, in the last few decades, infrastructures were created here that no longer drain the current amount of rainwater.

Jens Böther (left-hand side) – has been mayor of Bleckede since 2006. He holds a degree in public administration as well as in computer business management. Prior to his election as mayor, he served the District of Lüneburg in a managerial capacity. Jens Böther is a member of the CDU.

Dr. Markus Groth (right-hand side) – is a scientific staff member in the GERICS department for "Climate Impacts and Economics". He has been teaching sustainability economics at Leuphana University Lüneburg since October 2014. Groth studied economics at the University of Hanover and earned his doctorate at the University of Göttingen.

Good cooperation despite different preferences: HSV fan Jens Böther does not mind if Markus Groth prefers to drink from his Pauli cup.

Mr. Böther, why are you having the run-off behaviour, in particular, investigated by GERICS

Jens Böther: Floods on the Elbe have been closely studied in detail and we know how to deal with them. We still have very little experience with heavy rain events. We needed to flush the rainwater inlets and pipes during such events, which had become clogged with grass and sand. This costs the city of Bleckede a great deal of money, quickly amounting to a five digit sum. We now not only want to work on the symptoms, but we also want to get a handle on the causes. What leads to overloaded drains? What concerns us in Bleckede is sensitive urban development in regard to water.

Mr. Groth, how did you proceed in a scientific sense? How was the GERICS adaptation toolkit for cities put to use?

Markus Groth: On the one hand, we surveyed six hundred inhabitants in the affected urban areas as well as evaluated the volunteer fire brigade's field data. This is how we obtained a good data set on the damaging events, but we also uncovered how well-informed the citizens are and what measures have already been taken. These include, for example, constructing drainage systems, securing the water entryways or buoyancy protection for oil heating.

Were there methodological challenges in the investigation?

Markus Groth: With our partner, Tauw GmbH, we also modelled a severe rain event. We ran the simulations where we "drowned" Bleckede with the equivalent of sixty litres of water per square metre and observed what happened: Where does the water accumulate? Where can it run off? The approach in this model is standard. What was new, however, was that a very flat area was simulated and evaluated with a survey of historical events. The model has an accuracy of 1x1 metre.

Jens Böther: What impressed me was how closely the results reflect our experiences. This described our precise problem: these were the areas where we had experienced floods in recent years.

The GERICS adaptation toolkit for cities:
Planning that serves climate change – individually-tailored advice for cities

In various consulting modules, interdisciplinary solutions are developed for specific urban challenges. Processing takes place in cooperation with the city and is always case-related, as there are no cure-all solutions for adapting to climate change consequences. The modules, for example, cover city-specific climate information; urban green spaces; economics and financing; city planning that is adapted to climate; quality of life and residential environment; and water in the city.

The map of Bleckede shows the simulation of a heavy rain event. The areas in blue and red depict the areas that would be flooded.

We must act quickly through adaptation measures to keep regional climate impacts to the barest minimum. What measures does GERICS suggest?

Markus Groth: Buildings, which rapidly fill with water, obviously can't be moved, but there are numerous technical flood protective measures. We are therefore investigating what would be realistic. On the one hand, this can mean the intensivation of maintenance of the Bruchwetter Creek and other possible drainage pathways so that the ditches don't become overgrown with vegetation. On the other hand, the expected run-off behaviour can already be taken into account in new construction sites even before the planning phase.

Jens Böther: In some areas, we need to look at the pipe cross-sections and check if they perhaps need to be replaced. The insights are also helpful in future planning. Maybe an additional rainwater retention basin must be integrated into the plans for new development areas. This can clearly be seen in the simulation. In another area we might need to think about diverting the rain water first to a field rather than straight into the Bruchwetter Creek. In such cases, we would engage a hydraulic engineer who could draw up a concept for us on how to handle the issue in the future.

Mr. Groth, what further recommendations does the GERICS adaptation toolkit for cities provide?

Markus Groth: We recommend that the residents in such areas be provided with better information on severe rain events. Citizens should be informed, for example, on what property owners can do to be well-prepared should flooding occur due to severe rain events. This can be achieved through discussions, but informational material should also be produced.

Jens Böther: Building ordinances state that rainwater has to infiltrate onto the property itself. The circumstances are often different, which is completely normal. Sometimes the water simply seeps into the garden; on other properties, the rainwater, for example, flows via the driveway. In this case, you can educate the residents so that they look after their drainage systems or gutters. One way to appeal to citizens would be to say that their personal protection from heavy rains is not only the city's responsibility but is also a responsibility of those on private property.

Thank you very much for the interview.

The interview was conducted by Heidrun Hillen (HZG).

www.gerics.de/stadtbaukasten

Climate change: future simulation for the Baltic sea

Offshore wind parks, cruise ships, ferries – there's a lot going on in the Baltic Sea. In order to use these tools in the most economically efficient way, the operators need to be able to plan ahead. Scientific knowledge on the waves and on what is known as the sea state is helpful in this context

If wind park operators want to erect new installations or conduct maintenance measures, they must know beforehand at what time the sea state will be low enough for them to proceed. A similar principle applies to shipyards: if a new ship is to be built for given routes, it is useful to know which sea state can be expected on those routes and which extreme sea state the ship must face. For coastal protection, such data is essential: in Schleswig-Holstein, for example, the dikes will be heightened because the sea level is rising, and storm surges will become more frequent.

The data that serves as the planning basis comes from scientists. One such scientist is Dr Nikolaus Groll, a climatologist in the Institute for Coastal Research at the HZG. In the Coastal Climate Department, his work focuses mainly on the sea state in the North Sea and the Baltic Sea.

Together with colleagues, Groll has conducted simulations representing the future sea state of the Baltic Sea (http://www.borenv.net/BER/pdfs/ber22/ber22-001-012-Groll.pdf). The result shows that in the mean, the sea state of the Baltic Sea will increase by five to ten percent by the year 2100, which means that the wave height will increase. Higher waves can, for example, influence sediment transport and cause coastal erosion.

www.borenv.net/BER/pdfs/ber22/ber22-001-012-Groll.pdf

How do the scientists proceed with these simulations?

To be able to evaluate possible future developments of the sea state, the scientists start by looking at the past. For this task, they use what is known as reanalyses. This means that real weather data is transformed into numerical models. Then they verify whether the data calculated with the model corresponds to the real observations. If the chosen model represents the past sufficiently well, it can also be used for the future after slight adjustments.

Initially, global reanalyses are performed with numerical models. They have a low resolution and calculate the global climate. To achieve a higher resolution, regional models are driven by the results of the global models. If a simulation with a regional atmosphere model becomes available for the North and the Baltic Seas, Nikolaus Groll can extract the wind data. The wind is the decisive factor for creating waves, which is why Groll is especially interested in this data.

Calculations for future climate are, for example, based on emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC). These calculations drive global climate models, which are then used in turn for regional models.

How is the sea state calculated?

The wind data from the regional models is used as input for the wave model (WAM). Groll and his colleagues simulate the wave climate with different combinations of emission scenarios and initial conditions. The subsequent model calculations are performed by the supercomputer at the German Climate Computing Centre (DKRZ) in Hamburg. The simulations that Groll creates have a resolution of 3 x 3 nautical miles, which means approximately 5.5 x 5.5 kilometres. To calculate one month in his model, the computers require about half an hour.

These models are not only used for long time scales, but also for daily forecasts. This is why they are continually edited, improved and refined – this is the only way of creating better forecasts.

COP23 Climate Conference: A Noticeable Sense of Optimism

Experts at the Climate Service Center Germany (GERICS) in Hamburg closely followed events with interest at the climate summit in Bonn, which took place from the 6th to the 17th of November 2017. Some scientists were even in Bonn for the meeting. You can read their summit assessments here. Prof. Dr. Daniela Jacob found the result positive: "The determination of all participants at the global climate summit to join forces in reducing global warming as much as possible has shaped the mood."

Prof. Dr. Daniela Jacob

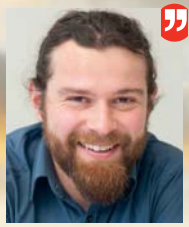
GERICS director and coordinating lead author of the next Special Report by the Intergovernmental Panel on Climate Change:
"Cities in particular—not exclusively governments now—are increasingly driving efforts to reduce global warming. Many states demonstrated a profound desire to cooperate, which deeply impressed me as, for example, the commitment of individual US states as well as companies."

Dr. Markus Groth

environmental economist and scientist at GERICS:
"Since COP23, at the latest, global withdrawal from coal-based energy has become unstoppable. This is important as well as the right thing to do because coal is harmful to human health and the main driver of climate change."

Katja Lamich

political scientist and researcher at GERICS:
"Evaluating adaptation measures will be a challenge – but it is essential to the success of global efforts."

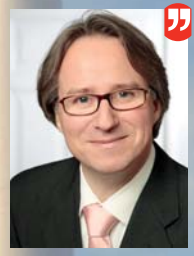


Dr. Andreas Hänsler

head of the Climate Systems Department at GERICS:
"African countries are placing local adaptation measures into the foreground to mitigate the negative consequences of climate change. They are pushing for industrialised nations to make and adhere to financial commitments as well as to promote technology transfer."

Dr. Diana Rechid

geographer, studies physical processes in the climate system and has worked as a researcher at GERICS since 2014:
"In addition to transforming energy systems, we need an agricultural transformation to halt global hunger while at the same time decreasing greenhouse gases. Numerous positive examples already exist in terms of such 'climate-intelligent agriculture.'



Dr. Peer Seipold

works at the interface between science and the economy at GERICS:
"Companies demand concrete steps and effective measures for meeting the German emissions targets by 2020. The economic sector sees itself as an important pillar in financing adaptation strategies. In order to fulfil its role, it needs clear regulations that provide planning and investment security." (Foundation 2°, World Bank, World Economic Forum, ICC)

Tania Guillén Bolaños

studies climate policy-related topics at GERICS:
"A substantial step in the COP political negotiations was the start of the development of a regulation framework ("rule book") for implementing the Paris Agreement. This set of rules, which will be adopted at COP24 in a year, is to ensure implementation of the Paris Agreement. This means not only fulfilling the limits on warming, but also adapting to the unavoidable consequences of climate change."

Apl.-Prof. Dr. Steffen Bender

heads the Department of Climate Impacts and Economics at GERICS:
"Cities are the predominant drivers of climate change. Municipal planning and development play a decisive role in further promoting climate mitigation measures. This especially applies to those uncontrolled and rapidly increasing megacities in Asia and Africa. In order to promote sustainable development, particularly in those regions, establishing an oversight institution would be viewed favourably."

www.gerics.de

A flying research platform – a zeppelin on its way to the Elbe River and the Wadden Sea

Ships, drones and zeppelins: at the end of September, scientists from the Helmholtz-Zentrum Geesthacht (HZG) and the Alfred Wegener Institute (AWI) in Bremerhaven, as well as from the Helmholtz Centre for Environmental Research (UFZ) in Leipzig undertook a joint four-day expedition led by HZG. Their destination was the Wadden Sea and Helgoland, including up the Elbe to Wittenberg.

First, they wanted to extensively study all the processes that cause the complex interactions between ocean, coasts, land and atmosphere. The effect of offshore wind power plants on the ocean currents in the North Sea was also investigated.

The expedition was made possible by a new Helmholtz Association project. The initiative, with a planned duration of fifteen years, is called MOSES: “Modular Observation Solutions for Earth Systems”. Twenty-eight million euros in total are available to the participating research centres for the development and operation of MOSES. More than twenty researchers are participating in this first expedition within the framework of the MOSES project.

In the Wadden Sea mudflats, the scientists from various Helmholtz centres have, for example, been measuring the tidal channels and seaweed inventory for a long time. They are investigating the interaction between nutrients and oxygen in the Elbe and are taking water samples or evaluating satellite data. Their knowledge of currents, waves and turbulence in the water make it possible, for example, to recognise vulnerable areas and efficiently plan and implement appropriate coastal protection measures.

Dynamic and long-term observations can now be directly linked to each other for the first time with the new mobile and modular MOSES concept. The focus is thereby how the ocean, coasts, land and atmosphere affect each other.

Meeting point at the Elbe Philharmonic Hall: the HZG research ship and the zeppelin met at Hamburg Harbour during the campaign.

That's why I chose science

Alexandra Amherd Hidalgo,
(PhD, Materials Research)

I consider that science is a synonym of future. If we look to the past, I can clearly see all the progress that science has done and how this fact changed our way of living. Me as a scientist, I believe that innovation, motivation, and efforts of every person in the scientific community can contribute to a better world development, and this is my driving force.

PD Dr. Ulrich Handge,
(Head of Department PMM, Institute of Polymer Research)

A central task of a scientist is to obtain new knowledge through theoretical models or experimental methods. The scientist thereby strives to create or complete models for a physical phenomenon, for example, or for a chemical reaction mechanism or other processes in nature. The scientist thus makes scientific or technical progress that eventually serves the entire population. In research, one is permanently developing new questions and paths to solutions. This is an extremely exciting task, and it is what motivates me to work in research.

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Warming and sea level rise are already a reality

What do we know about climate, climate change and it effects in Hamburg and Northern Germany?

The KlimaCampus Hamburg's 2nd Hamburg Climate Report summarises the current state of science.
View online: :

https://link.springer.com/book/10.1007/978-3-662-55379-4

Tip:
Different climate change scenarios for northern Germany are depicted on the interactive map produced by the Norddeutsches Küsten- und Klimabüro:

www.norddeutscher-klimaatlas.de