HELMHOLTZ-ZENTRUM GEESTHACHT

People with Ideas

in2science

Team Magazine

#3

Helmholtz-Zentrum Geesthacht

Centre for Materials and Coastal Research

ZHM

Zentrum für Hochleistungsmaterialien

TUHH
Technische Universität Hamburg

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

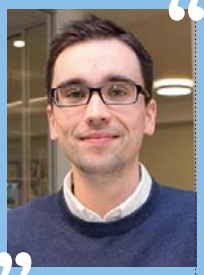
Structured doctoral education for materials scientists at the Helmholtz-Zentrum Geesthacht

This year marks the opening of the "Graduate School for Materials Science" dedicated to scientists in the field of materials research in Hamburg and Schleswig-Holstein. Overseeing the graduate school is the Centre for High Performance Materials. The centre was initiated a year ago as a joint establishment of the Technical University Hamburg (TUHH) and the Helmholtz-Zentrum Geesthacht (HZG).

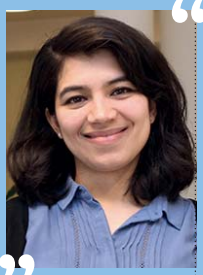
What is so fascinating about a doctoral degree in materials research?

We asked some of the first graduating students at the inauguration of the graduate school.

Natascha Zocoller Borba: I think it will be successful to try to mix these two knowledges: their applications and also the science behind this application. And this is, why I'm in materials science in my graduation.



Martin Reimann: What is fascinating in materials research is developing new things. Also, analysing new developments or understanding things that were incomprehensible before. What is particularly interesting here is that we develop things that could be used in the future in the aerospace or automotive industries.

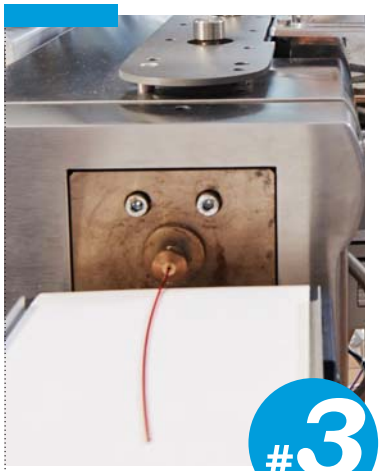


Anissa Bouali: It was very fascinating and very interesting for me. I know that there is a lot of excitement inside and a lot to develop. So I want to be part of it.

Johannes Schaper: Well, materials research fascinated me even during my undergraduate studies. You need to understand materials in detail in order to make them useable in different applications. That is exciting. When my department head had asked me, after I finished my master's degree, if I had any desire to undertake doctoral studies on the topic of "Magnesium for Implants", I immediately jumped at the chance.

At the Centre

Kathrin Sentker: The exciting thing about materials research for me is actually developing new materials. And in my doctoral work dealing with photovoltaics, I have the chance to research materials in the field of renewable energy. A terrific and meaningful challenge.



Editorial

Dear Colleagues,

In this edition, we visit the molecular cooks in polymer research.
Here in the Geesthacht polymer cooking studio,
it's less about a matter of taste.
The scientists are instead seeking the perfect membrane material
for various material separation applications.

We include many more tasty recipes for interesting stories provided by colleagues at the centre. The directors of the Institute of Coastal Research, for example, tell us about the work at their institutes during the "Year of Seas and Oceans".

We introduce the acting institute director Martin Müller and the hydrogen researcher Anna-Lisa Chaudhary in our Portrait section. While Martin Müller maintains his perspective at the macro and micro levels, Anna-Lisa Chaudhary investigates hydrogen storage materials at 2000 bar.

The new year invites us to look back and provides us a preview of what's to come: Dr Herbert Zeisel, Chair of our Supervisory Board, talks with *In2science* about what we have achieved at the centre as well as how he sees our future.

We hope you enjoy reading this issue and we look forward to receiving your feedback. Feel free to get in touch!
Your Editorial Team / In2science@hzg.de

Photo Feature

New Recipes

In the Geesthacht Cooking Studio: The Perfect Polymer

Mix, stir, heat: The fifty or so members of the Institute of Polymer Research at the Geesthacht site cook and try out new recipes. The common goal is to develop the perfect polymer for various applications in materials separation. With their tailor-made membrane materials, they have already managed to remove carbon dioxide from combustion exhaust gases and filter pollutants from water bodies.

In the Kitchen

The molecular cooks

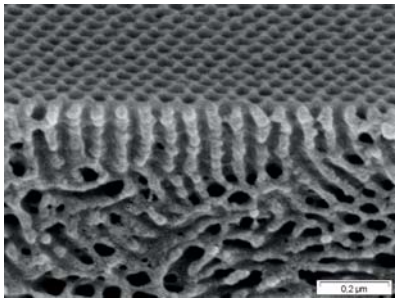
Sometimes they themselves cook and sometimes they turn to ready-meals: The polymer researchers develop new polymers in the reactor vessel using their own recipes of various monomers and additional ingredients. But they also use ready-made, commercial polymer pellets. Those will be refined and further processed using various methods.

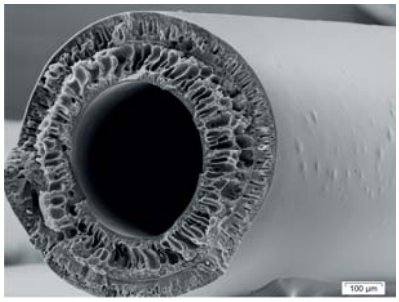
Product Tester:

Hard or soft – brittle or stiff

Small quantities of the new membrane material are tested in the laboratory. The researchers use highly varying methods – for example, tension and compression tests. What properties do the new materials possess?

In Detail





Looking beyond your own plate

Using various electron microscopes as well as an atomic force microscope, the structure and even the chemical composition of the new materials can be studied in minute detail. (Images on the left side)

Stretching Membranes

A scientist produces an initial membrane at a small testing facility. He applies a small portion of the fluid material onto a carrier layer (white). After precipitation in the water bath, a thin layer remains as a skin on the carrier layer.

Test Portion

FROM THE POLYMER RESEARCHERS' COOKBOOK:

"Formation of high thermally stable isoporous integral asymmetric block copolymer membranes"

published in the European Polymer Journal 2016, 85, 72-81,

dx.doi.org/10.1016/j.eurpolymj.2016.10.014

The work on membranes for ultrafiltration at the Institute of Polymer Research opens up new application potential for block copolymer membranes (BCP membranes):
In suitable conditions, isoporous integrally asymmetric BCP membranes can be produced in only one step through self-assembly of the block copolymer molecules. The researchers led by Prof Volker Abetz recently succeeded in producing a BCP membrane that is considerably more thermostable than all BCP membranes with the same structure thus far created. By choosing a matrix-forming block with a higher glass transition temperature and determining the necessary conditions for self-organisation, a BCP membrane was formed, which is stable up to 150 degrees Celsius. An application, for example, would be in the food industry because steam sterilisation of these membranes would be possible.

Pilot Plant

More polymers – more membranes

What works on a small scale is repeated on a large scale. The scientists produce metre-long membranes for their industrial membrane modules. These are cut up to produce membrane modules (image on the right). The modules undergo numerous tests and are used in specially developed pilot plants to, for example, remove carbon dioxide from flue gases.

Contents

Investing in the Future –

Interview with the Chair of the Supervisory Board Dr Herbert Zeisel:

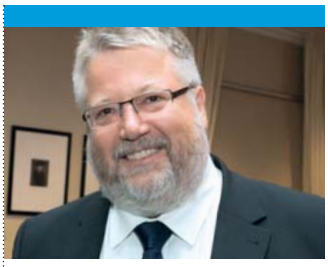
The HZG takes on an important role in not only monitoring this living environment and its changes but also in developing concepts for its future use and development.

Mr Zeisel, the slogan of our annual meeting this year was "For our life and habitat of tomorrow". What does this phrase mean to you in connection to the HZG?

The motto very clearly expresses the close connection between us and our surroundings and what interactions and dependencies exist in both directions – even if we're not always immediately aware of them. Our well-being as individuals is frequently portrayed as existing in conflict with environmental protection. The field of coastal studies as a research focus at the HZG, however, is an example of a holistic approach. The coastal regions will continue to be the most vital living environment in the world for human beings. The expected population growth by the year 2050 is expected to reach nine billion and the increase will only intensify this trend. The HZG takes on an important role in not only monitoring these living environments and their changes but also in developing concepts for future use and development. The strength of the HZG thereby certainly lies in the systemic consideration of this research topic.

We want to be prepared for the future with our new buildings. You said this money was well spent when speaking at the topping-out ceremony for the Coastal Competence Center in May 2015. Why?

In order to carry out top-notch research, particularly in scientific fields, we must provide a suitable working environment and the necessary infrastructure for excellent scientists on site that enables them to work and publish according to world-class standards. The federal government and the states have managed to pave the way in Geesthacht for an excellent infrastructure in the field of coastal research with the Coastal Competence Center (C3). By erecting modern laboratories and offices along with creating conference opportunities, the efficacy of research at the HZG increases and thereby the visibility of the centre as a whole. The C3 thereby contributes to the profile of the HZG and makes Geesthacht an attractive venue for scientists from all over the world in the field of marine and coastal research.



ABOUT

Dr Herbert Zeisel

has been the Chair of the Supervisory Board and the General Assembly of the HZG since June of 2015. Dr Zeisel studied chemical engineering at the University of Erlangen and earned his doctorate in the field of fluid dynamics.
As a member of the Supervisory Board, he has been representing the Federal Ministry of Education and Research since 2010 as representative for materials research.

The HZG has always succeeded in linking excellent basic research with applications and concrete societal uses.

In your view, what is the HZG's national and international standing?

As you know, the HZG is not one of the largest Helmholtz centres. It is, nevertheless, very well-respected both nationally and internationally and is perceived as such. The clear profile of the HZG with its two main fields of research, materials science as well as coastal research, certainly contributes to this reputation. In addition, the science-based performance indicators for research facilities such as the quantity and quality of publications, number of doctoral students, patents or international cooperation – to name but a few – speak clearly on our behalf. The HZG has been very successful especially in the highly competitive "external funding" market for years, both in Germany as well as in Europe. In many fields, it can also certainly compete with considerably larger research facilities. In doing so, the HZG has always succeeded in linking excellent basic research with applications and concrete societal uses – I can name GERICS here as an example. In addition, "output" in matters of upscaling and technology transfer to the industrially-relevant scale hits the mark, a field in which the HZG is very successful with test and pilot systems for new membrane technologies and works very closely with industry partners.

Where do you see the Helmholtz-Zentrum Geesthacht in ten – and twenty years?

It is always dangerous to rest on one's laurels from the past and to concentrate too heavily on the status quo. Science is always continuing to develop. This applies to both gaining knowledge as well as the manner in which science is carried out. Based on the recommendations of the Scientific Council, a process for further developing the HGF, which also comprises the research area of "key technologies", is currently taking place. The trend toward science digitalisation will play a vital role in this process and how we want to deal with information technologies and "big data" at the HGF. This also affects, of course, the future of materials research. In addition to the individual challenge facing each scientist and his or her field of study, a challenge also exists for the research location. How can we tune in to current trends as early as possible and possibly take them further – for example, in anticipating the biologisation of the industry and then react strategically?

The development of novel technologies, the changing requirement profiles for emerging scientists or changing societal needs must lead again and again to the adaptation and reorientation of the research strategy, without giving up the core competences and the profile of the HZG. Therefore, methods such as the "foresight process", which the HZG undertook in the field of materials research, are vital. I am convinced that the HZG with its competences will continue to play an important role in the scientific landscape of Germany and Europe, even if there are other issues in ten or twenty years and other scientific methods than today.

The "Clockwork Ocean Expedition" took place this year. In addition to the astounding scientific insights, the expedition was a media success. The expedition generated 154 million media contacts. How important is the public for science?

Public relations work today is very important to science's social impact. Science itself has a duty to communicate its research results as well as its societal utility to the public. This is especially the case if the research is largely financed by the public. This communication is thereby not to exist as a one-way street: the critical discourse between science and the broader public is important too. And scientists are, after all, members of the society.

I'm delighted that the Expedition Clockwork Ocean was a great success – not only because of the scientific results – and it was thanks to the outstanding work by the HZG Press Office that generated broad public interest in marine research.

Our employee publication In2science is a magazine that would like to introduce the people behind the science. Is there something that you would like to share with the centre's staff?

Good research – especially in the large HZG research focus areas – needs good infrastructure. Without the necessary laboratories and instruments it's impossible. But decisive in the success of a research establishment are, in the end, the staff with their knowledge, experience and enthusiasm for the topics in which they work.

I can only say: Stay curious, stay creative and pursue your ideas! Then I'm certain that excellent research will also be undertaken in the future at the HZG.

In this sense, I offer my heartfelt thanks to all staff at the HZG for their dedication and commitment in the service of science.

Many thanks for answering our questions.

Climate change affects Germany from the North Sea to the Alps

The new book presents all available information for the first time in a comprehensive and interdisciplinary format. In addition to the contents of the Fifth IPCC Progress Report, further scientific work and case studies were included. The result is an assessment that claims to represent the state of research and classifies the various positions. One of the results was as follows: Even global warming from only 1.5 to 2 degrees Celsius will lead to changes in Germany within all natural regions, economic sectors and every area of life.

With the increasing number of warm days and heat waves as well as the increase in ground-level ozone and fine particulate concentrations, the chronically ill, the elderly and allergy sufferers will be adversely affected in the future. This threatens urban spaces and requires climate-friendly city and regional planning. Furthermore, water resources will continue to vary as a result of climate change. On the one hand, increased precipitation threatens flooding while, on the other hand, periods of drought affect the creation of groundwater and endanger waterways. The quality of agricultural and forest soil decreases, for example, due to waterlogging or desiccation.

Increased erosion will continue to reduce the amount of available productive soil. One can assume that through the expected processes in the soil, numerous feedback effects take place that will in turn affect the climate.

GERICS and the German Climate Consortium organised a parliamentary evening in Berlin for the book launch. More than sixty guests attended a discussion with experts: (from right) Daniela Jacob (GERICS), Jürgen Scheffran (University of Hamburg), Marie-Luise Beck (DKK), Guy Brasseur (Max-Planck Institute for Meteorology), Andreas Vetter (Federal Environment Agency).

"There are numerous challenges for Germany that appear to be calculable despite their diverse interactions. We, however, must act fast so that the consequences are kept to a minimum and we can use the opportunities that arise: Adaptation measures and risk mitigation must be carried out throughout all aspects of society by using, for example, revisions of the environmental impact assessment standards as a starting point.

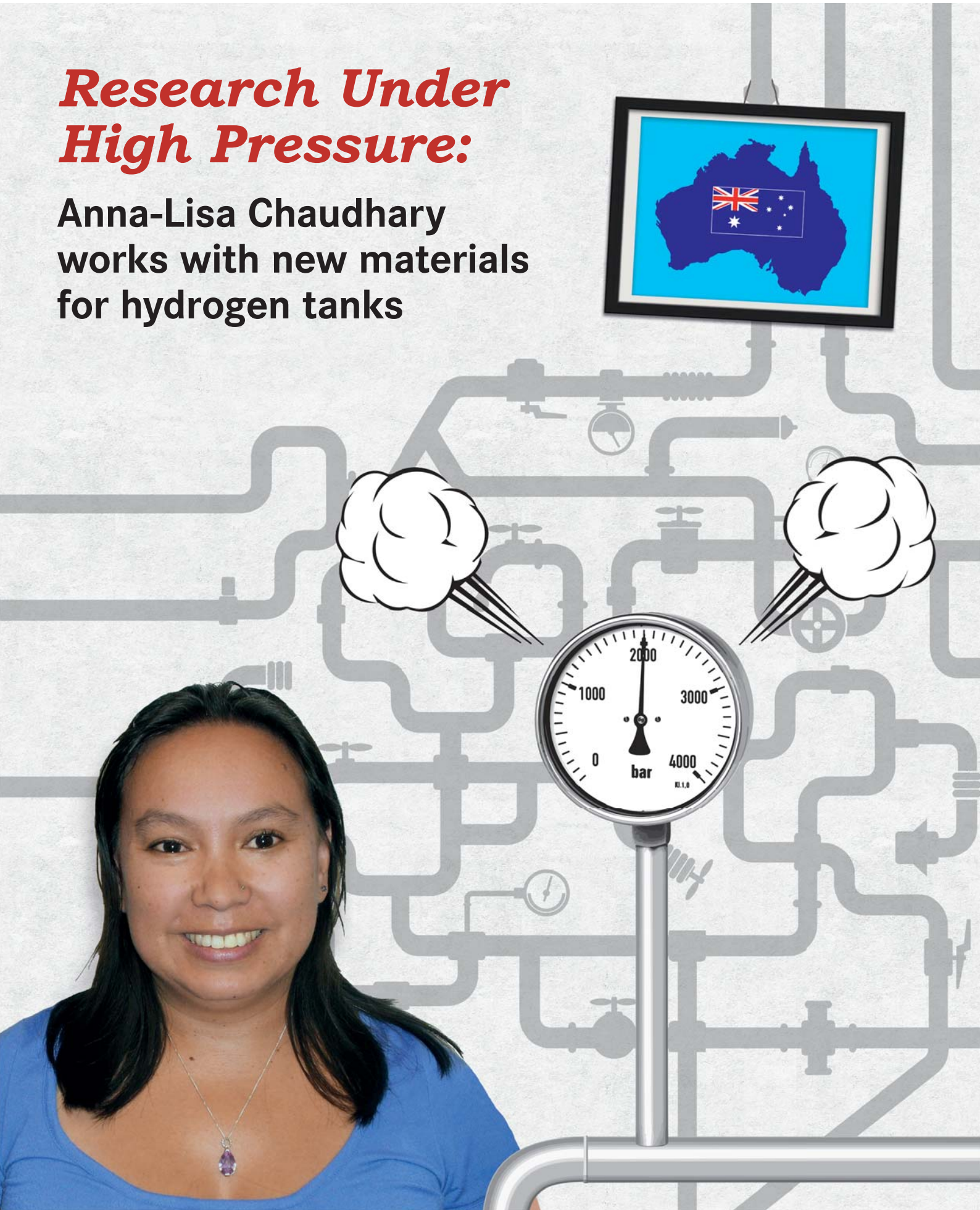
Vulnerability in the face of climate change must be incorporated into all planning projects, especially long-term infrastructural plans," explains Prof Daniela Jacob, editor of the compendium and director at the Climate Service Center Germany (GERICS), an establishment that is part of the Helmholtz-Zentrum Geesthacht. "We need integrative approaches that function beyond the borders of individual sectors." The initiator of the project and the former director of the Climate Service Center, Guy Brasseur, could design the editorial board in the most diverse manner possible. Including the most important scientists in Germany as authors guarantees a variety of topics, approaches and perspectives, that take into account the complexity of the subject. All contributions were scientifically reviewed multiple times and are open access.

New Book: (german only)
Klimawandel in Deutschland
Entwicklung, Folgen, Risiken und Perspektiven 2017, € 53,49 (D) ISBN 978-3-662-50396-6.
Free ebook available - Open Access.

About the Editors: Former director Prof Guy Brasseur and current director Prof Daniela Jacob of the Climate Service Center Germany (GERICS), as well as Susanne Schuck-Zöller were supported in creating this book by an editorial board of eleven outstanding scientists stemming from the most vital climate research establishments in Germany. In addition, 120 further authors from the most varying fields have contributed to this book, which was published in German.

Research Under High Pressure:

Anna-Lisa Chaudhary works with new materials for hydrogen tanks



Anna-Lisa Chaudhary

works on new materials for hydrogen tanks

The experimental setup is brand-new: a wardrobe-sized metal frame with many pipes, valves and pressure indicators. Visibly excited, Ann-Lisa Chaudhary goes through the core components: a compressor presses hydrogen gas to 2000 bar. A system consisting of pipes and valves regulates and distributes the hydrogen. Then there is as a small, bulky metal cylinder that can withstand high pressures and temperatures. "That is the sample chamber," the materials researcher says. "We use it to measure to what extent certain nanomaterials are suitable for storing hydrogen."

Many experts consider hydrogen a crucial component in the energy revolution. It helps store solar and wind energy so that it can also be supplied during night-time hours and during calm weather. In addition, fuel cell automobiles can be driven free of emissions if using hydrogen – and with a considerably higher cruising range than with battery-operated vehicles. There is, however, a need to do more research and development: the tanks for hydrogen cars are currently still too clunky and large. At the HZG's Institute of Materials Research, Ann-Lisa Chaudhary works on an alternative to the conventional pressure tanks — nanomaterials that store hydrogen by chemically binding to it.

"It may sound surprising, but in principle, much more hydrogen can be accommodated in a solid body than in a pressure tank," Chaudhary points out. She had already begun her work in her homeland of Australia. "I was fascinated by environmental topics even as a kid," the 39-year-old reminisces. Her father is British and her mother comes from the Philippines. She initially studied chemical engineering, after which she completed her doctorate in physics at Curtin University in Perth where she began her hydrogen storage research. She received a job offer from Geesthacht even before she completed her dissertation. She secured a position as a post-doctoral researcher and she had a concrete goal: the expert was to study materials that could bind hydrogen at high pressures – a very promising class of materials.

Chaudhary didn't need to mull it over for long. "Germany is clearly investing more in developing renewable energy than the coal country of Australia," she says. "The research possibilities in Geesthacht are fantastic." In 2013, she packed up her two kids, who were four and five at the time. "Initially I had some reservations because the schools are entirely in German here," the researcher says. "But within a few months, my children adjusted and now they speak better German than English."

Chaudhary was already familiar with Germany before accepting the position at the HZG as she'd visited her friends here several times. "That was always in winter though, so perhaps I had a somewhat skewed picture," she says, smiling. Since then, however, she's become acquainted with the country's sunnier side too.

"I really like it – especially the educational and healthcare systems – and of course, the working conditions."

The team she works with is international and mainly communicates in English. "Sometimes I wish German was spoken more often," the scientist points out. "Then I'd have more of an opportunity to practice the difficult grammar."

She began her work on the high-pressure experiment back in 2013 and the facility has been finished since May 2016. It is located in a building specially designed for hydrogen storage experiments. "My experimental set-up is unique worldwide," says Chaudhary, not without pride. Her team is still tweaking the software, but the experiments should be underway in 2017. They will then test metal hydrides based on magnesium, boron or aluminium for their suitability at pressures of up to 2000 bar and temperatures of up to 500 degrees.

The possible advantages are that, in principle, more hydrogen should be able to be stored under high pressure than in metal hydride tanks that function at normal pressure. Refuelling quickly should also be possible. The aim is to develop a hydrogen tank that can be filled just as quickly as a gasoline or diesel tank today – that is, within a few minutes.

"We're looking for a material that can store as much hydrogen as possible at high pressures and at moderate temperatures," the researcher explains. "I would love to test such a material in a tank prototype." Chaudhary's post-doc appointment runs out in July of 2017 however. "I'd really like to stay here and continue my research at the HZG," she says, smiling. "And I don't think my children would have anything against that."

Author: Frank Grotelüschen / Illustration: Maren Wilfert

At the Centre

Blind passenger – PFAS

Distribution studies of the chemical group in Europe and China

There's a gleam in Franziska Heydebreck's eyes when she talks about her research. You notice that her work on PFAS isn't just a means to an end but a matter close to her heart. You also notice that she isn't talking about her work outside of her research community for the first time. Her topic is of interest not only for the Department of Environmental Chemistry, in which she is working toward her PhD on the subject of PFAS at the HZG's Institute of Coastal Research, but also for other scientists and mainly to the public and to society.

PFAS are everywhere. Due to their properties, being water and dirt-repellent, they are mainly now used in the fluoropolymer industry – the keyword here is "Teflon". The textile industry also utilises PFAS in, for example, the production of outdoor clothing. In the meantime, the industry has developed many similar substitutes that differ in part in only one tiny detail—such as in a molecule within their structural formula – but otherwise provide the same properties as the original PFAS.

Persistent, bioaccumulative, toxic – these are words that Franziska Heydebreck will mention several times during the course of our conversation. The PFAS used in the industrial sector wind up in the environment, mainly in the water, and depending on the region of the planet, they are sometimes discharged directly from factories without pre-treatment. Because they are persistent – that is, not degradable – they remain in the environment and accumulate over time.

PFAS – The group of perfluorinated and polyfluorinated alkyl substances are what is meant by the abbreviation PFAS. These chemicals are popular in industrial production due to their properties – water-repellent, dirt-repellent – and are therefore widely used. On the other hand, PFAS are persistent, bioaccumulative and potentially toxic substances. PFAS are transported long distances and to remote regions like the Arctic or Antarctic, where they are detectable.

Franziska Heydebreck is not only interested in how the PFAS spread in this country, but also how the situation looks in China. Different environmental standards apply there today than do here with us. In order to pursue the question of what variations exist in the spread of PFAS in Europe and China, she travelled to Yantai in the spring of 2014 for a month and took samples in a textile factory on the Yangtze River.

Attaching a passive collector to estimate the pollutant content in the air of a textile factory floor.

Franziska Heydebreck studied food chemistry at the Technical University of Braunschweig. Her master's thesis, completed in the Department of Environmental Chemistry at the HZG's Institute of Coastal Research, dealt with plastic additives in sediments. She then began her doctoral studies in the same department in 2013 on the topic of per- and polyfluorinated alkyl substances.

She first learned Chinese so that she could communicate in the language of the country. This helped not only in interacting with scientists and staff at the textile factory, but also mainly in everyday life. At the local weekly market, for example, her linguistic ability enabled her to avoid the exorbitant prices demanded from tourists for vegetables and fruit.

Heydebreck was able to stay in student accommodations at the Yantai Institute of Coastal Zone Research (YIC) during her visit. The HZG has maintained scientific cooperation with the institute for many years. She particularly enjoyed the community atmosphere at the YIC. The students, for example, eat all their meals together. There is a two hour break in the afternoon and then they often work well after 8:00 PM.

Heydebreck flew back to Germany with the samples in her luggage so that she could examine them for PFAS in the Geesthacht laboratory. The result? While the samples from European rivers are already showing increased amounts of the substitute substances with similar properties, the samples from China show a high proportion of the original PFAS.

Sample drawing at Yangtze River.

Heydebreck travelled back to China again in 2016 for a research visit lasting several months. She presented her results from 2014 during her second visit at the factory where she first took samples. The staff there was very open-minded regarding the topic. Heydebreck even got the impression that the textile industry might be rethinking its approach now. The Zero Discharge of Hazardous Chemicals Roadmap was published in 2011, which envisages putting a halt to hazardous chemical emissions by 2020. Long-chain per- and polyfluorinated alkyl substances are also among these chemicals.

Author: Jessica Klepgen

At the Centre

New Magnesium Implant Project:

A Better Understanding of Decomposition

Eduardo Trindade da Silva has been working as a postdoctoral researcher since the summer of 2015 at the HZG's Institute of Materials Research in the Department of Corrosion and Surface Technology. The scientist recently received one of the esteemed Marie Sklodowska-Curie Fellowships granted by the European Union (EU). The European fellowship supports outstanding scientists at the postdoctoral stage of their careers. The awarded scientists are expected to change research institute and country.

Eduardo Trindade da Silva will therefore be undertaking research from September 2016 to August 2018 at the University of Aveiro, located near Porto, Portugal. The European Union supports his academic visit by providing 160,000 Euros. In addition to his research endeavours, Trindade will also gain experience in teaching as well as in interdisciplinary cooperation with Portuguese colleagues.

Corrosion testing of degradable magnesium implants is to be undertaken in the new MAGPLANT research project. Magnesium provides optimal properties for use as an absorbable implant material in medical applications such as orthopaedics. The material possesses characteristics similar to bone and is an essential element required by the human body. The correct degradation rate for implants - that is, corrosion - will be studied as part of the project. The aim is to investigate the corrosion of various magnesium alloys and to gain a better understanding as to how metal degrades within the body.

About: Eduardo Silva earned his bachelor's and master's degree as well as his PhD from the University Aveiro in the field of Materials Science. After a research visit to Brazil, at the University of Santa Catarina in Florianopolis, he was hired by the HZG in August 2015. In addition to his scientific work, the 30-year-old scientist will take on new responsibilities within the framework of his fellowship. The Marie Curie fellows are to involve themselves in outreach work, and Trindade da Silva plans to introduce experiments and talks at schools. Contributions on social media and other public platforms are also on his to do list.

Carbon Is Cleverly Bound with Metal

The renowned International Institute of Welding (IIW) has annually granted the most important emerging scientist award, the Henry Granjon Prize, in the area of joining technology since 1948. Materials scientist Dr Seyed Goushegir has been awarded the esteemed prize for his work at the Institute of Materials Research.

The method developed by Goushegir produces joints from carbon (CFRP) and metal. What is known as a metal-CFRP hybrid is used in modern automotive engineering for roof cladding and window pillars.

The new method used by Goushegir for binding metal and CFRP through overlapping is called Friction Spot Joining. The metal is thereby made selectively pliable through the frictional heat of a rapidly rotating sleeve. While the underlying CFRP is only melted at the surface, the overlying metal sheet becomes soft and pliable. When the rotating sleeve penetrates and retracts, a slight deformation of the CFRP occurs in the metal. The two different materials are thereby joined firmly and permanently.

The significant advantage is that the procedure is fast, economical and environmentally friendly as this technology does not require any adhesive.

About: The Iranian-born Seyed Goushegir was employed at the Helmholtz-Zentrum Geesthacht from 2011 to 2015. During this time, he completed his doctoral studies at the Technical University Hamburg. After some time as a researcher at the Technische Universität Ilmenau, he returned to the HZG in January 2017.

Working Together

Cafeteria, administration, parking lot: Intersections between coastal researchers and materials scientists at the centre are limited. At least that's what one would think. There are, however, surprising opportunities for cooperation.

Dr Martin Dornheim and Dr Götz Flöser

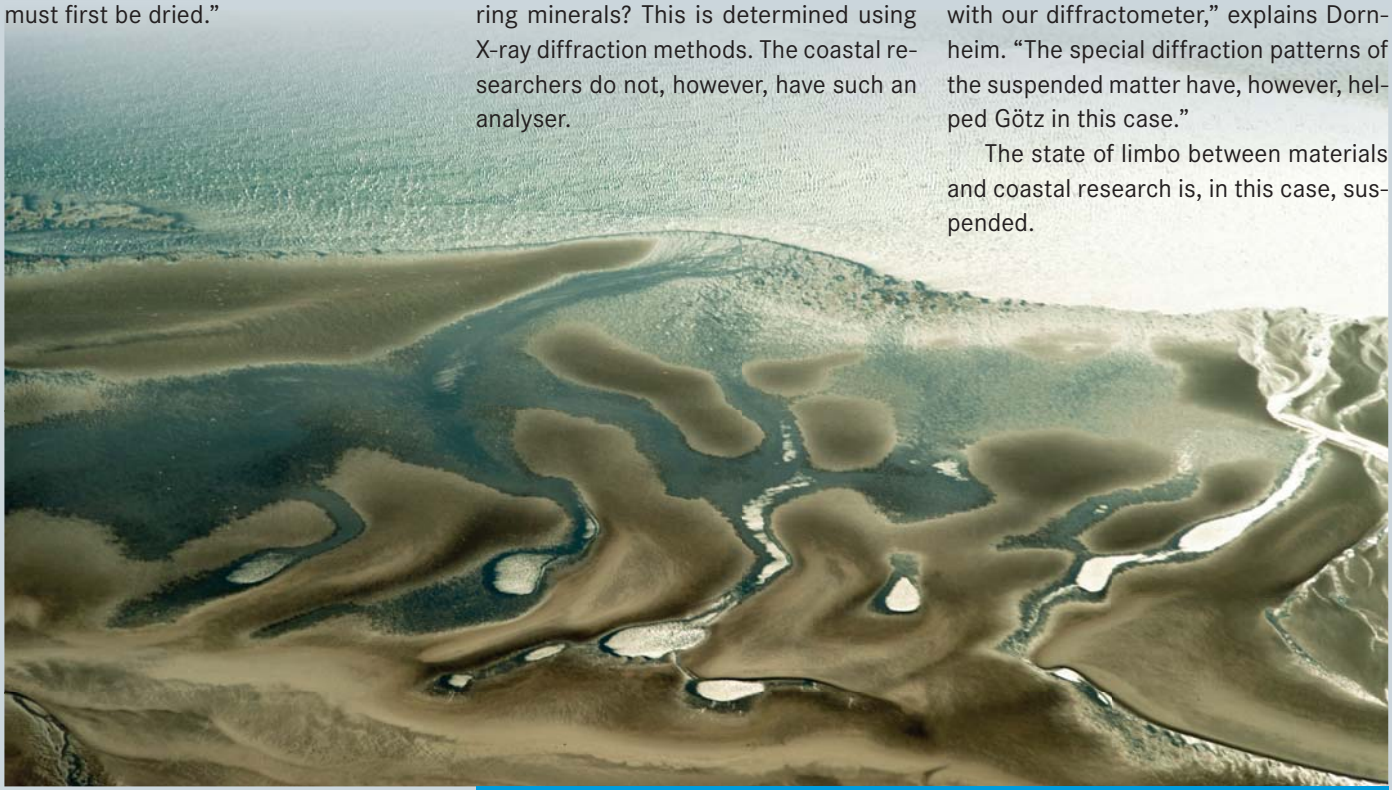
Coastal researcher Dr Götz Flöser is analysing suspended matter in water as part of his research. Suspended matter is made largely of inorganic material, such as clay minerals, but also consists of organic material, such as microalgae. The miniscule particles change the colour of the water or, when sinking, the nature of the seabed. "Analysing suspended matter provides us with information, for example, about heavy metal contamination, such as with cadmium or lead," explains Flöser of the Operational Systems Division. "Unfortunately it is very tricky to measure this. In order to do so, the miniscule particles must first be dried."

The water is filtered when measuring suspended matter concentration, and the filter is then dried and weighed. The concentration results from dividing the weight by the filtrated volume. Because the suspended matter containing minerals stores water, the results would be distorted: more mass is seemingly indicated than is actually present.

The error can be remedied with the help of a correction method, but in order to do so, the composition of the suspended matter must be known. In concrete terms: What portion of the mass of suspended matter stems from the water-storing minerals? This is determined using X-ray diffraction methods. The coastal researchers do not, however, have such an analyser.

"Then I had the idea to ask my friend who works in materials science," says Flöser. The hydrogen researcher and director of the Department of Nanotechnology, Dr Martin Dornheim, could actually help. "We normally study hydride structures with our diffractometer," explains Dornheim. "The special diffraction patterns of the suspended matter have, however, helped Götz in this case."

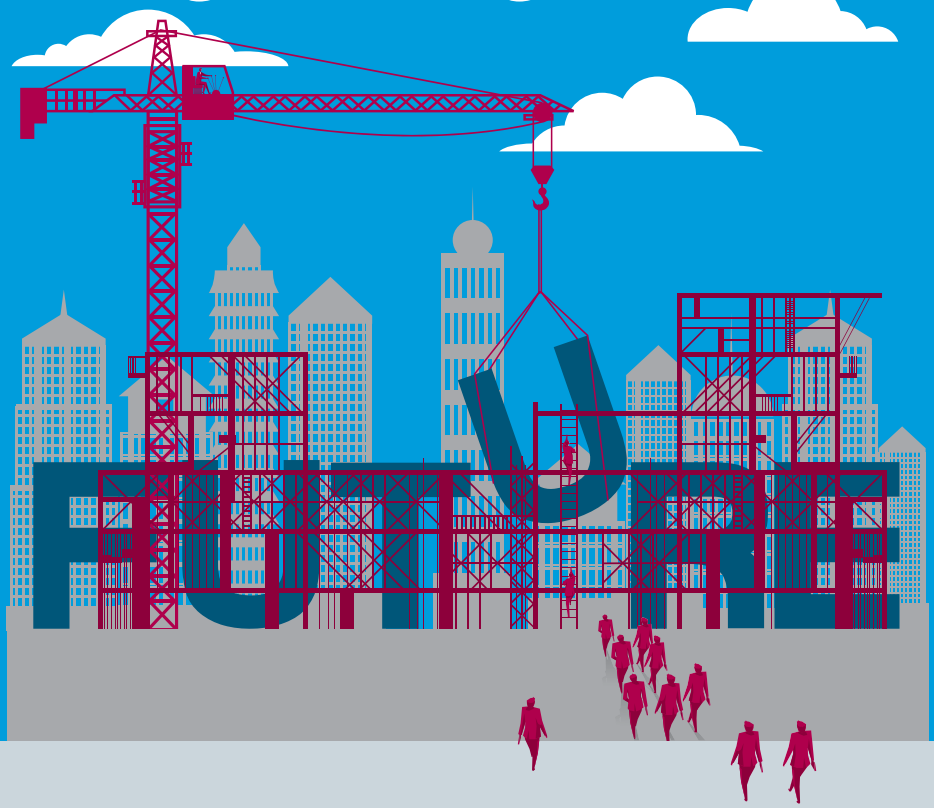
The state of limbo between materials and coastal research is, in this case, suspended.



Are you also collaborating?
In2science is interested in your story. Please get in touch at In2science@hzg.de

Our centre is growing

New research structures have been erected and are in progress in Geesthacht, Teltow and Hamburg.
In addition to the new buildings, numerous new devices and instruments have been acquired.



These structural developments have been erected or will be under construction between 2015 and 2018. These investments were largely included as part of the 2015 and 2016 basic funding budgets.

Multifunctional Polymers & Regenerative Medicine

Biomedical Technikum III: New building at the Teltow location with workspace of approximately 3300 square metres. The third stage of implementation for the Biomedical Technikum at the research centre in Teltow-Seehof was financed by the state of Brandenburg with almost ten million Euros and has now been completed after two years of construction. Supplemented by an investment of 1.5 million Euros from the Helmholtz-Zentrum Geesthacht, the necessary infrastructure was created for a broad research spectrum at the scientific location as well as for international cooperation between science and industry.

Materials Research

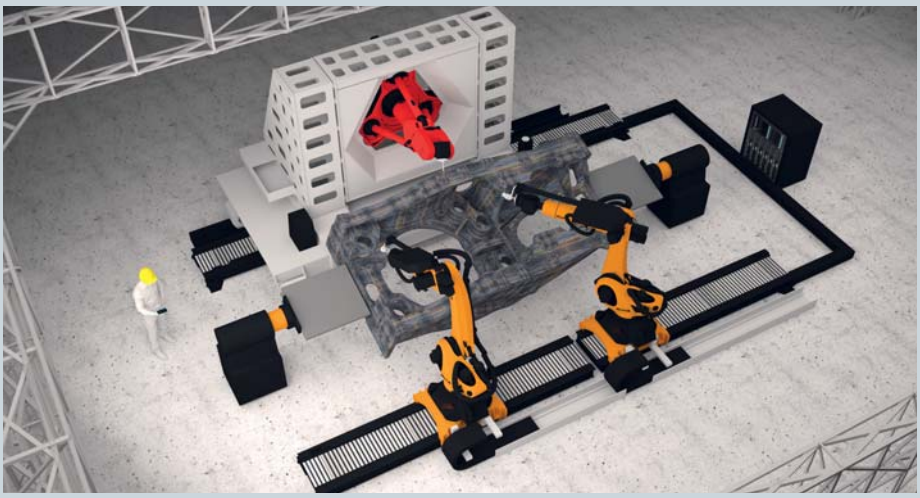
Close cooperation has arisen between the two research fields of "polymer membranes" and "hydrogen technology". The new joint buildings **"Polymer Technology Center, PTC/Hydrogen Technology Center, HTC"** celebrated with their topping out ceremony on July 4th, 2016. The scientists will be collaborating even more closely here from May 2017. Investment: Eight million Euros.
The sub-institutes "Metallic Biomaterials" and the "Magnesium Innovation Centre" (MagIC) were, for example, provided with a new sintering furnace, a new wire drawing machine and extrusion press as well as several special laboratory devices in the **Metallic Biomaterials Centre (MBC)**. Investment: Three million Euros.
GEMS - German Engineering Materials Science Centre, located at DESY in Hamburg: Construction of the Excellence Centre for material characterisation with photons and neutrons. HZG researchers and external beamline users are provided laboratory and office space as well as infrastructure for sample processing. Completion is estimated in summer 2018.

Coastal and Climate Research

New Coastal Competence Center (C^3): Two buildings with approximately 800 square meters of workspace are under construction for the Institute of Coastal Research. Construction began on May 4th, 2016. Completion is estimated for October 2017. Investment: 6.4 million Euros.

Processing Large Aircraft Components

Light, strong, rust-free – titanium is used in the aerospace industry for these particular properties. A challenge arises here in the processing of this precious metal because additive manufacturing processes are to be introduced in aerospace engineering. This includes, for example, production of large components in 3D layer printing. One challenge is that the additive manufacturing processes using titanium must be carried out in a protective gas atmosphere, otherwise the highly beneficial properties of the titanium materials are lost to oxygen contamination.



The aim of the LASIMM project is to develop technologies for additive/subtractive manufacturing and to provide a suitable system for such production. (Sources: Foster + Partners Ltd, UK) (This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723600.)

The new European research project LASIMM (Large Additive Subtractive Integrated Modular Machine) examines the potential of new manufacturing methods for large structures. Additive manufacturing processes could revolutionise vital technical fields such as in the energy, construction or aerospace sectors.

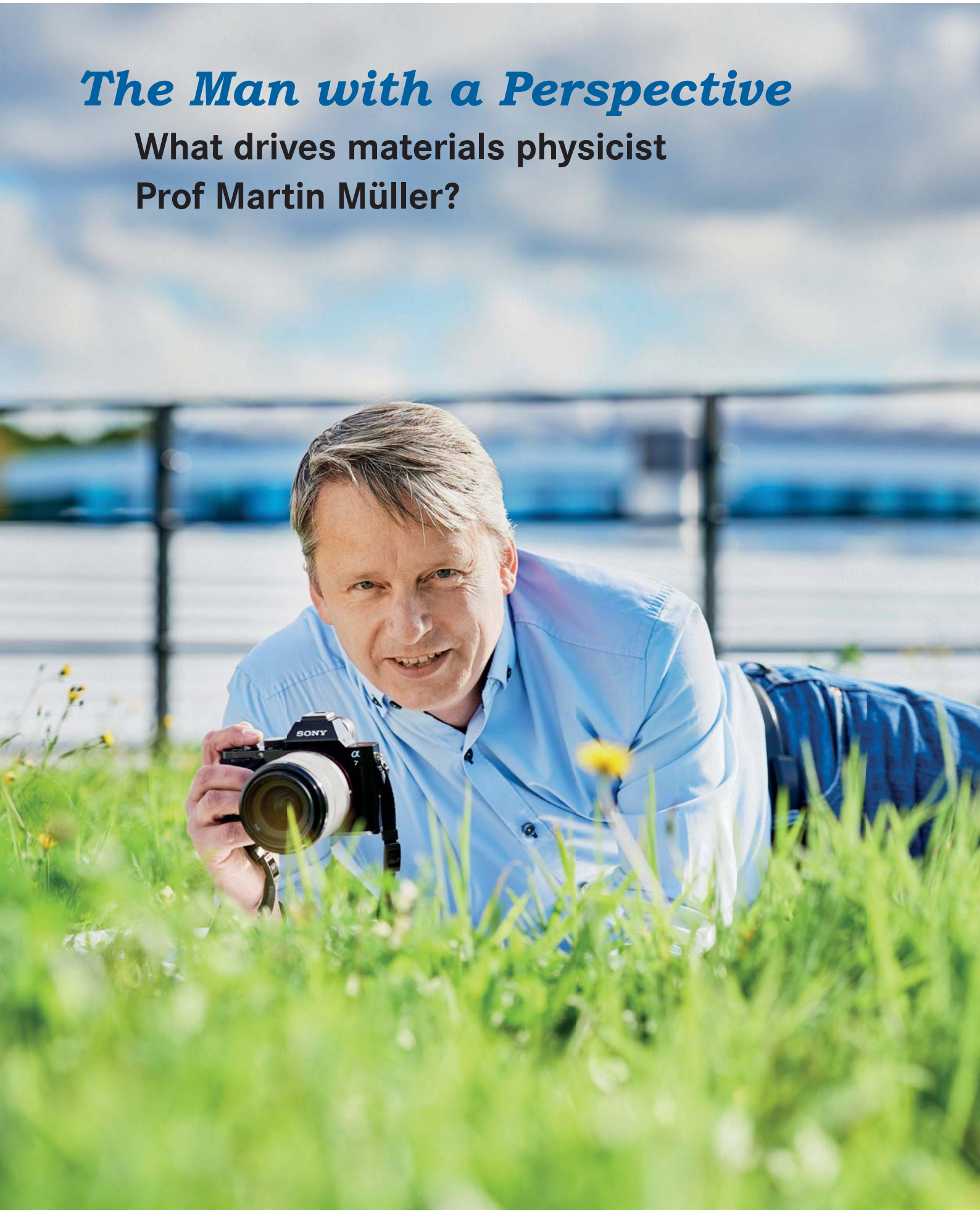
The Geesthacht materials researcher and HZG department head, Dr Jorge dos Santos points out, "Within the framework of this project, we examine possibilities for producing additive components made of titanium alloys using friction coating welding. With this welding method, material layers are coated at temperatures under the melting point. The oxygen contamination problem is thereby substantially reduced.

In addition, the Geesthacht materials researchers are studying the microstructural refinement and residual stress management of robot-supported cold working of additive-manufactured components. The positive effect of cold deformation on the microstructure and residual stress distribution in the finished component are known. In the LASIMM project, these advantages are extended to large 3D components by using robots. Processing strategies are developed and tested, which are coupled to the additive manufacturing processing. The developmental work is supplemented and supported by modelling.

LASIMM began in October 2016 and will run until September 2019. The European Community has made approximately five million Euros available to nine partners from six countries for the project. The partners: Cranfield University (GB), DELCAM Ltd (GB), European Federation for Welding Joining and Cutting (BE), Foster + Partners Limited (GB), Global Robots Ltd (GB), Instituto Superior Tecnico (PT), Loxin 2002, S. L. (IT) and Vestas Wind Systems A/S (DC).

The Man with a Perspective

What drives materials physicist Prof Martin Müller?



Prof. Martin Müller –

Prof Martin Müller leads the Materials Research Division with its X-ray and neutron instruments, amongst the most modern equipment in the world.

If your knee cramps up or you've got a pinch in your back, sooner or later you're going to land in the radiologist's office. A radiologist can glimpse inside your body without cutting you open.

We, too, have someone akin to a radiologist here at the HZG. Prof Martin Müller has been acting head of the Materials Research Division since the start of January. His mission is to gain insight. He and his team work with photons and neutrons at the user platform known as the German Engineering Materials Science Centre (GEMS) in order to make what occurs in various solids at the nano-level visible and comprehensible. Why do welded seams bear such heavy loads? Why is wood simultaneously so stable and ductile? Why can fine cracks sometimes occur in cast engine blocks? What precisely happens when hydrogen is stored in metal granules?

"Some of these questions can, of course, also be answered in the laboratory," Müller explains. "But you need our instruments and methods to observe the inner structures and processes."

Anyone who comes across Martin Müller could actually take him for a physician. His demeanour is markedly amicable and open. He's an attentive listener, nodding often and smiling. The 49-year-old's replies possess a considered eloquence. What changes has he implemented since he took over as institute director? "Initially, we created new structures," he explains. Four new groups have been created out of one very large department. His institute has also moved to other premises. In Müller's office, the moving boxes are piling up at DESY.

"Come, I'll show you where we do our measurements," he says. We head over to PETRA III, the large storage ring, where the three beamlines are located. The HZG researchers use these X-ray beamlines for their experiments. The radiation with which they work is five thousand times finer than a human hair. One of Müller's employees is sitting in the shed with two colleagues from China. The researchers from the Far East collaborate with the HZG's Magnesium Innovation Centre (MagIC) under the direction of Prof Karl Ulrich Kainer. At the beamline, they analyse how a certain magnesium alloy behaves when it is stretched. "It's fascinating," says one of the researchers from Shanghai. "The measurements tell us what happens in each individual grain of the alloy. We're learning a great deal from it." He thinks that the results of this study could be used in concrete applications in the automotive and aerospace industries within only one to two years. There are only four research centres in the world where such an experiment could be undertaken. "The equipment, however, is nowhere as modern as here in Hamburg."

Müller has ambitious plans for the future of his institute. His biggest aim is to work more closely with the other HZG institutes:

"I would like for my colleagues in materials, polymer and biomaterials research to utilise our GEMS technology as comfortably as they would the instruments in their own laboratory."

The lack of proximity is the greatest challenge here: Müller and his team's primary work is not carried out in Geesthacht. Their X-ray beamlines are located in Hamburg-Bahrenfeld and their neutron instruments are in Garching bei München. In addition, his institute only has 20 per cent of the measurement time at their disposal at DESY. "And we need these days mainly for improving the facilities and expanding our methods," says Müller. The remaining 80 per cent is assigned to researchers who apply from all over the world. "Of course, we would also like to continue serving external users as the leading German centre for studying materials using synchrotron radiation and neutrons," he explains.

For colleagues from the HZG, there is another type of "backdoor access" to GEMS technology, which can be found just a few meters further into the facility. One of the beamlines hides a small measuring stand. Researchers from Geesthacht are currently testing a sample for hydrogen storage.

"How did you get measurement time?" asks Müller.

"We just called," says his colleague.

Müller smiles. "See? It's relatively uncomplicated to use this side-station for HZG projects without a laborious application process or having to wait a long time."

Müller's fascination for X-ray studies stretches back to his master's degree at the University of Kiel, where he still teaches today. What was the most exciting HZG experiment of the past year for him? Müller thinks it over for a moment: "We recently watched a piece of equipment machine a metal part in real-time. We were able to make the deformation processes in the material visible using high-energy synchrotron radiation." The greatest breakthrough of the last few months for Müller was, however, the results from laser joining a titanium-aluminium alloy. The fact that the welded seams could be improved mechanically lies also in the expertise the researchers gained from using Müller's X-rays. "This success was only possible because our institute cooperated very closely with the Institute for Materials Mechanics led by Prof Norbert Huber," Müller points out.

That is how it works everywhere – not only in the research. You want more of what works well. For Müller that means working more closely with other HZG institutes, more collaborative work on the graduate student level, more HZG projects and more internships in Garching and at DESY.

When Müller talks about his employees, one phrase always arises: to be "all ears" for the people with whom he works. The man with a perspective at the HZG also wants to keep his ears to the ground in regards to topics stemming from other institutes. This means collective workshops, talks, seminars – perhaps, informal meetings at DESY or in the HZG cafeteria in Geesthacht.

Author: Jochen Metzger, Journalist / Photo: Christian Schmid

Research & Life

in the coastal region

They take water samples and measure wave heights. They equip satellites and install radar. They measure the seafloor and model the coastal region. They interview citizens living on the coast and advise government agencies as well as the public: these are the coastal researchers at the Helmholtz-Zentrum Geesthacht.

The more than 250 specialists at the Institute of Coastal Research possess backgrounds in the most varying fields, including physics, chemistry, biology, mathematics, oceanography, meteorology and other geosciences. The Science Year 2016*17 – Seas and Oceans is stepping up its activities, drawing these regions more into public focus.

Eine Initiative des Bundesministeriums für Bildung und Forschung

Wissenschaftsjahr 2016*17

MEERE UND OZEANE

The MS Wissenschaft presents marine reseach on the ship. On board also were exhibits from the Helmholtz-Centre Geesthacht.

Prof Burkard Baschek

Due to its location between land and sea, the coastal region affects numerous processes.

Science Years have been promoted annually since the year 2000 by the Federal Ministry of Education and Research (BMBF) together with Science in Dialogue (WiD). Each year the topic of focus changes. Science Years are dedicated to themes that are societally relevant for the future. The future of the seas and oceans as well as the coastal regions certainly rank among these topics.

Motivation and fascination

The coastal region. This includes not only areas where land is influenced by the sea but also where the sea is influenced by the land. The two regions, which are utilised differently and provide fascinatingly diverse living environments, however, form one whole. What is so interesting about this area that a research field has been specifically dedicated to studying the coasts?

The director of “Operational Systems” at the Institute of Coastal Research, Prof Burkard Baschek, says, “Our planet is covered 70 per cent by water, and the seas form the largest habitat on Earth. Every second person on the planet lives on the coast or within 100 kilometres of the sea now. This area between land and sea influences numerous global processes, which affect the carbon cycle, oxygen production, and atmospheric transportation processes. That is extremely exciting for us scientists.” Baschek also comments on the aspect of size: The overall length of the global coastlines on all continents and islands is one million kilometres. It’s a very large research area that still holds quite some secrets.

The coastal regions and seas provide a space for nature and culture

Human beings use this environment for tourism, fishing, offshore wind parks and intensive agriculture. Human influence on sensitive ecosystems such as the Wadden Sea, estuaries or coastal seas is becoming quickly noticeable. Protecting the coasts and utilising these regions with the future in mind is the subject of research at the Helmholtz-Zentrum Geesthacht.

At the beginning of the science year, the zeppelin for the "Expedition Clockwork Ocean" took off in Berlin. Numerous media representatives were drawn to the topic and reported on the research expedition.

What does this mean in terms of work at the institute?

"We must understand that it is all one 'coastal system' and that it's not enough to simply consider one single component," says Prof Corinna Schrum, Director of "System Analysis and Modelling" at the Institute of Coastal Research. It is rather a continuous interaction of numerous physical, biogeochemical and biological processes.

Schrum expands, "In addition to marine and atmospheric processes, the processes related to the land, such as riverine inputs, are very important. Furthermore, this region is heavily utilised by humans. Human influence, therefore, cannot be separated from natural conditions."

In order to understand all these processes and influential aspects, the coastal researchers utilise sophisticated measuring networks. Methods employed include the most modern laboratory technology, satellites, research vessels and diving robots.

Prof Kay-Christian Emeis, third director and head of "Biogeochemistry in the Coastal Seas", says, "Look at our coastal observation system COSYNA. COSYNA[1] uses the most diverse platforms to measure physical or biogeochemical properties such as temperature, salinity and sea state as well as nutrients and exchange processes between the water and the underlying seafloor."

The data from these measurement networks is integrated into extensive computer simulations. The aim is to obtain a detailed model of the coastal system as a whole, including all interactions between the sea, land, air and humans. This way we can satisfy long-term research efforts to understand the coastal system as a whole and beyond the limitations of individual physical, chemical or biological aspects. Emeis also points out, "In view of progressive climate change and increasing rise in pressure due to utilisation of the sea, the idea is to redefine the concept of the coast."

[1] *COSYNA: Coastal Observing System for Northern and Arctic Seas. COSYNA is an integrated observation and modelling system that operationally and synoptically describes the environmental condition of North Sea and Arctic coastal waters. COSYNA makes data and data products available that assist the governmental, commercial and public sectors in planning and processing routine tasks and emergency strategies as well as to assess trends.*

Prof Corinna Schrum

We must understand that it is all one "coastal system" and that it's not enough to simply consider one single component.

Research at anchor

"Research at sea" is the open ship of our research vessel "Ludwig Prandtl". Once a year, our scientists present their work at harbours along the German coast.

Corinna Schrum adds, "On the other hand, we are trying to make short-term predictions on how the currents develop in the next six or twelve hours. We also want to look farther into the future with prognoses on, for example, storm activity in the coastal regions."

Looking to the future coasts helps us make decisions

Kay Emeis says, "One example of how our research is utilised is by the offshore wind farm industry. We offer them products that are vital for planning. If we look at statistics from prior decades, what could we learn for the future? What weather windows do we have to install wind farms or to perform maintenance? Model statistics from the past, such as from CoastDat, are of great interest to users. In addition, what is the long-term wind park potential during the course of climate change and how does this influence the coast?"

Engaging in discourse and stirring the imagination

The glimpse into the future is of great interest to people as is current sea and coastal conditions. The public took notice of coastal research activities such as "Expedition Clockwork Ocean" and "Forschung vor Anker" (Research at Sea). The Geesthacht coastal research expedition kicked off at the end of June, right at the start of the Year of Science. This expedition enabled a zeppelin with high-tech equipment on board to detect small ocean eddies in the Baltic Sea. Interested spectators could often follow researchers live as they worked. The level of interest was phenomenal. The analysis of the results remains on-going, but the scientists appear to have reached an audience of 150 million through the Internet, newspapers and radio broadcasts.

The public is also very fond of activities on a smaller scale, such as the "Research at Sea" tour, which takes place annually at different harbours on the North and Baltic Seas. Numerous visitors learned more about the scientific work during the "Open Ship" this year in Wismar, Heiligenhafen and Rendsburg. The crew and the Geesthacht scientists were available on-board the vessel to dis-

Prof Kay-Christian Emeis

In the face of advancing environmental change and increasing pressure caused by utilisation of the seas, it is necessary to redefine the concept of the coasts.

Above: One of several interactive exhibits of the Coastal researcher.

At School events, science nights and on public holidays: Motivated coastal researchers present their work to the people.

cuss their research. The Institute of Coastal Research has been virtually presenting their endeavours with text and images to the public for several years now on the blog "Coastal Research". The scientists and their work are displayed on this site. Of course, the coastal researchers' commitment doesn't end in 2017: They will continue their research into the seas and coasts. In this regard, the three directors of the Institute of Coastal Research are of one mind:

The coasts are facing enormous challenges due to increasing population size and to climate change. We need to understand the coasts as a focal point as well as the role of the "global coasts" for the Earth system in order to facilitate sustainable utilisation.

Prof Dr Burkard Baschek
Director since 2012 of the division for Operational Systems at the Institute of Coastal Research. He teaches coastal research and instrumentation at Christian Albrecht University in Kiel.

Prof Dr Corinna Schrum
Director responsible since October 2015 for the division of "System Analysis and Modelling" at the Institute of Coastal Research in Geesthacht.
She also teaches in the Institute for Oceanography at the University of Hamburg.

Prof Dr Kay-Christian Emeis
Director since 2011 of the division for Biogeochemistry in Coastal Seas at the Institute of Coastal Research.
Since 2003 he has taught at the Institute for Geology at the University of Hamburg.

Hunting for Eddies Over the Baltic Sea

In June 2016 a large-scale expedition investigated the influence of small ocean eddies on the ocean circulation and the growth of microalgae. Three ships, an airplane and a zeppelin as well as additional devices were equipped with measuring instruments.

STEMME S10-VTX
The research airplane belonging to the FH Aachen, equipped with an infrared camera, departs in the early morning first.

FLOATING BUOY
The instruments floating freely in the sea transmit data of the sea currents via satellite.

LUDWIG PRANDTL – HELMHOLTZ-ZENTRUM GEESTHACHT
Water samples are examined on board in the laboratory. The FerryBox, an automated measurement system, determines temperature, salinity, turbidity, chlorophyll, pH value, oxygen content, algae groups and nutrients.

OCEAN GLIDER
Three ocean gliders are deployed. The 1.5-metre-long ocean robots are equipped with optical as well as turbulence sensors. They move approximately 1 km/h and dive up to 100 metres deep.

SCANFISH
The Scanfish is towed and moves up and down. Its sensors measure the density of the water, the oxygen content and the algae concentration.

AIRSHIP

The zeppelin parks directly above the eddy. From here, the researchers coordinate the ships.

An INFRARED CAMERA provides temperature maps of the water surface with 100 images per second. The thermal imaging camera measures temperature differences of 0.03 degrees Celsius.

A HYPERSPECTRAL CAMERA records up to one thousand different bands of the light spectrum, thus determining the "colour" of the water. The camera provides insights into the condition and growth of algae.

ELISABETH MANN BORGESE – LEIBNIZ-INSTITUT FÜR OSTSEEFORSCHUNG WARNEMÜNDE

Aboard the scientists coordinate the ocean gliders and collect additional Oceanographic data.

EDDY – HELMHOLTZ-ZENTRUM GEESTHACHT (HZG)

With the fast speedboat the researchers arrive at the examination area in no time.

SMALL OCEAN EDDIES

Small ocean eddies are part of the global ocean circulation. They measure up to 10 km in diameter. It is assumed that the eddies strongly influence the sea's circulation and food chain. What exactly occurs within the eddies is something that the research team wishes to uncover.

Sensors

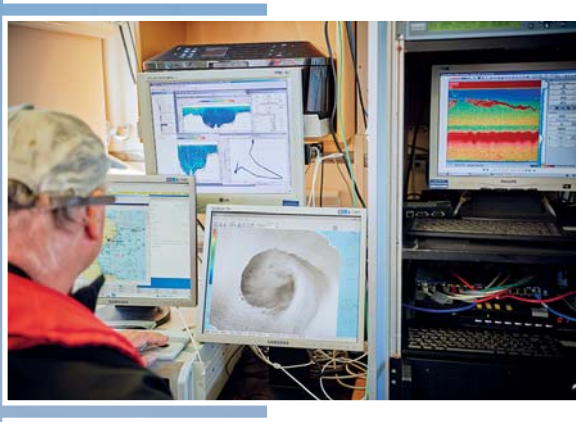
TRACKING CHAIN

The chain is equipped with sensors. It measures temperature, salt concentration, oxygen concentration and chlorphyll. This gives insights of temperature differences in the eddy and how much energy is included.

MONSUN

Several monsoon swarm robots from the University of Lübeck dive to a depth of up to 20 m. They can be moved in all directions, thereby collecting extensive oceanographic data.

Photos: Copyright:
Christian Schmid
Dr Torsten Fischer, HZG
Prof Burkard Baschek, HZG



International Research Team on the Hunt for Eddies

Under the leadership of Prof Burkard Baschek, director at the Institute of Coastal Research (HZG), more than forty additional scientists contributed to the expedition, which was carried out on land, on water and in the air. You can view more photos, results and additional information here:

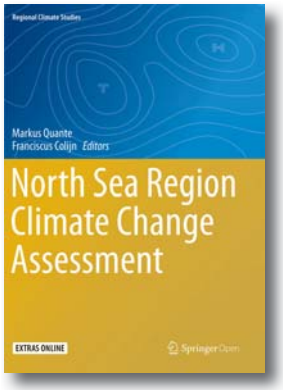
www.uhrwerk-ozean.de/index.html.en

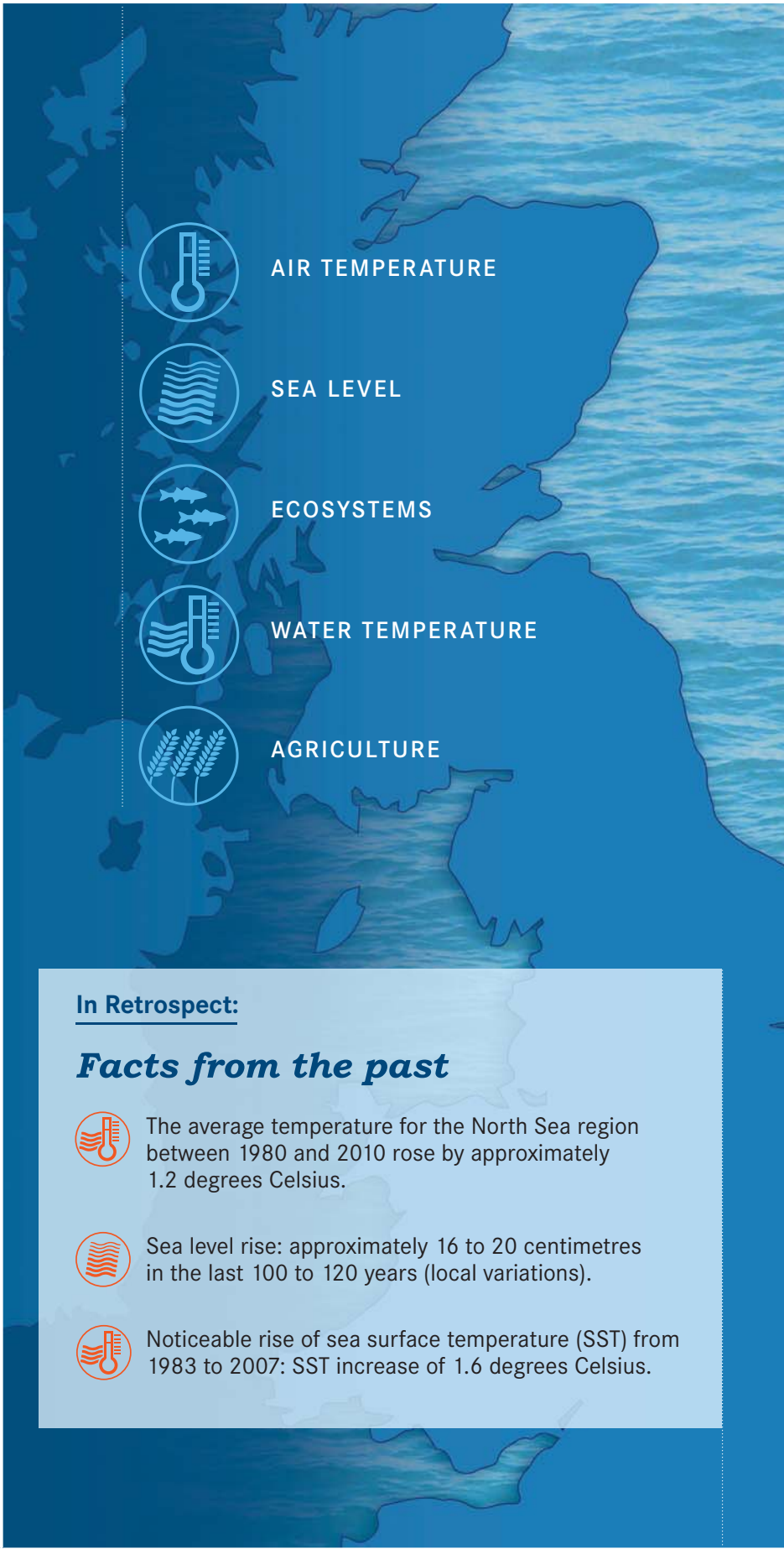
Recently Published:

First Detailed Climate Report for the North Sea region

The entire North Sea region is affected by climate change. The impact will increase in the decades to come. Adaptation strategies require a sound scientific foundation. This foundation is provided by the “North Sea Region Climate Change Assessment” (NOSCCA), which was initiated and coordinated by the Helmholtz-Zentrum Geesthacht.

Approximately two hundred scientists from fourteen European countries included a number of possible scenarios with which they determined the probabilities of certain changes and events. NOSCCA is an independent scientific initiative.





In Retrospect:

Facts from the past

The average temperature for the North Sea region between 1980 and 2010 rose by approximately 1.2 degrees Celsius.

Sea level rise: approximately 16 to 20 centimetres in the last 100 to 120 years (local variations).

Noticeable rise of sea surface temperature (SST) from 1983 to 2007: SST increase of 1.6 degrees Celsius.

Future prospects:

up to 2100

By the end of the century rise of the average air temperature between 1.7 and 3.2 degrees Celsius. Compared to the comparative period from 1971 to 2000, depending on the scenario.
The SST of the North Sea could rise by further 1 to 3 degrees.
The consequence would be a further acidification of the seas.

Particularly in the area of estuaries and tributaries more extreme situations and floods are expected: By 2100, in opposite to today more intensive outflows take up to 30 percent in the peak of the high water.

The distribution and abundance of many animals and plants species are changing: The sardine moves into the northern area of the North Sea, stripe mullet and sea bass spread their habitat towards the northwestern area of Norway.

Higher temperatures shorten the ice cover times.

Longer periods of growth lead to an increase in primary production, some plants and animals will spread northward.

NORTH SEA

HAMBURG

LONDON

Adaptation Measures and Sustainability Concepts

Agriculture in the future is likely to see a twenty to forty per cent increase in yield – assuming sufficient water and nutrients are available.

Overall, higher temperatures also mean additional warming in the cities.
The threat is that pollutant emissions, which are harmful to health, are increasing.
The tourism industry will benefit as long as sustainability concepts are developed in time.

Necessary coastal protection measures could reduce beach areas.

A bit of extra information: for colleagues who would like to see their story published here, please contact the editors at In2science@hzg.de.

We also cordially welcome suggestions, praise or criticism. Please contact us any time.

We look forward to hearing what you think about this issue of
in2*science*

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ZHM

Zentrum für Hochleistungsmaterialien

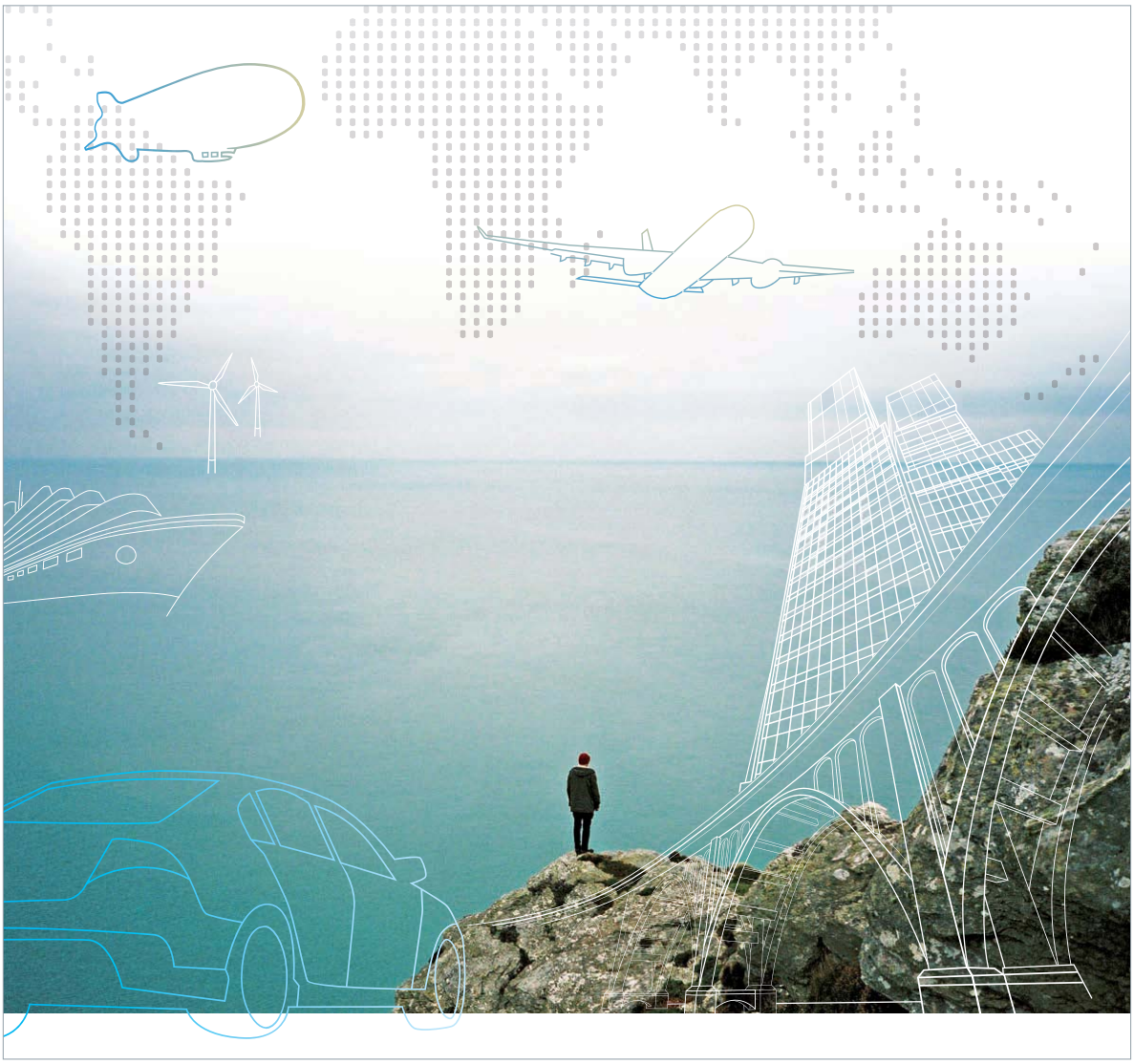
At the Centre

Ragle Raudsepp: Materials scientists look for connections between the underlying structure of a material, its properties, how processing changes it, and what the material can do. It is fascinating to create and combine materials in new ways.

Jannik Göbel: What I find particularly fascinating in materials science is that you can immerse yourself in the everyday application of a material as well as in its very fine microstructure – researching from the nanoscale to the meta-level of everyday application.

Jochen Harmuth: A suitable material can be developed for any requirement or application. Although people have been studying materials for quite a long time, the understanding of material properties continues to expand today. That's extremely exciting.

Daniel Laipple: I began to study physics because it's simply universal and it interested me very much for this reason. But then I veered increasingly toward the applied sciences. What interests me here in particular is the utilitarian aspect of work in materials research. That is, researching something that could then work its way into fundamental application.



FÜR DEN MENSCHEN UND SEINEN LEBENSRAUM VON MORGEN

For the Human Environment of Tomorrow – that's the motto of our new brochure. We would like our motto to demonstrate the motivation behind our research: We develop materials to maintain the quality of life for humankind. We study the human living environment to preserve it as a liveable space. We are thereby expanding upon our last slogan, "Science Creates Benefits". To address the immense global challenges, we research solutions that are then implemented through policy and industry.