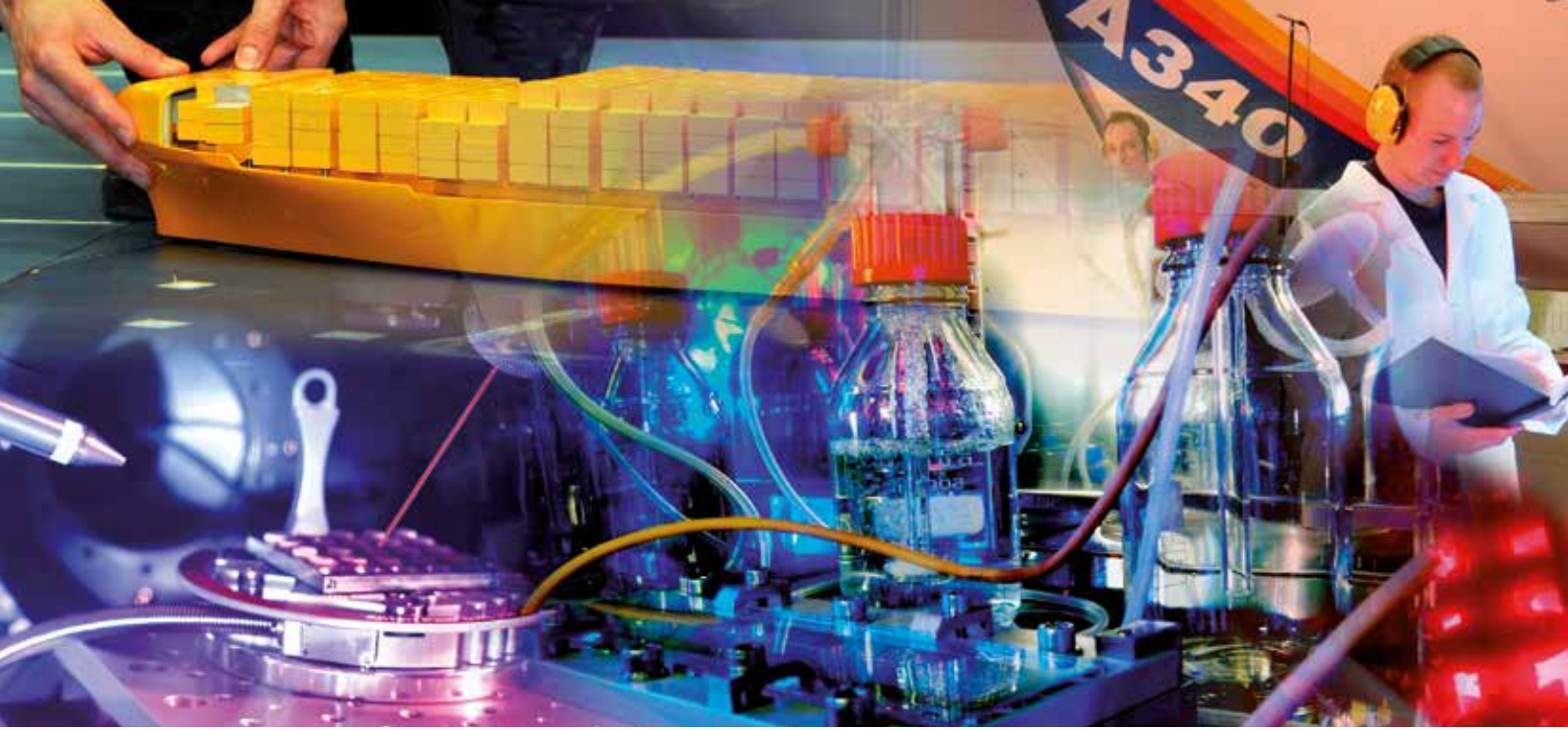


RESEARCH
CONCEPT AND CENTERS

ON- AND OFFSHORE CIVIL ENGINEERING STRUCTURES

INTEGRATED BIOTECHNOLOGY AND PROCESS ENGINEERING

CLIMATE-PROTECTING ENERGY AND ENVIRONMENTAL ENGINEERING

AERONAUTICS

MARITIME SYSTEMS

PRODUCT-ORIENTED MATERIALS DEVELOPMENT

REGENERATION, IMPLANTS, MEDICAL TECHNOLOGY

SELF-ORGANIZING WIRELESS SENSOR AND DATA NETWORKS

TUHH

Hamburg University of Technology

Hamburg University of Technology
Schwarzenbergstrasse 95
21073 Hamburg, Germany

www.tuhh.de

RESEARCH
CONCEPT AND CENTERS

Overview of research at the Hamburg University of Technology

The TUHH, founded in 1978 in the southern part of Hamburg, is Germany's northernmost university of technology. It was established as an independent university concentrating on and specializing in the "classical" engineering sciences. The TUHH's principal tasks and goals are first-class teaching, excellent research at a high international level and intensive knowledge and technology transfer in the field of engineering sciences.

Successful research must be undertaken cooperatively across institutional borders. Universities are concerned with competition between original and good ideas and, of course, with securing third-party funding. The reputation of a University of Technology depends to a very great extent on interdisciplinary research networks, for example, Collaborative Research Center (CRC) of the German Research Foundation (DFG) and research projects funded by the EU or the German Federal Ministry of Education and Research (BMBF).

In developing its strategy, the TUHH has further developed its research structure so as to highlight the existing research competencies of its research centers (RCs) and institutes. To achieve this, it bundled its research expertise in a Center of Research and Innovation (ZFI). Research activities have been brought together under the umbrella of the ZFI in three competence fields:

- Green Technologies, covering the research fields Renewable Energy, Systems – Storage – Networks, and Water and Environmental Technology,
- Life Science Technologies, covering the research fields Medical Technology, Biomaterials, and Chemical and Bioprocess Technology, and
- Aviation and Maritime Systems, covering the research fields Aeronautics, Logistics and Mobility, and Maritime Systems and Structures

Integrated into the ZFI is a College of Excellence that is intended to further the expansion and development of competence fields and research centers (RC) systematically by setting up scientific groups (junior professorships) and appoint doctoral candidates in close collaboration with the TUHH's research partners. In addition, establishing the College of Excellence enables the founding of an "umbrella" graduate school for interdisciplinary training of the next generation of scientists throughout the university.

The new research structure builds on bottom-up cross-departmental research projects in the form of research centers (RCs). The RCs are organized in a matrix-like structure and each involves contributions from 10 to 15 professors. Participation in a RC is voluntary and every professor is free to work in one or more RCs.

Each RC undertakes to deliver a specific output within the four-year project period, based on criteria that can be verified within the projects lifespan. RC applications are discussed by the President/Executive Board and then submitted to the Academic Senate for a final decision on whether to set up an RC. Each RC reports regularly to the Academic Senate on the results it has achieved.

The following nine RCs have been developed, evaluated by peers in the meantime, and prolonged:

- Integrated Biotechnology and Process Engineering
- Regeneration, Implants, Medical Technology
- Self-Organizing Mobile Sensor and Radio Data Transmission Networks
- On- and Offshore Civil Engineering Structures
- Maritime Systems
- Climate Protecting Energy and Environmental Engineering
- Aeronautics
- Product-Oriented Materials Development
- Logistics and Mobility

These RCs are bolstering the TUHH's already very good position in competition with other universities. Clear evidence of this is provided by two regional clusters of excellence acquired under the federal state excellence initiative, along with the CRC on Tailor-made Multi-scale Materials Systems, or M3, which was approved by the DFG in spring 2012.

Increased competition leads to a change in behavior. The vision is, by focusing on competence fields, to position and raise the profile of the TUHH with its proven track record in its areas of scientific research as an important player in the concert of universities of technology in Germany.

The TUHH is active in different areas of both basic and applied research and collaborates closely with the Hamburg universities, companies in the Hamburg metropolitan region, and non-university research institutes. Cases in point are its cooperation with AIRBUS in aviation research at the Finkenwerder Technology Center, and its collaboration with the Helmholtz Centre Geesthacht for Materials and Coastal Research, with the German Aerospace Research Centre (DLR), the Fraunhofer Society, and the DESY Research Center in Hamburg.

The TUHH's founding principles - research priority, interdisciplinarity, innovation, regionality and internationality - continue to be binding basics for the future development of the Hamburg University of Technology.

I hope you enjoy reading this brochure.

Prof. Dr.-Ing. Jürgen Grabe
–Vice-President Research –

Center of Research and Innovation – Setting out Along New Paths

The TUHH's guiding principle is to develop technology for people. To do justice to this aspiration, the university has reorganized its research structure and bundled research in a Center of Research and Innovation (ZFI). In doing so it is helping to ensure, through its research and development efforts, the sustained technological and scientific lead that is needed to safeguard Hamburg for the long term as a forward-looking location for technology. The TUHH's goal is to position itself internationally and nationally as an excellent North German research establishment by comparison with other universities of technology.

The ZFI comprises four interlinked components – three new competence fields that position the research expertise of the interdisciplinary Research Centers (RCs) with an external focus, and the scientific institutes and working groups that form the basis of research work at the TUHH.

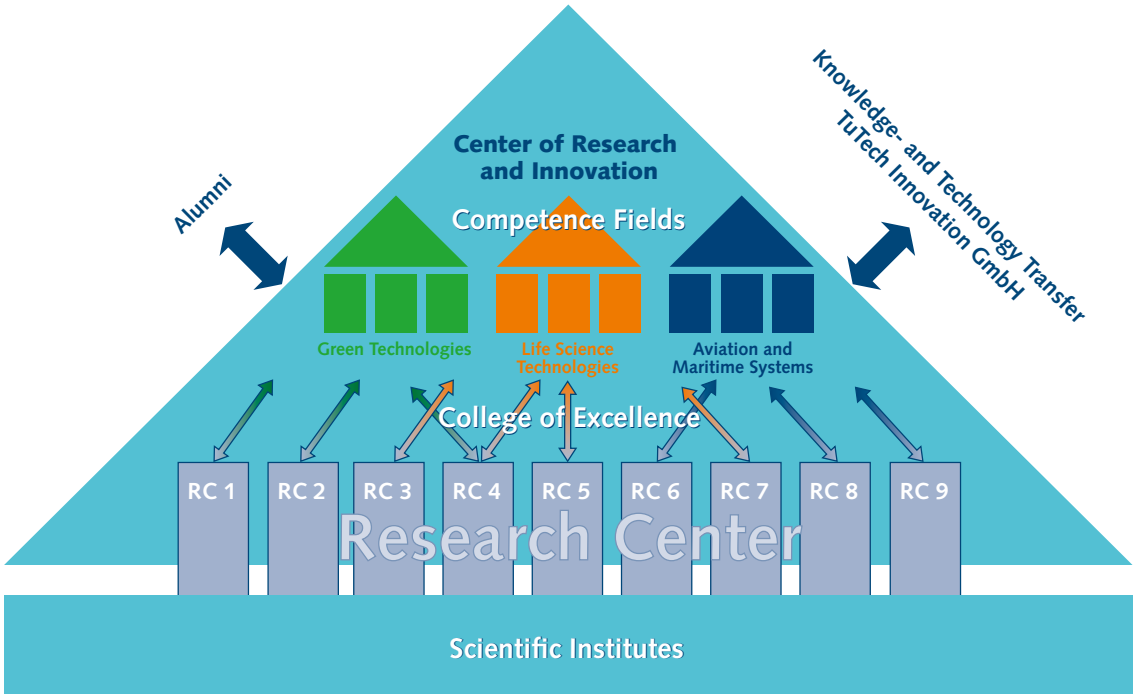
A College of Excellence will act as a link between the competence fields and the RCs. By setting up groups of young scientists and doctoral programs, it will support the development and expansion of competences and RCs in a targeted way (see chart).

Efficient knowledge and technology transfer will take place via qualified graduates of the TUHH and via TuTech Innovation GmbH.

In order to highlight the existing research competences of RCs and institutes, after detailed analysis the TUHH has developed three competence fields:

- **Green Technologies**, covering the research fields Renewable Energy, Systems – Storage – Networks, and Water and Environmental Technology
- **Life Science Technologies**, covering the research fields Medical Technology, Biomaterials, and Chemical and Bioprocess Technology, and
- **Aviation and Maritime Systems**, covering the research fields Aeronautics, Logistics and Mobility, and Maritime Systems and Structures

The central focus of the Green Technologies field of competence is on professional competence in the field of sustainable, environmentally compatible and innovative "green" research topics. These topics deal with the challenges of the move to alternative forms of energy and of increasingly scarce resources. The Renewable Energy research field is concerned with generating energy on and from the sea, with a special emphasis on the construction, operation and safety of offshore wind farms and utilization of wave and tidal energy. Further important fields of research are geothermal energy and the utilization of biomass. The key words in the field of biomass are biorefinery and waste recycling. The Systems – Storage – Networks research field focuses among other things on



questions of how fluctuating renewable energy can be stored and how this energy reaches end users. Finally, the Water and Environmental Technology research field is dedicated to questions of safe water supply, prevention of water pollution, and soil protection.

The Life Science Technologies field of competence takes up questions addressed to the change to an ageing society. The Medical Engineering research area explores, for example, how technologies can guarantee 24-hour patient supervision so as to enable patients to recover at home. This requires secure communication networks in order to safeguard sensitive data and ensure it is communicated efficiently. Other fields of application include imaging techniques or the transfer of medical data via sensor systems based on microsystems technology and nanoelectronics. Biomaterials and Biosystems Engineering research is involved with developing new implants and material systems, while Tissue Engineering explores how artificial tissue implants can be grown in a bioreactor. The research area Chemical and Bioprocess Engineering, the main pillar of this field of competence, explores questions of industrial "white" biotechnology through to food process engineering. Both applied and basic research is undertaken, extending into the field of Molecular Modeling and Design.

The Aviation and Maritime Systems field of competence expresses TUHH's strengths in aeronautical engineering, marine engineering and maritime structures research. Thanks to partners with a global impact such as aircraft builder Airbus, the maritime industry and the Port of Hamburg as a gateway to the world, TUHH has an excellent starting position for research with industry and business. TUHH aeronautical engineers, for example, are concerned with issues such as aircraft systems, cabins and comfort, materials and production, aircraft design and air transport systems. In the Maritime Systems and Structures research field new approaches in marine engineering are examined facing up to the challenges posed by port and waterways construction and coastal protection. The Mobility and Logistics research field combines ships and aircraft as modes of transport and is dedicated to developing mobility concepts and services, to maritime logistics, and the associated supply chain management. The focus here is on technologies such as RFID integration. New approaches to corporate planning and logistics round off the research spectrum.

One integral component of the ZFI is the College of Excellence that is being set up in the content of a TUHH excellence initiative. In a structured, scientific career program, outstanding scientists (in scientific groups comprising junior professors and postgraduates) will have the chance to undertake pioneering research work in the TUHH fields of competence. TUHH cooperation partners who wish to accompany and support this joint research initiative are part of this. In terms of topics, these science groups will be guided by the three competence fields outlined above and the fields of research they cover. The idea is for them to study original research questions that open up new fields of research.

The competence fields are based on the TUHH's nine interdisciplinary Research Centers in which scientists from different institutes and study groups participate. It is precisely interdisciplinary discussions that give rise to fruitful new research approaches.

The fields of competence are an important element in raising the profile of TUHH and will be introduced to the general public and the scientific community by means of high-profile events and specialist workshops and conferences. A research afternoon will be organized for each field of competence at the TUHH in order to show how its research expertise reflects the research needs of business and society. This ongoing dialogue will enable current research questions to be addressed better and approaches to solutions for pressing future challenges to be found sooner. The TUHH's partners in industry and business, universities and non-university research institutes, and public institutions, are invited to join the TUHH in shaping the future.

ON- AND OFFSHORE CIVIL ENGINEERING STRUCTURES

Water has always exercised a magic attraction on mankind. Port facilities, bridges and homes are increasingly taking over river banks and coastal areas. Construction is even going one step further: Wind power is especially easy to farm on the open sea. Innovative research is indispensable to ensure that structures of this kind in and by the water can resist the elements on a lasting basis.

Wind power is enjoying an unbroken upswing all over the world. With an installed capacity of more than 25 gigawatts, Germany is one of the leading wind power generators in Europe. As relatively constant winds blow on the coast and in the open sea and are not braked there by either forests or extensive construction, the trend in recent years has been toward offshore wind farms. Alpha Ventus, Germany's first offshore wind farm about 45 kilometers off the coast of the North Sea island of Borkum, is to be followed in the years ahead by a large number of other projects in the German Bight. That is why the On- and Offshore Civil Engineering Structures research center will have ambitious and complex issues to handle from this sector of the future for many years to come.

Which foundations at which sea depth and in which ground conditions make the most sense in geotechnical and constructional terms and how the gigantic power generation plants are best installed in the open sea are technical issues that are still by no means fully resolved. Wind and waves are a constant burden on the foundations and deform them as time goes by. How great this effect is and whether it might in certain circumstances lead to problems in the future remains to be seen. So does the question of how much soil excavation is needed for new kinds of shallow foundations without affecting seabed fauna and flora too adversely.

The constructional side of offshore wind power is but one of many issues with which TUHH institutes participating in the On- and Offshore Civil Engineering Structures research center are actively concerned. Near- and offshore civil engineering structures such as port facilities and dikes, lighthouses, bridges or works related to land reclamation in port areas are also focal points of research. Especially in view of its proximity to the Elbe River and the North and Baltic Seas, Hamburg could hardly be a better location for a research center of this kind.

The external loads to which on- and offshore structures are exposed are extremely varied. Changing water levels, currents, waves, wind, ice, corrosion and collisions with ships, when they occur, can cause damage. Against this backdrop the research center concentrates on interdisciplinary issues such as the development of new building materials and processes, serviceability and ultimate limit state computer simulations for buildings and constructions, the innovative operation of buildings with the aid of automation, studies related to the thermal comfort of people within buildings, the energy efficiency of those buildings and how to deal with the large number of existing buildings.

Research is already under way on, inter alia, the extent to which ultra high performance concrete can be used in the special conditions that prevail near and in the water. This will require extensive series of tests related to the chemistry and physics of building materials to establish the material's corrosion behavior. In dike construction the TUHH research scientists are looking for alternatives to Klei, an impermeable aged alluvial clay from the marsh region that is widely used to clad the outer surfaces of dikes.

Special attention is paid to the modernization and extension of port facilities. If the Port of Hamburg is to hold its own in competition with large seaport locations such as Antwerp or Rotterdam, it must be upgraded to accommodate future ship sizes. The largest freighters already carry up to 13,000 containers. As larger ships cause significantly higher loads on the existing quay walls, the quay walls will need to be extended or reinforced or redesigned. Construction methods themselves are on the testbed. They must be more economic in the future while staying safe.

Another major role in the constructions considered and investigated by the research center is the aspect of sustainable use of regenerative energy, such as geothermal energy. Intelligent façade renovation concepts for future use in Hamburg's Hafencity district are also intended to help optimize buildings in energy terms. Last but not least, innovative concepts in building comfort, building supervision and maintenance of existing and new buildings in and by the water are on the research agenda. The aim of all On- and Offshore Civil Engineering Structures research center activities is to ensure that people continue to enjoy living safely by the water.

Coordinators

Prof. Dr.-Ing Frank Schmidt-Döhl

Prof. Dr. Viktor Sigrist

TUHH
ON- AND OFFSHORE
CIVIL ENGINEERING
STRUCTURES

Prof. Dr. Frank Schmidt-Döhl
Phone 040 42878-3021, Fax -2905
E-Mail schmidt-doehl@tuhh.de
Eißendorfer Straße 42
21073 Hamburg, Germany

Prof. Dr. Viktor Sigrist
Phone 040 42878-3022, Fax -2969
E-Mail sigrist@tuhh.de
Denickestraße 17
21073 Hamburg, Germany

Participating Institutes
• Institute of Applied Building Technology • Institute of Concrete Structures • Institute of Fluid Dynamics and Ship Theory • Institute of Geotechnical Engineering and Construction Management • Institute of Materials, Physics and Chemistry of Buildings • Institute of Modeling and Computation • Institute of River and Coastal Engineering • Institute of Technology, Work Processes and Vocational Education • Institute of Thermo-Fluid Dynamics

• Information & Contact: *www.tuhh.de/fspbau.html*

INTEGRATED BIOTECHNOLOGY AND PROCESS ENGINEERING

Research in the field of Integrated Biotechnology and Process Engineering paves the way to a sustainable usage of the world's limited natural resources. The aim of this interdisciplinary research center is to achieve significant improvements in economic value creation, keeping German industry competitive and preparing the students of today to the employment situation of the future.

Industrial biotechnology – also known as white biotechnology – uses biological systems for the sustainable manufacture of (fine) chemicals, active substances, new materials and energy carriers from renewable raw materials. It is geared to the model of sustainability and also develops concepts ensuring ecological and social compatibility.

The classical disciplines of chemistry and biology provide catalysts that can be used in organic synthesis. In principle, the task of process engineering is to transfer these reactions, which are usually undertaken on a laboratory scale, to an industrial scale and thereby to ensure their economic feasibility. The aim of the research center "Integrated Biotechnology and Process Engineering" is to develop and take forward the potentials of white biotechnology in order to be able to make active use of them in the future. This includes developing new and unusual biocatalysts as well as developing and optimizing processes with a view to achieving a marked increase in energy and resource efficiency.

Implementing these scientific projects poses great challenges to research and technology. Only by means of the latest me-thodical developments can the increase in efficiency, required to make generating power from biomass or biotechnological processes competitive, be achieved. These processes must har-ness unusual reaction conditions and systems or use innovative materials and mathematical modeling of biological systems. Therefore, active interdisciplinary collaboration between mi-crobiologists, chemists, biotechnologists and engineers in the structure of the research center is absolutely essential. A net-work of SMEs associated with the research center, and of large chemical and life science enterprises, ensures that research is not undertaken in an "ivory tower" and that tasks with practi-cal relevance and high industrial implementation potential are taken up and worked on.

Waste derived from plants such as straw or wood can and is intended to be used in this way, as a source of both energy and raw material. Work is also in progress on expanding the palette of commodities that are suitable for biomass power stations so as to counteract competition with sources of food. The economic efficiency of biorefineries can be increased further by combining the production of biogas and biofuels and of further products and recyclables for the chemical industry

To accelerate the pace of research activity and put it on a wide basis, the institutes participating in the research center "Inte-grated Biotechnology and Process Engineering" aim to initiate and coordinate joint interdisciplinary third-party funding pro-jects at different levels and to establish a collaborative research center at the TUHH. The scientific knowledge newly acquired in this way is intended to achieve widely visible external public-ity for the TUHH.

By coordinating the two BMBF-funded research clusters "BIOKATALYSE2021-Sustainable Biotechnology Along New Lines" and "BIORAFFINERIE2021-Energy from Biomass" and the DFG-funded priority program "Porous Media with a Defined Pore Structure in Process Engineering - Modeling, Application, Synthesis", and by taking part in the Hamburg Excellence Initiative, the research center already has several lighthouse projects. The TUHH's excellent infrastructure also contributes towards the success of many research projects. Consequently, the research center can handle the entire process chain from gene to complex process on a pilot plant scale. In this way new, environment-friendly developments at the research center can be converted quickly into applied technologies.

At the intersection of engineering, molecular sciences and materials sciences the TUHH's research center "Integrated Biotechnology and Process Engineering" with its high potential for innovation thereby makes an active contribution toward extending Germany's scientific, technological and economic lead.

Coordinators

Prof. Dr. Andreas Liese

Prof. Dr.-Ing. Michael Schlüter

TUHH
INTEGRATED BIOTECHNOLOGY AND PROCESS ENGINEERING

Prof. Dr. Andreas Liese
Phone 040 42878-3018, Fax -2127
E-Mail liese@tuhh.de
Denickestraße 15
21073 Hamburg, Germany

Prof. Dr.-Ing. Michael Schlüter
Phone 040 42878-3252, Fax -2573
E-Mail michael.schlueter@tuhh.de
Eißendorfer Straße 38
21073 Hamburg, Germany

Participating Institutes
• Institute of Bioprocess and Biosystems Engineering • Institute of Chemical Reaction Engineering • Institute of Environmental Technology and Energy Economy • Institute of Microsystem Technology • Institute of Multiphase Flows • Institute of Process and Plant Engineering • Institute of Product Development and Mechanical Engineering Design • Institute of Solids Process Engineering and Particle Technology • Institute of Technical Biocatalysis • Institute of Technical Microbiology • Institute of Thermal Separation Processes • Institute of Wastewater Management and Water Protection

• Information & Contact: *www.bioprozesstechnik.de*

CLIMATE-PROTECTING ENERGY AND ENVIRONMENTAL ENGINEERING

What with algae as resource and energy suppliers, more efficient energy storage, multiple use of energy in urban areas, and power stations where the carbon dioxide is removed from flue gas, the Climate-Protecting Energy and Environmental Engineering research center is working on energy supply concepts that are especially easy on the climate and on resources and yet ensure safe operation.

How can energy supplies be easy on the environment and on resources and at the same time improve security of supply? This question will pose the overriding technical and societal policy challenge of the years ahead, and it is a challenge that the TUHH's Climate-Protecting Energy and Environmental Engineering research center has already taken up actively.

Sadly, there are no simple solutions in this area because it is clear there will never be a totally climate- and environment-compatible power supply. Every energy supply chain from source to consumer will involve a certain amount of irreversible energy and materials conversion. Energy from biomass is desirable, but if its share were to increase strongly in future, problems such as soil depletion and primeval forest clearance would be a foregone conclusion. That is why the utilization of bioresources from solid waste and wastewater is of special importance. In the final analysis, every end product in the energy conversion chain has a lasting effect on the environment. In the best case we may, however, succeed in minimizing irreversible energy and materials conversion as far as possible.

Lack of knowledge about different energy and materials chains and links between them has repeatedly led to errors of judgment in the past, as for instance in the case of nuclear energy, where the final storage issue has yet to be resolved. That is why an overall view of energy and materials conversion processes of this kind is absolutely essential, and in view of the complexity of the subject and the many overlapping specialized aspects, this scientific overview can only be gained within the framework of an interdisciplinary research group.

The TUHH's accumulated structures and extended strengths make it ideally suitable for the Climate-Protecting Energy and Environmental Engineering research center. Due to its proximity to shipbuilding and aeronautics technology, for example, the university has a traditional focus on research into

complex systems. Hamburg's competence as a capital city of transport logistics is a further advantage in developing energy-saving and environment-friendly transportation processes. As even with a local energy supply large-scale power stations cannot be dispensed with entirely, a further advantage is that the TUHH has nationally and internationally acknowledged institutes in this area that are strong in research. This sound knowledge infrastructure enables institutes participating in the research center to investigate the entire energy conversion chain from primary to final energy effectively for improvement potential.

In spite of their diversity, Climate-Protecting Energy and Environmental Engineering research center projects can be roughly divided into three subareas: efficient energy conversion and distribution, efficient utilization of biomass, and energy- and water-efficient settlement technology. Specific issues are, for example, a coal-fired power station with carbon dioxide separation, putting wastewater and solid waste to energy use in urban areas, energy-saving and heat recovery in water supplies, or assessing the consequences of climate change for agriculture in north Germany. Work is also under way on improving insulation of old buildings, on more efficiently cooled batteries and on better air conditioning systems. In collaboration with power utilities, consideration is also being given to how many small-scale gas-fired power stations can create a large virtual power station, how algae can be utilized as a source of biomass, and how water systems can be optimized.

Although each individual project in which the research center is involved aims to improve the entire energy conversion chain, attention is also paid to whether there may be alternative approaches and to the repercussions that the different approaches may have on the climate or the environment. In addition, common basic methods are to be developed in the individual projects to evaluate energy paths, for instance, or for numeric modeling of the different process chains. Public and internal workshops, seminars - especially postgraduate seminars - and above all joint projects provide the framework for this interdisciplinary work.

In its ambitious scientific projects the Climate-Protecting Energy and Environmental Engineering research center thereby strengthens and utilizes the especially cross-research system approach at the TUHH, which requires an overall view of technical correlations from the outset.

Coordinators

Prof. Dr.-Ing. Ralf Otterpohl

Prof. Dr.-Ing. Gerhard Schmitz

TUHH
CLIMATE-PROTECTING ENERGY AND ENVIRONMENTAL ENGINEERING

Prof. Dr.-Ing. Ralf Otterpohl
Phone 040 42878-3007, Fax -2684
E-Mail otterpohl@tuhh.de
Eißendorfer Straße 42
21073 Hamburg, Germany

Prof. Dr.-Ing. Gerhard Schmitz
Phone 040 42878-3144, Fax -2632
E-Mail schmitz@tuhh.de
Denickestraße 17
21073 Hamburg, Germany

Participating Institutes
• Institute of Electric Power Systems and Automation • Institute of Energy Technology • Institute of Environmental Technology and Energy Economy • Institute of Multiphase Flows • Institute of Process and Plant Engineering • Institute of Solids Process Engineering and Particle Technology • Institute of Thermal and Separation Processes • Institute of Transport Planning and Logistics • Institute of Wastewater Management and Water Protection • Institute of Water Resources and Water Supply

• Information & Contact: *www.tuhh.de/fsp-energieumwelt.html*

AERONAUTICS

From quiet and comfortable cabins, better communication systems, more comfortable seats and optimal air conditioning to more environment-compatible and energy-efficient aircraft systems, the Aeronautics research center investigates nearly all aspects of modern aviation, and Hamburg is a location that offers ideal opportunities to collaborate directly with leading system providers, suppliers and operators.

Since the beginning of 2000 the volume of international aviation has risen by an annual average of 5 percent, with no end to this constant increase in sight. To make the aviation industry more economic and more environment-friendly (and thereby more competitive and sustainable), strategic targets were set at the European level a few years ago that have exerted a major influence on the research landscape. They include reducing production costs by 35 percent, maintenance costs by 25 percent and fuel costs by 20 percent. Furthermore, development times are to be cut by 20 percent, external and internal noise levels by 10 percent and, last but not least, nitrous oxide and carbon dioxide emissions by 80 and 50 percent respectively.

Achieving these targets will require systematic further developments and new technologies ranging from lighter yet reliable structures such as CFC fuselages and wing sections to entirely new aircraft concepts such as the blended wing body, which is still at the research stage. The TUHH's Aviation research center aims to play a leading role in shaping these technologies and taking them forward, with activities that focus mainly on aircraft systems and equipment, cabins and comfort, materials and production, aircraft design and air transportation systems.

With local industry giants such as Airbus and Lufthansa Technik along with many smaller aeronautics specialists, Hamburg is an internationally outstanding civil aviation industry location and is therefore predestined to have an Aviation research center. Active collaboration between industry and the participating TUHH institutes ensures both corporate innovation and training of qualified employees, and does so sustainably and on a long-term basis. The research center's projects are geared to international research strategies aimed primarily at developing new foundations and technologies for designing, manufacturing, operating and utilizing aviation systems.

The intensive interdisciplinary collaboration of TUHH institutes in aviation, mechanical and electrical engineering is especially beneficial for this research work. In fact, the expertise of specialists in different disciplines, such as acoustics, thermodynamics, systems technology, design, and composites, can flow together effectively. In the process, synergy effects can be put to good use, leading to a strengthening of the research center's competences both internally as well as externally, which improves the university's prospects of third party funding.

Systems and Cabins research, for example, is focused on developing new acoustics concepts for aviation. To do so, TUHH scientists are conducting research into acoustically optimized materials, new kinds of cabin walls that reduce noise, or a virtual cabin with the aid of which the acoustics within the aircraft can be improved on the computer. The Systems and Cabins specialists are also investigating interaction between man and machine in the cabin, aircraft seat design, and strategies to safeguard jobs and locations. Other interdisciplinary topics are the increasing automation of aircraft systems and the optimization of development processes and tool chains up to and including hardware-in-the-loop tests.

In Materials and Production, all aspects of production are investigated. The research center's scientists are working, for example, on accelerating and ensuring serial production, a faster market launch and early achievement of a high level of technological maturity. To do so they are developing new assembly processes as well as methods and innovative logistics concepts. Another project in this research area is the Digital Boarding Assistant, a prospective replacement for the boarding card that is designed to relay passenger data wirelessly to a computer system. Work is also under way on wireless cabin networks to provide high data rates. These wireless networks will also reduce cables, - i.e. weight, and simpliy assembly and installation.

All of the research center's projects reflect both the competence of participating institutes and the current research requirements of aviation. Its success in the BMBF's top-ranking cluster competition with Hamburg's integrated New Flying strategy demonstrates that this kind of collaboration between science and industry is both wanted and important.

Coordinators

Prof. Dr.-Ing. Otto von Estorff

Prof. Dr.-Ing. Frank Thielecke

TUHH
AERONAUTICS

Prof. Dr.-Ing. Otto von Estorff
Phone 040 42878-3032, Fax -4353
E-Mail estorff@tuhh.de
Denickestraße 17
21073 Hamburg, Germany

Prof. Dr.-Ing. Frank Thielecke
Phone 040 42878-8201, Fax -8270
E-Mail frank.thielecke@tuhh.de
Neßpriel 5
21129 Hamburg, Germany

Participating Institutes
• Institute of Aircraft Cabin Systems • Institute of Aircraft Production Technology • Institute of Aircraft Systems Engineering • Institute of Air Transportation Systems • Institute of Communication Networks • Institute of Laser and System Technology • Institute of Modelling and Computation • Institute of Polymer Composites • Institute of Product Development and Mechanical Engineering Design • Institute of Production Management and Technology • Institute of Reliability Engineering • Institute of Telematics • Institute of Thermo-Fluid Dynamics • Physical Metallurgy and Material Technology Workgroup

• Information & Contact: *www.tuhh.de/forschung/fsp*

MARITIME SYSTEMS

From “singing” ship’s propellers and more efficient, low-emission large diesel engines to safe hull designs, the TUHH’s Maritime Systems research center tackles the wide range of urgent topics that European shipbuilding faces. To ensure a future for maritime industry, the research scientists aim to be at least as much better as they are more expensive than the competition.

With the North and Baltic Seas and the Elbe River on its doorstep, water has always been and continues to be the determining element of the Hanseatic City of Hamburg. Several shipyards large and small are based in Germany’s largest port -and the largest in Europe after Rotterdam and Antwerp. Their combined sales revenue is over one billion euros a year. These circumstances, combined with the TUHH’s engineering expertise, are ideal preconditions for a Maritime Systems research center at the TUHH. Its aim is to deal with the urgent issues of shipbuilding and ocean engineering and find solutions to ensure the long-term future of the maritime economy in Hamburg and Europe.

To do so, German and European shipbuilding, along with maritime systems technology combined with maritime infrastructure and logistics, must be thoroughly renewed and at the same time sustainably further developed. The interdisciplinary Maritime Systems research center basically pursues two research approaches, one of which can be summarized as Shipbuilding and Maritime Systems Technology. It investigates, inter alia, issues relating to the safe construction and operation of ships, more economic production processes and more efficient on-board systems.

The other research approach, Maritime Infrastructure and Logistics, deals mainly with areas such as safe offshore structures, for example oil platforms and wind farms, and new concepts in maritime transportation. Work on the many different Maritime Systems research center projects is based on three pillars. Scientists conduct research into the basics, work on state-of-the-art scientific and technological standards for industry, and advise the public sector.

Successful implementation of the research center’s extensive range of projects is not just desirable; it is essential to ensure that the industry remains competitive. Few if any sectors have been hit so hard by the current economic crisis as the maritime industry, and it is to be feared that a not

inconsiderable proportion of jobs in the industry could be lost unless countermeasures are taken. The only way to deal with this situation is to ensure that European ships really are as better as they are more expensive. An important factor in this respect is to optimize the energy efficiency of ships and their systems. Energy can, for example, be saved by deflecting propeller currents and changing the cavitation and by cavitation analysis or improved maneuvering. Further research areas include reducing large diesel engines' nitric oxide emissions and their sulfur dioxide by after-treatment of exhaust gases or by transient storage of propeller shafts.

Overall, all of the research center's projects are intended to contribute toward swift and successful System 30 implementation (ships built in Germany are in future to become 30 percent better and safer, to use 30 percent less fuel and emit 30 percent less noxious substances, and to command a 30 percent larger market share). Lifecycle costs and throughput time are also to be reduced by 30 percent and handling performance is to be increased by 30 percent. The medium- to long-term plan is to transform the research center into a research group that in turn will be enlarged into a collaborative research center where Safety of Maritime Systems will be taken up on a large scale. At present, the plan is to combine these activities under the heading Sustainability and Safety in the Design, Production and Operation of Ships and Their Components.

Implementing the Maritime Systems research center's ambitious objectives will not only contribute in the long term toward safeguarding the future of the maritime industry in Germany but also at the same time actively extend the lead the TUHH enjoys in shipping research in Germany -and thereby ensure for many years a supply of young research scientists with first-rate training.

Coordinators

Prof. Dr.-Ing. Stefan Krüger

Prof. Dr.-Ing. Moustafa Abdel-Maksoud

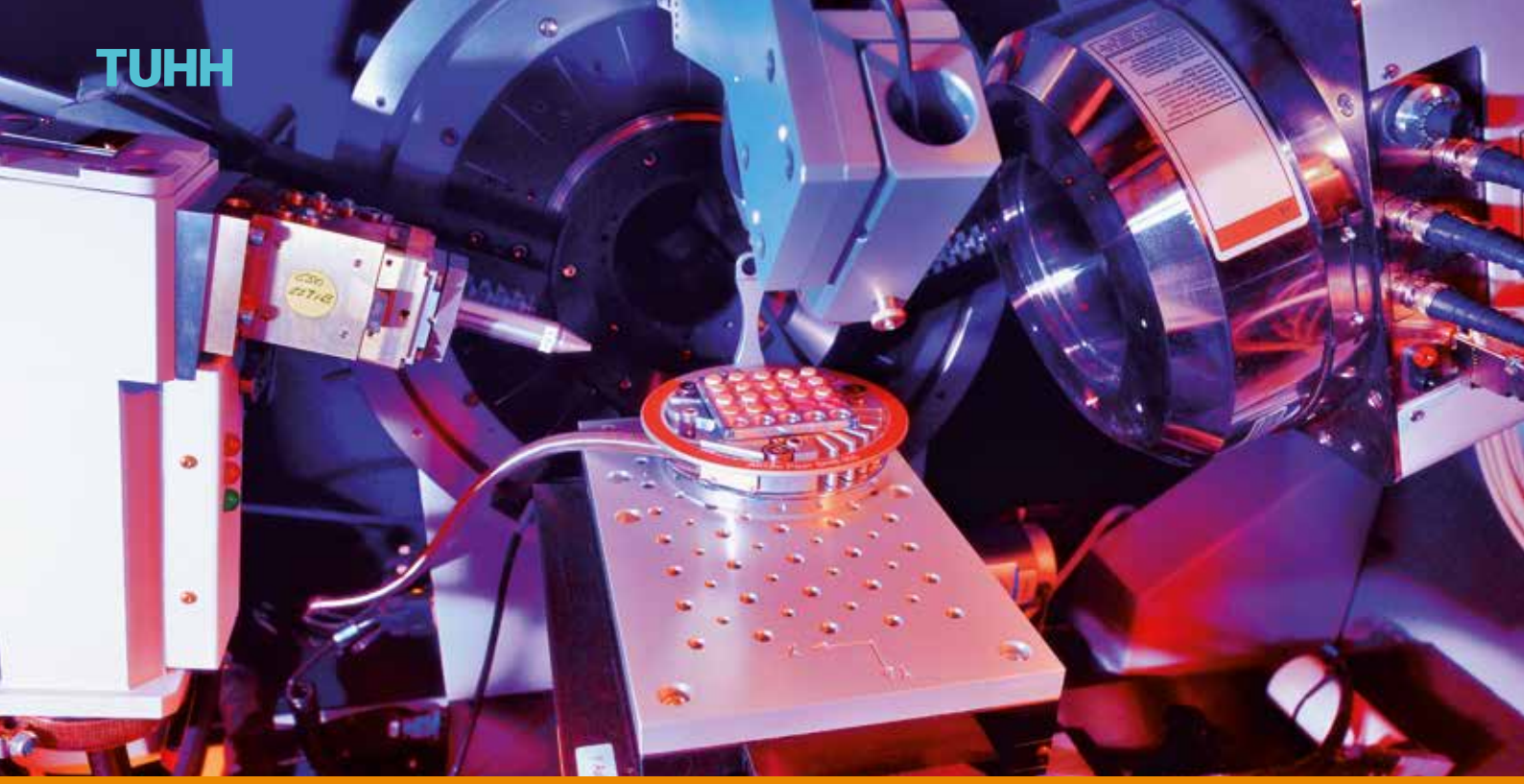
TUHH MARITIME SYSTEMS

Prof. Dr.-Ing. Stefan Krüger
Phone 040 42878-6105, Fax -6139
E-Mail krueger@tuhh.de
Schwarzenbergstraße 95
21073 Hamburg, Germany

Prof. Dr.-Ing. Moustafa Abdel-Maksoud
Phone 040 42878-6053, Fax -6055
E-Mail m.abdel-maksoud@tuhh.de
Schwarzenbergstraße 95
21073 Hamburg, Germany

Participating Institutes
• Institute of Business Logistics and General Management • Institute of Electric Power Systems and Automation • Institute of Energy Systems • Institute of Fluid Dynamics and Ship Theory • Institute of Geotechnical Engineering and Construction Management • Institute of Laser and System Technologies • Institute of Measurement Technology • Institute of Mechanics and Ocean Engineering • Institute of Production Management and Technology • Institute of Ship Design and Ship Safety • Institute of Ship Structural Design and Analysis • Institute of Transport Planning and Logistics

• Information & Contact: *www.tuhh.de/forschung/fsp*



PRODUCT-ORIENTED MATERIALS DEVELOPMENT

Applied materials development is one of the most important driving forces of the enormous innovative potential of Germany's science landscape. Materials developments envisioned at the TUHH's Product-Oriented Materials Development research center will contribute inter alia to improved and intelligent components that play a part in environmental protection and boost profitability.

To put it pointedly, one might say it was the idea of using materials systematically that made humankind an intelligent species. From the use of natural materials such as wood, stone or animal hide via the first systematic steel alloys in the industrial revolution to the modern high-temperature materials that are used in aircraft engines and gas turbines, without materials innovation there would have been no scientific progress. The economic performance of today's leading industrial countries is to a great extend based on the production and processing of modern materials.

That is why materials technology is classified as an interdisciplinary technology and enjoys special funding status in the Federal Ministry of Education and Research's High-Tech Strategy for Germany. The aim of the Product-Oriented Materials Development research center is to bundle existing materials research competences at the TUHH and network them with engineering design and production and process engineering. This is to lead to synergies that contribute toward the development of innovative concepts for marketable products based on new materials.

To take this application-oriented basic research forward into product development as swiftly as possible, the research center includes in its activities the competences and technologies of non-university research facilities, especially the Helmholtz-Center Geesthacht and DESY research centers, and other industrial cooperation partners. This collaboration aims to ensure that as much of the alloy or materials development value chain as possible finds its way into product manufacture. The research center thereby seeks to create an efficient platform for new product developments and cooperation arrangements with other university and non-university research institutions.

Starting with current research projects at the research center's participating TUHH institutes, work is to focus on high-throughput and knowledge-based materials development methods, materials, process and component modeling, multifunctional materials, component design using high-performance materials, and novel lightweight materials. A wide range of activities is already under way in the last-named area, with a focus on developing novel, extraordinarily damage-tolerant lightweight materials with integrated sensors and actuators.

Materials of this kind have built-in functions that enable them to undertake their own health monitoring. This new concepts exceed the previous confines of materials production. Three research groups at the research center are already looking into multiple aspects of this new class of materials.

One is developing novel ceramic-metal polymer composites with a very low polymer content for use as an "adhesive" between ceramic and metallic particles. The inspiration for this new material comes from nature. Hard tissue such as tooth enamel or mother of pearl is very hard and firm even though soft proteins and water create connecting bridges. Other research deals with new, very long-lasting plastic composites that will make a contribution toward environmental protection. Carbon nanotubes are incorporated in the plastic matrix to stop cracks from developing, thereby greatly prolonging the service life of components made of the material and enabling windfarms and aircraft to continue in use for longer periods. The thermal and electrical properties of the polymer composites are also improved.

Further projects lead to novel materials systems with mechanical stability and low heat conductivity at high temperatures. They are to achieve this by reflecting heat radiation and thereby reducing the heating of a component effectively – and prolonging its service life. With its wide-ranging activities the Product-Oriented Materials Development research center thus makes an active contribution toward maintaining and increasing the innovation capability of the science landscape in Germany.

Coordinators

Prof. Dr. Gerold Schneider

Prof. Dr.-Ing. Karl Schulte

TUHH
PRODUCT-ORIENTED
MATERIALS DEVELOPMENT

Prof. Dr. rer. nat. Gerold Schneider
Phone 040 42878-3037, Fax -2647
E-Mail g.schneider@tuhh.de
Denickestraße 15
21073 Hamburg, Germany

Prof. Dr.-Ing. Karl Schulte
Phone 040 42878-3138, Fax -2002
E-Mail schulte@tuhh.de
Denickestraße 15
21073 Hamburg, Germany

Participating Institutes
• Institute of Advanced Ceramics • Institute of Biomechanics • Institute of Chemical Reaction Engineering • Institute of Materials, Physics and Chemistry of Buildings • Institute of Materials Physics and Technology* • Institute of Microsystems Technology • Institute of Modeling and Computation • Institute of Nanoelectronics • Institute of Optical and Electronic Materials • Institute of Polymers and Composites • Institute of Product Development and Mechanical Engineering Design • Institute of Production Management and Technology
Associate members: Prof. Dr. rer. nat. Volker Abetz, Helmholtz Zentrum Geesthacht, Prof. Dr. rer. nat. Andreas Schreyer, University of Hamburg*

**Appointed jointly with the Helmholtz Center, Geesthacht*

• Information & Contact: *www.tuhh.de/forschung/fsp*

REGENERATION, IMPLANTS, MEDICAL TECHNOLOGY

An improved patient care, increased life expectancy and quality of life, and relieve of the health insurance - the expectations of modern medical technology could hardly be higher. The research center "Regeneration, Implants, Medical Technology" is responding to the challenges ahead, in collaboration with competent partners in the health care practice, for effective solutions.

It is still little more than a vision that patients will one day be supplied on a routine basis with organs or tissue from a bioreactor – just as reliable as a cardiac bypass operation on the heart today. The research center "Regeneration, Implants, Medical Technology" TUHH is working to ensure that this vision can really come true. Its relevance is obvious due to the demographic trends forecast for Germany. According to the Federal Statistics Office there will be fewer and fewer children and a significantly larger number of older people. Due to this aging of society, the number of cases of disease in Germany will increase sharply in the coming decades to come.

To find sustainable solutions to the complex scientific – and economically relevant – issues that are associated with this trend, the research center "Regeneration, Implants, Medical Technology" research center seeks active coope-ration with various prestigious institutions in and around Hamburg, such as the University Hospital Eppendorf, the Helmholtz-Centre for Materials and Coastal Research, and various medical technology companies. The TUHH institutes participating in the research center can contribute their outstanding engineer-ing competence in medical technology – a competence that is acknowledged well beyond the city's borders.

To meet the requirements of the strong interdisciplinary nature of research projects in medical technology, scientists from wide-ranging disciplines are joining their forces in the research center "Regeneration, Implants, Medical Techno-logy". These range from laser and plant systems technology, thermo-fluid dynamics, mechanics and ocean engineering via thermal process engineering, nanoelectronics, metrology, and numeric simulation to bioprocess and biosystems technology, biome-chanics, and plastics and composites.

In 2008/09, research scientists in these different fields, all of which are important for medical technology, raised over four million euros in funding. The aim of the research center is to deepen the already existing, successful medical research content under one roof, or to expand the research groups. The work group that emerged from the TUHH quality offence "Tissue Engineering" is one of the focal points of "regeneration". Its research scientists are, for example, are working on biohybrid implants, which connect biological and technical components such as cells and electrodes, and which can be grown in special bioreactors.

The work group can build on knowledge gained at the TUHH in an already completed project to develop a biohybrid joint implant. It seeks collaboration with highly specialized tissue engineering firms. Alongside tissue engineering, other collabo-rative research activities will take shape as a result of interac-tion, cooperation and knowledge transfer between individual institutes. A group of research scientists has been established to look into Bioreaction Technology for Tissue Cultivation, for example, and another is to deal with Implants and Medical Technology.

Ongoing research deals inter alia with implant technologies to warn against the occurrence of aneurysms in the aorta or monitor body functions such as heartbeat or brain waves, with the influence of electric fields on cell growth, and with an artificial hand. The last-named project is undertaken in close cooperation with the Federal Research Ministry. Subjects dealt with are continuously extended, updated, and evaluated; thereby laying the groundwork for a dynamic research landscape and enabling long-term bundling of the participating institutes' different research interests. The research center "Regeneration, Implants, Medical Technology" is very much open to new members because new ideas boost quality.

Coordinators

Prof. Dr.-Ing. Wolfgang Krautschneider

Prof. Dr.-Ing. Ralf Pörtner

TUHH
REGENERATION
IMPLANTS
MEDICAL TECHNOLOGY

Prof. Dr.-Ing. Wolfgang Krautschneider
Phone 040 42878-3030, Fax -2877
E-Mail krautschneider@tuhh.de
Eißendorfer Straße 38
21073 Hamburg, Germany

Prof. Dr.-Ing. Ralf Pörtner
Phone 040 42878-2886, Fax -2909
E-Mail poertner@tuhh.de
Denickestraße 15
21073 Hamburg, Germany

Participating Institutes
• Institute of Advanced Ceramics • Institute of Biomechanics • Institute of Bioprocess and Biosystems Engineering • Institute of High Frequency Technology • Institute of Laser and System Technologies • Institute of Mathematics • Institute of Measurement Technology • Institute of Mechanics and Ocean Engineering • Institute of Microsystem Technology • Institute of Nanoelectronics • Institute of Polymer Composites • Institute of Thermal and Separation Processes • Institute of Thermo-Fluid Dynamics

• Information & Contact: *www.tuhh.de/forschung/fsp*

SELF-ORGANIZING WIRELESS SENSOR AND DATA NETWORKS – SOMSED

Reliable wireless mobile sensor and radio data transmission networks that are self-organizing and provide their own energy supply are the key to comprehensive information across countless technical and biological systems. They will open up totally new application opportunities. Where economic issues too are concerned, the increase in knowledge gained in this way will in future become more and more important.

Knowledge is power. In the technological and scientific sense, knowledge is gained by, for example, measuring component conditions or environmental parameters by means of sensor technology. The more information that can be acquired in this way, the more detailed is the picture that is desired. In practice, the uses to which sensor technology can be put are often still limited. Power cables or short-lived batteries and the sheer size and, not least, high cost of sensors today rule out interesting possibilities and advanced application areas.

This is precisely where the work of the Self-Organizing Wireless Sensor and Data Networks research center, or SomSed, to use its German abbreviation, kicks in. The many participating TUHH institutes aim to conduct research into the basic and applied technology for lasting, comprehensive measurement of physical and biological parameters, including the relevant signal evaluation technology, by means of wireless sensor networks.

These networks consist of stationary or mobile sensor nodes with measuring technology, actuators, data processing unit, energy supply and wireless radio data transmission interface integrated in the smallest space. Used principally in inaccessible places such as an aircraft's landing gear, they can achieve a significantly higher spatial resolution for a large number of phenomena than has previously been possible. The nodes can do independent calculations – and thereby proceed immediately to intelligent processing of the data readings.

In an aircraft a wireless sensor network of this kind, generating its own energy, could inter alia monitor the condition and functioning of the many actuators that measure temperature and humidity in the cabin and keep an eye on the integrity of the wings and fuselage. This makes use of several advantages: no cables are required to supply energy, thereby reducing weight and, in the final analysis, fuel consumption; it also enables sensors to be fitted faster and easier. If you

always know what condition components are in, you only need to replace them when it is really necessary and no longer need to check and replace them at regular intervals on suspicion, as it were, as is currently the case. That saves time and money.

Equally conceivable is a highly dynamic traffic monitoring system in which each car is equipped with several sensors to form a mobile node in a network of sensors. Further potential uses are in environmental monitoring at, say, a chemicals factory, or as an early warning system for volcanic eruptions, forest fires and other natural disasters. There is also a wide range of potential new uses in medical and maritime systems and logistics and robotics.

The new wireless sensor networks will not only be able to relay much more information than in the past but also be of great economic significance, especially where sensors are used in a hostile environment where taking measurements is complicated or cabling is either very expensive or impossible. That is special attention is also paid at the SomSed research center to the weather resistance, robustness and independent energy supply of sensor nodes. The target is a minimum service life of ten years. Nodes are to generate the power on which they run by using energy harvesting methods and converting inter alia vibrations, heat or light into electric power.

As potential deployment scenarios and size of networks largely rule out manual monitoring and control, the networks in question must be able to ensure that they function even when partially defective without external intervention. The theoretical basis of this is the concept of self-organization. In other words, the influences that define structure and behavior originate from the elements of the self-organizing system itself and a central control unit is dispensed with.

The vision the research center is pursuing is clear: wireless sensor networks with thousands of nodes that can be deployed flexibly and function reliably and as self-sustaining systems for a long time. This research approach is unique in Germany in its scientific diversity and size.

Coordinators

Prof. Dr.-Ing. Andreas Timm-Giel

Prof. Dr. Volker Turau

TUHH
SELF-ORGANIZING
WIRELESS SENSOR AND
DATA NETWORKS

Prof. Dr.-Ing. Andreas Timm-Giel
Phone 040 42878-3049, Fax -2981
E-Mail timm-giel@tuhh.de
Schwarzenbergstraße 95
21073 Hamburg, Germany

Prof. Dr. Volker Turau
Phone 040 42878-3530, Fax -2581
E-Mail turau@tuhh.de
Schwarzenbergstraße 95
21073 Hamburg, Germany

Participating Institutes
• Institute of Automation Systems • Institute of Communication Networks • Institute of Control Systems • Institute of Measurement Technology • Institute of Microsystem Technology • Institute of Nanoelectronics • Institute of Security in Distributed Applications • Institute of Software Systems • Institute of Telecommunications • Institute of Telematics • Optical Communication Technology Workgroup

• Information & Contact: *www.tuhh.de/forschung/fsp/somsed.html*

COLLABORATIVE RESEARCH CENTER (SFB 986) „TAILOR-MADE MULTI-SCALE MATERIALS SYSTEMS – M³“

The long-term research goal of the Collaborative Research Center “SFB 986: Tailor-Made Multi-Scale Materials Systems - M3” is to develop experimental methods for producing and characterizing multi-scale structured materials with tailor-made mechanical, electrical, and photonic characteristics. It has been approved by the German Research Foundation (DFG) under the leadership of TUHH in close collaboration with the University of Hamburg and the Helmholtz-Zentrum Geesthacht. Within the SFB 986, 20 project leading scientists work on a cross-disciplinary approach to develop completely new types of materials.

The special innovation potential of the SFB 986 lies in how the materials are assembled: predominantly, from single building blocks of distinct discrete length scales. This hierarchical composition opens up possibilities to exchange building units in a concerted way in order to discretely alter materials properties and, thus, to achieve entirely new materials functions. In addition to the required experimental methods and based on their results, theoretical materials models are refined. Hence, the SFB 986 not only gains experimental expertise but also a theoretical understanding of how a hierarchical composition determines materials behavior. To this end, theoretical modeling includes atomistic, meso-scale, and continuum models.

For the hierarchical structures, the single building blocks are comprised of polymers, ceramics, metals, and carbon (in form of carbon nanotubes and aerographites). They form core-shell structures or cavities filled with polymers and, in turn, assemble to build up structured and functionalized units from the atom to the macro-scale.

The three project areas of the SFB 986 use different materials systems and vary both the multi-scale structure and the functionalized properties: While project area A focuses mainly on quasi-self-similar structures with multifunctional properties, project area B aims to generate integrated nanostructured multiphase material systems with a structural design that combines strength and functional, especially, electrical, properties. The main emphasis in project area C is on highly ordered hierarchical periodic and aperiodic structures and their photonic properties at high temperatures.

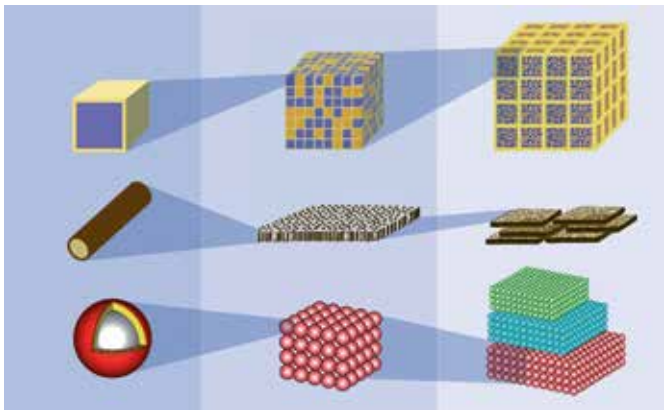


Chart: Schematic description: Structure of the three Multi-scale Materials Systems

By harnessing the inter-disciplinary potential of the SFB 986, the scientists in the three project areas will develop innovative macroscopic, multi-scale structured materials and components, the properties of which can be changed discontinuously by a controlled exchange of components. If the scientists succeed in implementing this concept, entirely new kinds of materials functions are expected.

Coordinators

f. left: Jörg Weißmüller (Head of projekt area B), Manfred Eich (Head of projekt area C, Vice-Chairman), Gerold Schneider (Head of projekt area A, Speaker), Norbert Huber (Vice-Chairman).

Speaker, Chairman

Prof. Dr. rer. nat. Gerold Schneider
Phone 040 42878-3037, Fax -2647
E-Mail g.schneider@tuhh.de
Hamburg University of Technology
Institute of Advanced Ceramics
Denickestraße 15
21073 Hamburg, Germany

Vice-Chairman of Collaborative Research Center

Prof. Dr.-Ing. Norbert Huber
E-Mail norbert.huber@hzg.de
Helmholtz-Zentrum Geesthacht -
Institute of Materials Research
Max-Planck-Straße 1
21502 Geesthacht, Germany

Prof. Dr. rer. nat. Manfred Eich
Phone 040 42878-3147
E-Mail m.eich@tuhh.de
Hamburg University of Technology
Institute of Optical and Electronic Materials
Eißendorfer Straße 38
21073 Hamburg, Germany

Participating Institutes and Partners

Hamburg University of Technology • Institute of Advanced Ceramics • Institute of Materials Physics and Technology • Institute of Optical and Electronic Materials • Institute of Polymer Composites • Institute of Solids Process Engineering and Particle Technology • Central Division Electron Microscopy • Center for Teaching and Learning - Engineering education • **Universität Hamburg** • Institute of Applied Physics • Institute of Physical Chemistry • **Helmholtz-Zentrum Geesthacht Center for Materials and Coastal Research** • Institute of Materials Research • Institute of Polymer Research

• Information & Contact about participating Partners: www.tuhh.de, www.min.uni-hamburg.de, www.hzg.de

JOACHIM HERZ STIFTUNG

LEXI
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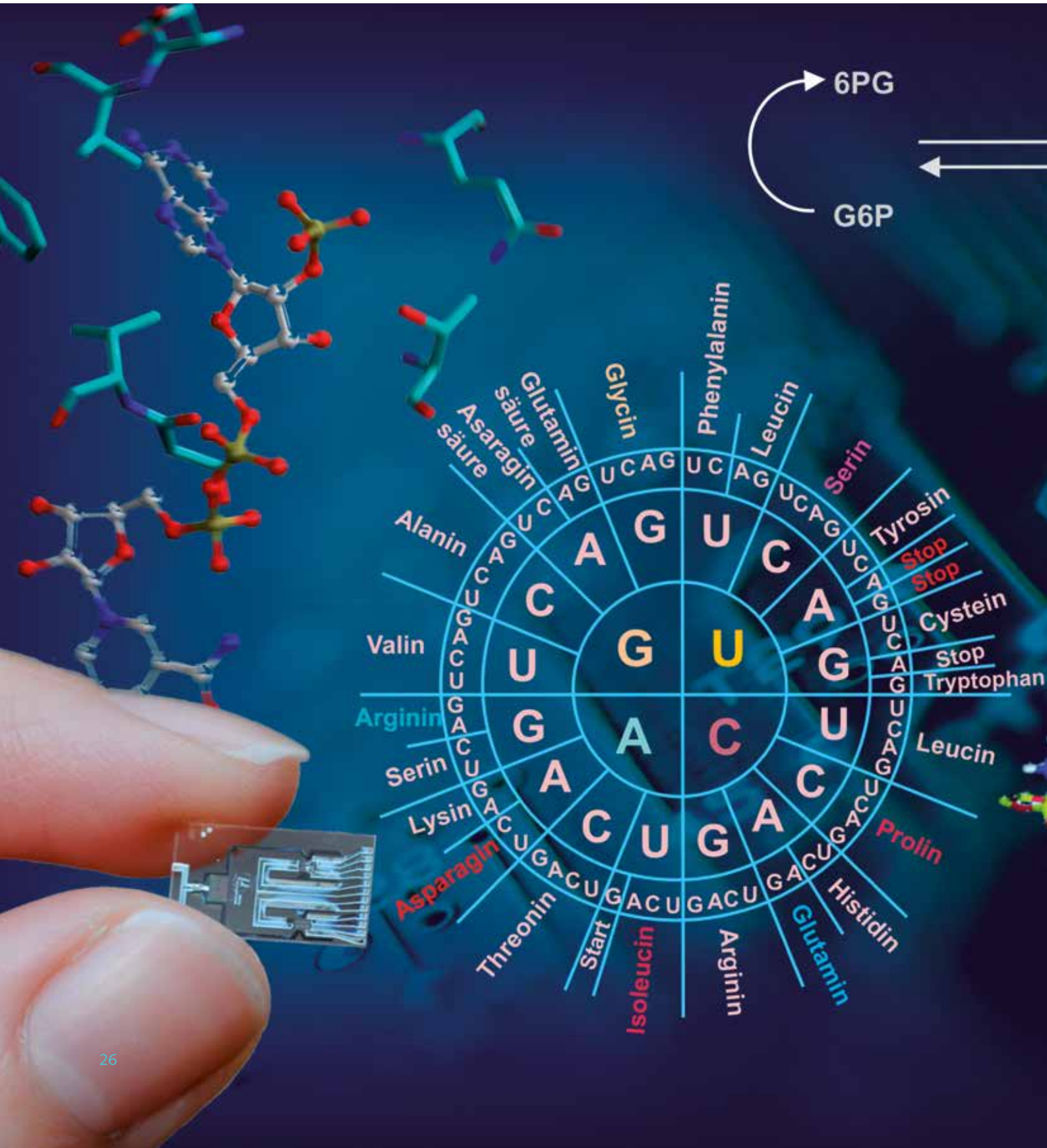


FUNDAMENTALS FOR SYNTHETIC BIOLOGICAL SYSTEMS (SynBio)

Both biology and engineering are entering new areas owing to rapid advances in enabling technologies such as genome sequencing, functional genomics, computation, microfluidics, nanotechnology, systems and synthetic biology.

The cluster SynBio studies biological and technological fundamentals of synthetic biology as an emerging new field. In addition to better understanding natural bioprocesses synthetic biology particularly aims at generating efficient and interchangeable parts by molecular-biological and engineering tools or directly from natural biology by screening and assembling them into technologically artificial but useful biological systems. Synthetic biology has thus a high potential for applications such as targeted synthesis of biopharmaceuticals, sustainable chemical industry and energy generation, and production of smart (bio)materials. Parallels have been drawn between the design and manufacture of semiconductor chips in information and communication technologies (ICTs) and the construction of standardized biological parts (also called biobricks) in synthetic biology. Whereas semiconductor and microelectronics have revolutionized ICTs, it is expected that synthetic biology in combination with microfluidics and nanotechnology has similar impacts for biotechnology and life sciences in the near future.

The structural and scientific objectives of SynBio are to establish an interdisciplinary and excellent research cluster in Hamburg with focus on studying fundamentals for developing novel synthetic biocatalytic pathways and systems with applications in biotechnology and life sciences.

Coordinators

Prof. Dr. An-Ping Zeng

Prof. Dr. Dr. h.c. Garabed Antranikian

TUHH

Prof. Dr. An-Ping Zeng
Phone +49 40 42878-4183, Fax -2909
E-Mail aze@tuhh.de
Denickestrasse 15
21073 Hamburg, Germany

Prof. Dr. Dr. h.c. Garabed Antranikian
Phone +49 40 42878-3117, Fax -2582
E-Mail antranikian@tuhh.de
Kasernenstrasse 12
21073 Hamburg, Germany

Participating Institutes
TUHH • Institute of Bioprocess and Biochemical Engineering • Institute of Technical Biocatalysis • Institute of Technical Microbiology • Institute of Thermal and Separation Processes • Institute of Thermo-Fluid Dynamics • Institute of Microsystems Technology • **University of Hamburg** • Center for Bioinformatics • Inorganic and Applied Chemistry • **European Molecular Biology Laboratory** (EMBL), DESY

• Information: *www.tuhh.de/synbio*

JOACHIM HERZ STIFTUNG

LEXI
LANDESEXZELLENZINITIATIVE HAMBURG

INTEGRATED MATERIALS SYSTEMS (IMS)

The „Integrated Materials Systems (IMS)“ Cluster of Excellence is based on a cooperation between the Hamburg University of Technology, Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, Research Centre DESY and University of Hamburg. The objective of this research project is to develop microstructurally controlled, damage tolerant and lightweight materials with integrated sensing and actuating functions. The scientific challenge is to explore the high potential of IMS by combining the degrees of freedom of microstructural design with lightweight and functional materials. In the metropolitan region of Hamburg and its neighbouring North German states, major economic driving forces include the aircraft and automobile industries, wind power plants, medical technology and the Hamburg harbour, where lightweight structural parts are key components for future system development.

The scientific objective of the Cluster „Integrated Materials Systems“ (IMS) is to break the existing limitations of today‘s materials technologies by exploiting integrated materials systems. This class of materials shall evolve from completely new ways of combining a designed microstructure with a desired functionality. Such a development requires new concepts for the hierarchical design of interpenetrating microstructural networks with controlled topologies. The realisation of multiphase materials with controlled positioning of dispersed functional particles is envisaged by applying physics- and chemistry-based approaches such as bottom-up and top-down strategies, or combinations thereof to design the envisioned IMS on different length scales. The goal is to obtain novel exceptionally damage tolerant lightweight materials with integrated sensing, including health monitoring and actuating functions with adaptive properties.

Coordinators

Prof. Dr. Gerold A. Schneider (TUHH)

Prof. Dr. Norbert Huber (HZG/TUHH)

TUHH

Prof. Dr. rer. nat. Gerold Schneider
Phone +49 40 42878-3037, Fax -2647
E-Mail g.schneider@tuhh.de
Denickestrasse 15
21073 Hamburg, Germany

Prof. Dr.-Ing. Norbert Huber
Phone +49 4152 87-2500
E-Mail norbert.huber@hzg.de
Helmholtz-Zentrum Geesthacht –
Centre for Materials and Coastal Research
Max-Planck-Strasse 1
21502 Geesthacht, Germany

Participating Institutes
TUHH • Institute of Advanced Ceramics • Institute of Business Logistics and General Management • Institute of Chemical Reaction Engineering • Institute of Materials Physics and Technology • Institute of Microsystem Technology • Institute of Nanoelectronics • Institute of Optical and Electronic Materials • Institute of Polymer Composites • Institute of Product Development and Mechanical Engineering • Institute of Solids Process Engineering and Particle Technology • **University of Hamburg** • Institute of Applied Physics, Institute for Technical and Macromolecular Chemistry • **Helmholtz-Zentrum Geesthacht – Centre for Materials and Coastal Research** • Institute of Materials Research • Institute of Polymer Research • **DESY** German Electron-Synchrotron Hamburg

- Information: *www.tuhh.de/lexi*

TUTECH INNOVATION GMBH
KNOWLEDGE . TECHNOLOGY . MARKETS

Collaboration and exchange with industry belong to the characteristics of Hamburg University of Technology (TUHH). In order to strengthen its knowledge transfer TUHH has outsourced the organization and the management of transfer processes into an own company TuTech Innovation GmbH (TuTech).

TuTech is a private company with a public mission to promote effective transfer and exploitation of knowledge, especially by sharing and using science and technology for wealth creation and the benefit of society. For almost two decades TuTech has been helping businesses work with Hamburg University of Technology.

TuTech offers a range of services to support knowledge transfer:
- R&D collaboration and cluster management
- International cooperation and EU office
- Business start-ups and innovation funding
- Open innovation and social media
- Patenting and licensing
- Training and continuing professional development
- PR and "Science and Society" communication
- IT and web design
- Conferences and workshop organization
- Project controlling support

TuTech is at home in various disciplines; topics range from participatory democracy to aircraft construction. As strategic partner TuTech supports the research centers and institutes of TUHH in bilateral collaborations as well as in the development and coordination of national or European network and cluster projects with partners from science, economy and government. In Germany TuTech is responsible for two major biotechnology clusters and a flagship project on climate change.

BIOCATALYSIS2021 – Sustainable Biocatalysis Opening New Paths

Based on a joint research cooperation between industry and academia the cluster BIOCATALYIS2021, supported by the BMBF, is pursuing the goal of researching systematically the enormous potential of biocatalysts from microorganisms as to their possible application in industry. The primary goals of the Cluster are the use and application of new biocatalysts achieving novel synthetic effects by subjecting them to unconventional conditions (extreme temperatures, pressures, pH values, concentrations of salt and solvents). The enzyme systems are to be used both as final products and in subsequent processes for the production of fine chemicals and active agents.

Consortium

The cluster BIOCATALYSIS2021 coordinates the expert knowledge of 15 large companies, 19 small and medium-sized companies, as well as of 27 academic research groups and 7 agencies promoting innovations and economy.

BIOREFINERY2021 – New Approaches towards the Biorefinery of the Future

Biomass is a sustainable alternative to fossil feedstock, which is currently used to produce fuels, chemicals and other valuable goods. Innovative technologies utilizing renewable plant-based materials are envisioned to serve as the foundation of a new sustainable bioindustry. To date the main feedstock for biorefineries is based on starch. However, lignocellulose is a more attractive renewable resource since it is available in large quantities and does not compete with food or feed. The joint project BIOREFINERY2021, which is funded by the German Federal Ministry for Education and Research (BMBF), aims at the development of a fully integrated and sustainable bioindustry based on lignocellulose.

Consortium

The cluster is a joint project between 9 partners from academia and 7 partners from industry forming a unique consortium. The expertise of the partners covers all relevant fields required to develop the biorefinery of the future including microbiologists, chemists, engineers and economists.

KLIMZUG-NORD – Strategic Approaches to Climate Change Adaptation in the Hamburg Metropolitan Region

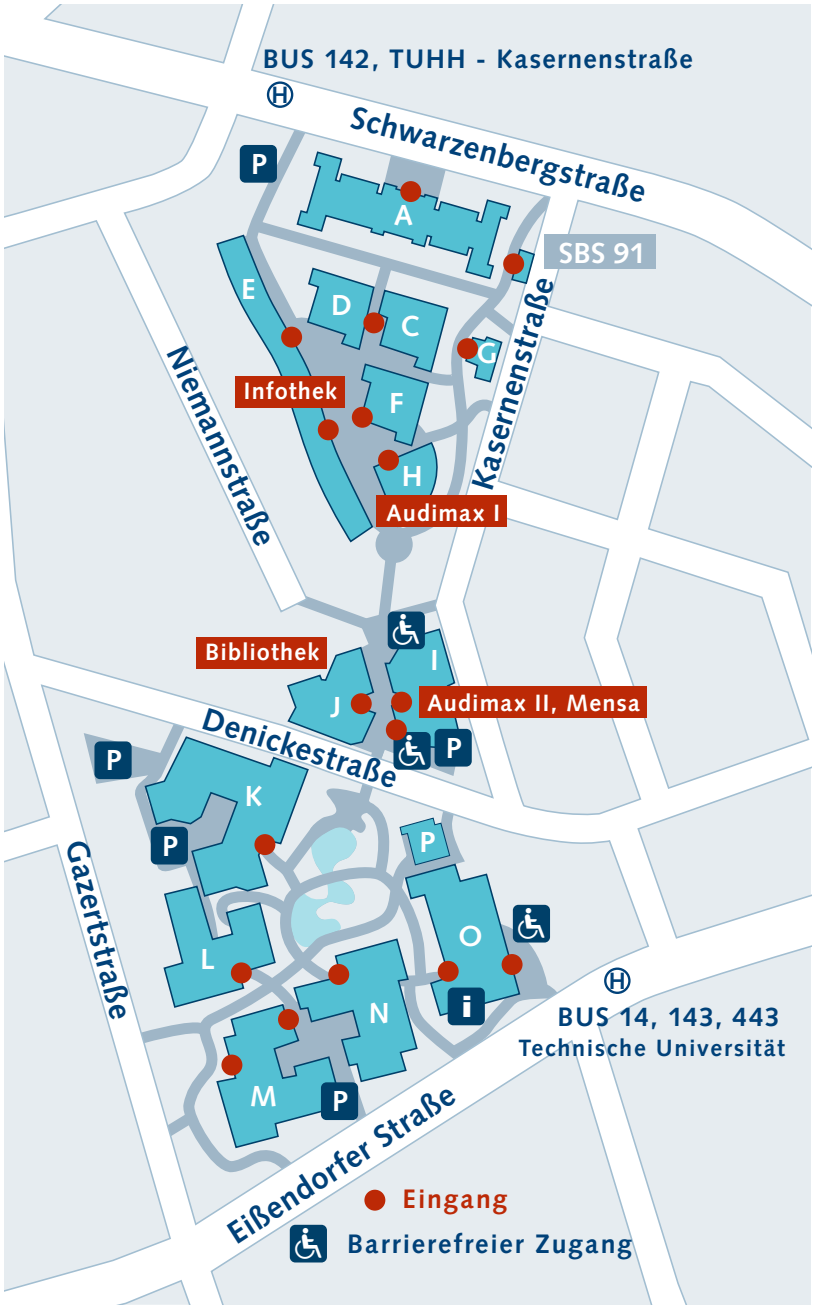
Within the research priority "KLIMZUG" the KLIMZUG-NORD project works with regional partners from 6 universities, 6 research centers, 10 offices related to city affairs, and 11 companies. The objective is to develop innovative strategies for adaptation to climate change and related regional weather extremes. The focus of this research is on three main topics concerning the impacts of climate change and how these can be dealt with: a) estuary river management, b) integrated urban development and c) sustainable cultivated environment.

Contact
TuTech Innovation GmbH
Harburger Schlossstrasse 6-12, 21079 Hamburg, Germany

Managing Director
Dr. Helmut Thamer

Phone +49 40 76629-6112
info@tutech.net **www.tutech.net**

UNIVERSITY CAMPUS



WITHIN EASY REACH

From Hamburg Airport: S1 rapid transit to Hamburg main station (Hauptbahnhof), then S31/S3 to Harburg-Rathaus or Heimfeld

By rail: Harburg is a station stop on the ICE and EC rail networks

By rapid transit: S31/S3 to Harburg-Rathaus or Heimfeld

By car from downtown Hamburg: via Elbbrücken and Wilhelmsburger Reichsstraße, Exit Hamburg-Harburg Mitte

By car: A1 autobahn (take Hamburg-Harburg exit), A7 autobahn (take Hamburg-Heimfeld exit), B75

CONTACT

Office of the President
Schwarzenbergstrasse 93/A
21073 Hamburg, Germany
Phone +49 40 42878-0
E-Mail pressestelle@tuhh.de

Managing Board of Research
Dr. Johannes Harpenau
Schwarzenbergstrasse 95/E
Phone +49 40 42878-3574
E-Mail harpenau@tuhh.de

Info Center
Phone +49 40 42878-2232
E-Mail studienberatung@tuhh.de
Office Hours
Monday and Wednesday, 9.00 am – 12.30 pm
Tuesday and Thursday, 13.00 pm – 16.00 pm

www.tuhh.de

Hamburg University of Technology
Schwarzenbergstrasse 95
21073 Hamburg, Germany

www.tuhh.de

Website

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