Dear colleagues and friends,

as you all know, the Cluster of Excellence EAM is presently in a transition phase. Current projects within EAM have been closed and new ones have been started as seed funding for the new proposal.

In April 2017, 195 draft proposals for new Clusters of Excellence were presented to DFG by 63 universities. After an international review by 21 panels based on research quality criteria, we were selected to proceed to the full proposal stage as one of 88 with our proposal for the Cluster of Excellence “Engineering of Functional Material Interfaces – From atomistic control to macroscopic performance (FUMIN)”. Under the leadership of Peter Wasserscheid, the aim of FUMIN is to make groundbreaking steps towards the fully-rational design and knowledge-driven engineering of functional interfaces to strengthen FAU’s leading position in materials and process research. Interfaces are decisive for many material properties. FUMIN’s focused and highly-interdisciplinary research program promises revolutionary developments in functional interfaces and breakthroughs in key areas of innovation such as materials research, chemical industry and energy technologies. The full proposal was submitted to DFG in February and our assessment took place in April in Munich. We have invested our utmost efforts into mastering this challenge.

In this issue of our newsletter, we report on two highlights from last fall. The first is the International Congress Engineering of Advanced Materials (ICEAM2017) that placed interdisciplinary research in the context of international materials and process research. Interfaces are decisive for many material properties. FUMIN’s focused and highly-interdisciplinary research program promises revolutionary developments in functional interfaces and breakthroughs in key areas of innovation such as materials research, chemical industry and energy technologies. The full proposal was submitted to DFG in February and our assessment took place in April in Munich. We have invested our utmost efforts into mastering this challenge.

In this issue of our newsletter, we report on two highlights from last fall. The first is the International Congress Engineering of Advanced Materials (ICEAM2017) that placed interdisciplinary research in the context of international materials and process-related science and technology. At the congress, top class results and insights from the past ten years of regular EAM funding were presented in conjunction with excellent international contributions.

The second is the interdisciplinary project “EAM Science meets Fiction”. It combined scientific research results relevant to EAM in the form of visual images and literature in an art exhibition accompanied by a diverse program of events that covered aspects from modeling and simulation to electron and scanning probe microscopy. We received over 100 contributions from professional and amateur writers. This year, a selection of them will be published in a book.

This issue’s Research News reflect the broad scientific scope of EAM with topics ranging from granular temperature, solar technology, liquid metal catalysis, coating technologies, physical approaches to cell behavior, and X-ray tomography.

The success of our scientific community is once again reflected by several outstanding research awards received by EAM Members. In particular, we would like to congratulate Peter Wasserscheid on receiving his second ERC Advanced Grant.

Let’s keep our fingers crossed that we will start a new and successful chapter with FUMIN in 2019!

I wish you all a pleasant summer.

Wolfgang Peukert

Editorial
From October 10 – 12, 2017, 270 scientists from all over the world visited Erlangen for the International Congress Engineering of Advanced Materials (ICEAM2017). During this three-day scientific event, there was a diverse program of presentations from FAU researchers, based on ten years of profound research experience in engineering of advanced materials, and from international experts from 17 different countries.

The focus of ICEAM2017 lay on the EAM research fields Nanoelectronic Materials, Photonic and Optical Materials, Catalytic Materials, and Lightweight Materials, with a special emphasis on EAM’s cross-sectional topics Functional Particle Systems, Nananalysis and Microscopy, and Multiscale Modeling and Simulation. This structure gave participants a sense of the interdisciplinary approach that has been at the core of EAM’s work for the past ten years and has advanced to give the research in Erlangen a competitive edge.

During ICEAM2017, plenary and keynote speeches from top-class speakers, complemented by a further 80 presentations held across a total of 20 sessions, inspired the interdisciplinary exchange of views at the heart of the congress. The venue, the university’s South Campus, clearly demonstrated the extent of FAU’s current investment in the best conditions for research in engineering of advanced materials.

EAM coordinator, Prof. Wolfgang Peukert, gave the opening speech, ably followed by Prof. Cynthia Friend (Harvard University) as the first plenary speaker. Throughout the congress, renowned invited speakers commenced each session; they included Prof. Ole Sigmund (Technical University of Denmark), Prof. Andreas Stein (University of Minnesota), Prof. Paolo Samori (Université de Strasbourg and CNRS) and Prof. Andreas Schreyer (European Spallation Source ESS ERIC). Rounding off the scientific schedule of the congress, a poster session in the Tentoria gave researchers the opportunity to present their latest scientific projects and get to know one another better. Three posters from the total of 96 received a poster prize.

A further highlight was the congress dinner on the second evening, which took place in an extraordinary location: The participants enjoyed a typical Franconian buffet in the Baroque surroundings of a former church in the heart of Erlangen. Afterwards, a Night Watchman guided tour was on offer, taking participants through the city’s narrow streets.

All in all, ICEAM2017 was an emphatic success, providing high-class insights into the past ten years of continuous funding for EAM and its results as well as creating a space for researchers to exchange and discuss outstanding international contributions to current work in the field. All this was made possible by an excellent Scientific Organizing Committee, the wholehearted commitment of all members of EAM’s administration, and the financial support of the German Research Foundation (DFG).
EAM Science meets Fiction: An interdisciplinary meeting of minds

Scientists use visual images for explaining and understanding, for visualizing abstract models and for casting light on data and hidden links. These scientific images, frequently governed by a distinct set of esthetics, were at the core of the EAM Science meets Fiction project, and provided its connecting leitmotif. The project was the first venture of its kind for EAM. In showcasing selected visual images from ten years of research in the Cluster of Excellence EAM and running a competition for literary reflections on the topic, EAM has created a new and unique space of intersection for science, literature and art, for the meeting of minds drawing on diverse disciplines and pursuing contrasting academic and artistic interests.

EAM Science meets Fiction encompassed three components: an art exhibition in the spirit of academic analysis, a competition inviting literary entries incorporated into the exhibition’s concept, and an accompanying program of events.

The exhibition, hosted by the church educational initiative BildungEvangelisch in the Erlangen venue Kreuz+Quer – Haus der Kirche at Bohlenplatz, ran from September 16 to October 27, 2017, and featured a total of 16 scientific images and 22 literary reflections on the topic. Visitors to the exhibition were treated to a diverse range of images from the world of nanoparticles and to views from under the microscope. The best entries from over 100 poems and prose works submitted to the competition complemented scientific descriptions of each image, opening up new perspectives by inviting viewers and readers to arrive at their own interpretations. EAM worked with Erlangen’s Center for Literature and Natural Science (ELINAS) to create and stage the exhibition.

EAM organized a diverse program of events, free of charge to attendees, to complement the exhibition and to promote discussion and reflection on the issues among scientists, authors and audiences alike. A series of talks explained the science behind selected images or explored topics such as the use of images in supporting the public understanding of science and copyright and intellectual property in images. EAM worked with a number of additional organizations and institutions to deliver these events; these were FAU’s Center for Applied Philosophy of Science and Key Qualifications (ZiWiS), the University Chaplaincy, and a number of FAU chairs.

Find out more about our collaborators on the project:
Erlangen’s Center for Literature and Natural Science (ELINAS)
http://elinas.fau.de/
BildungEvangelisch:
www.bildung-evangelisch.de
Center for Applied Philosophy of Science and Key Qualifications (ZiWiS):
www.ziwis.fau.de
University Chaplaincy:
www.fau.de/intranet/servicestellen/hochschulpfarramt/

EAM Science meets Fiction: www.eam.fau.de/de/science-meets-fiction/
Pöschel and his colleagues, the physicist Prof. Nikolai V. Brilliantov from the University of Leicester (UK) and the computer scientist Dr. Arno Formella from the University of Vigo (ESP), were able to prove the existence of this counterintuitive effect in complex simulations. To this end, the researchers used and developed established methods such as analytical mathematics, in particular the Kinetic Theory of gases, and the Monte Carlo method, a stochastic method based on the theory of probability. Pöschel explains: “By using a new system of kinetic equations and the relevant scaling methods, we were able to reliably depict the dynamics of particle aggregations in granular gases. We have not revised Haff’s law by any means, but we were able to demonstrate an important effect that had been overlooked up to now.”

The scientists’ findings could help to improve our understanding of the basic properties of granular gases such as soot agglomeration in flue gases on Earth or astrophysical phenomena such as cosmic dust or planetary rings in space.

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**Particle dynamics of granular gases**

Scientists from FAU, the University of Leicester and the University of Vigo have developed a theory to explain why the kinetic energy of the particles in granular gases such as dust clouds can increase temporarily even though mechanical energy is constantly being drawn out of the system. This finding, achieved using a new simulation method, has recently been published in the renowned journal *Nature Communications* under the title “Increasing temperature of cooling granular gases”.

Granular gases are systems that contain macroscopic particles at a low density. Examples include cosmic dust, the rings around the planets Saturn, Uranus and Neptune, and clouds of dust on Earth. They can essentially be described like molecular gases such as helium, but with one important difference – granular particles do not collide elastically. “In isolated granular gases without external energy input, the kinetic energy of the particles constantly decreases due to the collisions, which is why the granular temperature also decreases,” explains EAM Professor Thorsten Pöschel from the Chair for Multiscale Simulation of Particulate Systems at FAU. “This law of cooling, also known as Haff’s law, has been known since 1983 and is one of the key findings of the kinetics of granular gases.”

However, Haff’s law of granular cooling does not take one particular aspect into consideration. In systems with extremely small particles measuring only a few micrometers, various forces, such as surface adhesion or electrostatic charge, cause the particles to adhere to one another. “The particles grow and their properties change due to this aggregation. At the same time, they decrease in number in the system, and thus the number of degrees of freedom for particle motion also decreases,” explains Thorsten Pöschel. “Our result is that the granular temperature can increase temporarily because of this, even though mechanical energy is lost with every collision.”

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**Novel printed solar cells with perovskite structures**

The mineral perovskite has a reputation as a miracle optoelectronic semiconductor, particularly in solar technology applications. It is highly efficient, but unfortunately remains almost completely unsuitable for everyday use due to incompatible interfaces. Researchers at FAU led by Prof. Christoph Brabec, a materials scientist and EAM Member, are working to change this. They have developed a material system that enables the production of efficient and durable solar cells on the basis of perovskite. With the help of special nanoparticles, the FAU team has been able to develop a generic procedure for extremely precise doping of the boundary layers in solar cells. As all the associated processes take place at low temperatures in solution, the invention has the potential to revolutionize printed solar technology. The scientists have published their findings in the leading journal *Science*.

The semiconductor perovskite is considered to be particularly well-suited to converting sunlight into electricity. One factor in this is that the material itself is particularly easy to process. While standard semiconductors such as those made of silicon are either drawn from the melt or precipitated in high-vacuum systems, perovskite can be deposited from solution at room temperature, for example using printing and coating processes.
A new generation of catalysts - supported liquid metals

Catalysts are agents that initiate chemical reactions, speed them up or significantly increase the yield of the reaction's desired product. Scientific consensus thus considers new and improved catalysts key to creating more sustainable and efficient production processes in the chemical industry. In a joint research project, five EAM Members and their teams have recently discovered a new material concept that makes the creation of significantly more efficient catalysts possible. The researchers have published their findings in the prestigious journal *Nature Chemistry*.

This new generation of catalysts employs liquid drops of metal alloy attached to porous carriers that are brought into contact with the gaseous reactants. The microscopically small drops of alloy are fluid because they contain a high proportion of gallium, an element with a very low melting point. At the same time, this high concentration of gallium ensures thorough dispersal of the atoms of the dissolved secondary metal components. The individual metal atoms in solution within the gallium are responsible for the catalytic effect.
Over the past decade, researchers at FAU have repeatedly been able to demonstrate their international preeminence in the field of catalyst material innovation. Catalytic Materials is a key research area within EAM. Supported liquid catalysts have been a frequent focal point of interest for the FAU-based researchers. They combine the benefits of customized molecular reaction accelerators with the advantage of easier separability from the product. The concept outlined in the article published in *Nature Chemistry* describes the use of metal alloys in supported liquid catalysts for the first time, as well as representing the first attribution of catalytic activity to liquid metal alloys.

Moreover, the material combinations have been found in initial tests to significantly outperform standard technical catalysts that have taken years to develop. “It is particularly interesting that there is little to no deactivation of the supported metal complexes when carbon deposits form on them,” says EAM co-ordinator Prof. Peter Wasserscheid. “Deposits such as this are the principal form will usually exhibit,” explains Andreas Görling. Hans-Peter Steinrück adds: “This is why we are so fascinated by this new class of catalytic materials. We are convinced that supported alloy complexes can help us to develop highly efficient and very cost-effective catalysts that have considerable potential with regard to industrial applications.”

Gallium-rich Pd-Ga phases as supported liquid metal catalysts
*Nature Chemistry, 2017*, DOI: 10.1038/nchem.2822
Abstract: www.eam.fau.de/research/publications/taccardi2017/

It all began with a bet at a conference in Italy in 2013. The EAM Professor Nicolas Vogel, then a postdoctoral fellow in Prof. Joanna Aizenberg’s lab at the School of Engineering and Applied Sciences (SEAS) at Harvard University, gave a talk about the group’s Slippery Liquid-Infused Porous Surfaces (SLIPS) coatings, which promised to prevent different liquids and complex fluids adhering to structures to which they were applied. In the audience was Ali Miserez, an Associate Professor of Materials Science and Engineering at Nanyang Technological University (NTU) specializing in biological materials, who approached Vogel after the presentation and said confidently, “I bet mussels will stick to your coatings, because I have yet to see a surface that they won’t attach to.”

Vogel accepted the challenge and sent some SLIPS samples to Miserez, initiating a collaboration whose results are now reported in Science. The study demonstrated that a certain form of SLIPS is indeed essentially mussel-proof, and sheds light on how they thwart mussels’ expert attachment mechanisms. “I badly lost the bet,” says Miserez, who is a corresponding author of the paper along with Vogel and Aizenberg. “I think I owe Nicolas a nice dinner.”

Mussels are one of the worst perpetrators of biofouling, or the unwanted accumulation of organisms on underwater structures such as pipes, boats, industrial equipment, and docks. The vast majority of the weapons deployed against mussels and other clingers-on are paints and coatings that contain toxic chemicals, which have ecological impacts and are often insufficiently effective. Non-toxic “low surface energy” coatings based on silicone or siloxane polymers (compounds similar to those used in the medical industry for catheters) have been introduced as alternatives, but while these materials do allow for easier removal of biofouling species, they are less effective at preventing organisms from attaching in the first place, and are susceptible to damage and decay.
The liquid-infused repellent coatings, inspired by the slick lip of a carnivorous pitcher plant that sends insects sliding down to their doom, exploit the fact that it is very difficult for an organism to attach to a liquid surface. Such coatings consists of a solid surface infused with a liquid lubricant overlayer that is retained in place so that anything that comes into contact with the liquid layer will simply slide right off.

The muscular feet of mussels produce adhesive filaments called byssal threads whose tips, called adhesive plaques, contain special adhesive proteins that remove water molecules from the target surface to enable the plaques to bind to it. “Mussels have mastered the skill of sticking in an underwater environment, despite water being the biggest enemy of adhesion,” says Miserez.

To investigate whether liquid-infused coatings could hold their own against these expert biofoulers, the NTU team led by Miserez placed Asian green mussels on panels with a “checkerboard” pattern of different types of non-biocidal antifouling surfaces underwater, and let the mussels choose where to attach.

The experiment evaluated two different types of slippery surfaces infused with silicone oil as a lubricant: a very thin, silica-based and nanostructured 2D coating applied layer by layer (I-LBL) and a thicker, matrix-like 3D coating made of the polymer polydimethylsiloxane (i-PDMS).

Non-lubricant-infused versions of those coatings were included for comparison. After 24 hours, these had around 75 mussel adhesive plaques per panel, while i-PDMS had only five mussel plaques on one out of a total of fifteen panels, indicating that the mussels did not, in fact, stick well to i-PDMS.

The NTU researchers continued their investigation in order to determine exactly why the mussels did not readily bind to i-PDMS. The team measured the force needed to remove mussel adhesive plaques per panel, while i-PDMS had only five mussel plaques on one out of a total of fifteen panels, indicating that the mussels did not, in fact, stick well to i-PDMS.

To see whether the mussels were also attempting to attach fewer byssal threads, the researchers placed them on each of the surfaces and observed them in real-time. Mussels on the i-PDMS displayed several aberrant behaviors: they chose to attach their threads either to their own shells or to a neighboring, non-coated surface; they secreted a viscous gel that did not solidify into a thread; or they probed the surface for only a few seconds before swiftly retracting their foot into their shell without attempting to secrete a thread. The researcher performed a thorough analysis of the physical origins of this abnormal behavior and discovered that a combination of effects lead to the efficient prevention of mussel adhesion. On a molecular level, the surface chemistry of the liquid-infused coatings has a very low interfacial energy, which reduces the work of adhesion of the mussel foot proteins.

The coatings use hydrophobic oils to induce their slipperiness, hindering the mussel foot proteins, which have evolved to replace water molecules from the surface from making firm contact with the substrate. Finally, upon approach, the mussel senses an attractive, pulling force as a result of a liquid bridge forming between the approaching foot and the surface. Since the secretion of mussel foot proteins is speculated to be pressure sensitive, the authors hypothesize that this attractive force is interfering with the release mechanism of the adhesive proteins.

Finally, the team partnered with the NOAA Stellwagen Bank National Marine Sanctuary in Scituate, Massachusetts, to compare the laboratory findings with observations in real-world conditions. To this end, they submerged panels of all the lab-tested materials into Scituate Harbor for sixteen weeks to see whether organisms would grow on them. The liquid-infused coatings showed a four-fold decrease in mussel settlement and similarly outperformed reference and industry standard in resisting other biofouling species such as tunicates, hydroids, and slime.

“The beauty of this study is that we came to understand the mechanism of how mussels attach themselves to a surface from the molecular through the macroscopic scale and, therefore, how it can be prevented,” says Vogel. “These studies show the true value of interdisciplinary research, where fundamental aspects of different research fields combine to generate a detailed understanding, which, in turn, provides means to solve a global problem.”

This research was funded by the Singapore Maritime Institute, the US Department of Energy, the Office of Naval Research, the US Department of Defense, the FAU Cluster of Excellence EAM, and the Interdisciplinary Center for Functional Particle Systems.

Preventing mussel adhesion using lubricant-infused materials
EAM Research Area A1
Science, 2017. DOI: 10.1126/science.aai8977
Abstract: www.eam.fau.de/research/publications/amins2017/
**RESEARCH**

**Investigation of cell-cell contact phenomena**

What can physics do for medicine? A team of researchers led by EAM Professor Ana-Sunčana Smith of the PULS (Physics Underlying Life Sciences) Group and Professor of Theoretical Physics at FAU has worked with collaborators from Germany and France to tackle the often underestimated factors which govern cell-cell adhesion and its stability. Their findings have recently been published in the prominent journal *Nature Physics*.

For many of the body’s cells, controlled adhesion and division, which occur during the organ differentiation phase in embryos and when broken skin is repaired during wound healing, are extremely important. The significance of close cell-cell contact is most evident when it fails; in tumors, for example, adhesion decreases and cells eventually become detached. When this happens, intercellular junctions tend to dissolve and metastases can form as a result.

Cadherins, a class of transmembrane proteins, assume an important role in cell adhesion, as they can bind not only to one another, but also to cadherins of other cells. The binding of two cadherin molecules on two different cells thus provides the starting point for the formation of extensive contact zones. The FAU research team hypothesized that the process whereby contact is made and lost may be far more dependent on purely physical factors than was previously thought. Computer simulations and experiments conducted by researchers in Würzburg, Jülich, Stuttgart and Marseille have confirmed this theory.

Cadherin-containing model membranes were brought into contact with one another, and various physical parameters which influence the fluctuation behavior of the membrane, such as sugar or salt levels were then selectively altered. Even very small changes had a major impact on the formation and development of cell-cell contacts. This opens up the possibility of regulating biological processes by modifying purely physical parameters such as the temperature, activity or local lipid composition of the membrane. The researchers assume, in view of the physical nature of this control mechanism, that similar membrane-induced interactions may occur between the proteins in many cellular processes that are dependent on protein densities in the membrane.

The research was funded by a European Research Council (ERC) starting grant, an EAM starting grant of the FAU Cluster of Excellence EAM and by Research Training Group (RTG) 1962 at FAU. Its continuation is planned within the BIG-THERA project conducted by the FAU Emerging Fields Initiative in the context of adhesiveness of cells within breast cancer tissues.

Membrane fluctuations mediate lateral interaction between cadherin bonds
EAM Research Area A3
*Nature Physics*, 2017, DOI: 10.1038/nphys4138

**RESEARCH**

**X-ray tomography on the iridescent wings of butterflies**

Just one year since the material scientists around EAM Member Prof. Erdmann Spiecker from the Center for Nanoanalysis and Electron Microscopy (CENEM) at FAU were granted funding for one of the world’s best X-ray microscopes and they have already been able to help settle an open question in butterfly research with fascinating 3D analyses. Their findings have been published in the renowned scientific journal *Science Advances*.

Who is not fascinated by the wonderful iridescent colors of butterfly wings? Often, the stunning color is not generated by pigments, but rather by periodic structures made of chitin, a structure-forming polysaccharide. These so-called photonic crystals give rise to structural color by only reflecting specific wavelengths of the incoming solar spectrum. The resulting color serves as camouflage or signaling. But how do millions of these photonic crystals form within the tiny scales of butterfly wings? The opinions of scientists on this process differ.

In cooperation with two leading experts in butterfly research, Dr. Bodo Wilts from the University of Fribourg, Switzerland, and Dr. Gerd Schröder-Turk from Murdoch University in Perth, Australia, as well as with Dr. Stephen Kelly from Zeiss-Xradia, the material scientists from Erlangen employed various high-resolution microscopy techniques to reveal the mechanism behind the formation of these photonic crystal structures. The wings of the green butterfly *Thecla opisena*, which has its habitat in the Neotropics from Mexico to Venezuela, feature separate photonic crystal domains that increase in size from the base to the tip of the wing scales. This characteristic appears thus far to be unique, distinct to other butterflies. The scientists interpret this finding by proposing that photonic crystal growth was time-frozen at different stages of metamorphosis and detailed microscopic analyses can be employed to obtain important insights into these crystals’ formation processes.

Image: Colourbox
“High-resolution X-ray tomography provided findings essential to a deeper understanding of the formation mechanisms,” explains Erdmann Spiecker. The scientists assume that nascent chitin is extruded into a casting mold made of membranes. Spiecker continues: “The unique capability of X-ray tomography to analyze the 3D structure of entire wing scales enabled us to clarify where the chitin was originally extruded from.” Dr. Benjamin Apeleo Zubiri, who analyzed the 3D data in detail, was amazed: “The resolution of the reconstructed tomograms is so high that we were able to settle this question as well as identify the chirality (handedness) of each individual photonic crystal.” Previously, this had only been possible using electron tomography, as the researchers from CENEM had demonstrated in an earlier study. However, for the electron tomography investigation, the wing scales needed to be cut into little segments, which caused serious disadvantages.

Even though the material scientists have been investigating these butterfly wing scales for several years, this is a rather exotic field of study for CENEM, whose setup is usually employed in enhancing the knowledge of modern functional and energy materials and optimizing their properties for various applications. “The new X-ray microscope will also enable otherwise inaccessible insights in such areas as the investigation of porous structures for catalytic applications or the search for tiny faults in turbine materials,” explains Erdmann Spiecker. Photonic crystals are also relevant to modern materials science. These intriguing 3D structures with their unique optical properties may serve as prototypes for novel functional materials with applications in fields such as photovoltaics.

Butterfly gyroid nanostructures as a time-frozen glimpse of intracellular membrane development  EAM Research Areas A2, A3
Science Advances, 2017, DOI: 10.1126/sciadv.1603119
Abstract: www.eam.fau.de/research/publications/wilts2017/

AWARDS

AVS honors Prof. Steinrück with Welch Award

In 2017, the EAM Member Prof. Hans-Peter Steinrück, Chair of Physical Chemistry II, received the Medard W. Welch Award from the AVS – Science and Technology of Materials, Interfaces, and Processing (formerly American Vacuum Society) in recognition of “his pioneering studies on the properties and reactivity of the surfaces of ionic liquids employing the methods of surface science”. The award, established in 1969 to commemorate the pioneering efforts of the AVS founder Medard W. Welch, honors scientists who have performed outstanding theoretical and experimental research for more than ten years. It is endowed with a cash prize and a medal, and is officially awarded at the international annual conference of the AVS, where the recipient gives an honorary lecture; last year’s conference took place in November 2017. The award is one of the most prominent international honors in the field of surface and interface research.

Prof. Hans-Peter Steinrück's web page:
www.chemie.nat.fau.de/person/hans-peter-steinrued/
AWARDS

European Research Council awards 2.5 million euro to Prof. Peter Wasserscheid for further research on novel reaction accelerators

Very few researchers have the honor of receiving such an accolade, yet EAM co-coordinator Prof. Peter Wasserscheid, Chair of Chemical Engineering I (Reaction Engineering), has now been awarded the Advanced Investigator Grant of the European Research Council (ERC) for the second time.

Peter Wasserscheid is one of the world’s leading experts on ionic liquids – salts in liquid form. Recognition for his ground-breaking research in this field came as early as 2006 in the shape of the Gottfried Wilhelm Leibniz Prize, the most renowned German award in academic research. Four years later, in 2010, he received the ERC’s Advanced Investigator Grant, worth 2 million euro.

The second ERC Grant supports a logical continuation of the work carried out to date, using an entirely new approach that promises ground-breaking scientific findings and a technological leap forward for the chemical industry. One of the focal areas of the project is efficient hydrogen release from organic molecules using liquid reaction accelerators. However, this time the class of catalysts recently discovered by Wasserscheid and his colleagues at EAM is liquid drops of metal attached to porous carriers that are brought into contact with the reactants. (see page 5) “The ERC assessors seem to share my passion for highly dynamic catalyst surfaces,” says Peter Wasserscheid. “The unique research environment in Erlangen, with leading researchers in the fields of spectroscopy, microscopy, particle technology, X-ray diffraction and theoretical chemistry, has been absolutely essential to the quality and persuasiveness of our preliminary work.”

The prize money will be used to further research on a novel material concept for catalysis on the basis of the powerful reaction-accelerating effect provided by metal droplets with a low melting point.

Prof. Peter Wasserscheid’s web page:
www.crt.tf.fau.de/person/prof-dr-peter-wasserscheid/

AWARDS

Prof. Marion Merklein receives the Bavarian Order of Merit and the EDITION F Magazine Women’s Award

A great honor for EAM Member Prof. Marion Merklein: As professor at the Institute of Manufacturing Technology, she has been awarded the Bavarian Order of Merit as an acknowledgement of her outstanding achievements in scientific research as well as of her exemplary function for young academic talents.

As an excellent and internationally-leading researcher, Prof. Merklein works at the interface between materials science and manufacturing technology. Her work has already led to more than 300 publications with a wide range of subjects. Her focus lies on bulk metal forming concentrating on lightweight materials, material characterization and material modeling as well as on the simulation of forming processes. Prof. Merklein has an extraordinary voluntary commitment, which is reflected in her memberships in multiple scientific committees and research associations.

Her academic success has been recognized with numerous prestigious awards. For the fourth time, the online magazine EDITION F has selected 25 women whose inventions improve our daily lives for its “25 Women Award”. Among the winners in 2017 was Prof. Merklein.

No matter what means of transportation we take, there is always a light metal at the beginning of its development. However, these metals are not as easy to form as manufacturers would like. In order to enhance this technology, Marion Merklein developed a light-alloying process that immensely improves industrial production chains in the automotive industry as well as in rail and air transportation.

Prof. Marion Merklein’s web page:
www.lft.fau.de/index.php/de/mitarbeiter/leitung
Science Sets Sail: EAM crew heading for new shores

From August 2–12, 2017, the EAM crew was going on a scientific sailing experience in the Baltic Sea on board of the sailing ship “Thor Heyerdahl”. Together with a crew of the Department of Chemistry and Pharmacy and a crew of the Faculty of Medicine and Collaborative Research Center 1181 the EAM crew was taking part in a 9-day cruise from Tallinn to Rostock.

The goal of this journey was to grow together by sharing new experiences, while strengthening interdisciplinary research on a range of specific themes that are critical to our world today. Science Sets Sail was created by the FAU as an innovative way to establish new forms of cooperation with academics in Estonia, Finland, Latvia, Poland and Sweden, not to mention attract potential students and researchers to come to Germany.

The participating EAM crew was selected via a scientific competition amongst the cluster’s bright young researchers. Winners of the EAM call for proposal were Dr. Doris Segets, Chair of Particle Technology, and Dr. Jakob Albert, Chair of Chemical Reaction Engineering, with their project idea: Engineering of tailor-made catalysts based on polyoxometalates and nanoparticles for enhanced catalytic performance. Besides these two, the EAM crew consists of two other EAM researchers – Torben Schindler, Chair for Crystallography and Structural Physics and Dr. Yamini Avadhut, Erlangen Catalysis Resource Center – and six scientists from all over Europe, who had been invited to contribute their expertise to the discussion – Matthias Mendt from Leipzig University, Dr. Sabrina Kirner from Bundesanstalt für Materialforschung und -prüfung (BAM), Martin Bondesgaard from Aarhus University, Dr. Samir Salameh from Delft University of Technology, Dr. Ferdinand Hof from Centre de Recherche Paul Pascal, University of Bordeaux and Dr. Jerrik Mielby from Technical University of Denmark.

The three-mast topsail schooner “Thor Heyerdahl” and its crew set sail for a truly unique adventure from Tallinn to Rostock with stopovers in Gotland, Sweden and Bornholm, Denmark. Despite stormy sea, sea sickness and daily watches from 4 until 8, at night and during the day, the time on ship was used for team building, intense scientific discussion and establishing future collaborations which were only possible due to the EAM funding of this unique experience.

Science Sets Sail: https://science-sets-sail.fau.de
Collaboration with University of Minnesota expands to medical technologies

The second bilateral workshop for more than 30 scientists and researchers from FAU and the University of Minnesota (UMN) took place in Erlangen on June 6 – 7, 2017. After inspiring presentations and productive scientific discussions with topics ranging from plasma synthesis of nanocrystals and mesoscale computations for advanced materials design to magnetic nanotechnologies, representatives from both fields met with FAU President Hornegger before heading to a relaxed get-together at the Erlanger Bergkirchweih for all scientists involved.

The result of the second bilateral workshop is that starting from the established cooperation between the partners in the field of new materials and processes, activities are now being extended toward medical technologies. With medical engineering as a new emerging field of joint research, a third bilateral workshop will be held at UMN in September 19 –20, 2018, aiming to further connect the activities between both partners and to promote international exchange and interdisciplinary research across all levels. The new areas of joint interest range from wearables, computing and pattern recognition, biomaterials and porous materials towards to medical diagnostics. We wish our FAU delegates fruitful discussions and look forward to the establishment of exciting international projects.

Construction of ICNF proceeding according to plan

The new research building for the Interdisciplinary Center for Nanostructured Films (ICNF) on FAU’s southern campus is taking shape and work on the interior is proceeding according to schedule.

The building, financed by equal amounts of funding from the German and Bavarian governments, will sustainably strengthen FAU’s expertise in the field of new materials and processing and will create a unique research environment for the innovative research field of thin-film technologies. State-of-the-art chemistry and physics laboratories, cleanrooms, offices, and conference rooms are being built on an area measuring 4,600 square meters and split into four levels. The highlights of the new building include climate-controlled rooms, which will contain highly-sensitive major equipment and microscopes.

A milestone towards completion of the research building was reached last May. The topping out ceremony was held only one year after the groundbreaking ceremony took place, as the shell construction work had been completed and the building took on its final shape.

The laboratory equipment is currently being set up in the building and the call for tender for office furniture has been announced. If everything goes according to plan, the building can be handed over to future users at the end of 2018.

The ICNF benefits from the direct proximity to disciplines from seven FAU departments as well as from other non-university research institutions, including the Fraunhofer Institute IISB, the Max Planck Institute for the Physics of Light, the Bavarian Center for Applied Energy Research (ZAE), and the new Helmholtz Institute Erlangen-Nürnberg for Renewable Energies (HI ERN). Furthermore, this research building represents an important milestone for outstanding infrastructure in the new round of the Excellence Strategy.

ICNF Construction Diary: www.eam.fau.de/about-eam/new-eam-buildings/icnf-construction-diary/
GS AMP Members meet for an interdisciplinary dialogue

The members of the Graduate School Advanced Materials and Processes (GS AMP) met for the first time in 2018 for interdisciplinary discussions and academic exchange. EAM Professor and speaker of the graduate school Hannsjörg Freund presented current facts and figures from the GS AMP and provided an insight into the program for 2018. The candidates for the 2018 representatives also introduced themselves. To encourage discussion, four members gave flash talks, followed by a poster session where the doctoral students had the opportunity to learn about the research of the other members of the GS AMP. A vote for this year’s representatives was held and we are happy to welcome Andreas Kunzmann (Physical Chemistry I), Oliver Langmar (Physical Chemistry I) and Vinzent Strobel (Chemical Engineering I) as representatives who liaise between doctoral candidates and the program director at GS AMP.

There are several exciting plans for the program in 2018. In addition to the two annual soft-skill seminars, there will be a Career Planning Alumni-Event in fall 2018, where FAU graduates with different careers will talk about their experiences and answer questions. There will also be the second Young Researchers’ Day for and organized by doctoral candidates as an opportunity to promote interdisciplinary dialog.

Graduate School GS AMP:
www.eam.fau.de/graduate-school/

3rd CENEM Summer School for X-ray Scattering 2017

The 3rd CENEM Summer School for X-ray Scattering took place on July 24–27, 2017 at the Institute for Crystallography and Structural Physics (ICSP) in Erlangen. The Summer School was organized by the workgroup of EAM Professor Tobias Unruh and sponsored by Anton Paar GmbH. It provided a detailed insight into a variety of modern X-ray scattering techniques during seminars in the mornings and hands-on training in the afternoons. The main topics were X-ray powder diffraction (XRD), small-angle X-ray and neutron scattering (SAXS/SANS), X-ray reflectometry (XRR), grazing incidence small-angle X-ray scattering, and grazing incidence diffraction (GISAXS/GIXD). The theoretical background, instrumental details, data reduction, analysis strategies and current applications of X-ray scattering techniques were presented and discussed in the morning lectures. It was a particular pleasure to welcome Dr. Oliver Seeck from DESY, Hamburg, who gave a lecture about X-ray scattering techniques at synchrotron radiation sources.

The afternoon sessions were reserved for practical hands-on training, held in small groups of three to four participants to ensure that every participant had the chance to measure real sample systems on the state-of-the-art instruments that are available in the CENEM user facility. Each participant also reduced and analyzed the recorded data. The practical training was an important first qualification to enable participants to perform their own measurements.
The participants came from the research fields of EAM and beyond, including materials science, physics, chemistry, chemical and biological engineering and biotechnology. Also two external participants from Mateis-INSA laboratories, Lyon (France) and the Adolphe Merkle Institute, Fribourg (Switzerland) attended the summer school. The Summer School was mainly aimed at doctoral candidates but was also open to Bachelor’s and Master’s degree students, postdoctoral researchers, and employees. Due to the limited capacity of the hands-on training sessions, only 15 applicants could be accepted. At the end of the school, a barbecue was held at the institute, giving the participants the opportunity to discuss their own topics and interests with the members of the institute and to plan future cooperation.

Scattering Method Facility at CENEM:  
www.cenem.fau.de/facilities/scattering_methods.shtml  
Institute for Crystallography and Structural Physics:  
www.icsp.nat.fau.eu/

**EVENT REVIEW**

**EBAM 2018: Conference series on additive manufacturing continues successfully**

More than 150 participants from 21 different countries all over the world attended EBAM 2018, the 2nd International Conference on Electron Beam Additive Manufacturing, which was held from April 11–13, 2018 at the Nürnberger Akademie. The conference brought together leading experts and senior and junior scientists from research and industry who specialize in the field of electron beam-based additive manufacturing.

The idea for the conference emerged in 2015 as a result of more than ten years of experience with selective electron beam melting by EAM Member Prof. Carolin Körner. The EBAM conference series, which started in 2016, was the first conference of its kind in the world because of its distinct scientific focus on electron beam-based technologies. The success of this idea is reflected by its popularity, unfortunately demand exceeded the capacity available at the event location.

The focus on electron beam-based additive manufacturing technologies encouraged excellent presentations and high-quality scientific discussions. During nine sessions, the interdisciplinary exchange of views was encouraged by top keynote presentations. A wide range of high-performance materials was discussed such as titanium alloys, titanium aluminides, iron aluminides or nickel-based superalloys. The presentations covered the whole process cycle from powder aspects to post-processing of manufactured components. As a highlight, a presentation was given on in-situ process monitoring using electron optics, which opens the potential for this technology to detect and repair part defects during manufacturing. All sessions were supplemented by presentations on numerical simulations promoting a better understanding of the physical effects during the process.

Academic exchange and discussion were encouraged by a poster session of a very high standard where each participant had the opportunity to vote in the “Best Poster Awards”. The winners of these awards were Paria Karimi Neghlani (University West, Sweden), Marie Jurisch (Fraunhofer IFAM, Germany) and Dr. Ulric Ljungblad (Freemelt AB, Sweden). The conference was rounded off by enjoyable social events such as a historical tram ride through Nuremberg followed by a Franconian dinner.

The organizers received a great deal of positive feedback and many participants are looking forward to EBAM 2020, which will be held in a new location in the vicinity of Nuremberg’s city center to increase the number of participants who can attend.

EBAM2018:  
www.eam.fau.de/ebam2018
**EVENT REVIEW**

**FAU started its 275th anniversary celebrations with a scientific symposium called “Future of Research – Research of the Future”**

For 275 years, passionate research alongside excellent teaching and studying have been key focuses at FAU. Each of these areas creates knowledge and deepens the correlation between knowledge evolving and people benefiting. In 2018, FAU is celebrating its 275th anniversary. A diverse program of events on the theme of “Knowledge in Motion” awaits FAU throughout the year. The celebrations began on January 18–19 with an international scientific symposium titled “Future of Research – Research of the Future”.

The session “What tomorrow’s world is made of” was dedicated to topics related to EAM. The world of tomorrow needs a stable and affordable energy supply that does not adversely affect the living conditions on our planet. This involves not only generating enormous amounts of renewable electricity but also the ability to deal with fluctuations in the supply of solar and wind power. In his presentation “Sustainable Energy: Systems and Science” Prof. Robert Schlögl from the Fritz Haber Institute of the Max Planck Society in Berlin focused on the solution of “green” electricity as well as the challenges renewable energy currently faces.

Afterwards, EAM coordinator Prof. Wolfgang Peukert presented results from our Cluster to demonstrate that collaboration between chemical engineering and materials science in conjunction with the basic sciences opens new prospects for all disciplines involved. In his talk, he presented a multi-scale view from the molecular level at interfaces between macroscopic effects and applications.

This was followed by a talk by EAM Member and head of the Chair of Physical Chemistry I Prof. Dirk Guldi on the “Molecular basis for energy conversion and storage”.

Further invited speakers were Prof. Harald zur Hausen, Nobel Prize for Medicine 2008, Prof. Brian Kobilka, Nobel Prize for Chemistry 2012, and Prof. Peter Strohschneider, President of the German Research Foundation (DFG), among others.

In the evening, a wider audience was addressed with a talk open to the public given by the former astronaut Thomas Reiter. A further treat was in store for music lovers. As part of a celebratory anniversary concert, the university orchestra performed the premier of a cantata composed to mark the 275th birthday of FAU.

More information on FAU’s 275th anniversary and other events: www.275.fau.de

**EVENT REVIEW**

**Long Night of Sciences 2017**

The Long Night of Sciences in Erlangen, Fürth and Nuremberg took place on October 21, 2017, and has now become Germany’s largest festival of the sciences. It was the fifth time that EAM took part as it presented its activities to the public.

EAM organized a program of events for the evening in the Kreuz+Quer – Haus der Kirche in the center of Erlangen. In conjunction with Erlangen Center for Literature and Natural Science (ELINAS), EAM hosted an art exhibition titled “EAM Science meets Fiction” (see p. 3). The exhibition showed the esthetic beauty of scientific images and presented literary works that reflected free associations to the images on display.

More information on EAM events: www.EAM.de
Three 20-minute presentations given by EAM researchers revealed the secrets of some of the images in the EAM Science meets Fiction exhibition. What is “really” on the picture? What topics are being researched with this material? Which scientists are behind this research? And what benefits will this research have for us in the future? EAM Member Prof. Klaus Mecke spoke about “Matter with complex structures – the Milky Way and beyond”, EAM Professor Sabine Maier gave some insights into our world at the nanoscopic level with a scanning probe microscope, and EAM Member Prof. Wilhelm Schwieger talked about zeolites as a group of materials.

Functional high-performance materials have become an indispensable part of our lives. They can be found in extremely stable lightweight materials, in selective catalysts, flexible displays or high-efficiency solar cells. Visitors were given an insight into current trends in material research at the Cluster of Excellence at the EAM stand called “Material Research for the Future”.

The DSFD series originated in 1986 and is an internationally established forum for all researchers working with kinetic and stochastic based numerical models for fluid dynamics. In the spirit of the preceding conferences, the meeting covered a wide range of topics – from liquid films and microfluidics to thermal problems, colloids and suspensions, electro kinetics, as well as relativistic flows, industrial applications and, of course, numerical analysis and general model development.

The invited keynote lectures focused on complex flow applications and combined high level contributions on experimental, theoretical and numerical work from a wide range of scientific disciplines. Prof. Gerhard Gompper (Forschungszentrum Jülich) presented models of swimming bacteria to study the collective dynamics in active colloids. Prof. Hans Jürgen Herrmann (ETH Zürich) spoke about particle-laden flows in porous media, including numerical studies of deposition and erosion in porous structures. The collective dynamics of social insects was studied by Prof. Lakshminarayanan Mahadevan (Harvard University), while EAM Professor Thorsten Pöschel referred to so-called “vibrots” as a well-defined experimental system to test granular theories. Prof. David Quéré (ESPCI Paris) discussed the nanostructure of anti-fogging materials that minimize water adhesion. Urban physics simulations were discussed by Prof. Pierre Sagaut (M2P2 Marseille), who showed that lattice Boltzmann models can be used to predict flow in realistic full scale scenarios resembling the architecture of cities.

The 26th International Conference on Discrete Simulation of Fluid Dynamics (DSFD) (July 10 –14, 2017) was organized and hosted by the Helmholtz Institute Erlangen-Nürnberg for Renewable Energy (part of Forschungszentrum Jülich) and FAU. It took place in the center of Erlangen at Kreuz+Quer – Haus der Kirche and attracted more than 150 researchers from more than 19 different countries. The program featured nine internationally highly reputed keynote speakers, 101 contributed presentations, 20 poster contributions and two tutorial sessions.
To give the participants the chance to expand their knowledge even further, a tutorial session on entropic lattice Boltzmann schemes for high Reynolds numbers was held by Prof. Ilya Karlin (ETH Zürich) and Dr. Santosh Ansumali (Jawaharlal Nehru Centre for Advanced Scientific Research, India). This lecture was accompanied by a second tutorial by Dr. Sauro Succi (IAC-CNR Rome) on the history of the lattice Boltzmann method, as well as future perspectives. Furthermore, numerous high-quality talks and posters guaranteed an exciting meeting with five days full of engaging scientific discussion.

As usual, the conference also included networking opportunities. The most important of these was a conference dinner at the Bayerischer Hof restaurant in Erlangen that was very well attended. Additionally, on Wednesday afternoon, the participants enjoyed a guided tour through the historic center of Nuremberg, the beer cellars in Erlangen, or a visit to the Teufelshöhle caves and Pottenstein in Franconian Switzerland.

The response to the conference was overwhelmingly positive and the organizers would like to thank all contributors to the scientific program. The conference was supported by the DFG and EAM.

www.dsfd.org.dsfd2017.hi-em.de

Symposium of DESY-FAU-HZG collaboration

The symposium of the DESY-FAU-HZG “Kompetenzanker” collaboration took place on May 29–30, 2017 at the Institute for Crystallography and Structural Physics with support from EAM in Erlangen.

EAM co-coordinator Prof. Peter Wasserscheid started the symposium by presenting the upcoming excellence strategy of the collaboration and Prof. Edgar Weckert presented the DESY photon science strategy. This was followed by a presentation and discussion about the scientific status and future perspectives of the “Specific Target Research Projects” (STREPs).

EAM Professor Tobias Unruh presented new results about in-situ detection of metastable microstructures, Dr. Florian Bertram spoke about surface scattering possibilities at the high resolution diffraction beamline in DESY and EAM Member Prof. Hans-Peter Steinrück presented the in-situ studies of surface and interface reactions in his group. The model studies of new liquid organic hydrogen carriers were presented by EAM Member Prof. Jörg Libuda, who also spoke on operando investigation of model catalysts for hydrogen storage in Prof. Andreas Stierle’s absence.

On the next day, EAM coordinator Prof. Wolfgang Peukert presented the recent advances in particle formation dynamics in his group, Florian Galgon spoke about nano-precipitates in additive manufacturing materials, and Dr. Peter Staron presented the latest results from in-situ experiments for studying the selective laser melting process using high-energy X-rays.

After the break, a discussion session took place that collected feedback from various partners and discussed the strategies for supporting the integration of the collaboration into a National Excellence Strategy or the Program-Oriented Funding of the Helmholtz Association.
UPCOMING EVENTS

Particle Based Materials Symposium
September 20–21, 2018
Chemikum
Nikolaus-Fiebiger-Straße 10
Erlangen · Germany

10th European APT Workshop
November 7–9, 2018
VDEh-Betriebsforschungsinstitut GmbH
Sohnstraße 65 · 40237 Düsseldorf · Germany

EAM Young Researchers’ Day
October 4, 2018
Hans-Georg-Waeber-Saal
Schottkystraße 10
Erlangen · Germany

6th International Conference on Structured Catalysts and Reactors
September 11–13, 2019
Bad Herrenalb · Germany

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