

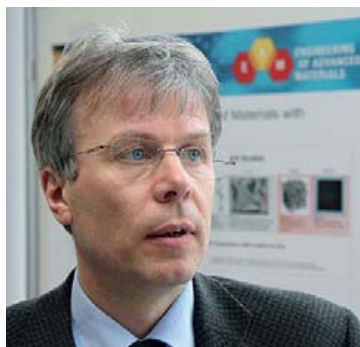


News Edition Winter 2009

- ◆ New professors Jana Zaumseil and Michael Stingl
- ◆ Titan³ 80 – 300 opens a new window into the nanoworld
- ◆ Professor Christoph Brabec publishes key articles on organic heterojunction solar cells
- ◆ Renowned grants for EAM members Andreas Hirsch, Peter Greil, Thomas Seyller

EDITORIAL

*Dear colleagues
and friends,*



As the end of 2009 draws ever closer, let us reflect upon our accomplishments of the past twelve months.

The first-ever EAM Symposium held recently in Wildbad Kreuth

was a resounding success. The presentations and posters highlighted the significant advances we are making in all research areas as well as the intensive networking that takes place among and between the different disciplines.

The workshops generated many new ideas and prompted lively discussions from which hopefully new and fruitful collaborations will evolve.

The new Titan³ 80 – 300 transmission electron microscope was ready to receive its first samples from EAM researchers in October, providing all research areas with spectacular new insights at the atomic scale.

In the past few weeks several members of the Cluster have been honored with awards for their outstanding scientific achievements. We certainly have many reasons to look back over 2009 with satisfaction and forward to 2010 with enthusiasm and optimism. But we should not rest on our laurels: continued strategic reorientation is essential in preparation for the upcoming proposal for continued funding. The meeting of all EAM members in January will help maintain this process of continuous self-appraisal. We will use this opportunity to further strengthen the internal coherence of the Cluster and to discuss the strategy for the coming years.

I would like to extend to you and your families my most heartfelt wishes for a wonderful holiday and a successful and happy New Year.

EVENT REVIEWS

First
graduate
school
members
admitted



Doctoral researchers working on EAM projects met on 26 October for the admission of the first members of the Cluster's Graduate School "Advanced Materials and Processes". About 35 Cluster researchers and students of the "Advanced Materials and Processes" (MAP) Elite Master's course received an introduction to the school from its coordinator, Carsten Schür. Monica Mayer, coordinator of the FAU Graduate School, also presented the role of her institution, which complements EAM's Graduate School. A university-wide program, it is open to all doctoral researchers at FAU, whether enrolled in a structured doctoral program or involved in independent graduate research projects. Following these presentations, the first EAM graduate school members received their official admission letters.

During an informal reception that concluded the event, students and faculty used the opportunity to make new contacts and exchange ideas for future meetings. Monthly meetings will take place to serve as a platform for networking among the young researchers in EAM.

For details on the Graduate School and application procedure, see http://www.eam.techfak.uni-erlangen.de/graduate_school.html





I wasn't aware how broad an interdisciplinary group we are!

EAM symposium: creative and innovative research exchange in a place of history

Taking a break from the daily grind, 144 Cluster of Excellence researchers assembled at EAM's first ever symposium in beautiful Wildbad Kreuth from 21-25 November. During the five-day conference 25 presentations from the EAM's seven research areas were given. Attendees were also able to hear keynote speeches from renowned external speakers and EAM advisory board members and view 62 posters representing every research project of EAM. The contributions from speakers set the groundwork for intensive interdisciplinary discussions among researchers. The conference also proved invaluable in cultivating the overall identity of and solidarity within the Cluster. It presented an opportunity to welcome new researchers and to reflect upon the Cluster's future developments and strategic orientation. Discussions among researchers from the various groups led to numerous ideas for new projects. "Getting to know the players and the ins and outs of the Cluster as well as the different areas of activity was a significant aspect of the symposium," said one new PhD student, "I wasn't aware how broad an interdisciplinary group we are." During the conference, the EAM Poster Award – worth 500 Euros – was presented to Indhumati Paramasivam and Robert Hahn, members of Professor Schmuki's group from research area D. The symposium also offered a gathering place for the Cluster's annual general assembly and members of the advisory board gathered for the first time, agreeing the basis for the advisory board's 2010 evaluation of EAM.

EAM TEM school

In the first half of October Prof. Erdmann Spiecker and his team organized a four-day intensive TEM school for members of the EAM-participating groups. The goal of the school was to provide an overview of the most important techniques of transmission electron microscopy and to introduce the new and exciting TEM opportunities that are now available at the university. PhD students and Postdocs from 16 different groups participated in the school which comprised morning lectures, exercises and practical work at the microscopes. Employing all three of the microscopes at the Cauerstrasse facility, a wide range of topics were covered, including electron diffraction, conventional TEM, high-resolution and analytical TEM. In addition, various techniques of TEM sample preparation were presented. As a highlight, the new aberration-corrected Titan³ 80 – 300 microscope and its unique capabilities for atomic scale analysis of materials was demonstrated. Based on the overall interest in the school (There were twice as many interested applicants as there were spaces available!) as well as the positive response of the participants, plans to organize a second TEM school next year are already in full swing.



PhD-student Benito Vieweg (right) explaining participants of the TEM school steps of the sample preparation



Prof. E. Spiecker and participants of the TEM school at the console terminal of the aberration-corrected Titan³ 80 – 300 microscope

Bavarian parliament vice president visits EAM

During his visit to the University of Erlangen-Nuremberg, vice-president of the Bavarian Parliament, Jörg Rohde received an introduction to the scope of research carried by the EAM. On a tour led by Cluster researchers, Rohde took in the new TEM as well as demonstrators along the nanoelectronics process chain.

Grand opening of the Erlangen Catalysis Resource Center (ECRC)

Participants at the Opening Ceremony (from left to right): Prof. Dr. Hans-Peter Steinrück, Prof. Dr. Martin Hartmann, Prof. Dr. Peter Wasserscheid, Prof. Avelino Corma, Ph.D. Prof. Dr. Wolfgang Peukert



Foto: ECRC (Mile Cindric)

The ECRC was established to strengthen research and education in the area of catalysis at the University of Erlangen-Nuremberg. Currently 14 research groups participate in this new interdisciplinary center.

The inauguration ceremony on 12 November 2009 was opened by Prof. Peter Wasserscheid, head of the of ECRC's board of directors, followed by welcoming remarks from university vice-president Prof. Hans-Peter Steinrück. During his presentation to participants, Prof. Martin Hartmann, ECRC's new professor for Catalysis, talked about the importance of the interface between Chemistry and Chemical Engineering to the structure of the Center. The highlight of the event was the inaugural lecture by EAM advisory board member Prof. Avelino Corma from the Instituto de Tecnología Química, Valencia, Spain. Corma, one of the world's leading scientists in catalysis, emphasized the necessary interplay between materials design and process engineering in order to successfully transfer laboratory research into industrial scale processes.

For more details on the ECRC, see www.ecrc.uni-erlangen.de

Cluster meeting Nanosilver – Production, Characterization and Application



In the framework of its technology transfer program, EAM hosted a half-day workshop for the Bavarian Cluster Nanotechnology. Thirty-five participants representing science and industry met on 3 December to hear presentations on the current state of antimicrobial silver nanoparticle research and applications. Prof. Helmut Münstedt reported on measurement of the release of silver ions. Presentations from companies Uvex and Rent-a Scientist on current applications for silver nanoparticles in the area of functional materials and occupational safety products offered insight into current areas of development. Rounding off the afternoon were contributions from the Fraunhofer ISI in Karlsruhe on the assessment of the environmental impact of silver ions from biocidal products as well as an overview of current opportunities for research funding by the Nano-initiative Bayern GmbH.



Late-night EAM research experience at the Lange Nacht der Wissenschaften

On Saturday, 24 October the “Lange Nacht der Wissenschaften” in Nuremberg, Fürth and Erlangen drew over 25,000 adults and kids to seven hours of “science hopping” in one evening. This multidisciplinary undertaking of various academic and private research institutions as well as industry aimed to showcase the work of scientists and engineers. The development of new and customized materials – the essence of the EAM – was a central theme of the event. Visitors to the “Lange Nacht” were able to experience it all by taking part in a scavenger hunt “From Molecules to Materials – from Electron to Electronic Device” through five of the cluster’s institutions. Visitors got a hands-on feel for what our researchers actually do and found answers to questions like: How are nanoparticles produced and what are their unique properties? Can you really print circuit boards on a jet ink printer?

All participants in the quiz who successfully made their way through the research institutes from the central lecture halls to via the Departments of Chemistry, Materials Engineering and Particle Technology ending up at the Fraunhofer IISB became certified Nano checkers. In addition, visitors got the chance to win many attractive prizes at the EAM raffle. A highlight of the children’s afternoon program was Prof. Wolfgang Peukert’s presentation “Why doesn’t the gecko fall off the ceiling”...

RESEARCH

A window into the nanoworld!

The new aberration-corrected Titan³ 80–300

Since the end of August a new transmission electron microscope purchased by EAM funds has been up and running (figure 1). The Titan³ 80–300 is a world-class high-resolution analytical TEM equipped with aberration-corrected electron optics, a very recent development in the field of electron microscopy.

Aberration correction offers great advantages for the microscopy of materials at the atomic scale. Conventional electron lenses suffer from severe lens aberrations, such as spherical aberration, which lead to blurring of object information in the image plane (a phenomenon also known as image delocalization). The new Titan microscope is equipped with an image-side aberration corrector which improves the microscope resolution to $\sim 0.8 \text{ \AA}$ and, equally important, drastically increases the interpretability of high-resolution TEM images. Figure 2 shows a HRTEM image of an ITO nanoparticle, one of the first images taken with the Titan. It is only because of the suppression of image delocalization by aberration correction that the abruptness of the interface between the nanoparticle and the surrounding vacuum can be revealed with such clarity. Analysis of images of this kind permit the study of the structure of nanoparticle surfaces and surface layers as well as interfaces between nanoparticles, a key issue in several cluster projects.

In addition to HRTEM the Titan offers many other high performance modes of operation, including HAADF-STEM, electron tomography, EDXS, EELS, EFTEM and energy-filtered CBED, to name only some of the most significant. Figure 3 shows an example of atomic number contrast imaging provided by the HAADF-STEM mode in which a small probe is scanned across the specimen and electrons scattered into large angles are detected. Tiny Ag clusters (down to less than 1 nm in diameter) are clearly revealed on the surface of a $\sim 300 \text{ nm}$ large SiO_2 sphere, allowing the study of metal coordination on the sphere, an important step in the fabrication of novel plasmonic Janus particles with tunable optical properties.

Now that the Titan is fully functioning, the different modes and their performance capabilities are being explored in collaborative projects within the Cluster. By exploiting the many opportunities the microscope offers, use of the aberration-corrected Titan³ 80–300 will certainly contribute significantly to a deeper understanding of the structure-property relationship of hierarchical materials. This is of course one of the key points of discussion in EAM!

Prof. Dr. Erdmann Spiecker
www.em.techfak.uni-erlangen.de



Figure 1: The aberration-corrected Titan³ 80–300 transmission electron microscope

Foto: © Jan Kraege Fotografie 2009

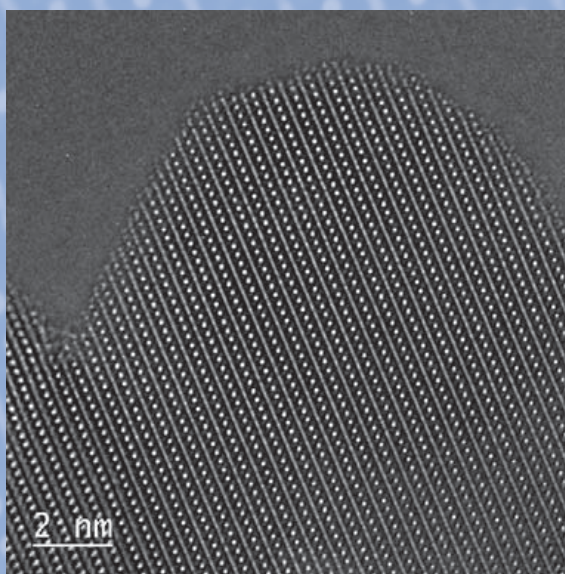


Figure 2: Aberration-corrected HRTEM image of an ITO nanoparticle (Cooperation with Prof. P. Wellmann, WW6)

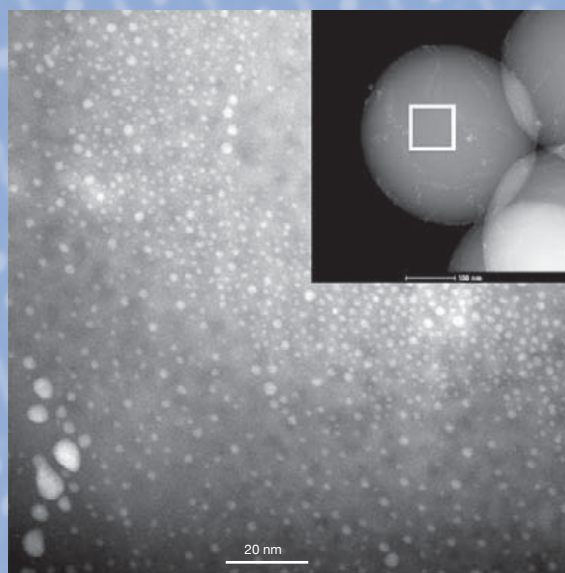
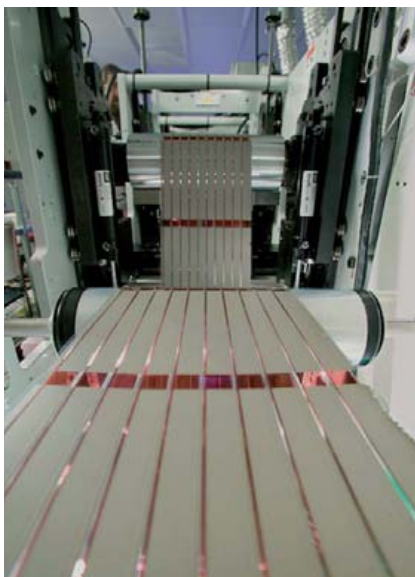


Figure 3: Z-contrast HAADF-STEM image of a SiO_2 sphere decorated with tiny Ag clusters (Cooperation with Prof. R. Klupp Taylor, LFG)



**Cluster member
Prof. Christoph
J. Brabec develops
technology for low-
cost photovoltaic
power production**

In August 2009 Prof. Christoph J. Brabec succeeded Prof. Albrecht Winnacker as head of the Institute of Materials Science VI – Materials for Electronics and Energy Technology. For many years Prof. Brabec has worked at the forefront of the development of so-called third generation photovoltaic (PV) devices including the dye sensitized and organic heterojunction solar cell. This work has mostly been conducted at Konarka Technologies Inc., where Brabec served as CTO before joining our university. In recent articles appearing in *Nature Photonics*¹ and *Advanced Materials*² Brabec presents and reviews the potential of a new class of organic PV. In particular, these articles illustrate the development of polymer materials which enable the generation of PV power for significantly less than the key threshold of \$1 per watt. The technology is based on solution-processed bulk heterojunction PV cells. Besides their potential for cheap mass production by standard roll-to-roll printing processes, these flexible solar cells show a high power-to-weight ratio, which makes them ideal for portable applications. The cells demonstrate very respectable efficiencies of up to 7 %. With further optimization of the materials, Brabec expects efficiencies of more than 10% for single junction cells and more than 15 % for tandem or multiple junction geometries are well within reach. First ageing tests on modules of the novel PV cells indicate lifetimes of 5 years or more for flexible modules, far exceeding the until recently assumed limit of 1–2 years for organic solar-cells. According to Brabec's cost per module calculations these values of efficiency and lifetime will make cost-efficient power generation with organic solar cells a commercial reality in the near future.



References

- 1 Russell Gaudiana and Christoph Brabec, Organic materials: Fantastic Plastic, *Nature Photonics* 2, 287-289 (2008) doi:10.1038/nphoton.2008.69
- 2 Gilles Dennler, Markus C. Scharber, and Christoph J. Brabec, Polymer-Fullerene Bulk-Heterojunction Solar Cells, *Adv. Mater.* 21, 1323 –1338 (2009) doi:10.1002/adma.200801283

Polymer photovoltaic
technology
Foto: Konarka

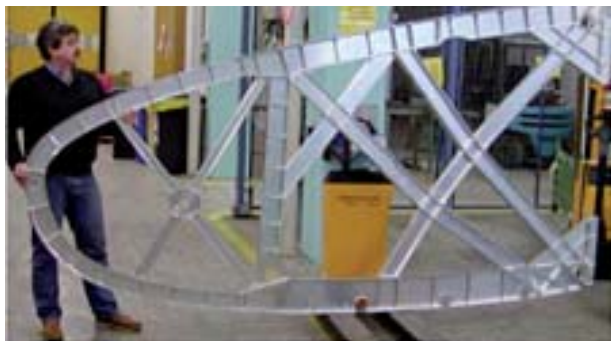
PEOPLE



**New
Professorship
for Applied
Mathematics**

Since May 2009 Michael Stingl has served as W1 Juniorprofessor for Applied Mathematics within the Cluster's Rising Star program. His scientific focus at EAM will be the development of lightweight and meta-materials by means of structural optimization in close cooperation with research area E Engineering of Lightweight Materials.

For his thesis as a student in Mathematics at the University of Erlangen-Nuremberg, Michael Stingl developed optimization algorithms to solve complex problems with a mechanical application background. Stingl then worked on a project funded by the German Federal Ministry of Education and Research (BMBF) and made several research appointments, including stays at the Israel Institute of Technology (Technion Haifa) and the Academy of Sciences in Prague. Stingl's focus of study was free material optimization, a new technology in the development of composite materials. This led to the design of the Airbus A 380's "Leading Edge Rib", which boasts a reduction in weight of over 33 percent.



One-third less weight. The completed prototype of the component for the Airbus 380 not only looks more delicate, it also forfeits nothing in the way of reliability. Foto: EADS

Returning to Erlangen in 2006, Stingl received his doctorate from the Department of Applied Mathematics in nonlinear semidefinite programming. The optimization software PENNON he developed during his dissertation work is unique worldwide and is used in numerous areas of application such as structure optimization, optimal process control and financial mathematics. Since 2006 Stingl has been involved in the EU- funded research project Plato-N. Joining an array of international researchers and industrial corporations (EADS, Airbus UK and Eurocopter), Stingl has helped develop a platform for finding solutions to the challenges of materials optimization in aerodynamics.

www.am.uni-erlangen.de/~stingl/

PEOPLE

First EAM Awardee in Erlangen

Prof. Jana Zaumseil
Ph.D. (Cantab.)
W2 Professor
for Nanoelectronics

About Professor Jana Zaumseil

Jana Zaumseil was born and raised in Germany. She studied Chemistry at the University of Leipzig with a focus on Physical Chemistry. Following a research internship at Bell Laboratories (Lucent Technologies, USA) where she worked on soft-lithography tools for organic field-effect transistors, she joined the Optoelectronics Group at the Cavendish Laboratory (University of Cambridge, UK) in order to pursue her doctorate under the guidance of Prof. Siringhaus. There she developed ambipolar and light-emitting polymer field-effect transistors and received her Ph.D. in 2007. Before coming to Erlangen she was a Ugo Fano post-doctoral fellow at the Center for Nanoscale Materials (Argonne National Laboratory, USA), where she studied electroluminescence from semiconducting carbon nanotubes. Within the framework of the EAM Awards Scheme she was appointed W2 Professor for Nanoelectronics on 1 October 1 2009, receiving resources of 750,000 Euros.

<http://www.nmoe.techfak.uni-erlangen.de/>

How did you learn about EAM, and what led you to pursue a position here?

I found out about EAM at the GAIN Conference in Boston in 2008 where several universities and funding agencies like the DFG advertised research opportunities in Germany. At the time I was looking for suitable positions in Europe and the Rising Star program and research focus of the Excellence Cluster seemed to be a perfect fit.

What do you enjoy and find most challenging about your work at EAM?

I have just been here for a few weeks now, so I am still getting to know the university and my new colleagues. German universities are very different from universities and research institutions in the UK and the United States, so I am still getting used to that. I am impressed with the number of interesting projects going on and the degree of collaboration within the EAM. I look forward to participating in the cluster program. What I find most challenging at the moment is setting up my lab, which is still a construction site. But I am hopeful that everything will be up and running within the next few months.



What were you doing prior to joining the faculty here?

Before coming to Erlangen I was a postdoctoral fellow at the Center for Nanoscale Materials at Argonne National Lab (USA). My research there focused on electroluminescence from semiconducting carbon nanotubes, which is potentially interesting for telecommunications applications.

What are your research interests and briefly describe your work in research area B?

The focus of my research is on nanomaterials that absorb and emit light in the near-infrared, like carbon nanotubes and some inorganic nanocrystals. These materials can be used in photodetectors, solar cells and light-emitting devices that operate at a wavelength range not visible for the human eye but quite important for many applications such as in vivo imaging, telecommunication, night vision and many more. The goal is to understand their charge transport and photophysical properties and apply them in a range of devices.

What are your first impressions of life in Erlangen and the region of Franconia?

I have not yet had the chance to explore Franconia at all. I like Erlangen; it is a friendly and pretty, though small town. I am looking forward to warmer weather to discover the surrounding areas by bike.

Erlangen chemist among the Top 100 most cited chemists worldwide



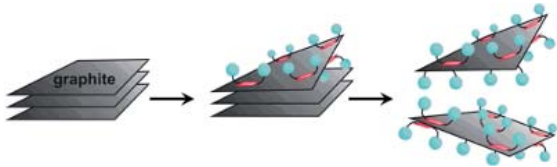
EAM member Prof. Dirk M. Guldi (Chair of Physical Chemistry) is among only a few German researchers who have made it into the top 100 of the ISI Web of Knowledge database of Chemists. With an h-index of 58, Guldi was rated number 76. The h-index (or Hirsch index, named after its proposer, Jorge E. Hirsch) is used to measure how frequently a scientist is cited by other researchers.

Professor Guldi's current research activities encompass the application of numerous microscopic and spectroscopic techniques to characterize chemical, physical and photocatalytic properties of novel molecular architectures. His research group pursues innovative synthetic strategies with respect to hybrid systems, quantum dots and rods and other functional nanoparticles. His expertise and contributions are especially strongly felt in the Cluster of Excellence through his work in research area B Nanoelectronic Materials.

ERC Advanced Investigator Grant for EAM member Andreas Hirsch



Professor Andreas Hirsch, Chair of Organic Chemistry II and coordinator of EAM research area B Nanoelectronic Materials, has been awarded an Advanced Investigator Grant by the European Research Council (ERC). The research project “Graphenochem-Large scale production, cloning, chemical functionalization and materials application of graphene” will receive funds amounting to 1.4 million Euros over the next five years. Andreas Hirsch is the first scientist at the University of Erlangen-Nuremberg to receive this grant which is earmarked by the ERC for exceptional research. Advanced Investigator Grants promote pioneering and interdisciplinary research projects that transcend the boundaries between basic and applied science as well as between research and industrial development.



The focus of the project Graphenochem is the chemical investigation of the preparation and derivatization of graphene, a material comprising a single atomic layer of sp²-bonded carbon atoms. This relatively new nanomaterial is reminiscent of the already well-known carbon nanotubes in terms of its extraordinary mechanical strength and flexibility. It also exhibits exceptional electronic conductivity, due to the quasi-massless behavior of its electrons.

The decisive factors for the ERC evaluation committee were Hirsch's outstanding scientific profile and the visionary, ground-breaking nature of his proposal. A further consideration in awarding the grant was the innovative environment of the University of Erlangen-Nuremberg as well as the interdisciplinarity of the project.



1.25 Million Euros granted for research into cellular ceramics

The scientific team of EAM member Professor Peter Greil, Department of Materials Science and Engineering (Chair of Glass and Ceramics), has been awarded 1.25 million Euros by

the DFG (German Research Foundation) for a Reinhart Koselleck Project. This five-year funding allows researchers with proven

scientific achievements the opportunity to carry out innovative, high-risk projects with significant scientific potential. The project's focus is the exploration of a new concept in the development and production of hierarchical cellular ceramics, a current subject of Greil's research in EAM research area E Lightweight Materials.

The research project is centered on a new approach to the design and production of hierarchical cellular ceramics through periodic addition of space-filling polyhedra. This leads to new and unexpected property changes such as e.g. crack healing, auxetic deformation, or a band gap-behavior that is impossible in monolithic materials. To demonstrate such novel functions, emphasis will be put on three examples with high innovation potential: non-brittle high-end ceramics with the ability to self-heal cracks, piezo-electric ceramics with auxetic behavior, and microwave ceramics with specific band-gap properties.

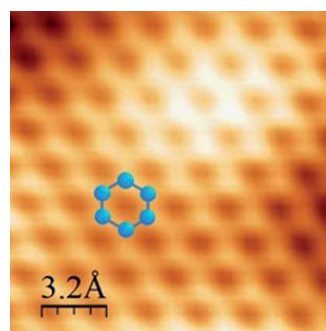
Highest recognition for physicists: EAM member PD Dr. Thomas Seyller receives 2010 Walter Schottky Award



PD Dr. Thomas Seyller, acting head of the Chair of Technical Physics at the University of Erlangen-Nuremberg's Institute for Condensed Matter Physics, has been named the recipient of the 2010 Walter Schottky Award by the German Physical Society. The 44-year-old scientist will receive the award, endowed with 15,000 Euros, for “his significant contributions to the physics of the growth of graphene, in particular for graphene synthesis on silicon carbide.”

Graphene is a single, ultrathin layer of carbon atoms. Because of its unusual properties, the two dimensional material is of great interest in terms of fundamental research and inspires the imagination of experts in the field.

Graphene is a promising material for electronic devices, but exploiting its full potential requires reproducible and uniform large-scale production. PD Dr. Seyller has developed a process by which high quality graphene can be synthesized on silicon carbide substrates making use of standard methods of semiconductor technology. Read more at www.graphene.nat.uni-erlangen.de



Picture of a graphen layer with a scanning tunneling microscope (STM)

WELCOME TO THE CLUSTER

New Members

PD Dr. Thomas Seyller Chair for Technical Physics

Prof. Dr. Michael Thoss Professor for Theoretical Physics, specializing in electron transport in molecules

New Professor

Prof. Dr. Bastian Etzold Professor for Catalytic Materials

NEWS

Funding of the Research Training Group (Graduiertenkolleg) on Disperse Systems for Electronic Applications will continue

We are pleased to announce that the DFG appropriations committee has approved the continued funding of the Research Training Group on Disperse Systems for Electronic Applications. Beginning 2010, four million Euros will be set aside for 11 sub-projects. Alongside EAM, this adds another element to the Cluster's research environment, which will strengthen the initiative as a whole in general and the field of Nanoelectronic Materials in particular.

The Lego Principle – for the development of innovative materials

Videoportrait of the Cluster of Excellence - Engineering of Advanced Materials is available online



We invite you to take a look at the DFG (German Research Foundation) video portal's promotional film on the Cluster of Excellence. Focusing in particular on the examples of nano-electronics and lightweight materials, the video illustrates one of EAM's principle philosophies, namely the interdisciplinary development of process chains leading from particles to structures to functional devices. It gives viewers an insight into the rich spectrum of materials challenges and solutions which make up EAM's research programme. Also introduced are our modern research facilities, including the Titan³ TEM and some of our scientists, who provide an enthusiastic narrative. Please take a look at the video at www.eam.uni-erlangen.de or at www.excellence-initiative.com

UPCOMING EVENTS

EAM strategy workshop 2010

29-30 January 2010 in Muggendorf

EAM Winter Schools 2010

Kirchberg, Tyrolia

15–18 March 2010: research areas A1, A3, C, B

22–25 March 2010: research areas A2, D, E

EAM at Hannover Messe 2010

19–23 April 2010, Hannover

EAM is represented at Hannover Messe at the joint booths of Bayern Innovativ. Research area E Lightweight Material will exhibit in Hall 2 – Industrial Supply and research area B Nanoelectronic Materials will exhibit in Hall 5 – Research and Technology.

EAM stand at POWTECH 2010

27-29 April 2010, Nuremberg, Hall 8, Booth 408

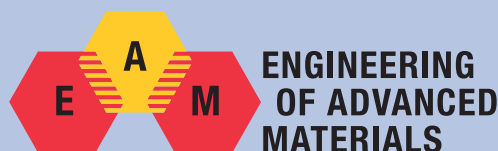
EAM will present its expertise in a broad range of topics of particle technology: synthesis, characterization, handling, functionalization, simulation. The World Congress on Particle Technology (WCPT6) is one of the largest particle technology related events in Europe. WCPT6 will take place simultaneously with POWTECH at the NürnbergMesse.

EAM stand at 3rd EuCheMS Chemistry Congress

29 August – 2nd September 2010, Nuremberg

EAM Symposium 2010

15-18 November 2010, Kloster Banz, Bad Staffelstein



Cluster of Excellence: Engineering of Advanced Materials
Nägelsbachstr. 49b | 91052 Erlangen
Phone: +49.9131.85-20846
E-Mail: administration@eam.uni-erlangen.de
Images: EAM, EAM/CENEM and private

