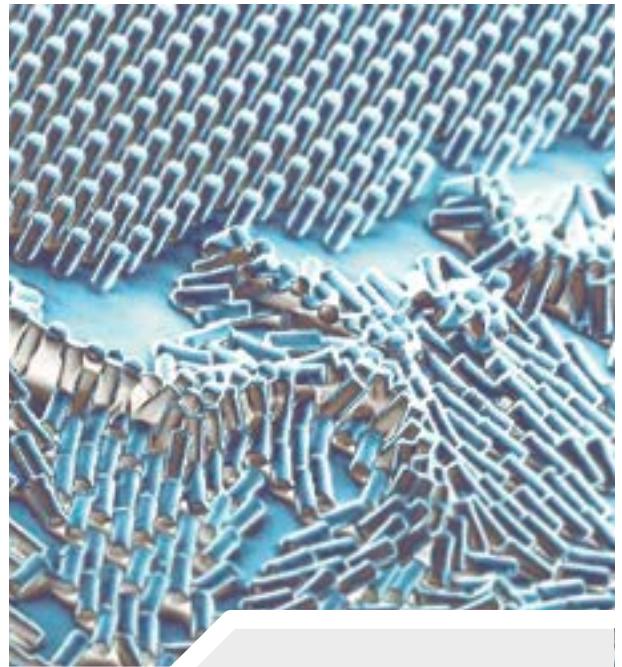
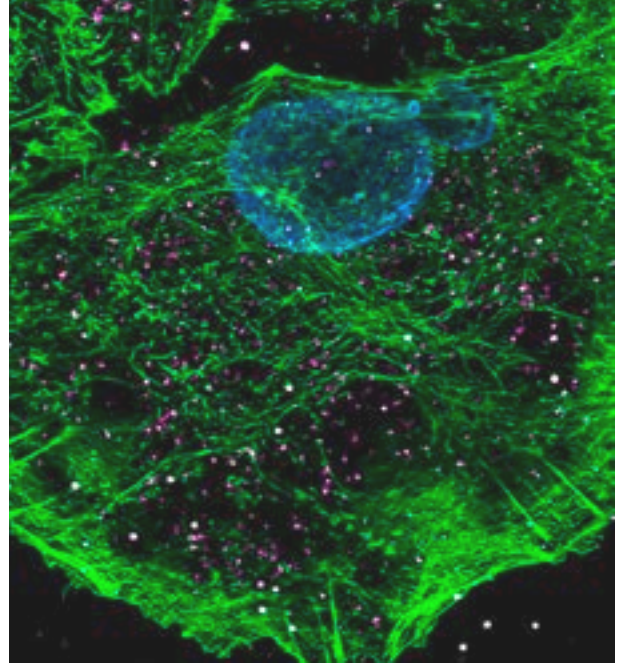


Neues Denken.  Neue Materialien.



 JAHRESBERICHT 2012  
ANNUAL REPORT 2012

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Dr. Roland Rolles  
Kaufmännischer Geschäftsführer

Prof. Dr. Eduard Arzt  
Wissenschaftlicher Geschäftsführer und  
Vorsitzender der Geschäftsführung

SEHR GEEHRTE LESERINNEN UND LESER,  
LIEBE FREUNDE DES INM,

in 2012 haben wir die Arbeiten an einer Vielzahl von Themen in den Forschungsfeldern Grenzflächenmaterialien, Materialien für die Biologie und Chemische Nanotechnologie erfolgreich fortgesetzt. Grundlegende Arbeiten offenbarten neue Erkenntnisse z. B. zu schaltbaren Oberflächen oder zum Verständnis von Phänomenen wie Reibung und Haftung. Es wurden neue Beschichtungen, etwa zur Verbesserung medizinischer Implantate oder für tribologische Anwendungen, entwickelt. Zahlreiche Entwicklungen mündeten in erfolgreiche Projekte mit Industriepartnern.

Seit Januar 2012 baut Prof. Niels de Jonge mit dem neuen Programmbereich Innovative Elektronenmikroskopie ein weiteres Forschungshighlight des INM auf. Im Fokus seiner Arbeiten steht neben der methodischen Weiterentwicklung der Elektronenmikroskopie die 3D- und Flüssigzellmikroskopie an biologischen und nanoskopischen Strukturen.

Mit Juni 2012 nahm die neue Juniorforschungsgruppe Energie-Materialien unter der Leitung von Jun.-Prof. Volker Presser im Rahmen des BMBF-Projektes nanoEES<sup>3D</sup> ihre Arbeit in einem extrem zukunftssträchtigen Feld der Materialforschung auf.

Wiederum freut es uns, dass das INM seine Attraktivität für internationale Kolleginnen und Kollegen auch in diesem Jahr weiter steigern konnte. Mit 3 Humboldt-Preisträgern und 2 Stipendiaten rangiert das INM im Spitzenfeld der Leibniz-Einrichtungen.

Ein besonderes Ereignis des Jahres 2012 war zweifellos das 25-jährige Jubiläum des Institutes, das gemeinsam mit vielen Gästen aus der Landesregierung, der Leibniz-Gemeinschaft, dem BMBF, der Universität und der Industrie gefeiert wurde.

Solche Erfolge sind nur durch das Zusammenspiel vieler zu erreichen. Wir danken allen Freunden, Partnern und Förderern des INM für ihre Unterstützung. Ein besonderer Dank gilt unseren Mitarbeiterinnen und Mitarbeitern: Ihr Einsatz macht diese Erfolge möglich!

DEAR READERS, DEAR FRIENDS OF INM,

also in 2012 we successfully continued our work on a large number of topics in the research fields interface materials, materials in biology and chemical nanotechnology. Fundamental work has revealed new insight in switchable surfaces and led to improved understanding of phenomena such as friction and adhesion. New coatings were developed to improve medical implants or tribological surfaces. Numerous established developments led to successful projects with industrial partners.

Since January 2012, Prof. Niels de Jonge has established another research highlight at INM by building up the new program division *Innovative electron Microscopy*. Beside the methodical advancements of electron microscopy the focus of his work lies on 3D and liquid cell microscopy of biological and nanoscale structures.

In June 2012 the newly formed junior research group *Energy Materials* under the direction of Prof. Volker Presser started its work within the frame of the BMBF project nanoEES<sup>3D</sup> in a very timely field of materials research.

Furthermore, we are especially delighted that INM managed to further increase its attractiveness for international colleagues. With currently 3 Humboldt award winners and 2 scholars, INM ranks among the top Leibniz Institutes.

An outstanding event in 2012 certainly represented the 25<sup>th</sup> anniversary of the institute, which was celebrated in the presence of many guests from the government, the Leibniz Association, the BMBF, Saarland University and industry.

Such a success can be only achieved with a close cooperation of many people. We thank all friends, partners and sponsors of INM for their support. A special thanks also goes to our employees: They make this success happen!

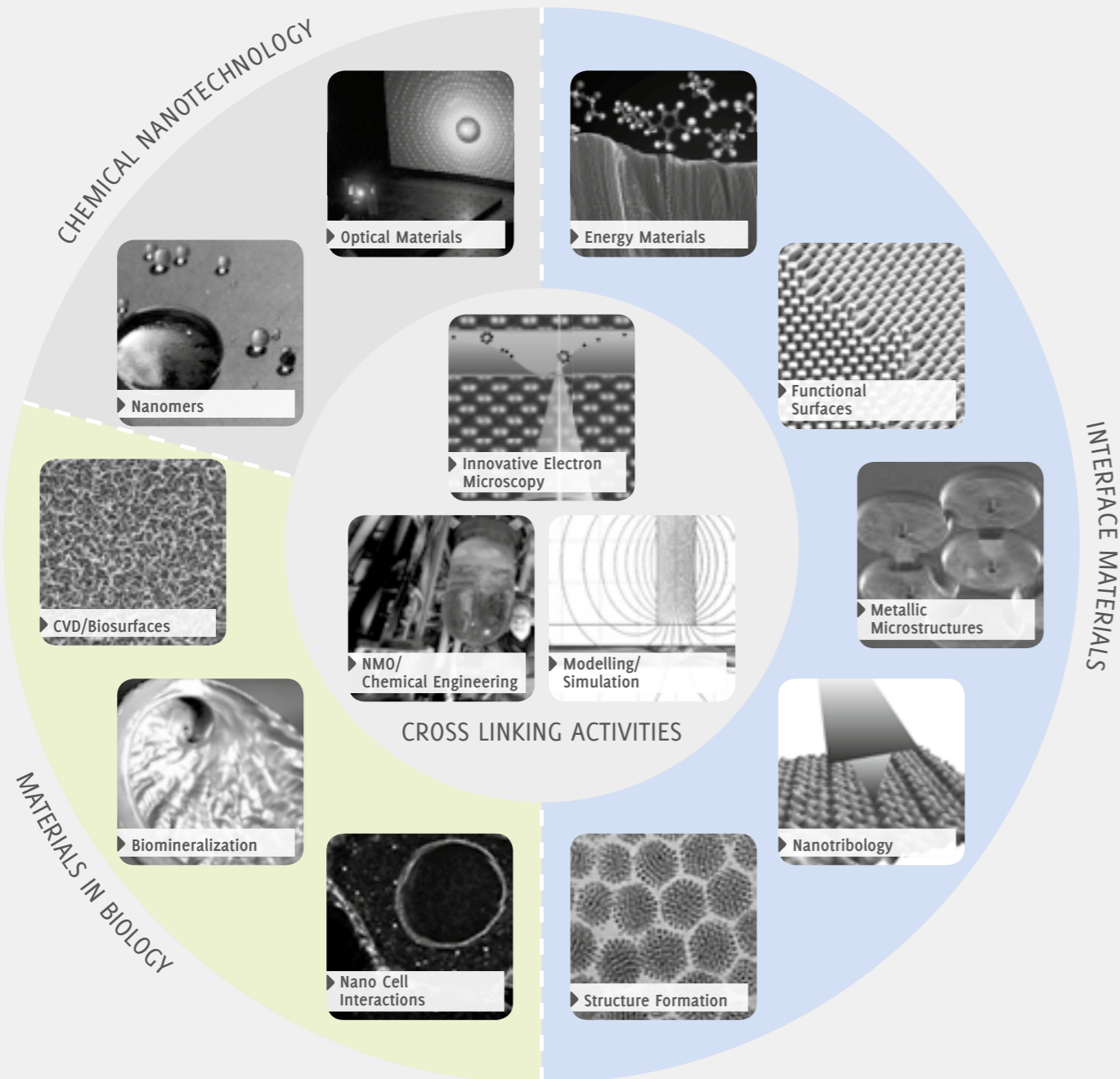




▶ GRUPPENBERICHTE /  
GROUP REPORTS



## ► FORSCHUNGSFELDER / RESEARCH ACTIVITIES



### DIE FORSCHUNGSFELDER DES INM

Die Arbeiten des Instituts werden in Programmbereichen und Juniorforschungsgruppen durchgeführt, die thematisch in drei Forschungsfelder und ein Querschnittsfeld gegliedert sind.

Das Forschungsfeld *Grenzflächenmaterialien* befasst sich mit neuen Methoden der Oberflächen- und Grenzflächenstrukturierung und erforscht physikalische Mechanismen an Oberflächen, so zum Beispiel tribologische Phänomene oder neue Materialien zur Energiespeicherung. Das Forschungsfeld beinhaltet die folgenden Programmbereiche bzw. Juniorforschungsgruppen (JFG): Energie-Materialien (JFG), Funktionelle Oberflächen, Metallische Mikrostrukturen (JFG), Nanotribologie und Strukturbildung auf kleinen Skalen (JFG).

Im Forschungsfeld *Materialien in der Biologie* werden die drei Programmbereiche Biomineralisation, CVD/Biooberflächen und Nano Zell Interaktionen zusammengefasst, deren Arbeit sich auf die Schnittstelle zwischen Materialwissenschaft und Biologie bzw. Medizin konzentriert.

Das Forschungsfeld *Chemische Nanotechnologie* widmet sich in den zwei Programmbereichen Nanomere und Optische Materialien nichtmetallisch-anorganischen Materialien und organisch-anorganischen Hybridmaterialien und ihren funktionellen Eigenschaften. Schwerpunkt sind nasschemische Synthesemethoden unter Nutzung von Nanopartikeln.

In einem übergreifenden Querschnittsfeld werden drei Programmbereiche zusammengefasst, deren besonderes Know-how und spezielle methodische Kompetenz einen zusätzlichen Nutzen generiert, von dem auch die anderen Abteilungen profitieren. Dies sind die Querschnittsbereiche Innovative Elektronenmikroskopie, Modellierung/Simulation und das Anwenderzentrum NMO/Verfahrenstechnik.

### THE RESEARCH ACTIVITIES OF THE INM

The research in the institute is conducted in program divisions and junior research groups (JRG), which are thematically grouped in three research fields and a unit containing groups with cross linking activities.

The research field *Interface Materials* deals with novel methods of surface and interface patterning and investigates physical mechanisms on surfaces, such as e.g. tribological phenomena or new materials for energy storage. The research area comprises the following program divisions and junior research groups: Energy Materials, Functional Surfaces, Metallic Microstructures, Nanotribology and Structure Formation.

In the research field *Materials in Biology* the three program divisions Biomineralization, CVD/Bio-surfaces and Nano Cell Interactions are integrated. Their work focusses on the interface between materials science and biology respective medicine.

The research field *Chemical Nanotechnology* consists of the program divisions Nanomers and Optical Materials. It is dedicated to non-metallic-inorganic and organic-inorganic hybrid materials and their functional properties with an emphasis on wet chemical synthesis methods using nanoparticles.

In a comprehensive cross linking area, program divisions with specific know-how are grouped. The program divisions Innovative Electron Microscopy, Modelling/Simulation and NMO/Chemical Engineering generate additional methodological competences, from which the other groups can benefit.

## ► ENERGIE-MATERIALIEN / ENERGY MATERIALS

JUN.-PROF. DR. VOLKER PRESSER

### DIE GRUPPE

Die Juniorforschungsgruppe Energie-Materialien erforscht und entwickelt elektrochemische Nanomaterialien zur elektrochemischen Energiespeicherung oder zur Entsalzung *via* kapazitiver Deionisierung. Auf der Materialseite liegt der Schwerpunkt auf hochporösen Kohlenstoffen, welche als Pulver, Dünnschichten, Schäume oder Nanofasern hergestellt werden können. Hieraus werden Elektroden für elektrochemische Doppelschichtkondensatoren entwickelt und durch die nanoskalige Implementierung von Metalloxiden, Metallnitriden und Polymeren hochleistungsfähige Pseudokondensatoren hergestellt. Ein zentrales Ziel des Programmbereichs ist die synergistische Zusammenführung von hoher Energie- und Leistungsdichte bei Ergänzung von Funktionalität basierend auf potentiell skalierbaren Materialien und Produktionsmethoden, ohne dass dabei die hohe Lebensdauer eingeschränkt wird. Besondere Bedeutung nimmt die Charakterisierung der elektrochemischen Phänomene, wenn möglich unter *in situ* Bedingungen, ein.

### MISSION

The year 2012 was a year of beginnings for the Energy Materials Junior Research Group (JRG). Having transitioned from Drexel University, Volker Presser started work in the Energy Materials Group in the summer of 2012 together with Dr. Mesut Aslan. The group has significantly grown since then: Dr. Jennifer Atchison joined the team in August and Dr. Emilie Perre in December 2012. Mr. Michael Naguib from Drexel University joined the group for 3 months as a DAAD PhD fellow. By the end of December 2013, most of the infrastructure for the BMBF project nanoEES<sup>3D</sup> had been purchased and the majority of systems have already arrived. In particular the electrochemical characterization suite, most notably the electrochemical dilatometer and the potentiostats, have been utilized to study materials synthesized by thermal and chemical treatments and electrospinning.

### CURRENT WORK

#### Porous Designer Carbons

In collaboration with the Technical University Dresden, we have developed ordered and disordered hierarchical porous carbon materials, namely ordered mesoporous carbide-derived carbon (OM CDC) *via* soft templating and high internal phase emulsion carbide-derived carbon (HIPE CDC). Through this work it has become apparent that a controlled complex pore hierarchy is more important than "just" providing a high internal surface area to realize increased electrochemical capacitance for improved ion storage *via* electrosorption. The reason is that when there is a large volume fraction of nanopores smaller 2 nm, diffusional limitations in and out of the pores significantly limited the power

### ► Jun.-Prof. Dr. Volker Presser

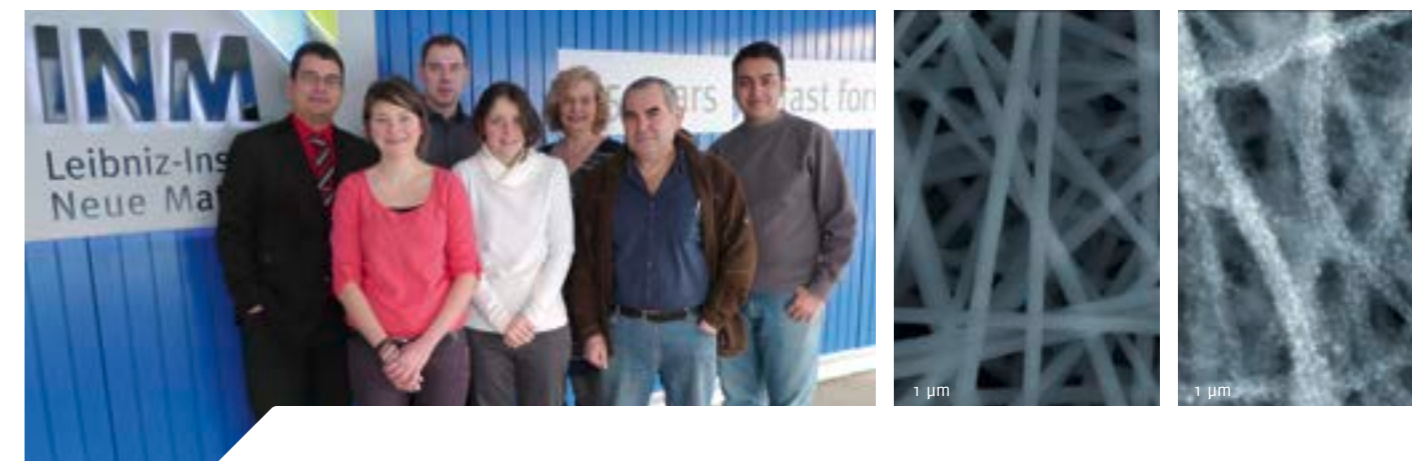


Jun.-Prof. Volker Presser promovierte 2009 in Tübingen, war von 2010 bis 2012 Feodor Lynen Stipendiat und Assistant Research Professor an der Drexel University, Philadelphia, USA. Seit 2012 ist er BMBF-geförderter Juniorforschungsgruppenleiter und seit 2013 Juniorprofessor an der Universität des Saarlandes.

handling ability. We showed in collaboration with Wetsus Centre of Excellence for Sustainable Water Technology that optimized pore architecture not only enables fast ion electrosorption but also the highest salt removal capacity yet reported for any porous material. Two-dimensional kinetic modeling of ion transport in porous carbons with defined pore size distribution *via* a modified Donnan approach corroborated this phenomenological observation.

#### Carbon Onions

Carbon onions have been derived via vacuum annealing of commercially available detonation and laser-ablation nanodiamond precursors. Our work has demonstrated that the quality, purity, and crystallinity of the precursor nanodiamond material dictates the resulting carbon onion structure obtained after thermal annealing in vacuum. Slightly disordered material with particularly small particles is of practical importance for electrochemical



#### Carbon Nanofibers

Binder-free carbon nanofiber mats have been obtained from electrospinning polymer based solutions. This facile processing method produces ultra-fine and nano-fibers with diameters in the 100 to 300 nm range. At the moment, two main research thrusts are being carried out: polyacrylonitrile (PAN) nanofibers as a benchmarking material for "simple" carbon fiber electrodes and carbide derived carbon (CDC) nanofibers as a platform material for electrode mats with high specific surface area. The other approach is to rationally design pore architectures and specific surface areas using CDC nanofibers. These nanofibers are realized by electrospinning a carrier polymer infiltrated with metal alkoxides. The resulting fiber mats are thermally converted to carbon fibers with embedded carbide nanocrystals that are transformed after chlorine treatment into CDC. These CDC nanofibers are mechanically flexible energy storage electrodes to be used without the addition of polymer binder that significantly lowers power handling ability.

energy storage because of its wide availability and high specific surface area.

#### OUTLOOK

In 2013, the Energy Materials Group will design optimized hybrid and pseudocapacitor systems which synergistically combine redox reactions, ion insertion, and double layer formation. We will optimize CDC nanofiber synthesis and tackle various carbide systems. In the field of carbide research, we are also going to continue our research in collaboration with Drexel University to investigate 2D metal carbides, MXenes, as electrode material. We will also deepen our *in situ* investigation of ion insertion and ion electrosorption in continuation of the fruitful collaboration with Bar Ilan University, Israel. Finally, cost efficient scalable energy storage is another main theme and will be approached with our activities related to flow and dynamic capacitor systems. Promising collaborations with other groups at INM are already under way.



## ► FUNKTIONELLE OBERFLÄCHEN / FUNCTIONAL SURFACES

PROF. DR. EDUARD ARZT, DR. ELMAR KRONER

### DIE GRUPPE

Mikro- und nanostrukturierte Oberflächen zeichnen sich häufig durch besondere Funktionen aus. So basieren beispielsweise die Farbe von Schmetterlingen, die Selbstreinigung von Lotusblumen oder die Hafteigenschaften von Geckos auf Oberflächenstrukturen. Im Programmbereich *Funktionelle Oberflächen* werden Materialoberflächen erforscht, charakterisiert und hergestellt, deren Eigenschaften gezielt durch eine Oberflächenstrukturierung eingestellt werden kann. Als Vorbild für solche funktionellen Oberflächen dienen oft Konzepte aus der belebten Natur, die auf künstliche Systeme übertragen werden. Die Bandbreite der Forschung reicht dabei von der Grundlagenforschung, wie beispielsweise der Untersuchung von Deformationsmechanismen mikrostrukturierter Proben oder dem Einfluss viskoelastischer Eigenschaften auf die Haftkraft, bis hin zu Anwendungen wie beispielsweise Implantatmaterial zur Behandlung gerissener Trommelfelle oder Greifsysteme für Roboter.

### MISSION

The focus of the program division *Functional Surfaces* lies on the modification of material surfaces to improve their properties or to achieve new functionality. One main topic is the development of advanced bioinspired adhesion systems (Gecomer technology of INM). Such systems are designed to show switchable adhesion, to adhere to soft surfaces such as tissue, or to enable industrial applications as in gripping robots. The goal of the research is the fabrication of surface patterns with well defined geometry, the characterization of the resulting properties and the optimization of the systems to fulfil the requirements of applications.

### CURRENT WORK

Hierarchically structured adhesion systems Many adhesion systems in nature exhibit a hierarchical structure. It is believed that such a structure is necessary for adhesion to rough surfaces.



In a project funded by DFG (SPP 1420), we investigate the influence of hierarchy on adhesion. We designed model structures with different numbers of hierarchy levels and found that a hierarchical structure may deliver more reliable adhesion on rough surfaces. Also, new routes to fabricate densely packed nanostructures for incorporation into hierarchical adhesion systems were developed together with the *JRG Structure Formation*.

### Switchable adhesion systems

One of the main advantages of bioinspired adhesion systems is their ability to attach and quickly detach. While this reversible change in adhesion is achieved in nature by a combination of complex surface structure and biomechanics, this kind of switching trigger may not be favourable for artificial adhesion systems. Thus, we investigate different switching mechanisms that allow changing the adhesive properties of a surface by different external stimuli. Pressure-actuated switchable adhesives, which modulate adhesion by tuning the compressive preload, have been developed and optimized for possible industrial applications. Also, we developed a hybrid switchable adhesion system based on a shape memory metal and a polymeric coating. A change in temperature causes the shape memory metal to reversibly form bumps on the surface. Thus, the contact area can be changed, which directly influences adhesion. This development was patented together with the *JRG Metallic Microstructures*.

### Bioinspired adhesion to soft materials

A promising field of application for bioinspired

adhesives is biomedical devices, such as wound patches for ruptured ear drums. Here, an artificial adhesion system is required that adheres to soft surfaces. For this purpose, we developed model systems which allow evaluation of the adhesion properties of patterned surfaces on soft model materials. Also, we fabricated different surface structures with varying material properties to optimize adhesion to soft surfaces. First prototypes show adhesion to skin but also point out the need for systematic investigations to improve the understanding of such systems. Relevant research topics include the effects of skin structure, hairs, particles and grease on adhesion.

### Bioinspired adhesives on the verge of applications

Bioinspired adhesives have large potential for industrial application due to their unique combination of properties: The adhesion is reversible and switchable, no residues are left behind after detachment, and adhesion is largely unspecific as to the substrate material. Other important properties are – in contrast to e.g. suction devices – adhesion maintenance without constant supply of energy or adhesion at low atmospheric pressure. To demonstrate the feasibility of implementing gripping devices with bioinspired adhesives, we developed a prototype robot which was exhibited at the Hanover trade show. The robot picked up and released a silicon wafer throughout the duration of the fair. Being improved to allow for multi-positioning placement, this development has met great interest of industrial collaborators.



#### ► Prof. Dr. Eduard Arzt

(Programmbereichsleiter) ist wissenschaftlicher Geschäftsführer und Vorsitzender der Geschäftsführung des INM sowie Professor für Neue Materialien an der Universität des Saarlandes. Er promovierte an der Universität Wien in Physik und Mathematik und forschte anschließend u. a. in Cambridge, UK, Stanford, Santa Barbara, am MIT, USA, und Stuttgart. Zuletzt war er Direktor am Max-Planck-Institut für Metallforschung in Stuttgart.



#### ► Dr. Elmar Kroner

(stv. Programmbereichsleiter) studierte Werkstoffwissenschaft an der Universität Stuttgart und dem MPI für Metallforschung in Stuttgart. Nach seiner Promotion an der Universität des Saarlandes und am INM wurde er 2011 stellvertretender Gruppenleiter des Programmbereichs Funktionelle Oberflächen.

## ► METALLISCHE MIKROSTRUKTUREN / METALLIC MICROSTRUCTURES

DR. ANDREAS SCHNEIDER

### DIE GRUPPE

Die Juniorforschungsgruppe (JFG) *Metallische Mikrostrukturen* beschäftigt sich mit der Mechanik kleinskaliger Proben, der Mikrostrukturierung von metallischen Oberflächen und der Durchführung von mikromechanischen Tests. Neben metallischen Werkstoffen werden auch hierarchisch aufgebaute Biomaterialien und Polymere charakterisiert. Ziele der aktuellen Forschung sind die Aufklärung von mechanischen Größeneffekten in Metallen, die Charakterisierung der Struktur-Eigenschafts-Beziehungen in biologischen Materialien und die Entwicklung von Strukturierungsmethoden für metallische Oberflächen, die zu einer Optimierung oder zu völlig neuen Eigenschaften führen. Basierend auf Formgedächtnismaterialien werden zudem Systeme entwickelt, deren Oberflächentopographie und damit zusammenhängende Eigenschaften über einen externen Stimulus, wie zum Beispiel die Temperatur, geschaltet werden können.

### ► Dr. Andreas Schneider



Dr. Andreas Schneider studierte Werkstoffwissenschaft in Stuttgart und promovierte 2010 bei Prof. Eduard Arzt. Nach der Promotion wechselte er ans INM – Leibniz-Institut für Neue Materialien und leitet dort seit 2011 die JFG Metallische Mikrostrukturen.

### MISSION

The Junior Research Group (JRG) *Metallic Microstructures* focuses on the mechanical characterization of small-scale metal structures. It is aimed to build a know-how base of mechanics and functions of modern metallic materials, coatings and micro/nanotechnological devices. Besides, we develop new structuring techniques for metal surfaces in order to modify their properties. We also focus on the understanding of the structure-property relationship in hierarchically structured biomaterials and the mechanics of polymers.

### CURRENT WORK

#### High temperature compression tests on bcc metals

In collaboration with Prof. Korte from the University in Erlangen we have performed microcompression tests on molybdenum (Mo) micropillars, both above and below the critical temperature of Mo at 300 K and 500 K. The results showed that the size scaling of bcc metals is strongly affected by temperature and transitions to an fcc-like behavior upon increasing temperature. By correlating the critical temperature with mechanical size dependence, the influence of the temperature could be attributed to the thermally activated screw dislocation mobility in bcc metals.

#### Structure-property relationship of stimulated plants

The structure-property relationship of sorghum bicolor plants that have been mechanically stimulated during growth was investigated in cooperation with the Program Division *Biomaterialization*. Three point bending tests showed that the bending

strength of the stimulated plants is significantly higher than that of the not stimulated ones. Based on light microscopy investigations performed on the stem cross-section, it was concluded that this is related to an increase in the fraction of the sclerenchyma most likely as a result of the mechanical stimulation.

#### Mechanics of soft polymers

Together with the Chair of Applied Mechanics at the Saarland University we have developed a procedure to characterize the effects of finite viscoelasticity and adhesion on the nanoindentation behavior of soft polymers. Different nanoindentation testing protocols were used to capture the viscoelastic properties as well as the adhesion between the indenter tip and the silicon rubber used. An inverse method based on finite element (FE) computation and a numerical optimization subroutine was used to reproduce the experimental results. In the FE program a numerical viscoelastic model and a traction-separation law to account for the adhesion were implemented. By matching the response of the numerical model with the force-displacement curves, the parameters of the chosen viscoelasticity model and the adhesive contact model were identified.

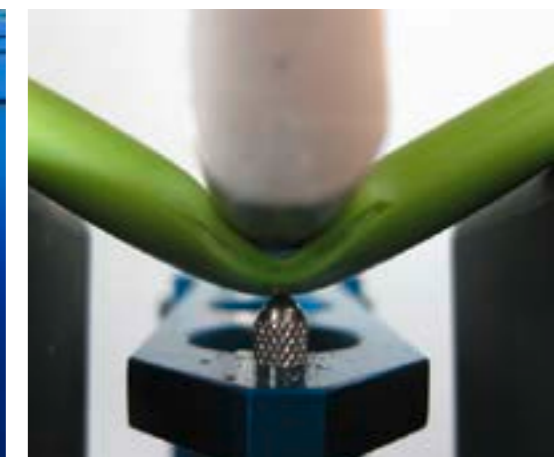
#### Copper/polymer composites for antibacterial coatings

In the framework of an industry project, copper (Cu)/polymer composites for antibacterial coatings were developed. The composites were prepared by

mixing Cu micro-/nanoparticles with polymers that harden by UV irradiation. A spin coating process was used to deposit a thin layer of the composite on various substrate materials. Bacterial tests performed on the coatings showed that microparticles lead to a higher antibacterial activity of the coating than nanoparticles. It is assumed that due to the limited thickness of the coating, the microparticles are not fully embedded in the polymer matrix. As a consequence, the ion release and also the interactions with the cells are enhanced in comparison to fully embedded nanoparticles.

### OUTLOOK

In 2013, the Junior Research Group *Metallic Microstructures* will continue to explore mechanical size effects in metals. The main focus will be on the characterization of alloys with a cesium-chloride crystal structure and the influence of age hardening treatments on AlCu micro-/nanostructures. To couple size dependent properties, we will also examine the effect of mechanical stress on the antibacterial properties of Cu thin films. Besides that, we will strengthen our activities in the field of biomaterials. Through micromechanical testing we aim to acquire new insights into the structure-property relationship of hierarchically structured materials. Finally, we will carry on our work on switchable shape memory surfaces. In this context, we will focus on the development of smart systems that can be switched by inductive or resistive heating or the application of a magnetic field.





## ▶ NANOTRIBOLOGIE / NANOTRIBOLOGY

PROF. DR. ROLAND BENNEWITZ

### DIE GRUPPE

Der Programmbereich *Nanotribologie* erforscht mechanische Materialeigenschaften aus grundlagenorientierter Sicht und konzentriert sich dabei auf mikroskopische Mechanismen. Mit unseren Ergebnissen wollen wir zum Verständnis von Phänomenen wie Reibung, Verschleiß und Haftung sowie zur wissensbasierten Entwicklung neuer Materialien mit speziellen mechanischen Eigenschaften beitragen. Die experimentellen Projekte basieren auf unserer Expertise in der hochauflösenden Rasterkraftmikroskopie. Außerdem haben wir neue experimentelle Methoden entwickelt, um mechanische Eigenschaften insbesondere biologischer Materialien auf verschiedenen Längenskalen zu untersuchen. Zu den herausragenden Ergebnissen des Jahres gehören die Untersuchung der Trennung von Gummi und Glas anhand der dabei ausgesandten Lichtblitze, eine Studie zur Dynamik der Bildung einzelner Versetzungen mit Hilfe der Rasterkraftmikroskopie sowie der Einsatz ionischer Flüssigkeiten zur elektrochemischen Kontrolle von Reibung.

### ▶ Prof. Dr. Roland Bennewitz



Prof. Dr. Roland Bennewitz leitet die Nanotribologie Gruppe und ist Honorarprofessor an der Universität des Saarlandes. Er promovierte an der Freien Universität Berlin, war Postdoc an der Universität Basel und hielt den Canada Research Chair in Experimental Nanomechanics der McGill Universität in Montreal.

### MISSION

The Program Division Nanotribology explores the mechanical properties of materials from a fundamental perspective with a focus on microscopic mechanisms. Our results contribute to an understanding of phenomena like friction, wear, or adhesion and to a rational design of novel materials with certain mechanical functions. Our experimental projects rely on our expertise in the field of high-resolution force microscopy, which we apply in ultra-high vacuum and electrochemical environments. Furthermore, we have developed new experimental methods for mechanical testing on various length scales. The methods and results of fundamental nanotribology are applied in collaborations, in particular within the INM. Examples are joint projects with the Junior Research Group *Metallic Microstructures* on the mechanical properties of micrometer-scale pillars, with the Program Division *Functional Surfaces* on friction and adhesion of biomimetic adhesives, and with the Program Division *NMO* on wear phenomena in polymer composites. The program division is well connected internationally, as documented for example in joint publications in 2012 with Tel Aviv University, Lehigh University, McGill University, University of Newcastle, and University of Wisconsin. Nationally, we collaborate with the Karlsruhe Institute of Technology and the University Clausthal-Zellerfeld, locally, we work on funded research projects with the Departments of Physics and Chemistry at Saarland University.

### CURRENT WORK

The following examples describe research results from 2012 which have resulted in publications or

conference presentations and are the basis for ongoing research projects:

#### Ionic liquids control friction

The lubricating properties of an ionic liquid on gold surfaces can be controlled by applying an electric potential to the sliding contact. Our nanotribology approach has been used to study the frictional behaviour of the ionic liquid ([Py<sub>1,4</sub>]<sub>2</sub>FAP) confined between sharp silica tips and a Au(111)

the given system the contribution of electrostatic attraction to the work of separation is minor. The study confirms that the adhesion mechanisms of recently developed biomimetic adhesives are correctly modelled by van der Waals interactions.

#### Plasticity with single dislocation resolution

Time-dependent indentation plasticity experiments have been conducted with single-dislocation resolution on KBr(100) surfaces using atomic force



microscopy. Friction forces vary with potential because the composition of a confined ion layer between the two surfaces changes from cation-enriched (at negative potentials) to anion-enriched (at positive potentials). This offers a new approach to tuning frictional forces reversibly at the molecular level without changing the substrates, employing a self-replenishing boundary lubricant with low vapor pressure.

#### Discharge sheds light on adhesion phenomena

Light emission due to discharge in air has been detected during and after the detachment of microstructured PDMS samples from glass surfaces, showing contact charging of the surfaces. The light emission provides information about the detachment process, like the velocity of the peeling front, which is difficult to obtain otherwise. While the work of separation exhibits the dependence on pulling velocity typically found for viscoelastic materials, the emission intensity exhibits almost no velocity dependence. We concluded that for

microscopy in ultrahigh vacuum. Discontinuous displacements of the tip (pop-ins) with a typical distance on the order of 1 Å or less indicate the nucleation and glide of single dislocations within the sample. The results indicate that nucleation of dislocations below the indenting AFM tip is stress-assisted and thermally activated. They help to understand the role of plastic deformation in sliding friction between surfaces with nanometer-scale roughness.

### OUTLOOK

The Program Division *Nanotribology* will continue exploring microscopic mechanisms of friction and wear in order to contribute to an understanding and design of new materials with dedicated mechanical function. In collaboration with the Department of Chemistry of Saarland University and supported by the Volkswagen Foundation, we will focus on surfaces functionalized by macromolecules. Other important topics will include the comparison of metals and metallic glasses as well as the electrochemical control of friction on conductive ceramics.

## ► STRUKTURBILDUNG AUF KLEINEN SKALEN / STRUCTURE FORMATION AT SMALL SCALES

DR. TOBIAS KRAUS

### DIE GRUPPE

Die Juniorforschungsgruppe *Strukturbildung* befasst sich mit der Anordnung von Partikeln zu Überstrukturen. Sie sucht Methoden, um die Geometrie der Überstrukturen zu beeinflussen und geordnete, vorhersagbare Partikelanordnungen herzustellen. Mit diesen Methoden werden Materialien gezielt und effizient strukturiert. Die Gruppe stellt Nanopartikel mit eng verteilter Geometrie und definierten Oberflächen her und charakterisiert sie detailliert. In besonderen Aufbauten werden die Partikel zur Agglomeration gebracht, auf Oberflächen abgeschieden oder in beschränkten Volumen angeordnet. Durch Licht- und Röntgenstreuung, optische Mikroskopie und Spektroskopie beobachten wir die Strukturbildung *in situ* abhängig von Partikeltyp und Prozessbedingungen. Auf diese Weise lassen sich auch technisch wichtige, industriell verbreitete Beschichtungsverfahren wie Rakeln genau untersuchen und für die Handhabung von Partikeln anpassen. In Zusammenarbeit mit anderen Forschungsgruppen und industriellen Partnern verbessern wir so die Herstellung partikelhaltiger Materialien.

### ► Dr. Tobias Kraus



Dr. Tobias Kraus studierte Chemie-Ingenieur an der TU München. Er forschte am MIT in Cambridge, USA und an der Université de Neuchâtel. Zur Promotion wechselte er an die ETH Zürich zu Prof. Nicholas D. Spencer und dann zum nahen Forschungslabor der IBM. Ab 2008 etablierte er am INM die Juniorforschungsgruppe Strukturbildung.

### MISSION

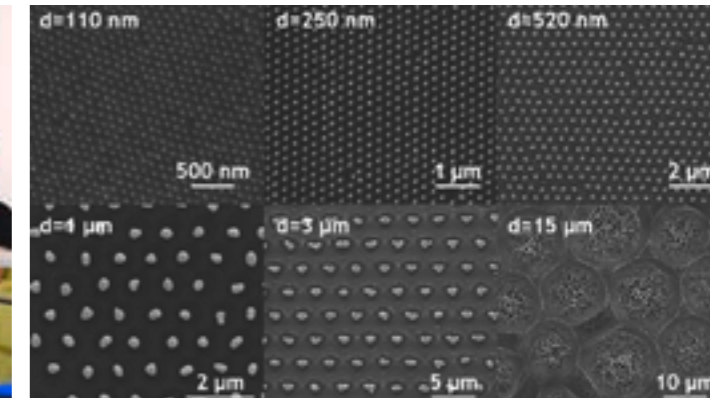
The Junior Research Group *Structure Formation at Small Scales* is concerned with the assembly of particles into superstructures. It searches methods to bias the geometry of superstructures and to prepare ordered, predictable particle arrangements. The methods are applied to structure materials efficiently. The group produces nanoparticles with narrowly distributed geometries and defined surfaces and characterizes them in detail. Using dedicated setups, the particles are agglomerated, deposited on surfaces or arranged in confined volumes. We use light and x-ray scattering, optical microscopy and spectroscopy to observe structure formation *in situ* depending on particle type and process conditions. This approach is suitable to study technologically relevant, industrially well-established coating methods such as doctor blading and to adjust them for the handling of particles. We collaborate with other research groups and industrial partners to thus improve the production of particle-containing materials.

### CURRENT RESEARCH

In 2012, several projects on fundamental questions of nanoparticle assembly culminated in scientific publications. Concurrently, projects were started to apply these results.

#### Order and disorder in nanoparticle agglomerates

Conventional wisdom suggests that nanoparticles agglomerate according to their isotropic interaction potentials. We find, however, that ligands strongly affect the microstructure of agglomerates. In this project, we systematically evaluate how



surfactants change agglomerate morphologies and how they can be used to tune the agglomerate morphology in materials. One goal of this DFG-funded project is to find surfactants that promote dense packing, for example for highly electrically conductive particle layers. Systematic evaluation of ligands is time-consuming. The group therefore progressed from batch measurements to fluidic setups that allow in-flow characterization of a continuously prepared sample. Systematic variations of concentrations and process conditions are simplified and statistical relevance of the measurements is improved.

#### From particles to X-ray detectors and gecko adhesives

In a collaborative, BMBF-funded project coordinated by Siemens, the *Structure Formation Group* and the *Program Division Optical Materials* collaborate to create soft x-ray detectors for medical imaging. Current detectors contain costly ceramic or single-crystal scintillators. A polymer film with scintillating nanoparticles can be produced at lower cost. *Optical Materials* focuses on the synthesis of scintillating nanoparticles, while the *Structure Formation Group* is concerned with the arrangement of these particles in the detector films. Other applications use particles as placeholders for fabrication. In a DFG-funded collaboration with the *Program Division Functional Surfaces* (SPP 1420), we create gecko-inspired adhesive surfaces using particles. Previous research allows us to create large areas of particle-coated substrates, where the particles with diameters between 250 and 1000 nm are

arranged in dense, ordered lattices. The polymer particles structure metal films, a process that has been submitted for patent in 2012. In collaboration with Prof. Nico Völcker of the University of South Australia (Adelaide), the metal is then etched into the underlying substrate to obtain templates. Polymer is molded from the template to obtain polymer fibres.

#### Synthesis and characterization of novel nanoparticles

The synthesis and characterization of narrowly dispersed nanoparticles is a core capability that we constantly develop in close collaboration with the *Program Division Nano-Cell Interactions*. In 2012, preparations began for a BMWi-funded collaboration with an industrial partner to create reference particles for an innovative analytical technique, field flow fractionation (FFF). Reference particles are required to make the technique applicable to environmental analytics. We will develop and supply reference particles in this project and analyze the mechanisms that lead to particle loss during analysis, leveraging our experience with particle-substrate interactions. Protocols and coatings will be developed to minimize such losses.

#### OUTLOOK

The Structure Formation Group will continue to transfer basic results on particle assembly into applied projects in collaboration with industry and other researchers. Several proposals have been submitted to design particle-based materials for electronics and photovoltaics.



## ► BIOMINERALISATION / BIOMINERALIZATION

PD DR. INGRID M. WEISS

### DIE GRUPPE

Im Programmbereich *Biomineralisation* werden mehrere Zielrichtungen verfolgt. Komplex aufgebaute Materialien lebender Organismen werden untersucht, um das Zusammenspiel der Einzelkomponenten im gesamten Gefüge zu verstehen. Im Laufe der Evolution wurden unterschiedlichste Materialeigenschaften für verschiedene Zwecke, wie z.B. mechanische Stabilität, kombiniert mit optischen Effekten, optimiert. Basierend auf den Erkenntnissen über diese Materialien lassen sich nun als zweite Zielrichtung neue Wege im Hinblick auf die Nutzung natürlicher Ressourcen verfolgen. Im Jahr 2012 gelang es uns erstmals, derartige Rohstoffe bereits in den verwendeten Zellen und Organismen mit besonders günstigen funktionellen Eigenschaften auszustatten und für die hierarchische Selbstorganisation von mineralischen Grundbausteinen zu nutzen. Zukünftig können wir auf dieser Basis neue Materialien mit verbesserter Gewebeverträglichkeit im Organismus und in Bezug auf allgemeine Stoffkreisläufe in der Umwelt generieren.

### ► PD Dr. Ingrid M. Weiss



Ingrid Weiss habilitierte sich im Fach Biochemie (zuvor TU München und Weizmann Institut). Sie untersucht das Wechselspiel zwischen zellulärer Biophysik und der hierarchischen Selbstorganisation und Funktion von komplexen Naturstoffen wie Perlen und Pfauenfedern.

### MISSION

The Program Division *Biomineralization* investigates a number of problems: For example, highly complex materials from living organisms are in the central focus in order to understand how each molecular species interacts with other components to form a functional composite. In the time course of evolution, various properties of these materials were optimized with respect to different purposes such as mechanical stability combined with optical effects. Based on our detailed knowledge about these materials, we can now tackle a number of problems from different directions with respect to using natural resources in completely new and more effective ways. In 2012, we managed for the first time to introduce specific advantages into natural resources by means of cells and organisms. The purified biomolecules then served for creating self-organized composite materials with fine-tuned mineralized structures of several hierarchical levels. Based on this technology, we hope to be able to generate new materials with improved tissue compatibility in organisms as well as for example in terms of general eco-recycling in the environment in the near future.

### CURRENT RESEARCH

#### Biomineralization-inspired materials and biotechnology

The molecular control of biomineralization in organisms is partly achieved by means of proteins. Nowadays, many soluble proteins can be produced in biotechnologically relevant bacteria. In many cases, however, solubility of proteins involved in biomineralization is a limiting factor in the fabrication process. By designing custom proteins

and peptides it became possible to produce larger amounts of such proteins in cell culture (Weber et al., PLoS ONE 2012, 7: e46653). Furthermore, our model system turned out to be very useful to design fundamental experiments which explain some important features of the recombinant proteins in terms of their interaction with minerals and crystals.

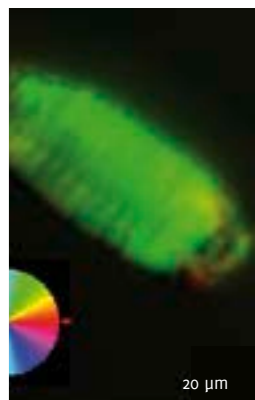
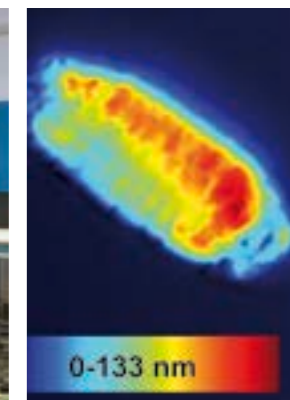
#### Structure – function relationships in natural biomineral composites

One of our strongest expertises is the investigation of enzymatic processes at the tissue-mineral interface while new mineral is deposited and transformed, especially in natural systems but with major relevance for implant materials. In collaboration with the JRG *Metallic Microstructures*, we discovered a new level of hierarchy in the prismatic region of mollusc shells. Our insights were obtained by conventional light-optical techniques and LC-PolScope microscopy in combination with highly sensitive micro- and nano-mechanical testing methods. Our

results provided further insights into biomineralization, also with respect to the growth mechanisms of different shell parts including nacre.

### OUTLOOK

The combination of both biotechnological "bottom-up" processing of functional and tunable molecular promoters for the generation of hierarchical composite materials and the careful structural, mechanical and optical "top-down" characterization of biological materials such as pearls and peacock feathers on multiple levels provides us with many unique insights into fundamental design strategies in nature. Our major long term goal is to use this knowledge for the benefit of our planet and for turning our society into an environmentally-friendly bio-economy.



## ► CVD/BIOBERFLÄCHEN / CVD/BIOSURFACES

DR. CENK AKTAS

### DIE GRUPPE

Im Programmbereich *CVD/Biooberflächen* werden Nanomaterialien nach dem Bottom-Up-Prinzip aus metallorganischen Precursor-Molekülen hergestellt. Zentrales Forschungsthema ist hierbei die Gasphasenabscheidung funktioneller, nanostrukturierter Schichten über CVD- und PVD-Verfahren. Zusätzlich kombiniert man im Programmbereich die physikalischen Methoden der plasma- und laserunterstützten Werkstoffherstellung mit dem großen Hintergrundwissen des INM bei nasschemischen Synthesemethoden für anwendungsspezifische Funktionalisierungen. Neben der Herstellung nimmt die Untersuchung und Charakterisierung der neuen, nanostrukturierten Oberflächen für künftige Anwendungen einen großen Raum ein. Das Hauptinteresse liegt dabei beim Einsatz für intelligente Oberflächen auf medizinischen Implantaten. 2012 wurden im Programmbereich mehrere interdisziplinäre Forschungs- und Weiterbildungsprojekte durchgeführt, von denen einige im Folgenden näher beschrieben werden.

### ► Dr. Cenk Aktas



Dr. Cenk Aktas erlangte sowohl seinen BSc als auch seinen MSc der Werkstoffwissenschaften in Kiel und besuchte ein Aufbaustudium zu Nanobiomaterialien. Er promovierte in Materialwissenschaften an der Universität des Saarlandes und ist seit 2010 Leiter des Programmbereichs *CVD/Biooberflächen*.

### MISSION

The program division *CVD/Biosurfaces* is specialized in bottom-up synthesis of nanomaterials. The main focus of the research is the development of functional nanomaterials through gas phase synthesis approaches such as CVD and PVD. In addition, we combine plasma and laser assisted material synthesis methods with INM's strong background in wet-chemical synthesis. Besides the synthesis, the group is focused to understand the characteristics of low dimensional materials for potential applications such as customized surfaces for medical implants.

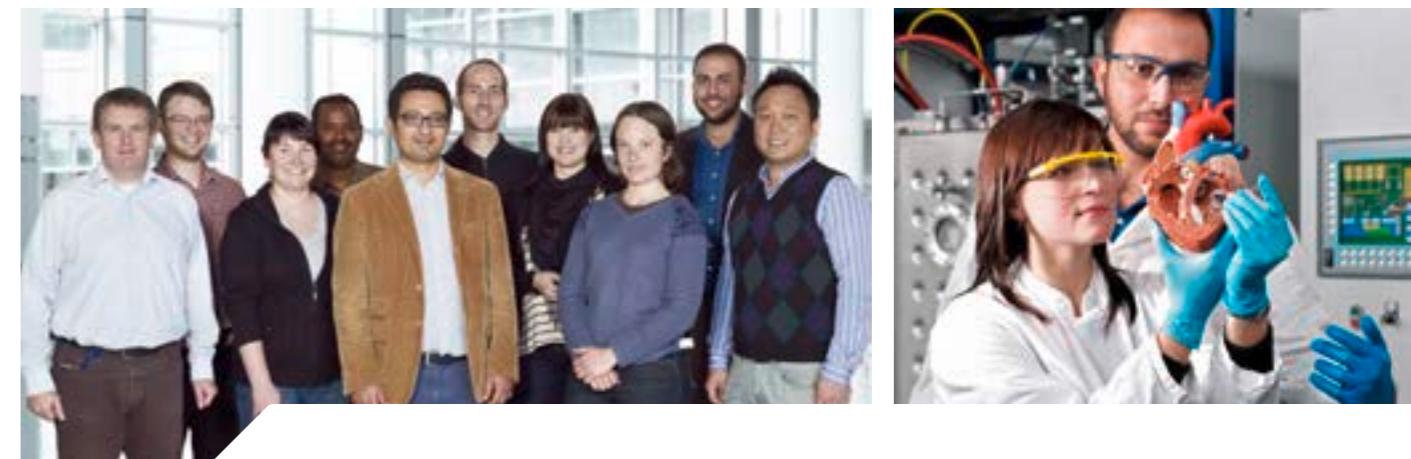
### CURRENT WORK

#### Nucleation and growth under micro- and hypergravity

Previously, we carried out an experiment during parabolic flight (supported by DLR) to understand the effect of the gravity on the nucleation and growth during a CVD process. Beside this sophisticated experiment, the analysis of more than 100 samples was completed this year. Results were published at a high ranking journal. In contrast to various reports, we showed that the effect of gravity on the size and morphology of droplets is not simply related to convection. Our observations indicate that under microgravity, thermal creep (which refers to the motion of fluid opposite to the temperature gradient along the gas-particle surface) seems to be dominant and this leads to a net upward (from the substrate surface) motion. Thus, microgravity decreases the interaction with the surface and leads to a more uniform formation of much smaller particles.

**Development of a multi-coating system**  
We developed a new deposition system which combines several deposition processes within one vacuum chamber. This new system contains E-beam evaporation and Knudsen cell evaporation modules which allow the co-deposition of several materials. In addition, the system contains a pulsed laser deposition (PLD) module which is effective for deposition of multi-component materials with the right stoichiometry. The new system also

with Department of Trauma and Reconstructive Surgery (Prof. Pohlemann), we reported that a topography which is composed of multi-scaled features (micro and nano) reduces the myofibroblast (MF) population without disturbing the proliferation of endothelial cells. This may form a basis for developing micro- and nanostructured stent surfaces for preventing stent restenosis, which is partially mediated by repopulation with MF and enhanced inflammation.



allows thermally activated CVD. While the thickness of the deposited layers was monitored precisely by using highly sensitive micro-balance sensors, the chemical state of the deposits was observed with *in situ* optical emission spectroscopy. We achieved ultra thin (1–3 nm) SiC layers by using the PLD module. We believe that this new system will be effective for the development of new multi-component materials.

#### Nanostructured surfaces for cardiovascular implants

In-stent restenosis is one of the common complications observed after stent implantation. The surface properties such as topography, roughness and free energy play a critical role in the first stage of endothelial monolayer formation. In collaboration with the Paediatric Cardiology Department of Saarland University Clinic (Prof. Abdul-Khaliq), *CVD/Biosurfaces* showed that not only the scale but also the distribution-density of nanostructures on the stent surface plays a major role on the endothelialisation. Additionally, in collaboration

#### Stem cell differentiation by nanotopography

Previously we showed that nanotopographies can be designed to promote or reduce cell adhesion which would be useful for a range of applications in regenerative medicine. In 2012, the group started investigating the effect of the nanotopography on cell differentiation. In collaboration with the Center for Stem Cell and Gene Therapies, Kocaeli, we started working on differentiation of mesenchymal stem cells into neurons by controlling the surface topography. The use of nanotopography for cell differentiation has obvious advantages in reducing, abolishing, or even enhancing chemical inducers and promoters.



## ▶ NANO ZELL INTERAKTIONEN / NANO CELL INTERACTIONS

DR. ANNETTE KRAEGELOH

### DIE GRUPPE

Der Programmbereich *Nano Zell Interaktionen* beschäftigt sich mit den Wechselwirkungen zwischen Zellen menschlicher Herkunft und technisch hergestellten nanoskaligen Partikeln vor dem Hintergrund einer möglichen Toxizität dieser Materialien. Ziel ist es, aufzuklären, welche Parameter die Aufnahme und Lokalisation der Partikel sowie die Struktur und Biochemie der Zellen beeinflussen. Hierfür werden Nanopartikel aus anorganischen Materialien gezielt hergestellt und charakterisiert. Dem Status der Partikel und ihren Wechselwirkungen mit biologisch relevanten Molekülen, z.B. Proteinen, wird besondere Aufmerksamkeit gewidmet. Für die Analysen werden chemische, biochemische und molekularbiologische Techniken eingesetzt. Zur Lokalisation fluoreszenzmarkierter Partikel oder Zellstrukturen werden besonders lichtmikroskopische Techniken angewendet. Der Einsatz der hochauflösenden Stimulated Emission Depletion (STED-) Mikroskopie für diesen Zweck stellt eine Besonderheit der Gruppe dar.

### ▶ Dr. Annette Kraegeloh



Die Diplom-Biologin hat an der Universität Bonn promoviert. Ihre Tätigkeit am INM hat sie im Jahr 2004 zunächst in der Gruppe *Life Science* zu biomedizinischen Anwendungen von Nanomaterialien aufgenommen. Seit 2008 leitet sie die JFG, später den Programmbereich *Nano Zell Interaktionen*.

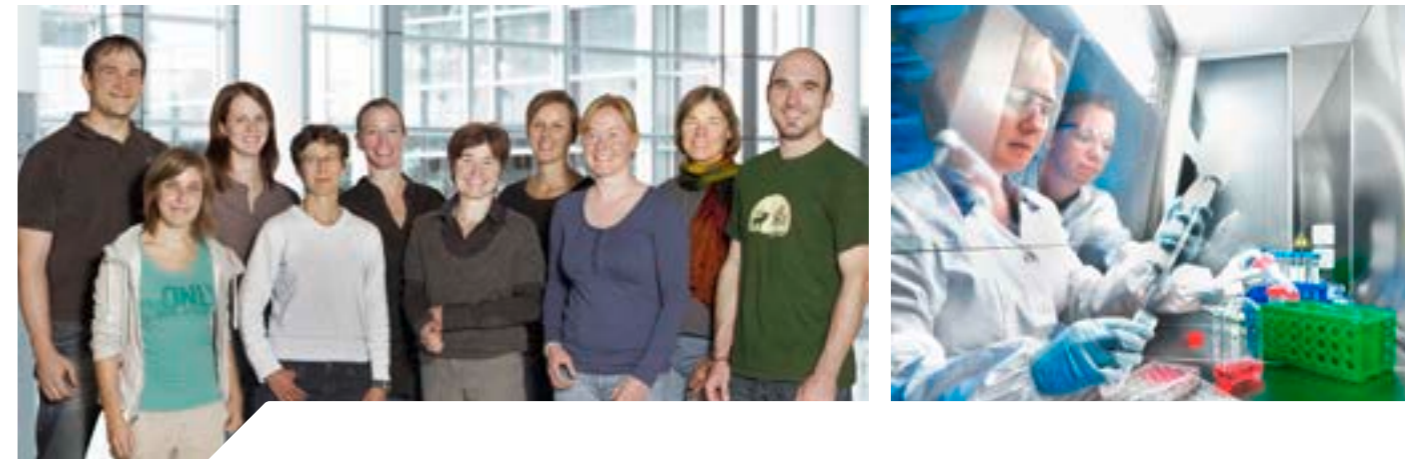
### MISSION

The Program Division *Nano Cell Interactions* investigates the interactions between cells of human origin and engineered nanoparticles (NPs), motivated by the potential toxicity of these materials. Aim of the research is to elucidate mechanisms affecting the uptake or location of particles as well as structure or biochemistry of the cells. In order to derive structure-activity relationships, well-defined NPs are specifically prepared and characterized, addressing the state of the particles as well as their interactions with biologically relevant molecules. Besides chemical, biochemical and molecular techniques, light microscopy is used for the localization of fluorescently labeled particles or cellular structures. The application of super-resolution Stimulated Emission Depletion (STED) microscopy for nanotoxicological questions is a distinctive feature.

### CURRENT WORK

#### Quantification of internalized nanoparticles

The quantification of internalized NPs is an important task in nanotoxicology. Here, it was performed by image processing of confocal and STED microscopy data using the "surface renderer" and "object analyzer" tools of the Huygens-software (SVI, Hilversum). Besides fluorescently labeled particles, various types of cellular structures were labeled. A dual labeling of the cytoplasmic membrane and the nuclear lamina gave promising results. The analysis of lung epithelial cells exposed to fluorescently labeled silica NPs revealed that the image processing allows discrimination between NPs inside and outside the cell as well as inside the nucleus. At present, a quantitative comparative study of the uptake of different particle sizes and exposition conditions is carried out.



#### Uptake and toxicity of silica particles

Using confocal microscopy, the uptake of differently sized fluorescently labeled silica nanoparticles in human lung epithelial cells (A549) was investigated. Aim of this study is to quantify the amount of particles taken up at varying experimental conditions. Here, the absence or presence of serum and serum proteins in the cell culture medium is of great interest. In the absence of serum proteins, silica particles caused a dose-dependent increase in cytotoxicity, measured as membrane damage. In the presence of single proteins present in serum, the cytotoxicity caused by silica nanoparticles was quenched significantly. In future experiments, the interactions of silica nanoparticles with fluorescently labeled proteins will be investigated using live cell as well as STED microscopy.

#### Nanostructured contrast agents

The BMBF-project NanoKon aims to evaluate the impact of nanostructured contrast agents on health. NanoKon is a collaboration with partners of Uds, University of Mainz and the companies Sarastro and Nanogate. Within this project, we take part in the development of contrast agents applicable for the dual imaging of the gastrointestinal (GI) tract via X-ray detection and Magnetic Resonance Imaging. For this purpose, iron oxide and barium sulphate NPs were covered with a silica coating and tested for stability and ion release in simulated fluids of the GI tract. A special focus was on the stability in artificial gastric juice. Future research, in collaboration with partners from Nanogate AG and Uds, will focus on

improving the imaging properties of the particle suspensions for *in vivo* testing.

#### Determination of endotoxin

Part of our work in the frame of NanoKon concentrates on the determination of endotoxin concentrations within preparations of nanomaterials. This is an important issue, not only for *in vitro* test systems or *in vivo* studies but also for commercial applications of such materials. The traditional *Limulus* Amebocyte lysate (LAL) gel clot assay was evaluated for the detection of endotoxins in NP suspensions with a focus on possible interferences of particles with the test system. Various types of bare or PEGylated silica nanoparticles, as well as iron oxide-silica core shell nanoparticles, were tested. The results revealed an enhancement of the *Limulus* coagulation cascade for all tested particles with bare silica-surface.

### OUTLOOK

Future studies aim to compare the influence of various particle types related to particle concentration or other parameters. In the frame of the newly established Leibniz Research Network "Nanosafety", we will focus on subtoxic effects of nanoparticles, potentially causing long term effects. In the frame of a joined PhD project, together with the Leibniz Institut für Umweltmedizinische Forschung, initial signaling events caused by nanoparticles will be analyzed.

## ▶ NANOMERE / NANOMERS

DR.-ING. CARSTEN BECKER-WILLINGER

### DIE GRUPPE

Der Programmbereich *Nanomere* befasst sich mit der Materialentwicklung im Bereich der Komposit- und Nanokompositmaterialien. Dabei werden partikuläre funktionelle Additive im Submikrometer- und Nanometerbereich verwendet, um in organischen Polymermatrizes sowie anorganisch-organischen Hybridpolymeren neue Werkstoffeigenschaften zu erzeugen. Über die keramische Natur der eingebrachten Partikel in Kombination mit nasschemisch erzeugten Bindemitteln lassen sich festkörperphysikalische Eigenschaften anorganischer Materialien über einfach beherrschbare Verarbeitungstechniken aus dem Polymer- und Lackbereich in Oberflächenbeschichtungen und kompakte Werkstoffe übertragen. Erzielbare Funktionen sind Gleitreibungsminderung und Kontrolle von Reibung, Korrosionsschutz oder Abriebfestigkeit gepaart mit Transparenz und Barrierewirkung.

### CURRENT WORK

The research and development activities of the program division *Nanomers* comprise basic studies and application-oriented projects in cooperation with industry.

One research topic concerns highly structured composite layers which exhibit excellent barrier properties against diffusion of gases and corrosive substances. Application of such composites on steel and aluminum alloys provides surface coatings with high corrosion protection ability. The basic structural principle has been protected by a patent application serving as a basis for an industry project. One version also comprises anti-fouling properties which were further investigated in field tests. From a fundamental point of view the coating layers are investigated by impedance spectroscopy and methods to observe local corrosion mechanisms around artificial damages to understand the corrosion protection ability better. Routes include the incorporation of active corrosion protection features in addition to the purely physical barrier effect, especially on steel substrates. Synthesis of suitable nanoparticulate elements is currently investigated.

Another research topic deals with tribological coatings for dry lubrication and simultaneous corrosion protection. New composite morphologies with finely structured layers of solid state lubricant and thin platelets incorporated in a polymer matrix exhibit a coefficient of friction that comes close to hydrodynamic friction in oil or in grease. The active principle of these types of coating layers is not fully understood yet and will be subject to further investigations, including the

variation of particle surface modifiers and particle size distribution of the solid state lubricants. In addition, the initial part of a friction phenomenon intimately connected with the stick-slip behaviour will be further investigated in detail using a newly developed linear tribometer.

An industry supported project is carried out dealing with electrical insulation layers for power transformer applications. The key point of the project is the use of doped nanoparticles with an electrical defect structure and able to dissipate electrical excess voltage and electrical discharge phenomena. In this way the lifetime of the insulating layer is improved by a factor of more than 100. The basic principle is subject of a materials patent. Special UV curing equipment has been developed during the past year that allows fast curing of the insulation layers with the perspective of a transfer of the process to an industrial partner in 2013.

The EU-project CuVito ("Nano-structured copper coatings, based on Vitolane technology, for antimicrobial applications") with seven partners from Europe and Mexico led to rational synthesis routes for metallic copper nanoparticles, so called copper colloids with a particle size between 10 nm and 30 nm. In current studies the anti-microbial properties of the nanoparticles are investigated at INM and in the consortium after incorporation in paints and

coating formulations usable on rigid and flexible substrates. Applications are focused on surfaces for medical environments and textiles. The project will end in 2013 with demonstrator formation and dissemination of the project results.

A diploma thesis was dealing with thermoplastic composites for foil applications with improved gas barrier properties due to platelets with high aspect ratio and thermoplastic polyurethanes as model systems. The platelets were finely dispersed and oriented in the polymer matrix. Concepts were established that enable manufacture of the composites via compounding in a twin screw extruder. Currently the filler content is increased and the gas barrier properties are measured on foils prepared of the compounded materials.

### OUTLOOK

In the area of functional coatings, the research will be extended to water based coating materials. In the research field tribology, UV curable low friction coatings are envisaged that allow fast processing. In the area of gradient materials, a new technology platform is planned for providing new materials to alter the wettability of porous systems. For the topic compact polymer matrix composites, research will be driven towards translucent high barrier foils achievable by compounding using the new concepts screened in the diploma thesis.

### ▶ Dr.-Ing. Carsten Becker-Willinger



Dr. Carsten Becker-Willinger studierte Chemie in Freiburg i. Br. Von 1993 bis 1998 promovierte er am INM bei Prof. H. Schmidt über Struktur-Eigenschaftsbeziehungen in thermoplastischen Nanokompositen an Polymethylmethacrylat Modellsystemen. Seit 2001 leitet er den Bereich Nanomere.





## ▶ OPTISCHE MATERIALIEN / OPTICAL MATERIALS

DR. PETER WILLIAM DE OLIVEIRA

### DIE GRUPPE

Der Programmbereich *Optische Materialien* beschäftigt sich mit der Entwicklung neuer Materialien und Werkstoffe, deren Funktion die Wechselwirkung mit elektromagnetischer Strahlung darstellt. Im Jahr 2012 wurde eine Reihe erfolgreicher Industrieprojekte durchgeführt. In diesem Bericht können jedoch aufgrund von Geheimhaltungsvereinbarungen mit Projektpartnern nicht alle Ergebnisse präsentiert werden. Hierunter fallen z.B. Arbeiten zu Schichten, die Licht in besonderer Weise reflektieren, beugen oder streuen, Schichten, die unter Lichteinfluss Effekte wie z.B. Photometallisierung durch photokatalytische Zersetzung organischer Moleküle zeigen, sowie hochtransparente Schichten zur Anwendung in Displays, gedruckter Elektronik und Sensorik, die mit Funktionen wie z.B. elektrischer Leitfähigkeit oder Gasdiffusionssperrwirkung kombiniert wurden. Die Materialien zur optischen Funktionalisierung von Oberflächen werden nasschemisch auf verschiedenen Substraten hergestellt.

### ▶ Dr. Peter William de Oliveira



Dr. Peter William de Oliveira leitet seit Sommer 2005 die Arbeitsgruppe *Optische Materialien* am INM. Er studierte Physik in Brasilien und kam nach Diplom- und Master-Abschluss ans INM. In seiner Doktorarbeit befasste er sich mit diffraktiven mikrooptischen Komponenten in Nanokompositmaterialien.

### CURRENT WORK

#### Basic research

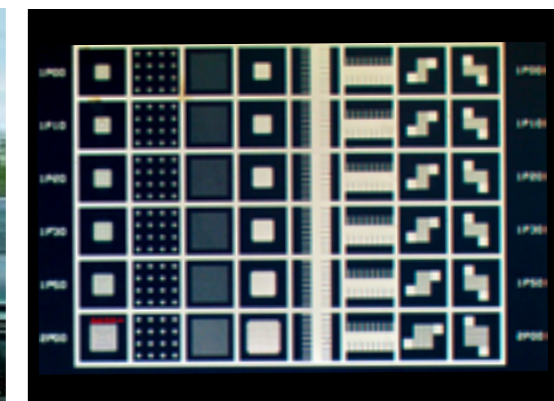
In 2012 the *Optical Materials* division has focused its fundamental research on the improvement of knowledge in the area of photo metallization. This method comprises the production of highly conductive electrodes at the micro or submicron scale using a combination of printing and embossing techniques to be incorporated in the roll-to-roll process. The silver patterning process is based on stamping of a silver complex with UV-transparent stamp instead of using a photo mask. This allows large scale patterning of polymer foils in a continuous high-speed process. When irradiated with UV light, silver structures form in the pre-scribed patterns. Up to now, circuits with structure widths down to 1  $\mu\text{m}$  have been formed; its sheet resistance is above twice the ideal value of silver. The typically used transparent conducting oxide materials for electrodes in solar cell production are wide band gap n-type semiconductors, mostly employing pure or doped indium oxide, tin oxide or zinc oxide. The photo-metallization process can be easily combined with an ITO or AZO ink to produce transparent electrodes for OLEDs, solar cells or displays.

#### Nano particle production and standardization

Wet coating materials are not standardized nor are they easily available. Therefore they often have to be developed by the users. Both factors can be a major drawback due to which wet coating techniques have not yet gained the same significance for large area/high volume applications as e.g. magnetron sputtering or chemical vapor deposition. This is in contrast to the large potential

connected with chemical material synthesis, which allows the generation of highly functional coating materials with interesting properties for glass surfaces. Also equipment costs may be only a fraction of the costs compared to other techniques. For the coating process technology using wet chemistry the first stage is the standardization of the sol production and consequently the production of the nanoparticles. The EU-FP7 project *In-Sight "In-line characterization of nanoparticles*

Optical coating and structuring techniques In 2009, the *Optical Materials* division has started the development of a new wet chemical thin film technology. This research occupies currently an important key position in the development of optical device technologies at INM. For example the combination of high optical transmission in the visible range with high electronic conductivity, makes them an essential component for various types of displays (LCD, EL displays or touch screen



using a combination of analytical techniques in real-time" aims at developing novel tools for real time monitoring of nanoparticle characteristics during nanoparticle synthesis. A round of mutual measurements of the same particles between several methods was executed. It was found that measurement results without exact definition of measurement protocols nor access to the complete data sets has proven unreliable. It was learned that seemingly simple parameters such as size, refractive index or density of nanoparticles are not easily determinable, and a deduction from bulk values is not reliable. These values are however of great importance for the mathematical models used in the novel measuring methods developed by the project consortium.

panels), thin film solar cells and anti-reflective applications. Beyond the electrical conductivity, the closely related IR reflectivity and the photocatalytic effect open a broad field of applications such as heat insulating windows in architecture (low-emissivity glasses), security (electromagnetic shielding) or domestic areas (ovens, refrigerators). The thickness of such coatings is in the range of approx. 100 nm and thickness variations of less than  $\pm 2\%$  are demanded for high quality coatings. The combination between materials development, coating processes and structuring techniques in the same department allows the design and development of optical elements that can be applied in a wide range of optical products, like holograms, gratings, micro lens arrays, interference coatings, light guiding elements (waveguides, diffusers, reflectors), and optical data storage. The structures of the micro optical elements are based on layers with surface relief patterns in the range of 100 nm to 1  $\mu\text{m}$ .

## ▶ INNOVATIVE ELEKTRONENMIKROSKOPIE / INNOVATIVE ELECTRON MICROSCOPY

PROF. DR. NIELS DE JONGE

### DIE GRUPPE

Eine nanometergenaue Materialcharakterisierung ist unabdingbar für die Weiterentwicklung der modernen Nanotechnologie, der Energiewissenschaft und der Biologie. Der Programmbereich *Innovative Elektronenmikroskopie* betreibt interdisziplinäre Forschung an der Schnittstelle von Bio-Nanotechnologie, Materialwissenschaft, Zellbiologie, Physik der Elektronenmikroskopie (EM) und Bildverarbeitung. Zur dreidimensionalen (3D) Atomstrukturanalyse, zur chemischen Materialanalyse sowie für die Untersuchung von biologischen Systemen und funktionellen Materialien in Flüssigkeit stehen dem Programmbereich ein hochmodernes Rastertransmissionselektronenmikroskop (JEOL ARM200F) und weitere Messgeräte wie ESEM (FEI Quanta), TEM, SEM und FIB zur Verfügung. Zudem verfügen wir über mehrere Röntgendiffraktometer. Es existieren vielfältige Forschungsoperationen innerhalb des INM sowie mit verschiedenen Universitäten und der Industrie.

### ▶ Prof. Dr. Niels de Jonge



Niels de Jonge ist ein Biophysiker mit Schwerpunkt auf biologischer Elektronenmikroskopie und Nanotechnologie. Die Gruppe *Innovative Elektronenmikroskopie* leitet er seit Januar 2012. Er ist Adjunct Assistant Professor der Abt. Molekular- und Biophysik an der Vanderbilt University, Nashville, USA.

### MISSION

The group *Innovative Electron Microscopy (IEM)* was newly founded in January 2012, headed by Niels de Jonge. It also provides service characterization for INM using electron microscopy and X-ray diffraction. Various collaborations exist for example with Prof. F. Mücklich, Saarland University, Prof. P. Slusallek, DFKI, Saarbrücken, Prof. V. Flockerzi, Saarland University, Prof. W. Mader, University of Bonn, Prof. N. Sommerdijk, Eindhoven University, Netherlands, Dr. P. Visser, MPI for Intelligent Systems, Stuttgart. Furthermore, research projects with Prof. A.K. Kenworthy, and Prof. D.W. Piston of Vanderbilt University School of Medicine, Nashville, TN, USA were continued.

### CURRENT WORK

#### Aberration-corrected STEM

The INM has recently acquired a state-of-the-art aberration corrected scanning transmission electron microscope (STEM) of the type ARM200, JEOL, Japan, with a combined energy filter and an electron energy loss analyzer (Gatan). Several new projects have been initiated in the areas of functional nanomaterials and energy-related materials. The properties of functional materials are closely related to the atomic structure and especially dislocations of atoms within the bulk structure and at interfaces. Aberration corrected STEM is capable of atomic-resolution elemental mapping, such that dislocations of single atoms can be studied within the atomic matrix.

#### 3D STEM

We are developing a novel methodology to acquire three-dimensional (3D) data sets using aberration



corrected STEM. The primary method currently used for obtaining nanoscale 3D information of materials is via tilt-series TEM (tomography). A 3D cubic volume is reconstructed from images recorded at several projections obtained by mechanically tilting the sample stage. A novel approach uses aberration-corrected STEM, which is capable of high-resolution 3D imaging without a tilt stage. In a manner similar to confocal light microscopy, the sample is scanned layer-by-layer by changing the objective lens focus so that a focal series is recorded. The technique is possible with high axial (vertical) resolution due to the greatly reduced depth of field in an aberration-corrected STEM.

#### Liquid STEM

Niels de Jonge and his team have recently developed a novel method to image whole eukaryotic cells in liquid using a microfluidic chamber for STEM. Eukaryotic cells in liquid are enclosed in a micro-fluidic chamber with a thickness of up to 10  $\mu\text{m}$  contained between two ultra-thin and electron-transparent windows. This chamber is then placed in the vacuum chamber of the electron microscope. The specimen is imaged with STEM. On account of the atomic number (Z) contrast of the STEM, nanoparticles of a high-Z material, such as gold, can be detected within the background signal produced by a low-Z liquid, such as water. Nanoparticles specifically attached to proteins can then be used to study protein distributions in whole cells in liquid, similar as proteins tagged with fluorescent labels can be used to study protein distributions in cells with fluorescence microscopy,

but with a much better spatial resolution. The microfluidic device developed for Liquid STEM will also be used to study nanomaterials in liquid. The microfluidic channel allows the rapid injection of fluids. The capability to image materials in liquid with nanoscale resolution is especially relevant for material science related to energy storage. The experiments have to be carefully designed and interpreted for effects of Brownian motion, electric charging, and radiation damage.

#### Industry collaboration

A collaboration exists with Protochips Inc, NC, USA. INM was provided with a liquid specimen holder for STEM/TEM.

#### OUTLOOK

The group is well situated to conduct research at the international forefront of electron microscopy both in the areas of biology/biophysics and materials science, including energy science. It can be expected that several grants will be funded in the near future. One of our future aims is to study processes of protein complexes occurring in eukaryotic cells, and at the solid:liquid interface in materials science by combining liquid STEM with high resolution fluorescence microscopy. With this novel microscopy method we may discover new phenomena that are not visible with existing microscopy methods.



## ► MODELLIERUNG/SIMULATION / MODELLING/SIMULATION

N.N.

### DIE GRUPPE

Aufgabe des Programmbereichs im personellen Aufbau ist die Unterstützung der anderen PBs durch die Erstellung von Modellen und Simulationen. Zukünftig sollen auch verstärkt eigene Forschungsprojekte betrieben werden. Im Jahr 2012 wurden vier Forschungsprojekte in enger Verzahnung mit anderen PBs bearbeitet:

Die Studie *NeuroNano* untersucht den Einfluss beschichteter Silber-Nanopartikel (NP)-induzierter Diversifikationen einzelner Zellen über die Antwort neuronaler Systeme bis hin zu makroskopischen Effekten elektrophysiologisch messbarer Feldpotenziale von Kortexneuronen.

Das in Kooperation mit US Partnern entstandene *NanoRyR* Projekt untersucht den Einfluss beschichteter Gold- & Silber-NP auf Ryanodin-Rezeptoren.

Gleichzeitig wurde in der Verbundstudie *Ca<sup>2+</sup> Release* mit der Entwicklung eines Modells begonnen, welches *in vitro* gemessene Effekte auf Ryanodin-Rezeptoren bei NP Exposition adaptiert, um dann auf die induzierten Wirkmechanismen schließen zu können.

Das *FundTribo* Projekt beschäftigt sich mit der Vorhersage tribologischer Eigenschaften von Polymerwerkstoffen zur ressourcenschonenden Entwicklung spezifischer Verbundwerkstoffe.

### CURRENT RESEARCH

#### NeuroNano (with *Nano Cell Interactions*)

In former studies, we evaluated the effects of various concentrations of coated silver-nanoparticles (NPs) on the ion flux of single excitable cells by a patch-clamp technique. The aim was to disclose potential mechanisms responsible for the measured electrophysiological effects of such NPs on neuronal cells. The Hodgkin-Huxley (HH) model of dynamic changes in membrane conductance was fitted to the data by using a Differential-Evolution-Algorithm and by evaluating the diversified components of the HH-model. Later on,

we developed an up-scaling of the NPs-induced diversifications on single cells to a neuronal feedback circuit to simulate their influence on resonance processes. Thus, we explored feasible effects of NPs on circuit dynamics *in silico*, i.e., modeling intrinsic single cell dynamics and network oscillations in a circuit by reverting to an extended HH-type formalism and dynamic synaptic coupling using an established thalamocortical feedback model as example. We compared the neuronal response dynamics of the network neurons assuming the presence and absence of interfering coated silver-NPs in specific, non-specific, and reticular thalamic cells. This was followed by further model extension where we expand the existing model by integrating the output to spatiotemporal scale of field potentials. Those are supposed to originate from the parallel activity of a variety of synchronized thalamocortical columns at quasi-microscopic level, where the involved neurons are gathered in units. By means of our new study we imposed again coated silver-NPs induced alternations on the ionic currents of the involved thalamic neurons and our model was able to represent the influence of such NPs on spatiotemporal neural field oscillations originating from cortical pyramidal neurons in thalamocortical networks. We found extensive diversified pattern formations of neural field potentials when comparing to the modeled activity without neuro-modulating NPs added. These predictions could be validated by high spatiotemporal resolution using voltage sensitive dye imaging and electrophysiological multiarray electrode recordings. The outcome of this simplified *in silico* model is expected to serve as an initial approximation of *in vivo* neuromodulatory effects of NPs in neural feedback

circuits and corresponding neural fields. The first *in silico* results suggest that small dose of coated NPs brought into contact with few cells of any neuronal feedback circuit, are operating as neuromodulators and change network rhythms of large neuronal populations as well as more macroscopic neural field potentials spreading locally over cortical areas. The models are important for a further understanding of possible benefits and risks of the exposure of neuronal structures to NPs and thus relevant for nanotoxicology.

#### NanoRyR (with Dept. of Molecular Biophysics & Physiology (DMBP), Rush University Medical Center, Chicago, USA & Nano Cell Interactions)

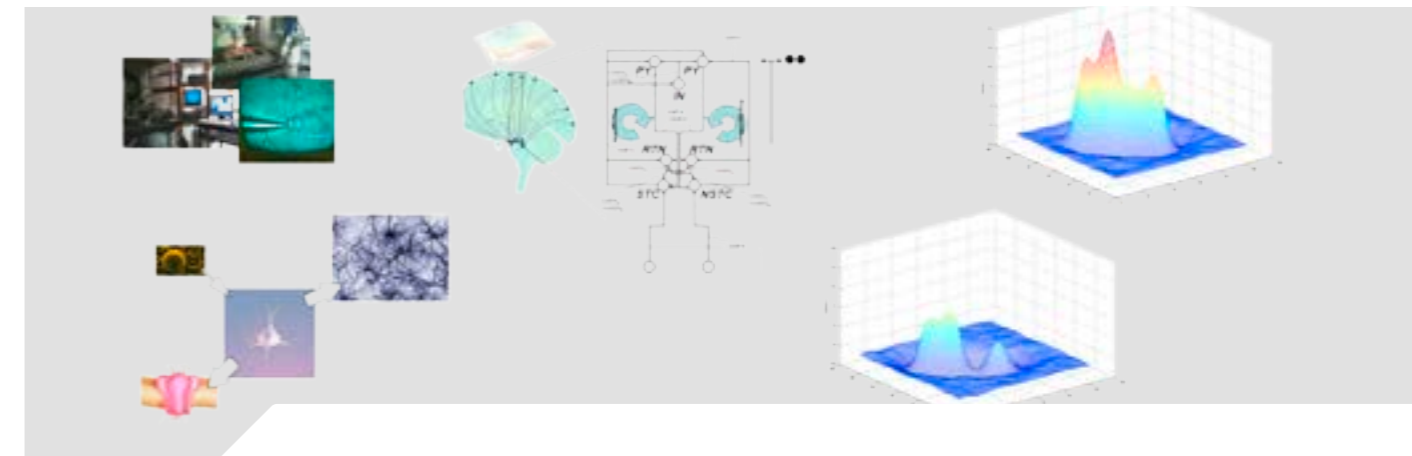
We tested the influence of almost equal sized coated silver- & gold NPs on sarcoplasmic reticulum (SR) calcium signalling in cardiac muscle cells during contraction: We measured the Ca<sup>2+</sup> outflux from SR through ryanodine receptor (RyR) during a Ca<sup>2+</sup> spark employing *in vitro* laser scanning confocal microscopy and single channel recordings on rat cardiac cells. We observed immediate NPs type & concentration dependent influences on the Ca<sup>2+</sup> outflux from SR in the recordings. First data suggested a major influence of silver NPs on the signalling behaviour whereas gold NPs did not show strong effects. Data collection is still ongoing.

#### Ca<sup>2+</sup> Release (also with DMBP)

Based on the measured *in vitro* data from CardioNano, a mathematical model was introduced which describes the Ca<sup>2+</sup> release from the SR in cardiac muscle cells in terms of an equivalent circuit model. The simplified *in silico* model able to map and vary parameters that are relevant for the Ca<sup>2+</sup> genesis will be applied to model the NPs induced changes of Ca<sup>2+</sup> outflux. This helps to illuminate mechanisms of NPs-cardiac-cells interactions. Since Ca<sup>2+</sup> signalling pathways are widely similar in cardiac muscle cells and neurons, one can apply the results obtained to neuronal tissues.

#### Tribological Black-Box Modeling (with Nanotribology and the Chair of Composite Engineering, University of Kaiserslautern)

Based on a study in 2011, we developed a novel artificial neural network approach to make very accurate predictions on friction coefficient and wear rate of PEEK composites during tribological testing. The model predictions can be used to identify which compound will show best tribological performance at what applied physical condition. These forecasts allow to discriminate the usability of different even not yet engineered compounds that meet pre-defined conditions.



## ► NMO/VERFAHRENSTECHNIK / NMO/PROCESS ENGINEERING

DR.-ING. CARSTEN BECKER-WILLINGER (KOMM.), DR. PETER W. DE OLIVEIRA (KOMM.)

### DIE GRUPPE

Das Anwendungszentrum NMO (Neue Materialien Oberflächentechnik) ist die Schnittstelle für den Transfer von materialtechnischen Entwicklungen aus dem INM in die Industrie. NMO entwickelt materialangepasste Applikationsmethoden, basierend auf technisch verfügbaren Verfahren spezifisch für Industriepartner des INM und führt die Maßstabvergrößerung chemischer Synthesen inklusive Qualitätssicherungsprogramm durch. In speziellen Fällen unterstützt NMO im Rahmen von Drittmittelprojekten mit der Industrie ebenso den modularen Aufbau von Gerätschaften, welche für die Verarbeitung der neu entwickelten Materialien aus den anderen Programmbereichen benötigt werden.

### CURRENT WORK

In the past year developments concerning technology phases from bilateral projects with industry have been primarily performed in the application centre NMO.

NMO was engaged in process development concerning spray coating application and the determination of the coating parameters for tubes and the internal coating of real pup-joints for field tests at the customer site. The objective was a reproducible and defect free coating of the internal surfaces of steel tubes with a corrosion protection coating. From this, a reliable coating technology for the joining section of the tubes is being derived. The experiments have been performed in the spray booth chamber using a six axis robotic system equipped with a spray lance of 1 m length and a roller block that enabled the tubes to be rotated during the coating process. The roller

block has been designed in close cooperation with the mechanical workshop of INM and is equipped with an explosion-proof motor.

From the viewpoint of process engineering, UV curing equipment based on UV-LED technology has been built to homogeneously coat copper parts with photo curable epoxy resins on the plain area and also at the edges in order to achieve electrical insulation effect. The equipment is very variable in

their parts to be coated with materials from the INM technology platform shelf in order to show basic effects and to provide starting points for research and development cooperation.

### OUTLOOK

In the past years several rearrangements have been performed at NMO that led to a significant streamlining. Since autumn 2011 an intensive search has



adjusting intensity, distance from the surface and incident angle of the focussed UV light and allowed to work out the best coating conditions in a short development time.

In the field of particle technology NMO has performed the chemical up-scaling process for the synthesis of heatable proppants from the lab scale of about 100 g to the small technical scale of about 5 kg. Key point was the introduction of a special pelletizing technology that produces uniform particles with perfectly round shape, while avoiding significant waste formation. The requirements are driven by interest from an industrial customer. A first customer could be found in the oil and gas industry which is requiring several hundreds of kilograms for a field test. For this reason the up-scaling process will be pursued and it is planned to build a process facility with appropriate size in order to fulfil the demand.

In addition to this much sampling work has been performed for potential industrial customers. Industry partners from very diverse branches send

been started to recruit a new head for the program division, who in particular should have engineering skills. In addition this person should acquire third party funding and implement new topics of scientific interest for NMO. Furthermore it is envisaged to hire new staff by appropriate team formation in order to manage an increasing number of projects.



#### ► Dr.-Ing. Carsten Becker-Willinger

Dr. Carsten Becker-Willinger studierte Chemie in Freiburg i. Br. Von 1993 bis 1998 promovierte er am INM bei Prof. H. Schmidt über Struktur-Eigenschaftsbeziehungen in thermoplastischen Nanokompositen an Polymethylmethacrylat Modellsystemen. Seit 2001 leitet er den Bereich Nanomere.



#### ► Dr. Peter W. de Oliveira

Dr. Peter William Oliveira leitet seit Sommer 2005 die Arbeitsgruppe *Optische Materialien* am INM. Er studierte Physik in Brasilien und kam nach Diplom- und Master-Abschluss ans INM. In seiner Doktorarbeit befasste er sich mit diffraktiven mikrooptischen Komponenten in Nanokompositmaterialien.



## ► SERVICEGRUPPE BIBLIOTHEK, INFORMATION & DOKUMENTATION

ELKE BUBEL



Die Bibliothek des INM ist eine wissenschaftliche Spezialbibliothek und erbringt Dienstleistungen im Bereich Information, Dokumentation, Recherche und Dokumentlieferung. Die Bibliothek ist öffentlich.

### ARBEITEN 2012

#### Bibliothekssystem KOHA

2012 war geprägt von der Einführung und Inbetriebnahme des integrierten Bibliothekssystems KOHA, einer Open-Source-Software, die von Bibliotheksservice-Zentrum Baden-Württemberg (BSZ) nach dem Modell „Software as a Service“ angeboten wird. Einrichtung und Konfiguration des Systems erfolgten in enger Abstimmung mit dem BSZ. Nach Abschluss aller Datenmigrationsarbeiten konnte zum Jahresende das bisherige System LIBERO der Fa. LIB- IT GmbH abgelöst werden.

### Elektronische Lizenzen

Elektronische Zeitschriften und Datenbanken bezieht die Bibliothek über zahlreiche Verlagslizenzen, Konsortien sowie National- und Allianz-Lizenzen.

### Relaunch INM-Internetpräsenz

Die Bibliothek war an der Umsetzung des neuen Corporate Design des INM beteiligt. Ihr oblag der Relaunch der Instituts-Website nach Vorgaben der beauftragten Werbeagentur. Auch der Online-Katalog der Bibliothek wurde in diesem Zusammenhang an das neue Corporate Design angepasst.

### Open Access

Die INM-Bibliothek hat 2012 ihre Aktivitäten im Bereich „Open Access“ (OA) verstärkt. Unter Beachtung der urheberrechtlichen Bestimmungen werden kontinuierlich INM-Publikationen auf Leibniz-Open, dem Repositorium der Leibniz-Gemeinschaft, frei zugänglich gemacht.

### Umfrage zu Publikationszählung

Die INM-Bibliothek hat sich an der Konzeption und Umsetzung einer Umfrage innerhalb des AK Bibliotheken der Leibniz-Gemeinschaft zur Zählweise von Publikationen in den Instituten der Leibniz-Gemeinschaft beteiligt. Die Ergebnisse wurden beim 13. Jahrestreffen des AK in Hannover vorgestellt.

### AUSBLICK

2013 ist die Einführung eines sog. Discovery Systems geplant. Discovery Systeme ermöglichen, große Datenmengen unterschiedlicher Herkunft in einem einzigen Suchindex zu erschließen.

## ► SERVICEGRUPPE ANALYTIK

DR. CLAUDIA FINK-STRAUBE

Der Servicebereich Analytik bietet analytische Dienstleistungen in den methodischen Bereichen Chromatographie, NMR-Spektroskopie und Atom-spektrometrie sowohl für den institutsinternen Bedarf als auch für externe Auftraggeber an.

Neben Routinemessungen zur qualitativen und quantitativen Bestimmung der Zusammensetzung werden Messmethoden für spezielle Anforderungen optimiert und komplexe Analysenlösungen gemäß Aufgabenstellung entwickelt.

Dabei kommen Flüssig- (HPLC) und Gaschromatographie gekoppelt mit Massenspektrometrie (GC/MS), <sup>1</sup>H-, <sup>13</sup>C- und <sup>29</sup>Si-Flüssig-Nuclear-Magnetic-Resonance-Spektroskopie (NMR) sowie atomspektrometrische Verfahren der Atomabsorption mit Flammen- (FAAS) und Graphitrohratomisierung (GFAAS), letzteres auch für die automatisierte Feststoffeinfuhr, als auch der optischen Emission mit induktiv gekoppelten Plasma (ICP OES) und die CHNS- Analyse zum Einsatz.

### ARBEITEN 2012

Im Jahre 2012 wurden neben den analytischen Fragestellungen für die wissenschaftlichen Programmbereiche des Institutes 14% des Zeitaufwands für Kooperationen mit der Universität und 8% für externe Auftraggeber bearbeitet.

### Beispiele bearbeiteter Projekte:

- ▶ Quantitative Spurenanalytik von Metallkonzentration (Cu, Ag, Au, Fe) in verschiedenen Zellmedien mit GFAAS
- ▶ Vergleichende Untersuchungen der Ag-Gehalte in antimikrobiellen Produkten (diverse Kosmetik- und Haushaltsartikel, Textilien) mit GFAAS und ICP OES nach MW-Aufschluss
- ▶ Ermittlung der Reinheit von Kompressorölen nach Durchlaufen von Druckaufbereitungsanlagen mit GC/MS
- ▶ Überprüfung der Homogenität der Phosphorverteilung in Drähten aus CuAg-Legierung mit ICP OES



## ▶ SERVICEGRUPPE ENGINEERING

DIETMAR SERWAS



### AUFGABE DES SERVICEBEREICHS

Das Hauptarbeitsgebiet des Servicebereichs liegt in Entwicklung und Bau wissenschaftlicher Anlagen und Komponenten für die Forschungsabteilungen. Die Bandbreite reicht hierbei von kleinen Laborgeräten bis hin zu großen Pilotanlagen. Aus den Vorgaben der Forschung werden nach Präzisierung der Anforderungen die erforderlichen Konstruktionen in enger Verzahnung mit den wissenschaftlichen Bereichen des Hauses erstellt. Die Umsetzung erfolgt in den Werkstätten durch weitestgehend eigene Fertigung, sowohl von Steuerungen und Softwareentwicklungen als auch mechanischer Herstellung einschließlich Zusammenbau zur kompletten Anlage. Ein weiteres Arbeitsgebiet ist die Messwerterfassung zur Charakterisierung elektrischer Materialeigenschaften. Weiterhin führt die Arbeitsgruppe im Rahmen einer Kooperation die Werkstattaufgaben für den Lehrstuhl „Technische Physik“ der Universität des Saarlandes durch. Der Auszubildendenanteil von 20% belegt den hohen Stellenwert der Ausbildung.

### Automatisierte Niedrigohm-Messungen in dampfhaltigen Atmosphären

Die Leiterbahnen von mit Schutzlack beschichteten Platinen werden dampfhaltigen Atmosphären mit Temperaturen bis zu 150°C ausgesetzt. Die Zunahme der ohmschen Widerstände der Leiterbahnen in Abhängigkeit von der Zeit ist ein Indikator für Veränderungen der Schutzschicht. Die Widerstandswerte von bis zu 40 Proben werden mit einem Digitalmultimeter mit eingebauten Scannermodulen gemessen. Über das user interface des Messwerterfassungsprogrammes werden die Scanintervalle individuell vorgeben und nach Zwischenspeicherung im Digitalmultimeter in den Messpausen automatisch zum Programm transferiert.

### AUSBLICK

Durch die weiter gestiegenen Anforderungen der Forschungsgruppen wird das Know-How der Arbeiten in der Mikromechanik erweitert, wobei dies speziell auch Zerspanungen von exotischeren Materialien einschließt.

## ▶ SERVICEGRUPPE WERKSTOFFPRÜFUNG/ PULVERSYNTHESE

KARL-PETER SCHMITT, ROBERT DRUMM

### AUFGABE DES SERVICEBEREICHS

Die Werkstoffprüfung umfasst die mechanischen Prüfverfahren, mit denen die Werkstoffkenngrößen von Werkstoffproben oder Bauteilen unter mechanischen, thermischen oder chemischen Beanspruchungen ermittelt werden. Diese dienen zur Charakterisierung der Festigkeit, des Verformungs- und Bruchverhaltens sowie der Härte und des Verschleißwiderstandes. Neben Spindelprüfmaschinen stehen auch servohydraulische Prüfsysteme zur Charakterisierung unter zyklischer Beanspruchung in einem Temperaturbereich von -100 bis 600°C zur Verfügung. Zur Ermittlung von Härte und plastischem/elastischem Verhalten an dünnen Schichten stehen registrierende Härteprüfverfahren zur Verfügung. Daran können mit Scratchtestern Kratz- und Haftfestigkeiten ermittelt werden. Tribologische Eigenschaften werden im Gleit- und Schwingverschleiß bestimmt.

Außer den mechanischen Charakterisierungsverfahren werden auch thermische Charakterisierungsverfahren wie Dilatometrie, DTA/DSC sowie die Simultane Thermo-Analyse (STA), eine Kombination von Thermogravimetrie mit DTA/DSC sowie gekoppelter Massenspektrometrie und Infrarotspektroskopie (FTIR) angeboten.

Im Bereich der Pulversynthese stehen die Synthese und Bereitstellung von Nanopartikeln sowie das Up-Scaling bis in den Technikumsmaßstab im Vordergrund. Es wurden auch Untersuchungen zum Dispergierverhalten von nanoskaligen Partikeln in flüssigen und pastösen Medien durchgeführt.

### Herstellung ferrimagnetischer Proppants

In 2012 wurden im Rahmen einer Arbeit ferrimagnetische Proppants (Stützmittel) im Kilogramm-Maßstab zur Verfügung gestellt. Der Eignungstest beim Kunden verlief erfolgreich, so dass Vorbereitungen getroffen wurden, die begonnene Entwicklung ferrimagnetischer Proppants in Bezug auf ein Upscaling im Tonnen-Maßstab weiterzuführen.







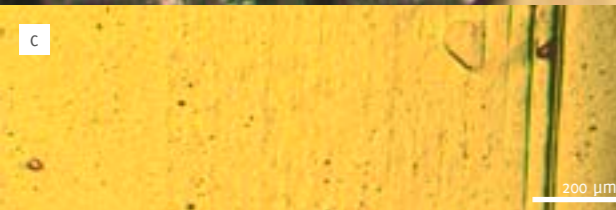
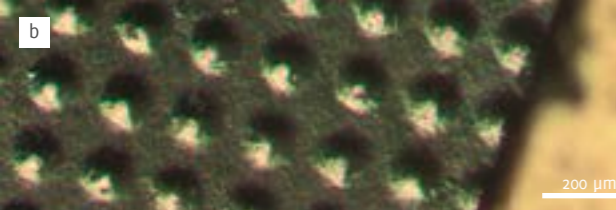
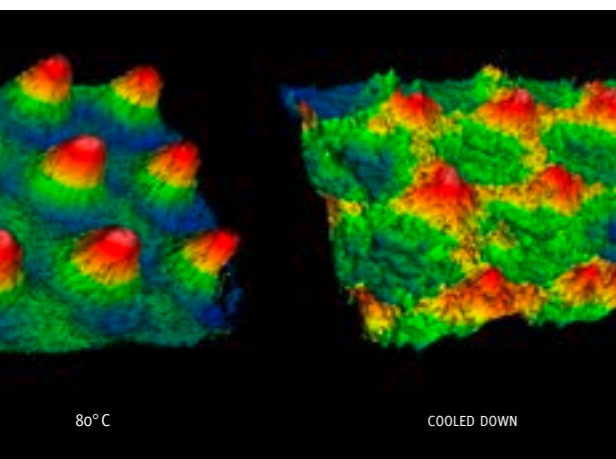
▶ HIGHLIGHTS  
2012



## ► NiTi-POLYMER HYBRID MATERIAL FOR SWITCHABLE ADHESION

M. FRENSEMEIER<sup>1,2</sup>, J. KAISER<sup>1</sup>, E. KRONER<sup>1</sup>, A. SCHNEIDER<sup>2</sup>, E. ARZT<sup>1</sup>

1) Functional Surfaces Group // 2) Metallic Microstructures Group



In a cooperation between the Program Division *Functional Surfaces* and the Junior Research Group *Metallic Microstructures* a switchable adhesive system consisting of a Nickel Titanium (NiTi) shape memory alloy and polydimethylsiloxane (PDMS) was developed. In this system the indentation induced two-way shape memory effect was used to reversibly change the surface topography of NiTi as a function of temperature. The PDMS was deposited on top of the pre-structured NiTi, where it acts as an adhesion mediating contact element. It was shown that the adhesion of the system decreases upon heating, as the structures formed on the NiTi protrude into the polymer surface thus reducing the contact area. Above the switching temperature at 80°C adhesion is reduced by nearly 80%. Cooling down to room temperature recovers the flat surface as shown in Fig. 1 and thus initial adhesion is restored. The system is capable of switching its adhesion highly reversibly by an order of magnitude.

We investigated two different topographies, bump and line arrays, which were produced by conventional indentation and scratch testing. Fig. 2 shows the topographies at low (a, c) and high (b, d) temperature. In the low temperature modification surfaces are almost completely flat, while at elevated temperature the two-way shape memory effect leads to the formation of protrusions.

This system has the potential for application in modern pick and place processes, as it allows an externally stimulated change in adhesion. Future investigations will aim to induce the switch by other external triggers e.g. magnetic or electric fields, and to increase the switching speed. Also, such systems are promising materials for other applications apart from adhesion, such as switchable optical devices. A patent has been filed.

Contact: Dr. Elmar Kroner  
Program Division Functional Surfaces

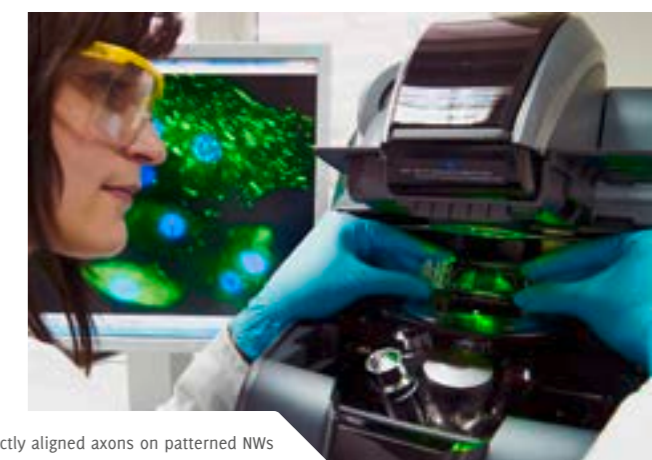
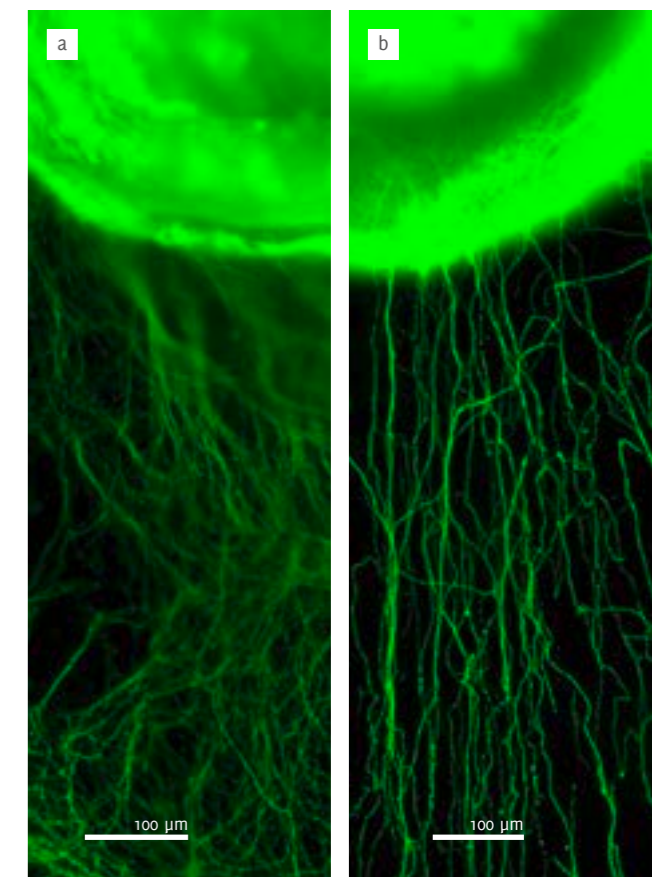
► Fig. 1: Bumpy surface of switchable hybrid system, 80°C: adhesion loss, cooling: original surface structure and adhesive properties.  
Fig. 2: Low temperature topography (a, c), and high temperature topography (b, d) for bump and line patterns.

## ► TOPOGRAPHY INDUCED SELECTIVE ADHESION AND ALIGNMENT OF CELLS

J. LEE, M. M. MIRÓ, C. K. AKKAN, A. MAY, M. VEITH, C. AKTAS

Topographic modification of surfaces is as an effective tool to control cell adhesion, migration, orientation, shape, and even gene expression. Previously we presented selective cell responses to  $\text{Al}_2\text{O}_3$  nanostructures. Several top-down and bottom-up methods have been used to fabricate various surface patterns. Structuring of surfaces by laser is one of the most preferred methods to pattern biomaterials because of its versatility and the non-contact processing. Especially nano-grooves and nano-gratings are commonly used as topographical features for exploring cell-surface interaction. A laser beam can be easily focused on any substrate to create lines or holes directly onto the surface in so called direct laser writing. Laser interference patterning (LIP) is another effective structuring approach which is based on superimposing two or more laser beams. In this current work using LIP we structured  $\text{Al}_2\text{O}_3$  nanowires (NWs) synthesized by chemical vapor deposition (CVD). LIP of NWs leads to hierarchical structures composed of both micro- and nanoscale features. Following the laser treatment, bi-phasic nature of NWs (Al core and  $\text{Al}_2\text{O}_3$  shell) leads to preservation of the surface chemistry (oxidation of Al to  $\text{Al}_2\text{O}_3$ ). Since  $\text{Al}_2\text{O}_3$  is known as a biocompatible material and has been used in many implant applications, our patterned surface forms an ideal model to study the cell guidance. We examined the interactions of neurons (from rat dorsal root ganglion), human umbilical vein smooth muscle cells (HUVMSC), human umbilical vein endothelial cells (HUVEC) and human osteoblasts (HOB) on these laser treated surfaces. While patterned NWs lead to alignment of axons (see Figure 1), the morphology of HUVMSC exhibited a stretched morphology. On the other hand HUVEC and HOB did not show such a response. Our results show that different cell types exhibit diverse responses to the multi-scale topography.

Contact: Dr. C. Aktas  
Program Division CVD/Biosurfaces

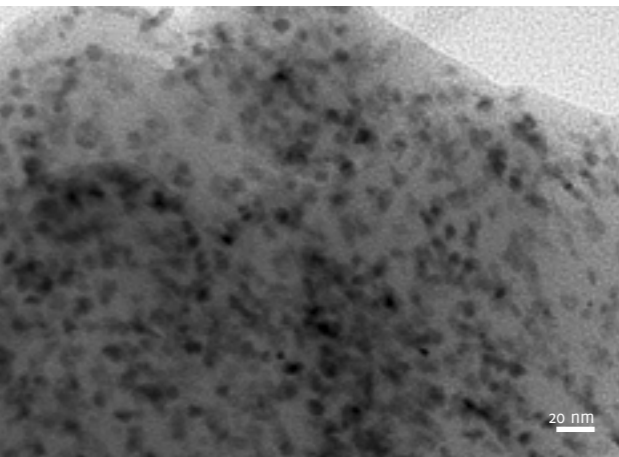


► Fig. 1: (a) non-aligned axons on as deposited NWs, (b) perfectly aligned axons on patterned NWs



## ► SYNTHESIS OF BaTiO<sub>3</sub> NANOPARTICLES FOR THEIR USE IN OPTICAL MATERIALS

D. BENTZ, C. BECKER-WILLINGER



Nanoparticles are an effective tool to transfer solid state physical characteristics into composite materials. If their size is below 10–15 nm, light scattering can be neglected and the resulting materials can remain transparent. Exact control of the surface chemistry of the nanoparticles is essential to disperse particles in a binder matrix homogeneously.

In this work, nanoscaled BaTiO<sub>3</sub> was synthesized using a wet chemical approach because it offers UV-protection without undesired photocatalytic effects which usually degrade organic binding matrices. Highly crystalline, surface modified BaTiO<sub>3</sub> nanoparticles were synthesized using a lyothermal procedure in an autoclave. The average crystallite size, calculated from XRD results, was found to be 9 nm. These particles were directly dispersible in organic and organic-inorganic hybrid matrices. TEM investigation on cured polymer matrix filled with 5 wt % BaTiO<sub>3</sub> revealed a uniform particle dispersion. Furthermore transparent nanocomposite coatings based on polymer-hybrid materials on fused silica substrates showed UV protection with a sharp absorption edge at 330 cm<sup>-1</sup> (50 % absorption, degree of filling: 10 wt %). Such types of compositions could also be used as coatings on plastic substrates. In addition, the transfer of the BaTiO<sub>3</sub> nanoparticles into acrylic matrices led to compact bulk parts with increased refractive index compared to the pristine unfilled polymer. A substitution of glass in many fields of application may be feasible by a combination of these nanocomposite coatings with transparent polymer material.

Contact: Dr. Carsten Becker-Willinger  
Program Division Nanomers



► Fig. 1: TEM image of BaTiO<sub>3</sub> nanoparticles in cured polymer matrix // Fig. 2: BaTiO<sub>3</sub> nanoparticle synthesis in an autoclave

## ► HIDE AND SEEK: ENDOTOXIN DETECTION IN NANOPARTICLE SUSPENSIONS

M. KUCKI, A. KRAEGELOH

Engineered nanomaterials (ENM) for medical applications have to be tested for possible contaminations with lipopolysaccharides (LPS), components of the outer leaflet of gram-negative bacteria. Even small amounts of LPS, also denoted endotoxins, can trigger a rapid immunological response. For *in vivo* and *in vitro* studies on the impact of ENM on human and animal health, especially on the innate immune system, undetected LPS-contaminations can generate misleading results, influencing the general safety assessment of the ENM. An obstacle for the generation of reliable test results is the interference of ENM with biological test systems.

In the project NanoKon – Systematic evaluation of health effects of nanoscale contrast agents, funded by the German Federal Ministry of Education and Research (BMBF) two endotoxin detection systems are validated with respect to application with aqueous nanoparticle suspensions. Interferences can be caused by inherent optical properties of the ENM, that affect the optical read out system, or by other material properties. In this study, silica nanoparticles were used to exclude optical interferences. Size and surface modification of the particles were systematically varied. Detailed inhibition/enhancement controls for every tested particle type and batch proved necessary for reliable data. Assay inhibition and enhancement were observed, which were dependent on the applied particle concentration, but not clearly related to the calculated particle surface area. Our findings give evidence that protein-particle interactions govern the observed non-optical assay interferences. The results of our study give a valuable contribution to the understanding of the interference mechanisms and supports the development of new test strategies.

Contact: Dr. Annette Kraegeloh  
Program Division Nano Cell Interactions



► Fig.: Limulus polyphemus, biological resource for LAL (Limulus Amebocyte Lysate) endotoxin detection systems



## ► CONFERENCE ON IN-SITU AND CORRELATIVE ELECTRON MICROSCOPY (CISCHEM)

N. DE JONGE

The program division *Innovative Electron Microscopy* organized an international conference in the field of electron microscopy. The conference entitled Conference on In-Situ and Correlative Electron Microscopy (CISCHEM) was held 6-7 Nov. 2012, in Saarbrücken, Germany. Research in electron microscopy has been focused on achieving higher resolution for several decades. Sub-Angstrom resolution is nowadays obtained on a routine basis with aberration corrected transmission electron microscopy. The question is: What is next? The aim of the conference was to bring together an interdisciplinary group of scientists from the fields of biology, materials science, chemistry, and physics, to discuss future directions of electron microscopy research. The topics of the different sessions were carbon-based materials, correlative fluorescence and electron microscopy, electron microscopy of biological specimens in their native environment, imaging growth of nanomaterials in liquid, in-situ studies of electronic materials and metals, and studying electrochemistry with liquid cell electron microscopy. The conference served also as scientific opening session of the new electron microscopy facility at the INM including a TEM/STEM (ARM200, JEOL).

### ACKNOWLEDGEMENTS

The logistics of the conference were organized by Christine Hartmann, Elke Bubel designed the conference website, and the INM provided financial support. The following sponsors are greatly acknowledged: CEOS GmbH, Heidelberg, Germany, FEI, Hillsboro, OR, USA (high-level sponsor), E.A. Fischione Instruments, Inc., Export, PA, USA, Gatan Inc., Pleasanton, CA, USA, JEOL GmbH, München, Germany, Protochips Inc., Raleigh, NC, USA.



## ► “NANOSAFETY”: A NEW LEIBNIZ RESEARCH NETWORK

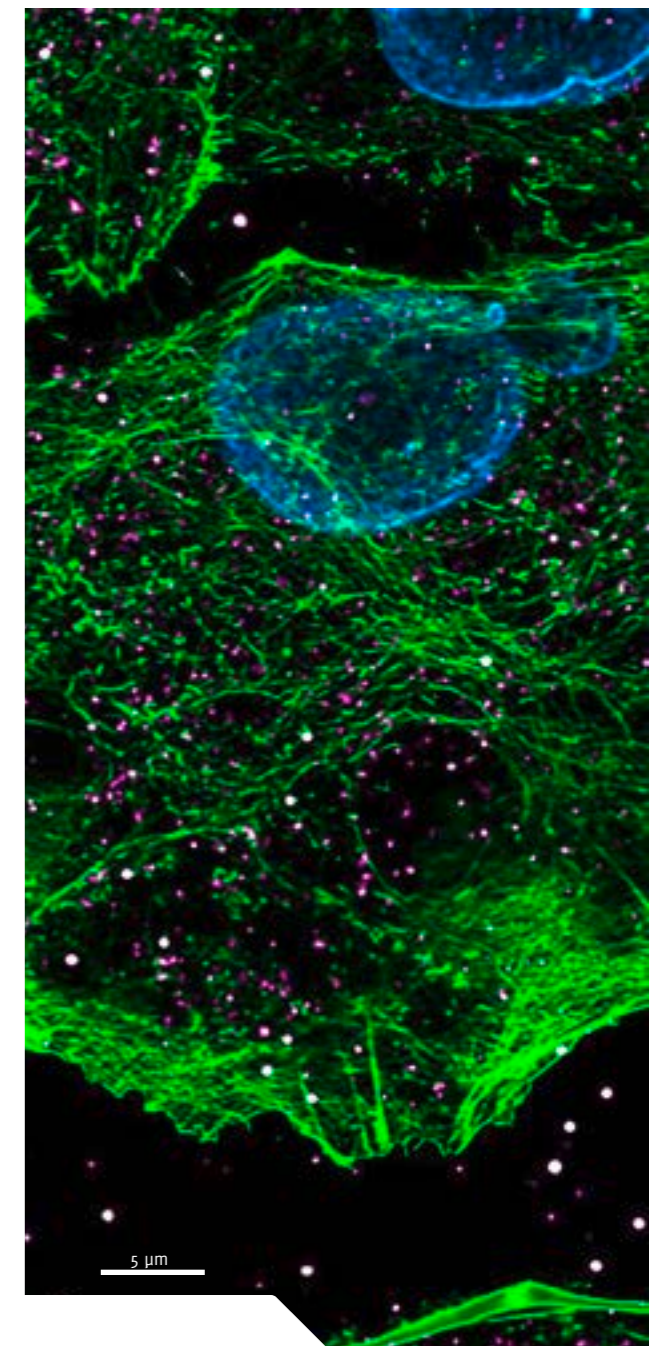
A. KRAEGELOH, E. ARZT

Nanotechnologies and the development of new nanomaterials are increasingly becoming part of the daily working world and market development. For this reason, the safe production, application and disposal of nanomaterials are of high importance to society. In order to address this topic, the research network “Nanosafety” was established in 2012 by the executive committee of the Leibniz Association for a duration of five years. The research network was initiated and is led by Eduard Arzt at INM with Annette Kraegeloh acting as a scientific coordinator. As a cooperation of six Leibniz institutes, “Nanosafety” not only addresses the potential impact elicited by nanomaterials but also product safety enabled by applications of nanotechnology.

The main work package focuses on interactions of nanomaterials with human cells, tissues, and organs. The effects on various cell types are examined, investigating inflammation, signaling events, and aging. The uptake of well-defined nanomaterials into cells and tissues is analyzed by use of microscopy. The results will be used to support the design of safer nanomaterials. The second topic addresses the development of hidden safety features, in order to shield sensitive products including pharmaceuticals or technical components from piracy of products. A third subject is related to a scientific investigation of the public perception of nanosafety. The fourth work package includes the establishment of an infrastructure enabling management of research data and development of an ontology on nanosafety.

### PARTNERS IN THE NETWORK:

Leibniz-Institut für Neue Materialien, Saarbrücken (INM)  
 Leibniz-Institut für Umweltmedizinische Forschung an der Heinrich-Heine-Universität Düsseldorf (IUF)  
 Leibniz-Institut für Arbeitsforschung an der TU Dortmund (IfADo)  
 Forschungszentrum Borstel, Leibniz-Zentrum für Medizin und Biowissenschaften (FZB)  
 Leibniz-Institut für Wissensmedien, Tübingen (IWM)  
 Leibniz-Institut für Informationsinfrastruktur, Karlsruhe (FIZ)





## ► FIRST WORKSHOP OF THE LEIBNIZ NETWORK NANO IN BERLIN

M. QUILITZ, E. ARZT



The Leibniz Network Nano was established as a platform for the information exchange between institutional partners in 2011. With now fourteen institutes the network combines the knowledge and experience of most institutes conducting high level research in nanotechnology within the Leibniz Association. The network is coordinated by Prof. Arzt and Dr. Quilitz at INM.

The First Workshop of the Leibniz Network Nano was held on the 30th and 31st January 2012. As a venue the new headquarter of the Leibniz Association in the centre of Berlin was chosen. The workshop intended to bring together the active players in the network, to help them gain a better knowledge of the partners and their respective competencies, to forge new contacts, to deepen already existing connections and to set up promising and potential new collaborations.

The workshop program filled one and a half days with a rather ambitious program. The agenda was dominated by 17 talks in five sessions. The sessions covered the themes Nanostructuring/Nanoeffects, Functional Surfaces, Nanoelectronics/Nanosensorics/Nanooptics, the area of Nanobio/Nanomedicine/Nanosafety and Nanoanalytics. The variety of topics addressed in the talks illustrated impressively the diversity of nanotechnology research topics in the Leibniz Association. In addition, 36 posters covering an even broader variety of topics were exhibited in the poster sessions.

With 63 participants from 13 institutions the workshop was successful in bringing together a good cross section of the institutes as seeds for future cooperations. Most institutes were very active in participation, and in their contributions. Especially it was agreed that the comparably large number of young researchers was an additional asset.



► Figs.: Impressions from the audience and an aerial view on the poster session

## ► 25 YEARS INM

C. JUNG

On November 8, the employees and about 90 guests celebrated the 25th anniversary of INM in the festive auditorium of Saarland University. Representatives from the local and federal government, the Leibniz Association, Saarland University and from Saarland-based companies proved in an impressive manner the important role of INM in the scientific landscape, for Saarland and for industry.

### CHEMICAL NANOTECHNOLOGY AND SUCCESSFUL TECHNOLOGY TRANSFER

When the institute was founded in 1987, the main focus was on nanotechnology, a new field at the time. In this phase, researchers at INM used special techniques of chemical nanotechnology in order to develop novel materials. Success stories were the creation of new surfaces, such as scratch-resistant, dirt-repellent or antireflective coatings. In the mid-nineties, the first nanotechnology products were developed and found their way into everyday use, resulting from many fruitful cooperations with industry. The focus on development led to a wave of spin-off companies all created between 1995 and 2003.

### NEW THINKING. NEW MATERIALS

Since 2005, INM has been striving for a new position: With its current leading subjects – new materials for energy applications, new concepts for implant surfaces, nano-safety as well as new surfaces for tribological applications – INM today represents a multi-disciplinary think tank. Physicists, chemists, materials scientists, biologists, physicians and engineers investigate new effects and phenomena, create materials with new properties and transfer them into application. According to the motto of Leibniz "Theoria cum praxi", present-day research at INM aims at a balance between knowledge acquisition and its application.



► Figs.: Impressions from the anniversary celebration



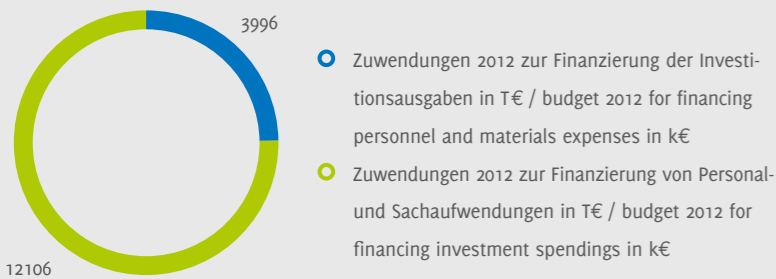
▶ FAKTEN UND ZAHLEN /  
FACTS AND FIGURES



## ► DAS INM IN ZAHLEN / INM IN FIGURES

### FINANZ- UND ERTRAGSLAGE / VERMÖGENSLAGE DER GESELLSCHAFT

Als Forschungseinrichtung der Leibniz-Gemeinschaft hat das INM auch im Haushaltsjahr 2012 eine gemeinsame Förderung durch den Bund und die Länder erhalten. Diese belief sich auf 16.102 T€; hiervon 12.106 T€ zur Finanzierung von Personal- und Sachaufwendungen, sowie 3.996 T€ für erforderliche Neu- und Ersatzinvestitionen. Gegenüber dem Vorjahr erfolgte entsprechend der Beschlusslage der Gemeinsamen Wissenschaftskonferenz eine Erhöhung des Kernhaushaltes um 5 %.



Im Geschäftsjahr 2012 erzielte das INM eigene Erlöse aus Forschung und Entwicklung sowie sonstige betriebliche Erträge in Höhe von 3.737 T€. Im Rahmen öffentlicher Projektfinanzierungen erzielte das INM im Jahr 2012 Erlöse in Höhe von 2.129 T€. Die Industrieerlöse aus Forschung und Entwicklung sowie aus Lizenzvereinbarungen beliefen sich auf 1.301 T€. Sonstige Erlöse und betriebliche Erträge in Höhe von 306 T€ resultierten überwiegend aus der Weiterbelastung von Gebäude-, Patent- und sonstigen Kosten.

Der Gesamtumsatz 2012 der Gesellschaft betrug 18.838 T€. Die Erhöhung gegenüber dem Vorjahr resultiert in erster Linie aus der deutlichen Zunahme der vorgenannten Drittmittelerlöse. Die Erlöse aus der gemeinsamen Finanzierung durch den Bund und die Länder sind für das Geschäftsjahr 2012 geringer als im Vorjahr; dies war dadurch begründet, dass in 2011 in hohem Maße auch Zuwendungsmittel des Jahres 2010 aufgewendet wurden.

Die Bilanzsumme der Gesellschaft zum 31. Dezember 2012 beträgt 23.110 T€; gegenüber dem Vorjahr eine Erhöhung um 2.046 T€. Sowohl für das Anlagevermögen, als auch für das Umlaufvermögen ist gegenüber dem Bilanzstichtag des Vorjahres eine Erhöhung festzustellen. Die Investitionstätigkeit der Gesellschaft (4.033 T€) überstieg im Geschäftsjahr 2012 erneut deutlich die Abschreibungen in Höhe von 2.809 T€. Die Verbindlichkeiten der Gesellschaft beliefen sich zum Bilanzstichtag auf 1.481 T€. Die Steigerung gegenüber dem Vorjahr (415 T€) ist durch höhere Verbindlichkeiten aus Lieferungen und Leistungen sowie gegenüber der öffentlichen Hand begründet.

### PERSONALENTWICKLUNG

Die Anzahl der Beschäftigten belief sich im Durchschnitt des Jahres 2012 auf 188 Mitarbeiterinnen und Mitarbeiter. Hiervon waren 61 wissenschaftliche und graduierte Mitarbeiter/innen, 20 Doktorandinnen und Doktoranden, 47 Beschäftigte in den Bereichen Labor, Technik und Service sowie 21 Hilfwissenschaftlerinnen und Hilfwissenschaftler. In den Bereichen Verwaltung und Sekretariate waren 33 Mitarbeiterinnen und Mitarbeiter beschäftigt. Des Weiteren befanden sich im Jahresdurchschnitt 2012 sechs Auszubildende in der Ausbildung.

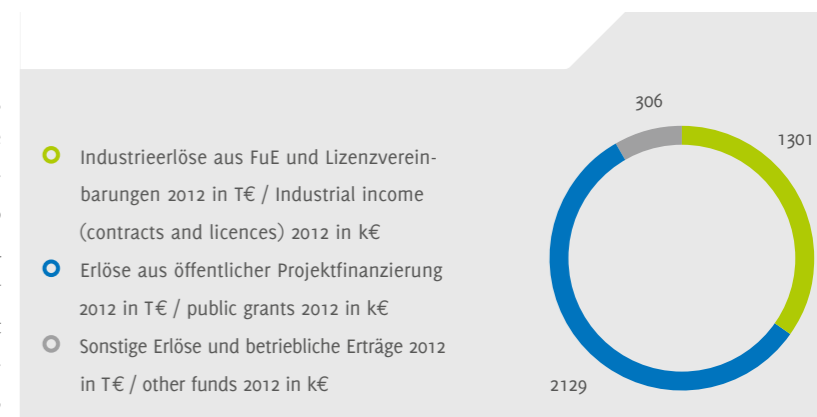
### FINANCIAL AND INCOME SITUATION OF THE CORPORATION

As a research institute of the Leibniz Association, INM obtained common financial support from the federal government and the federal states in the financial year 2012. This amounted to 16,102 k€; 12,106 k€ of those were used for financing personnel and materials expenses and 3,996 k€ for necessary new and replacement investments. According to the Joint Science Conference (GWK – Gemeinsame Wissenschaftskonferenz), the core budget increased by 5 % compared to the previous year.

In the financial year 2012, INM generated own proceeds from research grants and contracts as well as from other operating income amounting to 3,737 k€. From public grants, INM generated proceeds amounting to 2,129 k€ in 2012. Industrial contracts and patents/licences generated 1,301 k€. Other income amounting to 306 k€ resulted mainly from the cost transfer for expenditures on buildings, patents and others.

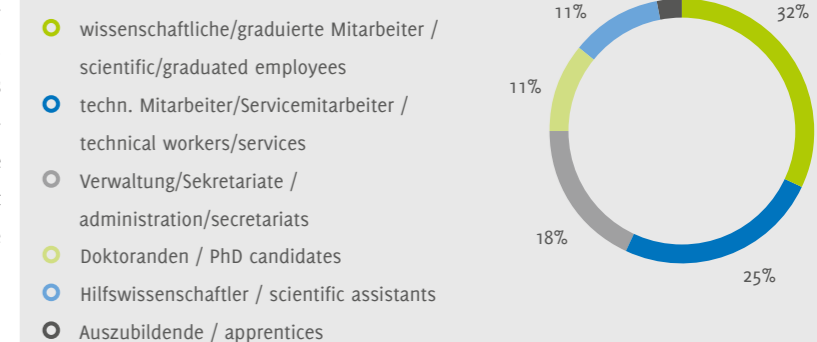
In 2012, the total turnover of the corporation added up to 18,838 k€. The increase compared to the previous year results primarily from the fact that aforementioned third-party funds increased significantly. For the financial year 2012, the recorded revenues from the joint financing through the federal government and the federal states are smaller than in the previous year. This is justified on the grounds that some financial contributions received in 2010 were spent in 2011.

The balance sheet total of the corporation is 23,110 k€ on 31st December 2012, which is an increase of 2,046 k€ compared to the preceding year. Both the fixed assets and the current assets increased compared to the balance sheet date of the previous year. The investment activity amounting to 4,033 k€ again significantly exceeded the depreciation amounting to 2,809 k€ in the financial year 2012. The liabilities of the corporation amounted to 1,481 k€ on the balance sheet date. Reasons for this increase compared to the previous year (415 k€) are the higher liabilities from deliveries and services as well as toward the public authorities.



### PERSONNEL DEVELOPMENT

The average number of employees totalled 188 in 2012. This total included 61 scientific and graduate employees, 20 doctoral candidates and 47 employees in the laboratories and the technical services as well as 21 graduate assistants. 33 employees worked in the administration and secretarial offices. Furthermore, six apprentices were in vocational education in the course of the year 2012.



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Session Chair: *NanoTR VIII, Nanoscience and Nanotechnology Conference*, June 26–29, 2012, Ankara,  
*1st Annual Congress on Stem Cell Research*, September 28–October 2, Sapanca  
Referee bei Zeitschriften:  
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Vorsitz Leibniz-Netzwerk Nano  
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Mitglied im Editorial Board / Advisory Board der Zeitschriften:  
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Honorarprofessor der Universität des Saarlandes, Saarbrücken  
Berufung in das Prüfungsamt für das Lehramt an Schulen



Beratertätigkeit für die Fernsehserie „Frag doch mal die Maus“ über Reibung von Buchseiten  
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Mitglied im Program Committee: *Nanobrücken II - Nanomechanical Testing Workshop & Hysitron User Meeting*, Saarbrücken, Germany, March 22–23, 2012  
Gutachtertätigkeit für:  
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Gutachtertätigkeit für:  
Danish Agency for Science, Technology and Innovation, National Institute of Health, Small Business Innovation Research (SBIR) Grants  
Referee bei Zeitschriften:  
*ACS Nano, Chemistry of Materials, Journal of Visualized Experiments, Microscopy and Microanalysis, Microscopy Research and Technique, Nano Letters Scientific Reports, Ultramicroscopy, Journal of Structural Biology*

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Mitglied des Dechema-Arbeitskreises:  
Responsible Production and Use of Nanomaterials

Koordination des Leibniz-Forschungsverbundes Nanosicherheit  
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Ko-Vorsitzender des Arbeitskreises “*Grenzflächen: statisch und dynamisch*” im Fachausschuss Bioinspirierte und interaktive Materialien der Deutschen Gesellschaft für Materialkunde  
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#### Marie-Louise Lemloh

Substitute Management Committee Member, EU COST Action TD0903, Understanding and manipulating enzymatic and proteomic processes in biomineralization – towards new biomimetic strategies, the creation of tailored nano-scale architectures and environmental monitoring

#### Dr. Mario Quilitz

Koordinator des Leibniz-Netzwerkes Nano  
Mitarbeit beim Leibniz-Forschungsverbund Nanosicherheit  
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#### Dr. Roland Rolles

Mitglied im  
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#### Dr. Herbert Schmid

Referee bei Zeitschriften:  
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Koorganisation des International Indentation Workshop Nanobrücken II, Saarbrücken,  
Koorganisation des Nanoindentation Symposium at the upcoming 8th European Solid Mechanics Conference, Graz, Austria  
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Externes Beratungsmitglied, LCC Toulouse, France  
Sprecher, Internationales Graduiertenkolleg GRK 532  
Leiter Frankreichzentrum, Universität des Saarlandes, Saarbrücken  
Vorstandsmitglied, International Ring Systems (IRIS), International Meetings: Germanium, Tin, Lead (GTL)  
Mitglied bei:  
▶ Akademie der Wissenschaften und der Literatur, Mainz  
▶ Deutsche Akademie der Naturforscher Leopoldina, Halle  
▶ Fellow of the Royal Society of Chemistry, London, UK  
▶ Ecole Doctorale Metz-Nancy, France  
▶ Expertengruppe Metropolprojekt Saarbrücken – Moselle Est, France  
▶ Verwaltungsrat der EEIGM Nancy, France  
▶ Arbeitsausschuss Angewandte Anorganische Chemie DECHEMA e.V., Frankfurt/M.  
Mitglied im Editorial Board / International Advisory Board der Zeitschriften:  
*Synthesis and Reactivity in Inorganic and Metal-Organic, and Nano-Metal Chemistry (European Ed.),*

*Anorganische und Allgemeine Chemie ZAAC*

Referee bei Zeitschriften:  
*Advanced Engineering Materials, Applied Organometallic Chemistry, Chemistry of Materials, European Journal of Inorganic Chemistry, Inorganic Chemistry, Progress in Organic Coatings, Zeitschrift für Anorganische und Allgemeine Chemie ZAAC*  
Gutachtertätigkeit für:  
BMBF, Projektträger Jülich

#### PD Dr. habil. Ingrid Weiss

Co-Organisator CECAM Workshop “Structure-Property Relationships in Hierarchical Biocomposites”, EPFL, Lausanne, July 16 – 18, 2012  
Session Chair, SS3: CaCO<sub>3</sub> Systems, MRS Spring Meeting, San Francisco, USA, April 11, 2012  
Referee bei Zeitschriften:  
*African Journal of Agricultural Research, Biochemical Journal, Chemistry of Materials, ChemBioChem, European Journal of Inorganic Chemistry, International Journal of Mechanical Sciences, Journal of Materials Chemistry, Journal of Structural Biology, Journal of the Royal Society Interface, Nature Chemical Biology, Plant and Cell Physiology*  
Gutachtertätigkeit für:  
EU Research Executive Agency; Evaluation of calls FP7-PEOPLE-2012, IEF, IIF and IOF BSF – United States Israel Binational Science Foundation, ECTS - European Calcified Tissue Society

## AUSZEICHNUNGEN / AWARDS

### Dr. Cenk Aktas

*Prof. Baki Komsuoglu Award,*  
Kocaeli University, Türkei

### Prof. Dr. Eduard Arzt

*Israel Pollak Distinguished Lecture Award,*  
Technion – Israel Institute of Technology,  
Haifa / Israel

### Prof. Dr. Niels de Jonge

*Microscopy and Microanalysis Best Paper Award,*  
*Best Instrumentation or Techniques*  
*Development paper*

### Prof. Norman A. Fleck, Cambridge

*Humboldt-Forschungspreis*

**Ayman Haidar, Marina Martinez Miro, Cagri Kaan Akkan, Ju Seok Lee, Karin Löw, Prof. Michael Veith, Prof. Hashim Abdul-Khaliq, Dr. Cenk Aktas**  
*Outstanding Research Award, 8th Nanoscience – Nanotechnology Congress & IANM 3rd World Congress, Ankara / Turkey*

### Dr. Elmar Kroner

*The Adhesion Society Distinguished Paper Award 2012, Adhesion Society*

### Dr. Melanie Kucki, Dr. Christian Cavalius,

### Dr. Annette Kraegeloh

*3rd Prize, Poster Award, NanoImpaceNet – QNano Research Infrastructure Conference, Dublin / Ireland*

### Ju Seok Lee

*Best Poster Award, EU-Korea Conference on Science and Technology*

### Dr. Marc Legros, Toulouse

*Humboldt-Forschungspreis, Friedrich Wilhelm Bessel-Forschungspreis*

### Prof. Robert McMeeking, Santa Barbara

*Humboldt-Forschungspreis Verlängerung*

### Nicolas Peter

*MINT Excellence-Stipendium der Manfred Lautenschläger-Stiftung*

### Dr. Volker Presser

*Bayer Early Excellence in Science Award 2012*  
in der Kategorie Materialien

2. Platz *Science Award Electrochemistry*

(VW & BASF)

3. Preis Foto-Wettbewerb, *cc-NanoBioNet*

### Dr. Thomas Ruckelshausen, Dr. Henrike Peuschel

2. Platz, *Huygens Image Contest*

### Anika Schwarz

Jahrgangsbeste Saarland, Ausbildung Chemielaborantin

## DISSERTATIONEN / DOCTORAL THESES

### DISSERTATIONEN AM INM / DOCTORAL THESES AT INM

#### Born, Philip

*Crystallization of nanoscaled colloids*  
Universität des Saarlandes, Saarbrücken,  
Diss (2012), Prof. Dr. E. Arzt

#### Dufloux, Cecile

*Vergleich zweier chemischer Gasphasenabscheidungsprozesse mit den Precursoren  $[H_2AlOtBu]_2$  und  $[Cl_2AlH^*2nmp]$*   
Universität des Saarlandes, Saarbrücken,  
Diss (2012), Prof. Dr. Dr. h.c. M. Veith

#### Kirs, Tatiana

*Synthese und Charakterisierung von neuartigen Halogenalanderivaten und deren Anwendung in der chemischen Gasphasenabscheidung (CVD)*  
Universität des Saarlandes, Saarbrücken,  
Diss (2012), Prof. Dr. Dr. h.c. M. Veith

#### Paretkar, Dadhichi

*Switchability induced by mechanical instability in bioinspired adhesives*  
Universität des Saarlandes, Saarbrücken,  
Diss (2012), Prof. Dr. E. Arzt

### VON INM-WISSENSCHAFTLERN BETREUTE DISSERTATIONEN / DOCTORAL THESES SUPERVISED BY INM SCIENTISTS

#### Aminuddin, Mai Mariam Mohamed

*Electrophysiological habituation correlates for the objective loudness scaling estimation*  
Universität des Saarlandes, Saarbrücken,  
Diss (2012), Prof. Dr. Dr. D. J. Strauss

#### Summa, Daniela

*Reaktionsverhalten von Indium(III)-tert-Butoxiden gegenüber Übergangsmetallchloriden und  $[Na(O^tBu)_3Sn]_2$*   
Universität des Saarlandes, Saarbrücken,  
Diss (2012), Prof. Dr. Dr. h.c. M. Veith





## ▶ MASTER- UND BACHELORBEITEN / MASTER AND BACHELOR THESES

### MASTERARBEITEN AM INM / MASTER THESES AT INM

#### **Frensemeier, Mareike**

*Herstellung schaltbarer Oberflächenstrukturen mittels identations-induziertem Zweiwegeeffekt bei NiTi-Formgedächtnislegierungen*  
Universität des Saarlandes, Saarbrücken,  
Master (2012), Prof. Dr. E. Arzt

#### **Frohne, Verena**

*Optimierung glasartiger Schichten als Barriere-schicht für CIGS-Dünnschichtsolarzellen*  
Universität des Saarlandes, Saarbrücken,  
Master (2012), Prof. Dr. E. Arzt

#### **Haidar, Ayman**

*Interaction of endothelial cells and smooth muscle cells on nano- and microstructured surfaces*  
Universität des Saarlandes, Saarbrücken,  
Master (2012), Prof. Dr. Dr. h.c. M. Veith

#### **May, Alexander**

*Abscheidung und Strukturierung dünner SiC-Schichten mittels Pulsed Laser Deposition und Ablation für biokompatible Anwendungen*  
Fachhochschule Kaiserslautern, Zweibrücken,,  
Master (2012), Prof. Dr. H. Möbius

#### **Pyo, Jinkyung**

*Characterization of microstructure and mechanical properties of commercially pure titanium modified by plasma nitriding*  
Universität des Saarlandes, Saarbrücken,  
Master (2012), Prof. Dr. E. Arzt

### VON INM-WISSENSCHAFTLERN BETREUTE MASTERARBEITEN / MASTER THESES SUPERVISED BY INM SCIENTISTS

#### **Gonzalez-Trejo, Ernesto**

*Dysfunctional inhibitory neurotransmission in the adult attention deficit hyperactivity disorder*  
HTW, Saarbrücken,  
Master (2012), Prof. Dr. Dr. D. J. Strauss

#### **Romero Santiago, Alejandro Ernesto**

*Neuroimaging using voltage-sensitive dyes*  
HTW, Saarbrücken,  
Master (2012), Prof. Dr. Dr. D. J. Strauss

#### **Rusczyk, Lilian**

*Entwicklung eines personalisierten und integrierten Tinnitus Diagnostik und Therapie Systems*  
HTW, Saarbrücken,  
Master (2012), Prof. Dr. Dr. D. J. Strauss

#### **Scheerer, Mario**

*Development of an equivalent circuit model of sarcoplasmic reticulum calcium signaling*  
HTW, Saarbrücken,  
Master (2012), Prof. Dr. Dr. D. J. Strauss

#### **Wolf, Arnaud**

*C++ software implementation for auditory evoked potentials – Development of an TCP/IP-interface*  
Université Lorraine, Nancy, France,  
Master (2012), Prof. Dr. Dr. D. J. Strauss

### BACHELORARBEITEN AM INM / BACHELOR THESES AT INM

#### **Graucob, Annalena**

*Dependence of adhesion on the E-modulus of elastomers*  
Fachhochschule Lübeck, Lübeck,  
Bachelor (2012), Prof. Dr. J. Wochnowski

#### **Müller, Martin**

*Makroindentation*  
Universität des Saarlandes, Saarbrücken,  
Bachelor (2012), Prof. Dr. S. Diebels

#### **Pohl, Anna**

*Struktur-Eigenschafts-Beziehung von Hirse (Sorghum bicolor)*  
Universität des Saarlandes, Saarbrücken,  
Bachelor (2012), Prof. Dr. A. Ott

#### **Stein, Michael**

*Reibungsanisotropie auf Oberflächen mit dreizähliger Symmetrie*  
Universität des Saarlandes, Saarbrücken,  
Bachelor (2012), Prof. Dr. R. Bennewitz

#### **Wonn, Anne**

*Neue Methoden zur Mikrostrukturierung von Silikon-elastomeren als biomimetische Haftoberflächen*  
Fachhochschule Kaiserslautern, Pirmasens,  
Bachelor (2012), Prof. Dr.-Ing. J. Schuster

#### **Zeiger, Marco**

*Optimierung der mikrobiziden Wirkung von Kupfer mittels Mikrostrukturierung*  
Universität des Saarlandes, Saarbrücken,  
Bachelor (2012), Prof. Dr. R. Bennewitz

### VON INM-WISSENSCHAFTLERN BETREUTE BACHELORARBEITEN / BACHELOR THESES SUPERVISED BY INM SCIENTISTS

#### **Bekiesch, Katrin**

*Aufnahme und Analyse laminaspezifischer intrakortikaler Potentiale im auditorischen Kortex der Ratte*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Brauner, Ulrike H.**

*Validierung eines numerischen Modells ereigniskorrelierter Hirnstammopotentiale*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Heiny, Steffen**

*Software Implementierung zur Aufnahme und Verarbeitung von auditorisch evozierten Potentialen (AEPs) – Aufbau einer TCP/IP-Schnittstelle*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Herrmann, David Peter**

*Untersuchung von Top-Down Einflüssen bei der Wahrnehmung von Noise-Vocoded Speech anhand einer kombinierten EEG/EDA Studie*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Hmila, Mehdi**

*Voltage-Sensitive Dye Imaging – Technisches Setup und Aufbau*

HTW, Saarbrücken,

Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Klauke, Isabelle**

*Verwendung der Wavelet Phasen Entropie zur Extraktion großskaliger Effekte selektiver Aufmerksamkeit und Korrelaten der multimodalen neuronalen Integration*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Ruckert, Jonathan**

*Quantitative Modellierung der Ausbreitung neuronaler Spiking-Aktivität im DCN*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Schäfer, Cordula**

*Evaluierung eines somatosensorischen Neurofeedbacksystems zum Training selektiver auditorischer Aufmerksamkeit*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

#### **Schun, Agota**

*Numerische Modellierung funktioneller thalamokortikaler Elemente der auditorischen Verarbeitung*  
HTW, Saarbrücken,  
Bachelor (2012), Prof. Dr. Dr. D. J. Strauss

## ▶ DOKTORANDEN / DOCTORAL STUDENTS

**Akkan, M.Sc. Çağrı Kaan**  
Prof. Dr. Dr. M. Hammadeh,  
Universitätsklinikum des Saarlandes

**Bauer, Dipl. Biophys. Christina**  
Prof. Dr. E. Arzt

**Balijepalli, M.Sc. Ram Gopal**  
Prof. Dr. E. Arzt

**Blass, Dipl. Biophys. Johanna**  
Prof. Dr. R. Bennewitz

**Böse, M.Sc. Katharina**  
Prof. Dr. A. K. Kierner

**Brörmann, M.Sc. Katrin**  
Prof. Dr. R. Bennewitz

**Frensemeier, M. Sc. Mareike**  
Prof. Dr. E. Arzt

**Gerstner, Dipl.-Phys. Dominik**  
Prof. Dr. E. Arzt

**Gralla, Dipl. Werkstoffwiss., Robert**  
Prof. Dr. R. Bennewitz

**Hausen, Dipl.-Chem. Florian**  
Prof. Dr. R. Bennewitz

**Held, M.Sc. Christian**  
Prof. Dr. R. Bennewitz

**Jochum, Dipl.-Chem. Marlon**  
Prof. Dr. Dr. h.c. M. Veith

**Kaiser, Dipl.-Ing. (FH), M.Sc., Jessica**  
Prof. Dr. E. Arzt

**Kasper, Dipl.-Chem. Christoph**  
Prof. Dr. Dr. h.c. M. Veith

**Lacava, Dipl.-Ing. Johann**  
Prof. Dr. E. Arzt

**Lee, M.Sc. Ju Seok**  
Prof. Dr. Dr. h.c. M. Veith

**Martinez Miró, Dipl.-Ing. Martina**  
Prof. Dr. Dr. h.c. M. Veith

**Soorali Ganeshamurthy, M.Sc. Balakrishna**  
Prof. Dr. R. Bennewitz

**Támara Florez, M. Sc. Juan Carlos**  
Prof. Dr. E. Arzt

**Torrents Abad, M.Sc. Oscar**  
Prof. Dr. E. Arzt

**Wählich, Dipl.-Ing. Felix**  
Prof. Dr. R. Bennewitz

**Weber, Dipl.-Biol. Eva**  
PD Dr. I. Weiß

## ▶ GASTWISSENSCHAFTLER / VISITING SCIENTISTS

**Akkan, Çağrı Kaan, Türkei**

**Al-Dahoudi, Dr., Naji Mutlaq Mahmoud, Palästina**

**Alejo Rodriguez, Omar Andrés, Kolumbien**

**Ali, Awadelkareem, Sudan**

**Ali, Dr., Budiman, Indonesien**

**Al-Kahlout, Dr., Amal, Palästina**

**Atchison, PhD, Jennifer, Vereinigte Staaten von Amerika**

**Balijepalli, Ram Gopal, Indien**

**Baowan, Dr., Duangkamon, Thailand**

**Belot, Dr., Céline, Frankreich**

**Brodoceanu, Dr. techn., Daniel, Rumänien**

**Callender, Julia, Vereinigte Staaten von Amerika**

**Caron, Dr.-Ing., Arnaud, Frankreich**

**Dufloux, Cecile, Frankreich**

**Eder, Dr., Magdalena, Österreich**

**Egorov, Dr., Yuri, Russland**

**Fernandes de Oliveira, Carlos Alberto, Brasilien**

**Fleck, Prof. Dr., Norman Andrew, Vereinigte Staaten von Amerika**

**Garcia Morales, María Inmaculada, Venezuela**

**Ghailane, Anas, Marokko**

**Ghatak, Prof. Dr., Animangsu, Indien**

**Haidar, Ayman, Libanon**

**Jacquin, Elisabeth, Frankreich**

**Jesbeer, Muhamed, Indien**

**Lacava, Johann, Frankreich**

**Lasserre, Federico Alberto, Argentinien**

**Lee, Ju Seok, Südkorea**

**Lee, Yoonjoo, Südkorea**

**Lin, Leyu, China**

**Martinez Miró, Marina, Spanien**

**Micciché, Maurizio, Italien**

**Mousavi, Dr., Sayed Hadi, Iran**

**Nadi Gad Abd El-Sayed, Martina, Ägypten**

**Naguib Abdelmalak, Michael, Ägypten**

**Ndimfitu, Winfred Tangeni, Namibia**

**Okay, Sena, Türkei**

**Ouali, Ahmed-Amine, Frankreich**

**Paretkar, Dr., Dadhichi, Indien**

**Peek, Alex, Vereinigte Staaten von Amerika**

**Pei, Dr., Xianqiang, China**

**Perre, Dr., Emilie Marie, Frankreich**

**Pyo, Jinkyung, Südkorea**

**Qin, Dr., Enwei, China**

**Sahin, Fadime, Türkei**

**Sengupta Ghatak, Dr., Anindita, Indien**

**Soorali Ganeshamurthy, Balakrishna, Indien**

**Souza Carmona, Nicolas, Spanien**

**Suarez Vallejo, Sebastian, Uruguay**

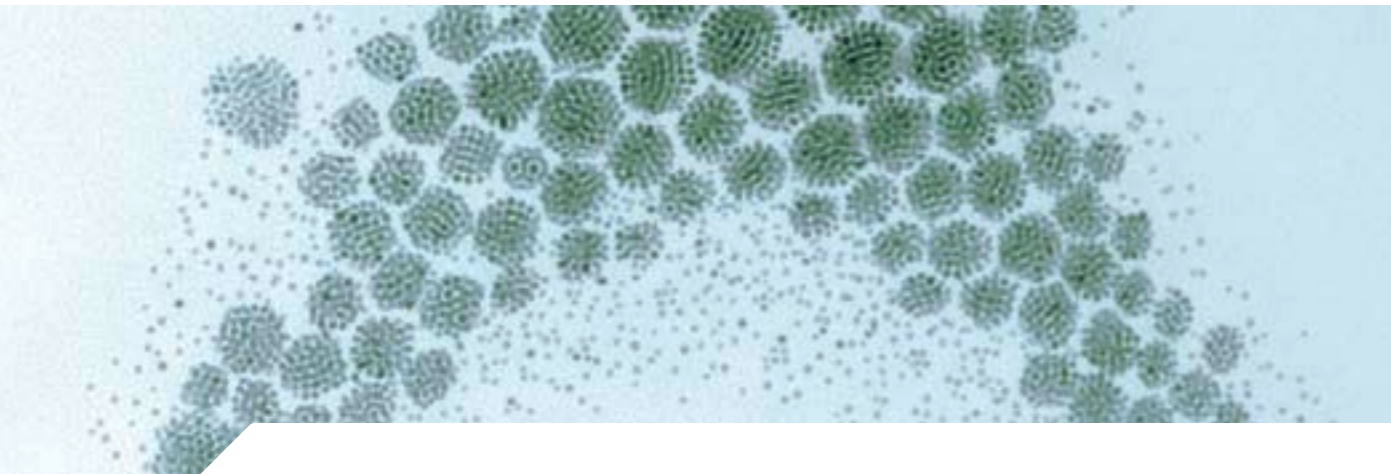
**Támara Florez, Juan Carlos, Kolumbien**

**Torrents Abad, Oscar, Spanien**

**Viegas Greco de Oliveira, Mariana, Brasilien**

**Zang, Yan Nan, China**

**Zeimyte, Simona, Litauen**





## PUBLIKATIONEN / PUBLICATIONS

Stand: 31.03.2013 / As of: 31.03.2013

### REFERIERTE PUBLIKATIONEN

#### Energie-Materialien

**M. M. Hantel, V. Presser, J. K. McDonough, G. Feng, P. T. Cummings, Y. G. Gogotsi and R. Kötz**  
*In situ electrochemical dilatometry of onion-like carbon and carbon black*  
J Electrochem Soc 2012, 159, (11), A1897–A1903 [02.590 (2011)]

**M. Oschatz, L. Borchardt, M. Thommes, K. A. Cychosz, I. Senkowska, N. Klein, R. Frind, M. Leistner, V. Presser, Y. G. Gogotsi and S. Kaskel**  
*Carbide-derived carbon monoliths with hierarchical pore architectures*  
Angew Chem Int Edit 2012, 51, (30), 7577–7580 [13.455 (2011)]

**M. Oschatz, L. Borchardt, M. Thommes, K. A. Cychosz, I. Senkowska, N. Klein, R. Frind, M. Leistner, V. Presser, Y. G. Gogotsi and S. Kaskel**  
*Aus Carbiden abgeleitete Kohlenstoffmonolithe mit hierarchischer Porenarchitektur*  
Angew Chem 2012, 124, (30), 7695–7698 [-]

**V. Presser and C. Vakifahmetoglu**  
*Comment on synthesis, characterization and growth mechanism of flower-like vanadium carbide hierarchical nanocrystals*  
Cryst Eng Comm 2012, 14, (13), 4525–4526 [03.842 (2011)]

**V. Presser, S.-H. Yeon, C. Vakifahmetoglu, C. A. Howell, S. R. Sandeman, P. Colombo, S. Mikhalovsky and Y. G. Gogotsi**  
*Hierarchical porous carbide-derived carbons for the removal of cytokines from blood plasma*  
Adv Healthc Mater 2012, 1, (6), 796–800 [-]

**H. Zhou, M. Rouha, G. Feng, S. S. Lee, H. Docherty, P. Fenter, P. T. Cummings, P. F. Fulvio, S. Dai, J. K. McDonough, V. Presser and Y. G. Gogotsi**  
*Nanoscale perturbations of room temperature ionic liquid structure at charged and uncharged interfaces*  
ACS Nano 2012, 6, (11), 9818–9827 [11.421 (2011)]

#### Funktionelle Oberflächen

**E. P. Arul and A. Ghatak**  
*Control of adhesion via internally pressurized subsurface microchannels*  
Langmuir 2012, 28, (9), 4339–4345 [04.186 (2011)]

**N. Cañas, M. Kamperman, B. Völker, E. Kroner, R. M. McMeeking and E. Arzt**  
*Effect of nano- and micro-roughness on adhesion of bioinspired micropatterned surfaces*  
Acta Biomater 2012, 8, (1), 282–288 [04.865 (2011)]

**S. R. Ganneboyina and A. Ghatak**  
*Generation of air-water two-phase flow patterns by altering the helix angle in triple helical microchannels*  
Ind Eng Chem Res 2012, 51, (27), 9356–9364 [02.237 (2011)]

**P. A. Gruber, A. Wanner, R. Spolenak and E. Arzt**  
*Response to comment on: Size effects on yield strength and strain hardening for ultra-thin Cu films with and without passivation: A study by synchrotron and bulge test techniques*  
Scripta Mater 2012, 67, (7–8), 740–742 [02.699 (2011)]

**A. Jagota, D. Paretkar and A. Ghatak**  
*Surface-tension-induced flattening of a nearly plane elastic solid*  
Phys Rev E 2012, 85, (5), 051602 [02.255 (2011)]

**E. Kroner and E. Arzt**  
*Single macropillars as model systems for tilt angle dependent adhesion measurements*  
Int J Adhes Adhes 2012, 36, (July), 32–38 [02.170 (2011)]

**E. Kroner, J. Blau and E. Arzt**  
*An adhesion measurement setup for bioinspired fibrillar surfaces using flat probes*  
Rev Sci Instrum 2012, 83, (1), 016101-3 [01.367 (2011)]

**E. Kroner, J. Blau and E. Arzt**  
*An adhesion measurement setup for bioinspired fibrillar surfaces using flat probes*  
Vir J Bio Phys Res 2012, 32, (2), -, <http://link.aip.org/link/?RSINAK/83/016101/1>, online: 09.01.2012

**E. Kroner, J. S. Kaiser, S. C. Fischer and E. Arzt**  
*Bioinspired polymeric surface patterns for medical applications*

J Appl Biomater Funct Mater 2012, 10, (3), 287–292, doi:10.5301/JABFM.2012.10365, online: 13.12.2012

**A. Majumder, S. Mondal, A. K. Tiwari, A. Ghatak and A. Sharma**  
*Direction specific adhesion induced by subsurface liquid filled microchannels*  
Soft Matter 2012, 8, (27), 3228–3233 [04.390 (2011)]

**R. M. McMeeking, E. Arzt and R. Wehner**  
*Cataglyphis desert ants improve their mobility by raising the gaster*  
J Theor Biol 2012, 297, (1–3), 17–25 [02.208 (2011)]

**A. S. Schneider, B. Heiland, N. J. Peter, C. Guth, E. Arzt and I. M. Weiss**  
*Hierarchical super-structure identified by polarized light microscopy, electron microscopy and nanoindentation: Implications for the limits of biological control over the growth mode of abalone sea shells*  
BMC Biophys 2012, 5, (1), 19 [- (2011)]

**P. Sonnweber-Ribic, P. A. Gruber, G. Dehm, H. P. Strunk and E. Arzt**  
*Kinetics and driving forces of abnormal grain growth in thin Cu films*  
Acta Mater 2012, 60, (5), 2397–2406 [03.755 (2011)]

#### Metallische Mikrostrukturen

**N. J. Peter, X.-S. Zhang, S.-G. Chu, F.-Y. Zhu, H. Seidel and H.-X. Zhang**  
*Tunable wetting behavior of nanostructured poly(dimethylsiloxane) by plasma combination treatments*  
Appl Phys Lett 2012, 101, (22), 221601-4 [03.844 (2011)]

**A. S. Schneider, B. Heiland, N. J. Peter, C. Guth, E. Arzt and I. M. Weiss**  
*Hierarchical super-structure identified by polarized light microscopy, electron microscopy and nanoindentation: Implications for the limits of biological control over the growth mode of abalone sea shells*  
BMC Biophys 2012, 5, (1), 19 [- (2011)]

#### Nanotribologie

**K. Brörmann, K. Burger, A. Jagota and R. Bennewitz**  
*Discharge during detachment of micro-structured PDMS sheds light on the role of electrostatics in adhesion*  
J Adhes 2012, 88, (7), 589–607 [01.310 (2011)]

**A. Caron, Q. S. Zhang, A. Minkow, V. A. Zadorozhnyy, M. Fukuhara, H.-J. Fecht, D. V. Louzguine-Luzgin and A. Inoue**  
*Mesostructural effects on the mechanical properties of Zr-based bulk metallic glasses*  
Mat Sci Eng A 2012, 555, 57–62 [02.003 (2011)]

**A. Y. Churyumov, A. I. Bazlov, V. Y. Zadorozhnyy, A. N. Solonin, A. Caron and D. V. Louzguine-Luzgin**  
*Phase transformations in Zr-based bulk metallic glass cyclically loaded before plastic yielding*  
Mat Sci Eng A 2012, 550, 358–362 [02.003 (2011)]

**P. Egberts, R. Gralla and R. Bennewitz**  
*Temporal development of indentation plasticity on the atomic scale revealed by force microscopy*  
Phys Rev B 2012, 86, (3), 035446 [03.691 (2011)]

**C. Held, T. Seyller and R. Bennewitz**  
*Quantitative multichannel NC-AFM data analysis of graphene growth on SiC(0001)*  
Beilstein J Nanotechnol 2012, 3, 179–185 [00.789 (2011)]

**A. Labuda, M. Lysy, W. Paul, Y. Miyahara, P. Grütter, R. Bennewitz and M. Sutton**  
*Stochastic noise in atomic force microscopy*  
Phys Rev E 2012, 86, (3), 031104 [02.255 (2011)]

**D. Marchetto, C. Held, F. Hausen, F. Wählich, M. Dienwiebel and R. Bennewitz**  
*Friction and wear on single-layer epitaxial graphene in multi-asperity contacts*  
Tribol Lett 2012, 48, (1), 77–82 [01.582 (2011)]

**M. Mishra, P. Egberts, R. Bennewitz and I. Szlufarska**  
*Friction model for single-asperity elastic-plastic contacts*  
Phys Rev B 2012, 86, (4), 045452 [03.691 (2011)]

**J. Sweeney, F. Hausen, R. Hayes, G. B. Webber, F. Endres, M. W. Rutland, R. Bennewitz and R. Atkin**  
*Control of nanoscale friction on gold in an ionic liquid by a potential-dependent ionic lubricant layer*  
Phys Rev Lett 2012, 109, (15), 155502 [07.370 (2011)]

### Strukturbildung

**P. Born, A. Munoz, C. Cavelius and T. Kraus**  
*Crystallization mechanisms in convective particle assembly*  
Langmuir 2012, 28, (22), 8300–8308 [04.186 (2011)]

**S. Chen and T. Kraus**  
*Nanorod-depolarized dynamic light scattering in a gelling liquid*  
J Phys Chem C 2012, 116, (31), 16766–16775 [04.805 (2011)]

**T. Geyer, P. Born and T. Kraus**  
*Switching between crystallization and amorphous agglomeration of alkyl thiol-coated gold nanoparticles*  
Phys Rev Lett 2012, 109, (12), 128302 [07.370 (2011)]

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*Modeling the influences of nanoparticles on neural  
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*Probing structures of electrolytes at graphene surface: Coupling X-ray interface scattering with molecular modeling*  
 Materials Science & Technology 2012 Conference & Exhibition, October 8, 2012, Pittsburgh <PA, USA>

#### Funktionelle Oberflächen

**D. Brodoceanu, C. Huber, A. Wonn, P. Born, E. Kroner and T. Kraus**  
*Metal nanoparticle arrays by controlled decomposition of polymer particles*  
 EIPBN 2012 - The 56th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication, May 29–June 1, 2012 Waikola <HI, USA>

**C. Huber**

*Dry adhesives with hierarchical structure*  
Doktorandenforum der Sektion D (Leibniz  
Gemeinschaft), June 7–8, 2012, Berlin

**C. Huber, D. Brodoceanu, A. Wonn, T. Kraus, E. Kroner  
and E. Arzt**

*Measurements of adhesion on hierarchical model  
"gecko-structures"*  
Winter School SPP 1420, March 19–20, 2012,  
Potsdam

**J. S. Kaiser, V. Willnecker, B. Schick, E. Kroner and  
E. Arzt**

*Multifunctional mesostructured surfaces for  
medical application*  
Jahrestagung der Gesellschaft für Biomaterialien,  
November 10–12, 2012, Gießen

**E. Kroner, J. S. Kaiser, S. C. Fischer and E. Arzt**

*Bioinspired polymeric surface patterns for medical  
applications*  
Advanced Functional Polymers for Medicine 2012,  
July 4–6, 2012, Vico Equense <Italy>

**D. Paretkar, M. Kamperman, A. S. Schneider,  
D. Martina, C. Creton and E. Arzt**

*Bioinspired pressure actuated adhesive system*  
1. Workshop des Leibniz-Verbundes Nanotech-  
nologie, January 30–31, 2012, Berlin

## Metallische Mikrostrukturen

**D. Paretkar, M. Kamperman, A. S. Schneider,  
D. Martina, C. Creton and E. Arzt**

*Bioinspired pressure actuated adhesive system*  
1. Workshop des Leibniz-Verbundes Nanotech-  
nologie, January 30–31, 2012, Berlin

**N. J. Peter, A. S. Schneider and E. Arzt**

*Structure-property relationship of nacre in abalone  
sea shell*  
Nanobrücken II - Nanomechanical Testing Work-  
shop and Hysitron User Meeting, March 22–23,  
2012, Saarbrücken

**E. Qin, A. S. Schneider, M. Frensemeier, C. P. Frick  
and E. Arzt**

*One-way and two-way shape-memory effects induced  
by Vickers indentation in austenitic matrix NiTi*  
Nanobrücken II - Nanomechanical Testing Work-  
shop and Hysitron User Meeting, March 22–23,  
2012, Saarbrücken

**H. W. Strauss, F. Wählich, O. Torrents Abad,  
R. Bennewitz and R. R. Chromik**

*Surface adhesion and sub-microscopic structure  
of diamond-like carbon transfer*  
Gordon Research Conference on Tribology, July  
8–13, 2012, Waterville <ME, USA>

## Nanotribologie

**K. Brörmann, K. Burger, A. Jagota and R. Bennewitz**

*Discharge during detachment of microstructured  
PDMS sheds light on the role of electrostatics in  
adhesion*  
Doktorandenforum der Sektion D (Leibniz  
Gemeinschaft), June 7–8, 2012, Berlin

**R. Gralla, P. Egberts and R. Bennewitz**

*AFM-based indentation in KBr(100): Measurement  
of homogeneous dislocation nucleation in three  
dimensions*  
Nanobrücken II - Nanomechanical Testing Work-  
shop and Hysitron User Meeting, March 22–23,  
2012, Saarbrücken

**F. Hausen and R. Bennewitz**

*Atomic friction experiments under electrochemical  
control*  
Bunsentagung 2012, May 17–19, 2012, Leipzig

**A. Klemenz, L. Pastewka, B. Soorali, A. Caron,  
R. Bennewitz and M. Moseler**

*Wear of supported graphene*  
Gordon Research Conference on Tribology, July  
8–13, 2012, Waterville <ME, USA>

**D. Marchetto, C. Held, F. Hausen, F. Wählich,  
M. Dienwiebel and R. Bennewitz**

*Microscale tribology of epitaxial graphene on SiC*

Gordon Research Conference on Tribology, July  
8–13, 2012, Waterville <ME, USA>

**H. W. Strauss, F. Wählich, O. Torrents Abad,  
R. Bennewitz and R. R. Chromik**

*Surface adhesion and sub-microscopic structure of  
diamond-like carbon transfer*  
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**F. Wählich, J. Hoth, I. M. Weiss, E. Arzt and  
R. Bennewitz**

*Wear resistance of blue mollusc shells tested with  
a micro-tribometer*  
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*Wear resistance of blue mollusc shells tested with  
a microtribometer*  
Gordon Research Conference on Tribology, July  
8–13, 2012, Waterville <ME, USA>

## Strukturbildung

**P. Born, S. Blum, A. Munoz, J. Becker and T. Kraus**

*Crystallization in colloidal systems*  
1. Workshop des Leibniz-Verbundes Nanotech-  
nologie, January 30–31, 2012, Berlin

**P. Born, S. Blum, A. Munoz and T. Kraus**

*Convective particle assembly*  
International Conference CODEF III "Colloidal  
Dispersions in External Fields", Gustav-Stresemann-  
Institut, March 20–23, 2012, Bonn-Bad Godesberg

**P. Born and T. Kraus**

*Agglomeration in sterically stabilized nanoparticle  
suspensions revisited*  
ECIS 2012, 26th Conference of the European  
Colloid and Interface Society, Lund University and  
Malmö University, September 2–7, 2012, Lund/  
Malmö <Sweden>

**D. Brodoceanu, C. Huber, A. Wonn, P. Born, E. Kroner  
and T. Kraus**

*Metal nanoparticle arrays by controlled decompo-  
sition of polymer particles*  
EIPBN 2012 - The 56th International Conference  
on Electron, Ion, and Photon Beam Technology  
and Nanofabrication, May 29–June 1, 2012, Waikola  
<HI, USA>

**C. Huber, D. Brodoceanu, A. Wonn, T. Kraus, E. Kroner  
and E. Arzt**

*Measurements of adhesion on hierarchical model  
"gecko-structures"*  
Winter School SPP 1420, March 19–20, 2012, Potsdam

**T. Kraus and J. Lacava**

*Assembling nanoparticles inside emulsion droplets*  
Gordon Research Conference on Nanostructure  
Fabrication, University of New England, July  
15–20, 2012, Biddeford <ME, USA>

**J. Lacava and T. Kraus**

*On the behaviour of nanoparticles on evaporating  
emulsions*  
Doktorandenforum der Sektion D (Leibniz  
Gemeinschaft), June 7–8, 2012, Berlin

## Biomineralisation

**M. Eder, A. Rutz and I. M. Weiss**

*Heterologous expression of biomineralization  
proteins in Dictyostelium discoideum*  
Gordon Research Seminar and Conference on Bio-  
mineralization, August 12–17, 2012, New London  
<NH, USA>

**M.-L. Lemloh, F. Marin, F. Herbst, L. Plasseraud,  
Schweikert, J. Baier, J. Bill and F. Brümmer**

*Biomineralization in a Ciliate (Colepshirtus)*  
Ringberg Symposium "Generation of Inorganic  
Functional Materials: Implementation of Biomi-  
neralization Principles", September 30–October 3,  
2012, Rottach



- M.-L. Lemloh, E. Weber, C. Guth and I. M. Weiss**  
*Biomaterialization - Insights from light- and electron microscopy studies*  
CISCEM - Conference on In-Situ and Correlative Electron Microscopy, November 6–7, 2012, Saarbrücken
- B. Reinhard, A. Rutz and I. M. Weiss**  
*Pflanzliche Rohstoffe für hochwertige Baumaterialien*  
8. Woche der Wissenschaften in der Interaktiven Forschungsausstellung, September 17–22, 2012, Saarbrücken
- B. Reinhard, I. M. Weiss and A. Kraegeloh**  
*Materials in biology: New tools for the analysis of induced biological response*  
4th International Symposium Interface Biology of Implants, May 9–11, 2012, Rostock-Warnemünde
- B. Reinhard, I. M. Weiss and A. Kraegeloh**  
*Materials in biology: New tools for the analysis of induced biological response*  
509th Heraeus Seminar on Physics of the Extracellular Matrix, June 17–20, 2012, Bad Honnef
- E. Weber**  
*Biomaterialization and biotechnology: Sustainable routes towards new materials*  
Doktorandenforum der Sektion D (Leibniz Gemeinschaft), June 7–8, 2012, Berlin
- E. Weber, C. Guth, P. Bauer and I. M. Weiss**  
*Biotechnology of biomaterialization proteins in bacteria and plants*  
Gordon Research Seminar and Conference on Biomaterialization, August 12–17, 2012, New London <NH, USA>
- I. M. Weiss**  
*Backstage the formation of biomaterialization scaffolds*  
509th Heraeus Seminar on Physics of the Extracellular Matrix, June 17–20, 2012, Bad Honnef
- I. M. Weiss**  
*From cells to materials: Extra- and intracellular origin of mineralized and non-mineralized integuments*  
9th Japanese-German Frontiers of Science Symposium, October 25–28, 2012, Potsdam

## CVD / Biooberflächen

- O. C. Aktas, M. Martinez Miró, J. Lee, S. Brück, F. Oktar, A. Haidar, K. Löw and H. Abdul-Khalik**  
*The key issue for cellular response to topography - identical surface chemistry*  
4th International Symposium Interface Biology of Implants, May 10, 2012, Warnemünde
- C. Dufloux, M. Martinez Miró, C. K. Akkan, J. Lee, O. C. Aktas and M. Veith**  
*Decomposition of tert-butoxyaluminumdihydrid by plasma enhanced chemical vapor deposition*  
Doktorandenforum der Sektion D (Leibniz Gemeinschaft), June 7–8, 2012, Berlin
- A. Haidar, M. Martinez Miró, C. K. Akkan, J. Lee, K. Löw, H. Abdul-Khalik, M. Veith and O. C. Aktas**  
*Laser interference patterned 1D Al/Al<sub>2</sub>O<sub>3</sub> nanostructures for vascular implant applications*  
NanoTR VIII, 8th Nanoscience and Nanotechnology Conference, June 26–29, 2012, Ankara <Turkey>  
Outstanding Research Award
- J. Lee, L. K. Schwarz, C. K. Akkan, M. Martinez Miró, K.-H. Schäfer, O. C. Aktas and M. Veith**  
*Laser interference patterning of bi-phasic nanowires for neurite guidance*  
EU-Korea Conference on Science and Technology 2012, July 26–28, 2012, Berlin  
Best Poster Award

## Nano Zell Interaktion

- A. Kraegeloh, S. Kiefer, C. Cavelius and M. Koch**  
*Analysis of cell-associated silver after exposition of cells to nanosilver*  
Biological Barriers 2012 - The 9th International Conference and Workshop on Biological Barriers, Saarland University, February 29–March 9, 2012, Saarbrücken
- M. Kucki, C. Cavelius, A.-R. Jochem, S. Schmidt and A. Kraegeloh**  
*Interference of nanoparticle suspensions with the rekombinant factor C endotoxin-detection system*

Biological Barriers 2012 - The 9th International Conference and Workshop on Biological Barriers, Saarland University, February 29–March 9, 2012, Saarbrücken

**M. Kucki, C. Cavelius and A. Kraegeloh**  
*Hide and seek - endotoxin-detection in nanoparticle suspensions*  
NanoImpactnet 2012, University College, February 27–29, 2012, Dublin <Ireland>  
3rd Prize in the NanoImpactNet-QNano Research Infrastructure conference young investigator competition was awarded to Melanie Kucki

**K. Narr, A. K. Kiemer and A. Kraegeloh**  
*Intracellular distribution of gold nanoparticles in human lung epithelial cells and their potential cytotoxicity*  
1. Workshop des Leibniz-Verbundes Nanotechnologie, January 30–31, 2012, Berlin

**K. Narr, A. K. Kiemer and A. Kraegeloh**  
*Intracellular distribution of gold nanoparticles in human lung epithelial cells and their potential cytotoxicity*  
Biological Barriers 2012 - The 9th International Conference and Workshop on Biological Barriers, Saarland University, February 29–March 9, 2012, Saarbrücken

**H. Peuschel, C. Cavelius, A.-R. Jochem and A. Kraegeloh**  
*Influence of proteins on cytotoxicity testing of silica nanoparticles in vitro*  
Biological Barriers 2012 - The 9th International Conference and Workshop on Biological Barriers, Saarland University, February 29–March 9, 2012, Saarbrücken

**B. Reinhard, I. M. Weiss and A. Kraegeloh**  
*Materials in biology: New tools for the analysis of induced biological response*  
4th International Symposium Interface Biology of Implants, May 9–11, 2012, Rostock-Warnemünde

**B. Reinhard, I. M. Weiss and A. Kraegeloh**  
*Materials in biology: New tools for the analysis of induced biological response*  
509th Heraeus Seminar on Physics of the Extracellular Matrix, June 17–20, 2012, Bad Honnef

## Nanomere

- C. Becker-Willinger, D. Bentz, U. Werner and M. Veith**  
*Preparation of monodisperse TiO<sub>2</sub> nanorods and nanoparticles and their agglomerate free insertion into acrylic matrix*  
1. Workshop des Leibniz-Verbundes Nanotechnologie, January 30–31, 2012, Berlin
- C. Becker-Willinger, S. Schmitz-Stöwe, M. Opsölder, M. Jochum and M. Veith**  
*Nanomer multifunctional corrosion protection coatings*  
1. Workshop des Leibniz-Verbundes Nanotechnologie, January 30–31, 2012, Berlin

## Optische Materialien

**J. Adam**  
*Printable memory solutions for sensor, ID, and media applications - EU-project PriMeBits*  
1. Workshop des Leibniz-Verbundes Nanotechnologie, January 30–31, 2012, Berlin

**K. Moh, S. Schumacher and P. W. Oliveira**  
*Photochemical metallization - A versatile tool for the production of thin conductive layer and microstructures*  
1. Workshop des Leibniz-Verbundes Nanotechnologie, January 30–31, 2012, Berlin

## Innovative Elektronenmikroskopie

**C. Becker-Willinger, D. Bentz, U. Werner and M. Veith**  
*Preparation of monodisperse TiO<sub>2</sub> nanorods and nanoparticles and their agglomerate free insertion into acrylic matrix*  
1. Workshop des Leibniz-Verbundes Nanotechnologie, January 30–31, 2012, Berlin

## VORTRÄGE / TALKS

### **N. de Jonge and D. Peckys**

*Scanning transmission electron microscopy of whole eukaryotic cells in liquid*

Conference on In-Situ and Correlative Electron Microscopy, November 6–7, 2012, Saarbrücken

### **M. Koch and N. De Jonge**

*Contact angle analysis of water microdroplets on leaf surfaces by in-situ scanning electron microscopy*

Conference on In-Situ and Correlative Electron Microscopy, November 6–7, 2012, Saarbrücken

### **A. Kraegeloh, S. Kiefer, C. Cavalius and M. Koch**

*Analysis of cell-associated silver after exposition of cells to nanosilver*

Biological Barriers 2012 - The 9th International Conference and Workshop on Biological Barriers, Saarland University, February 29–March 9, 2012, Saarbrücken

### IM JB 2011 FEHLEN DIE FOLGENDEN REFERIERTEN PUBLIKATIONEN:

#### Optische Materialien

### **A. Haase, E. Kraker, J. Krenn, C. Palfinger, S. Heusing, P.W. Oliveira and M. Veith**

*Organic photodiodes on printed ito coatings*  
Int J High Speed Electron Syst 2011, 20, (4), 787–799 [-]

#### Funktionelle Oberflächen

### **J. S. Kaiser, B. Schick, E. Kroner and E. Arzt**

*Multifunctional mesostructured surfaces for medical application*

BIOMaterialien 2011, 12, (1–4), 112 [-]

### EINLADUNGEN ZU WISSENSCHAFTLICHEN VORTRÄGEN

#### Energie-Materialien

##### **V. Presser**

*Novel and hierarchical carbon nanomaterials for energy-related applications*

Seminar aus Halbleiterphysik und Nanotechnologie, Montanuniversität Leoben; August 28, 2012; Leoben <Austria>

##### **V. Presser**

*Nanoporous carbon nanomaterials for desalination via capacitive deionization*

2. Fachtagung „Nano-Kohlenstoff“ Neue Hybridwerkstoffe für Energie und Umwelt; September 28, 2012; Augsburg

##### **V. Presser**

*Nanomaterials for water treatment: a journey through carbon wonderland*

Wetsus Congress; October 2, 2012; Leeuwarden <Netherlands>

#### Funktionelle Oberflächen

##### **E. Arzt**

*Bioinspired mesotextured surfaces - a strategy for tunable adhesion*

Bio-Inspired Meeting, Harvard University; January 16–20, 2012; Cambridge <MA, USA>

##### **E. Arzt**

*Das Unsichtbare sichtbar machen - Forschung und Lehre am ‚neuen‘ INM*

Vortrag für die Freunde der Universität; January 25, 2012; Saarbrücken

##### **E. Arzt**

*Eröffnungsrede*

1. Workshop des Leibniz-Verbundes Nanotechnologie; January 30–31, 2012; Berlin

##### **E. Arzt**

*Bioinspired mesotextured surfaces for active surface control*

Max-Planck-Institut für Eisenforschung GmbH (MPIE) – Institutskolloquium; February 6, 2012; Düsseldorf

##### **E. Arzt**

*Strength, adhesion and sound: size effects in materials and structures*

Israel Pollak Distinguished Lecture Series, Technion – Israel Institute of Technology; February 23, 2012; Haifa <Israel>

##### **E. Arzt**

*Mesotextured surfaces with switchable functionality inspired by nature*

Israel Pollak Distinguished Lecture Series, Technion – Israel Institute of Technology; February 26, 2012; Haifa <Israel>

##### **E. Arzt**

*Bioinspired mesotextured surfaces with new adhesive functions*

15th Israel Materials Engineering Conference (IMEC-15); February 28–March 1, 2012; Dead Sea <Israel>

##### **E. Arzt**

*Bioinspired mesotextured surfaces - a strategy for tunable adhesion*

Bio-inspired Materials – International School and Conference on Biological Materials Systems, DGM; March 21–23, 2012; Potsdam

##### **E. Arzt**

*Biomimetische Haftoberflächen*

KIT-Kolloquium; March 12–13, 2012; Karlsruhe

##### **E. Arzt**

*Smarte 3D-mikrostrukturierte Oberflächen: von passiven zu aktiven Funktionen*

Arlberg-Kolloquium; April 14–17, 2012; Arlberg <Austria>

##### **E. Arzt**

*Bioinspired 3D micropatterned surfaces with new adhesive functions*

Advances in Materials Seminar, Ecole Polytechnique Fédérale de Lausanne (EPFL); May 7, 2012; Lausanne <Schweiz>

##### **E. Arzt**

*Vom Vorbild Natur zu neuen Materialien*

Wissenschafts-Matinee, WissenschaftsForum Saar e.V.; May 13, 2012; Dillingen

##### **E. Arzt**

*Bioinspired 3D micropatterned surfaces with new adhesive functions*

XXXV Encontro Nacional de Física da Matéria Condensada (ENFMC); May 14–18, 2012; Águas de Lindóia <Brasília>

##### **E. Arzt**

*Der Forschungsverbund Nanosicherheit der Leibniz-Gemeinschaft*

Fachdialoge Nanotechnologien, Bundesumweltministerium; October 16, 2012; Berlin

##### **E. Arzt**

*Micropatterned artificial “gecko” surfaces: a path to switchable adhesive function*

ASME 2012 Conference on Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS); September 19, 2012; Stone Mountain <GA, USA>

##### **E. Arzt**

*Biomimetic gripping surfaces with switchable functionality*

The INT Nanomaterials Days; August 23, 2012; Karlsruhe

##### **E. Arzt**

*Bioinspired 3D micropatterns for controlled adhesive functions*

Empa-Akademie, Empa – Swiss Federal Laboratories for Materials Science and Technology; July 2, 2012; Dübendorf <Switzerland>



**E. Kroner, J. S. Kaiser, D. Paretkar, C. Huber and E. Arzt**  
*Bioinspired adhesives - New frontiers in materials science*

Doktorandenforum der Sektion D (Leibniz Gemeinschaft); June 8, 2012; Berlin

**E. Kroner, D. Paretkar, J. S. Kaiser, C. Huber and E. Arzt**  
*Bioinspired adhesives: New frontiers in materials science*

1. Workshop des Leibniz-Verbundes Nanotechnologie; January 30–31, 2012; Berlin

## Metallische Mikrostrukturen

**A. S. Schneider**

*Metallic microstructures*

Admedes Schuessler GmbH; February 13, 2012; Karlsruhe

**A. S. Schneider, C. P. Frick and E. Arzt**

*Influence of crystal defects on the strength of Ni microcompression pillars*

ASME International Mechanical Engineering Congress and Exposition; November 13, 2012; Houston <TX, USA>

**A. S. Schneider, C. P. Frick, B. G. Clark, P. A. Gruber and E. Arzt**

*Influence of orientation on the size effect in BCC pillars with different critical temperatures*

International Symposium on Plasticity; January 3, 2012; San Juan <Puerto Rico>

**A. S. Schneider, E. Qin, M. Frensemeier, C. P. Frick and E. Arzt**

*One-way and two-way shape-memory effects induced by Vickers indentation in austenitic matrix NiTi*  
ESMC-2012 – 8th European Solid Mechanics Conference; July 10, 2012; Graz <Austria>

## Nanotribologie

**R. Bennewitz**

*Atomic structure and friction*

Lorentz Center Workshop “Fundamental Aspects of Friction and Lubrication”, Lorentz Center; April 15–20, 2012; Leiden <Netherlands>

**R. Bennewitz**

*Atomic-scale wear studied by force microscopy*

German-Russian Workshop on “Friction: From elementary mechanisms to macroscopic behavior”; October 16–17, 2012; Berlin

**R. Bennewitz and N. Strobach**

*Mikroskopie - Sicht auf das Unsichtbare*

Abendvortrag an der Sommerakademie der Studienstiftung des Deutschen Volkes; August 28, 2012; Greifswald

## Strukturbildung

**T. Kraus**

*Order and disorder in particle agglomeration: science and process engineering of particle self-assembly*

2nd International Symposium on Disperse Systems for Electronic Applications; March 1–2, 2012; Erlangen

**T. Kraus**

*Understanding and tuning the morphology of particle deposits*

Friedrich-Alexander-Universität; March 27, 2012; Nürnberg-Erlangen

**T. Kraus**

*Particle films, clusters and supercrystals: science and process engineering of nanoparticle self-assembly*

Université du Luxembourg; March 20, 2012; Belvaux <Luxembourg>

**T. Kraus**

*Depositing particles from menisci: capillarity, convection, and surprising order*

Sommerschule des Exzellenzclusters EAM; July 25–27, 2012; Luisenthal

## Biomineralsation

**I. M. Weiss**

*From soft to hard matter: Myosin chitin synthases and cell mechanics in molluscs*

PhysCell2012; September 5–8, 2012; Hyères <France>

**I. M. Weiss**

*Some thoughts concerning the elementary choice for the solidification of protists, plants and animals*

Botanisches Kolloquium, Johannes Gutenberg-Universität; December 17, 2012; Mainz

**I. M. Weiss**

*Controlled biomineralization – A unique event in the life-time of our planet*

9th Japanese-German Frontiers of Science Symposium; October 25–28, 2012; Potsdam

**I. M. Weiss and V. Schönitzer**

*Why is the mollusc chitin synthase such a complex molecular machine?*

20th Annual Meeting of the German Crystallographic Society (DGK); March 12–15, 2012; München

**I. M. Weiss and E. Weber**

*Biotechnological mineral composites via vaterite precursors*

MRS Spring Meeting; April 10–13, 2012; San Francisco <CA, USA>

## CVD / Biooberflächen

**O. C. Aktas**

*Nanostructured surfaces for medical applications*

NanoTR VIII, Nanoscience and Nanotechnology Conference; June 26–29, 2012; Ankara <Turkey>

**O. C. Aktas, J. Lee, S. Brück and C. K. Akkan**

*Nanostructured surfaces*

Medipol University, Science Fest; May 24, 2012; Istanbul <Turkey>

**O. C. Aktas, J. Lee, M. Martinez Miró, A. Haidar and K. Löw**

*Nanostructured surfaces for biomedical applications*  
Hacettepe University; 2012; Ankara <Turkey>

**O. C. Aktas, M. Martinez Miró, K. Löw and A. Haidar**

*Nanomaterials and medicine*

Marmara University; May 26, 2012; Istanbul <Turkey>

**J. Lee and O. C. Aktas**

*Bi-phasic nanostructures and applications*

Global Technology Collaboration Day 2012, Korea Institute for Advancement of Technology and Ministry of Knowledge Economy of Korea; April 24, 2012; Seoul <South Korea>

**J. Lee, O. C. Aktas and M. Veith**

*Inorganic materials and single source precursors for thin film techniques*

KETI – Korea Electronics Technology Institute; April 19, 2012; Ongnam <South Korea>

**J. Lee, M. Martinez Miró and O. C. Aktas**

*Topography driven bio-surface interaction*

Workshop on Horizons of Heart care (New Indigo); January 10, 2012; Chennai <India>

**J. Lee, M. Martinez Miró, D. Anshütz and O. C. Aktas**

*Synthesis of single source precursors and applications*

DOW Chem. R&D Center; April 20, 2012; Hwaseong <South Korea>

**J. Lee, M. Martinez Miró, D. Anshütz and O. C. Aktas**

*Nano and micro structures for bio-medical applications*

AMORE PACIFIC R&D Center; April 25, 2012; Yongin <South Korea>

**M. Veith**

*Surfaces for medical uses by molecular gas phase reactions*

OOCUMI-2012, International Conference and Humboldt-Kolleg, University of Lucknow; January 6, 2012; Lucknow <India>

**M. Veith**

*Inorganic surfaces for medical care*

ICAM 2012, International Conference on Advanced Materials, Loyola College; January 7, 2012; Chennai <India>

**M. Veith**

*Structured surfaces for biology*

IIT Madras, Department of Chemistry; January 9, 2012; Chennai <India>

**M. Veith**

*Aluminium-oxide surfaces and embryonic stem cells*  
INDIGO-Meeting, IIT Madras, Department of Physics; January 11, 2012; Chennai <India>

**M. Veith**

*Surfaces for medical uses by molecular gas phase reactions*

Mawson Institute, University of South Australia; April 24, 2012; Adelaide <Australia>

**M. Veith**

*Surfaces synthétiques et interactions ciblées avec des micro-organismes*

Laboratoire de Chimie de Coordination (LCC), Université Paul Sabatier; September 24, 2012; Toulouse <France>

**M. Veith**

*Einführung in die Chemische Nanotechnologie*  
GDCh-Kurs: Chemische Nanotechnologien mit Anwendungen in Technik und Bio/Life Sciences; September 25, 2012; Saarbrücken

**Nano Zell Interaktion****A. Kraegeloh**

*Nanoparticle interactions at the cellular scale: Application of STED microscopy*  
1. Workshop des Leibniz-Verbundes Nanotechnologie; January 30–31, 2012; Berlin

**A. Kraegeloh**

*Nano cell interactions: insights by microscopical and chemical analyses*  
IUF-Leibniz-Institut für Umweltmedizinische Forschung; May 16, 2012; Düsseldorf

**A. Kraegeloh**

*Looking sharply at nanoparticles: insights by microscopical, chemical and biological analyses*  
EMPA, Swiss Federal Laboratories for Materials Science and Technology; May 10, 2012; St. Gallen <Schweiz>

**A. Kraegeloh**

*NanoKon - systematische Bewertung der Gesundheitsauswirkungen nanoskaliger Kontrastmittel*  
Clustertreffen der BMBF-Fördermaßnahmen NanoCare und NanoNature; March 13–14, 2012; Frankfurt am Main

**A. Kraegeloh**

*Partikel: Größe und biologische Relevanz*  
5. NRW-Nanokonferenz; September 18–19, 2012; Dortmund

**A. Kraegeloh**

*Focus on nanoparticles: interactions with bacterial and human cells*  
Seminar der AG Biochemie, Prof. Rita Bernhardt, Universität des Saarlandes; August 27, 2012; Saarbrücken

**A. Kraegeloh**

*NanoKon - novel nanoscaled contrast agents and systematic evaluation of their safety*  
Max-Planck-Institut für Polymerforschung, Dynamo Workshop; August 20, 2012; Mainz

**A. Kraegeloh**

*NanoKon - novel nanoscaled contrast agents and systematic evaluation of their safety*  
NanoMed Workshop, Friedrich-Schiller-Universität; June 26–27, 2012; Jena

**Nanomere****C. Becker-Willinger**

*Nanostrukturierte Korrosionsschutzbeschichtungen für Stahl und Aluminium*  
FARBE UND LACK Konferenz; Juni 12–13, 2012; Stuttgart

**C. Becker-Willinger**

*PU-Hybridmaterialien als Kratzfestschichten für Kunststoffe*  
4. TAW-Sol-Gel Fachtagung, Sol-Gel: Grundlagen, Technologien, Anwendungen; September 26–27, 2012; Saarbrücken

**C. Becker-Willinger, C. Kasper, F. Hollmann, D. Bentz and M. Veith**

*Neue verschleißbeständige Gleitlacke mit integriertem Korrosionsschutz*

Hannover Messe 2012; April 23–27, 2012; Hannover

**Optische Materialien****P. W. de Oliveira**

*Transparent and conductive coatings*  
OLED Workshop; January 9–10, 2012; Dresden

**P. W. de Oliveira**

*Optical coatings - material and processing*  
Universidade Federal de Sao Carlos – UFSC; February 15, 2012; Sao Carlos <Brazil>

**P. W. de Oliveira**

*Optical material developments for the industry*  
Universidade Federal de Pernambuco – UFPE; July 10, 2012; Recife <Brasil>

**P. W. de Oliveira**

*Light management films*  
Universidade Federal de Pernambuco – UFPE; July 11, 2012; Recife <Brasil>

**P. W. de Oliveira**

*Optical material*  
CETEC; July 18, 2012; Belo Horizonte <MG, Brazil>

**P. W. de Oliveira**

*Biomimetics in optics*  
Universidade Federal de Minas Gerais – UFMG; July 19, 2012; Belo Horizonte <MG, Brazil>

**P. W. de Oliveira**

*Micro-structuring of silver coating*  
CETEC; July 20, 2012; Belo Horizonte <MG, Brazil>

**R. Drumm, J. Adam, G. Klein and M. Veith**

*Kolloidales Processing von ZrO<sub>2</sub>-Nanopartikeln in Rührwerkskugelmöhlen*  
GDCh-Kurs: Chemische Nanotechnologien mit Anwendungen in Technik und Bio/Life Sciences; September 25, 2012; Saarbrücken

**R. Drumm, M. Quilitz and K.-P. Schmitt**

*Herstellung keramischer Nanopartikel über Verfahren der chemischen Nanotechnologie*  
GDCh-Kurs: Chemische Nanotechnologien mit Anwendungen in Technik und Bio/Life Sciences; September 25, 2012; Saarbrücken

**S. Heusing**

*Nasschemisch hergestellte TCO-Schichten mit ITO-Nanopartikeln*  
Workshop „Transparente leitfähige Oxide – Festkörperphysikalische Grundlagen und Technologien“ der EFDS (Europäische Forschungsgesellschaft Dünne Schichten e.V.); May 21–22, 2012; Dresden

**T. S. Müller**

*Projekt EcoRepair - Energieeffiziente Reparatur von Glasurfehlern in Sanitärkeramiken*  
Tag der offenen Tür der Effizienzfabrik, Kalkscheune; November 20, 2012; Berlin

**T. S. Müller and P. W. Oliveira**

*Optische Funktionalisierung von Oberflächen - Materialien für druckbare Elektronik*  
Hannover Messe 2012, tech transfer – Forum Gateway2Innovation; April 23–27, 2012; Hannover

**M. Quilitz**

*Nanotechnology in the Leibniz Association - The new Network Leibniz Nano*  
Hannover Messe 2012, Innovations for Industry Forum; April 23–27, 2012; Hannover

**M. Quilitz**

*INM - Leibniz-Institute for New Materials - Nanotechnology from the Molecule to the Pilot Production*  
Hannover Messe 2012, Innovations for Industry Forum; April 23–27, 2012; Hannover

**Innovative Elektronenmikroskopie****N. de Jonge**

*Liquid cell STEM of nanomaterials*  
1. Workshop des Leibniz-Verbundes Nanotechnologie; January 30–31, 2012; Berlin



**N. de Jonge**

*Scanning transmission electron microscopy of cells in liquid*

Physikalisches Kolloquium an der Universität des Saarlandes; April 26, 2012; Saarbrücken

**N. de Jonge**

*Scanning transmission electron microscopy of whole eukaryotic cells in liquid and outlook on in situ studies of functional materials at realistic conditions*

Colloquium at the MPI for Intelligent Systems; May 21, 2012; Stuttgart

**N. de Jonge**

*Scanning transmission electron microscopy for biology and nanotechnology*

Gruppenseminar Prof. Hartman, Universität des Saarlandes; January 13, 2012; Saarbrücken

**N. de Jonge**

*Scanning transmission electron microscopy of eukaryotic cells in liquid*

SFB894, University of Saarland; June 14, 2012; Homburg

**N. de Jonge**

*Scanning transmission electron microscopy of eukaryotic cells in liquid*

Cryo TEM Colloquium, Eindhoven University of Technology; August 20, 2012; Eindhoven <Netherlands>

**N. de Jonge**

*Imaging tagged proteins in eukaryotic cells in liquid with scanning transmission electron microscopy*

Leibniz-Institut für Analytische Wissenschaften; December 6, 2012; Dortmund

**D. Peckys**

*Scanning transmission electron microscopy of nanoparticles in whole eukaryotic cells in water*

Helmholtz-Institut für Pharmazeutische Forschung Saarland; November 13, 2012; Saarbrücken

**NMO / Verfahrenstechnik****A. K. Schlarb**

*Controlling the tribological behavior of polymer sliding systems by the incorporation of fillers*

Nanyang Technological University; March 27, 2012; Singapore

**A. K. Schlarb**

*An approach for successful compounding of nanocomposites in large-scale production*

Masterbatch Asia 2012; March 26, 2012; Singapore

**A. K. Schlarb**

*Challenges and opportunities of polymer composites reinforced on different scales*

Thai German Graduate School, King Mongkut's University of Technology; March 22, 2012; Bangkok <Thailand>

**A. K. Schlarb**

*On the supermolecular morphology of polypropylene reinforced on the nanoscale*

Suranaree University of Technology SUT; March 8, 2012; Nakhon Ratchasima <Thailand>

**A. K. Schlarb**

*Improving the performance of polymer sliding systems by the incorporation of fillers on different scales*

National Metal and Materials Technology Center MTEC; March 6, 2012; Bangkok <Thailand>

**A. K. Schlarb**

*An approach of the compounding of nanocomposites via twin-screw extrusion*

Thai Polymer Society, Ministry of Research and Technology; March 5, 2012; Bangkok <Thailand>

**A. K. Schlarb**

*On the supermolecular morphology of thermoplastic polymers reinforced on the nanoscale*

Thai Polymer Society, Ministry of Research and Technology; March 5, 2012; Bangkok <Thailand>

**A. K. Schlarb**

*Processing-dependent properties of thermoplastic-based nanocomposites*

Chulalongkorn University; November 12, 2012; Bangkok <Thailand>

**A. K. Schlarb**

*Opportunities for the sustainable development of moving systems due to fiber-reinforcement.*

Sythetic Fibre Talks, DWI, RWTH Aachen; April 26, 2012; Aachen

**A. K. Schlarb, L. Josch, V. Goetz, S. Emrich, C. Wagner and M. Kopnarski**

*Einfluss des Umformens auf das tribologische Verhalten von Halbschalen aus einem Metall-Kunststoffverbund mit verstärktem PEEK*

53. Tribologie-Fachtagung; September 26, 2012; Göttingen

**A. K. Schlarb and L. Lin**

*Effects of processing on the properties of thermoplastic-based nanocomposites*

8th Asian-Australasian Conference on Composite Materials – ACCM-8; November 7, 2012; Kuala Lumpur <Malaysia>

**A. K. Schlarb and L. Lin**

*Processing controlled properties of thermoplastic-based nanocomposites*

15th European Conference on Composite Materials – ECCM15; June 24–28, 2012; Venice <Italy>

**Programmbereichsungebunden****R. Drumm, J. Adam, G. Klein and M. Veith**

*Kolloidales Processing von ZrO<sub>2</sub>-Nanopartikeln in Rührwerkskugelmühlen*

GDCh-Kurs: Chemische Nanotechnologien mit Anwendungen in Technik und Bio/Life Sciences; September 25, 2012; Saarbrücken

**R. Drumm, M. Quilitz and K.-P. Schmitt**

*Herstellung keramischer Nanopartikel über Verfahren der chemischen Nanotechnologie*

GDCh-Kurs: Chemische Nanotechnologien mit Anwendungen in Technik und Bio/Life Sciences; September 25, 2012; Saarbrücken

**SONSTIGE VORTRÄGE****Energie-Materialien****T. M. Arruda, M. Heon, V. Presser, Y. G. Gogotsi and N. Balke**

*Nanoscale characterization of CDC supercapacitors by in situ scanning probe microscopy methods*  
PRiME 2012; October 11, 2012; Honolulu <HI, USA>

**J. W. Campos, V. Presser, C. R. Dennison, K. W. Knehr, E. C. Kumbur and Y. G. Gogotsi**

*Investigation of electrode materials for an electrochemical flow capacitor*  
244th ACS National Meeting & Exposition; August 20, 2012; Philadelphia <PA, USA>

**C. R. Dennison, V. Presser, J. W. Campos, K. W. Knehr, E. C. Kumbur and Y. G. Gogotsi**

*Electrochemical flow capacitors: A new technology for grid-scale energy storage*  
244th ACS National Meeting & Exposition; August 19, 2012; Philadelphia <PA, USA>

**C. R. Dennison, V. Presser, J. W. Campos, K. W. Knehr, E. C. Kumbur and Y. G. Gogotsi**

*Electrochemical flow capacitors: A new concept for high-power scalable energy storage*  
PRiME 2012; October 11, 2012; Honolulu <HI, USA>

**B. Dyatkin, V. Presser and Y. G. Gogotsi**

*Development of materials and fabrication of a complete environmentally friendly supercapacitor*  
244th ACS National Meeting & Exposition; August 21, 2012; Philadelphia <PA, USA>

**M. Naguib, J. Come, O. Mashtalir, V. Presser, P.-L. Taberna, P. Simon, M. W. Barsoum and Y. G. Gogotsi**

*MXenes: A new family of 2D transition metal carbides for use in lithium ion batteries and lithium ion capacitors*  
244th ACS National Meeting & Exposition; August 21, 2012; Philadelphia <PA, USA>

**M. Naguib, J. Come, O. Mashtalir, V. Presser, P.-L. Taberna, P. Simon, M. W. Barsoum and Y. G. Gogotsi**  
*MXenes - A new family of two dimensional transition metal carbides used as intercalation compounds*  
PRiME 2012; October 10, 2012; Honolulu <HI, USA>

**M. Naguib, J. Come, O. Mashtalir, V. Presser, P.-L. Taberna, P. Simon, M. W. Barsoum and Y. G. Gogotsi**  
*MXenes: A new family of 2D transition metal carbides for use in lithium ion batteries and lithium ion capacitors*  
Materials Science & Technology 2012 Conference & Exhibition; October 8, 2012; Pittsburgh <PA, USA>

**M. Naguib, O. Mashtalir, J. Carle, K. M., V. Presser, J. Lu, L. Hultman, Y. G. Gogotsi and M. W. Barsoum**  
*MXenes: A new family of 2D early transition metal carbides produced by exfoliation of the MAX phases*  
244th ACS National Meeting & Exposition; August 19, 2012; Philadelphia <PA, USA>

**V. Presser, E. Perre, M. Lukatskaya, B. Dunn and Y. G. Gogotsi**  
*Pseudocapacitive behavior of hierarchical porous carbide-derived carbon with integrated niobium pentoxide nanoparticles*  
63rd Annual Meeting of the International Society of Electrochemistry; August 23, 2012; Prague <Czech Republic>

**V. Presser, E. Perre, M. Lukatskaya, B. Dunn and Y. G. Gogotsi**  
*Pseudocapacitive behavior of hierarchical porous carbide-derived carbon with integrated niobium pentoxide nanoparticles*  
PRiME 2012; October 8, 2012; Honolulu <HI, USA>

**H. Zhou, P. Fenter, P. Ganesh, P. Kent, D. Jiang, A. Chialvo, P. F. Fulvio, S. Dai, V. Presser, J. K. McDonough, Y. G. Gogotsi, M. C. F. Wander, K. Shuford, M. Rouha, G. Feng and P. T. Cummings**  
*Probing structures of electrolytes at graphene surface: Coupling X-ray interface scattering with molecular modeling*  
Materials Science & Technology 2012 Conference & Exhibition; October 8, 2012; Pittsburgh <PA, USA>

## Funktionelle Oberflächen

**R. Balijepalli, R. M. McMeeking, E. Arzt, M. R. Begley and M. Utz**  
*Modeling the effect of geometry on fibrillar adhesion*  
World Congress on Computational Mechanics WCCM 2012; July 8–13, 2012; São Paulo <Brazil>

**C. Huber, D. Brodoceanu, A. Wonn, P. Born, E. Kroner, E. Arzt and T. Kraus**  
*Particle-based patterning of biomimetic structures with multiple length scales*  
Materials Science and Engineering 2012; September 25–27, 2012; Darmstadt

**C. Huber, D. Brodoceanu, A. Wonn, T. Kraus, E. Kroner and E. Arzt**  
*Adhesion mechanisms in micropatterned dry adhesives with hierarchical structures*  
Winterschool 2012, SPP1420 (DFG Priority Programme 1420: Biomimetic Materials Research: Functionality by Hierarchical Structuring of Materials); March 18–20, 2012; Potsdam

**E. Kroner and E. Arzt**  
*Adhesion measurements with spherical and flat probes - a comparison*  
Adhesion Society Meeting 2012; February 26–29, 2012; New Orleans <LA, USA>

**E. Kroner and E. Arzt**  
*Measuring adhesion on micropatterned surfaces: The role of alignment*  
EURADH 2012; September 16–20, 2012; Friedrichshafen

## Metallische Mikrostrukturen

**N. J. Peter and A. S. Schneider**  
*Metallic and biological materials at INM*  
Peking University; June 15, 2012; Beijing <China>

**A. S. Schneider**  
*Auf der Suche nach neuen Eigenschaften - Metalle in der Mikrowelt*  
Tag der Offenen Tür der Universität des Saarlandes; June 2, 2012; Saarbrücken

**A. S. Schneider**  
*Mikrostrukturierung von metallischen Implantatmaterialien*  
Workshop „Implantate/Biomineralisation“ an der Uniklinik Homburg; April 20, 2012; Homburg

**A. S. Schneider**  
*Antibacterial copper*  
Workshop “Implantate/Biomineralisation” an der Uniklinik Homburg; September 24, 2012; Homburg

## Nanotribologie

**R. Bennewitz**  
*Multi-scale nanoindentation*  
Nanobrücken II – Nanomechanical Testing Workshop and Hysitron User Meeting; March 22–23, 2012; Saarbrücken

**R. Bennewitz**  
*Graphen als Schmierstoff*  
Inno.CNT Jahrestagung; January 30–February 1, 2012; Bayreuth

**K. Brörmann, K. Burger, A. Jagota and R. Bennewitz**  
*Discharge during detachment of microstructured PDMS sheds light on the role of electrostatics in adhesion*  
Doktorandenforum der Leibniz-Gemeinschaft; June 7–8, 2012; Berlin

**K. Brörmann, K. Burger, A. Jagota and R. Bennewitz**  
*Microstructured elastomer surfaces: I. Influence of electrostatic forces on adhesion; II. Frictional behavior*  
Johannes Gutenberg Universität Mainz, Institut für Physikalische Chemie; June 6, 2012; Mainz

**A. Caron, D. V. Louzguine-Luzgin and R. Bennewitz**  
*Nanotribology of metallic glasses and effect of surface oxide on their nano-friction and nano-wear behaviour*  
ISMANAM, 19th International Symposium on Metastable Amorphous and Nanostructured Materials; June 18–22, 2012; Moscow <Russia>

**F. Hausen, R. Bennewitz, N. N. Gosvami, P. Egberts, C. Held, T. Filleter and A. Labuda**  
*Atomic friction experiments*  
Universität des Saarlandes, Seminar der Physikalischen Chemie; February 27, 2012; Saarbrücken

**F. Wählich, J. Hoth, C. Held and R. Bennewitz**  
*Wear of graphitic lubricant on SiC(0001) during dry sliding*  
INASCON 2012; August 3–5, 2012; Saarbrücken  
Best speech award

## Strukturbildung

**P. Born, T. Geyer and T. Kraus**  
*Tuning the agglomerate morphologies of nanoparticles: from amorphous fibrils to compact supercrystals*  
Materials Science and Engineering 2012; September 25–27, 2012; Darmstadt

**D. Gerstner and T. Kraus**  
*Nanoparticle agglomeration in a flow process*  
PhD Student's Day, Saarland University; June 28–29, 2012; Saarbrücken

**C. Huber, D. Brodoceanu, A. Wonn, P. Born, E. Kroner, E. Arzt and T. Kraus**  
*Particle-based patterning of biomimetic structures with multiple length scales*  
Materials Science and Engineering 2012; September 25–27, 2012; Darmstadt

**C. Huber, D. Brodoceanu, A. Wonn, T. Kraus, E. Kroner and E. Arzt**  
*Adhesion mechanisms in micropatterned dry adhesives with hierarchical structures*  
Winterschool 2012, SPP1420 (DFG Priority Programme 1420: Biomimetic Materials Research: Functionality by Hierarchical Structuring of Materials); March 18–20, 2012; Potsdam

**T. Kraus**  
*Particle-based routes to biomimetic surface microstructures*  
Bio-inspired Materials Conference 2012; March 21–23, 2012; Potsdam



**T. Kraus**

*Why does anything not order*

ZRL Alumni Convention 2012, IBM Zurich Research Lab; June 1, 2012; Rüschlikon <Switzerland>

**T. Kraus**

*Nanostrukturierte Schichten für Photovoltaik und Elektronik aus kontrollierter Partikelabscheidung*  
Treofan Germany GmbH; October 11, 2012; Neunkirchen

**J. Lacava, P. Born and T. Kraus**

*Self-assembly of nanoparticles into Lennard-Jones-like clusters*

NanoSEA 2012 – 4th International Conference on Nano-structures Self-Assembly; June 25–29, 2012; S. Margherita di Pula <Sardinia, Italy>

**J. Lacava, P. Born and T. Kraus**

*Agglomeration of confined metal nanoparticles into Lennard-Jones-like clusters*

19th Ostwald-Kolloquium; September 20–21, 2012; Berlin

**A.-A. Ouali, J. Lacava and T. Kraus**

*Stability and structure of emulsions co-stabilized by surfactants and nanoparticles*

International Conference on Colloids and Complex Fluids: Challenges and Opportunities, Colloids 2012; October 17–19, 2012; Rueil-Malmaison <France>

**Biom mineralisation****H. O. K. Kirchner**

*Aspekte der Implantologie*

Workshop „Implantate/Biom mineralisation“, Universitätsklinikum des Saarlandes; February 17, 2012; Homburg

**M.-L. Lemloh, F. Marin, F. Herbst, L. Plasseraud,**

**Schweikert, J. Baier, J. Bill and F. Brümmer**

*Biom mineralization in a Ciliate (Colepshirtus)*

Ringberg Symposium “Generation of Inorganic Functional Materials: Implementation of Biom mineralization Principles”; September 30–October 3, 2012; Rottach

**E. Weber, M. Eder and I. M. Weiss**

*Biotechnology of biopolymers for functional hierarchical composites*

Bio-inspired Materials Conference 2012; March 20–23, 2012; Berlin

**E. Weber, C. Guth, P. Bauer and I. M. Weiss**

*Biotechnology of biom mineralization proteins in bacteria and plants*

Gordon Research Seminar and Conference on Biom mineralization; August 12–17, 2012; New London <NH, USA>

**E. Weber and I. M. Weiss**

*Biom mineralisation and biotechnology: Sustainable routes towards new materials*

Doktorandenforum der Leibniz-Gemeinschaft; June 7–8, 2012; Berlin

**I. M. Weiss**

*Evolutionary pathways of biom mineralization*

*explored using transformed Dictyostelium*  
22nd V.M. Goldschmidt Conference 2012; June 24–29, 2012; Montreal <Canada>

**I. M. Weiss**

*Tailored templates for minerals by glycosyltransferases*

Panel discussion on “The Future of Biomaterials”, MRS Spring Meeting; April 9, 2012; San Francisco <CA, USA>

**I. M. Weiss**

*Enzyme im Kontext von Biom mineralisation und Zellmechanik*

Workshop „Implantate/Biom mineralisation“, Universitätsklinikum des Saarlandes; February 17, 2012; Homburg

**CVD / Biooberflächen**

**E. Akman, B. Genc Oztoprak, M. Gunes, E. Kacar,**

**O. C. Aktas and A. Demir**

*Production of Co, Ni and Ti nanoparticles in liquid environment using femtosecond laser*

2nd Conference on Laser Ablation and Nanoparticle Generation in Liquids; May 22–24, 2012; Taormina <Italy>

**O. C. Aktas, H. Kenar, M. M. Miro, D. Anschütz, K. Löw, J. Schütt, S. Brück, A. Haidar, E. Karaöz and H. Abdul-Khaliq**

*Hemocompatible carbon based biosurfaces for cardiovascular implants*

46th Annual Meeting of the Association for European Paediatric Cardiology; May 23–26, 2012; Istanbul <Turkey>

**O. C. Aktas, J. Lee, A. Barnoush, M. Martinez Miró and M. Veith**

*Alpha alumina synthesis by laser treatment of composite nanowires: functional applications*

European Materials Research Society Spring Meeting; May 14–18, 2012; Strasbourg <France>

**O. C. Aktas, L. K. Schwarz, M. Martinez Miró, J. Lee, U. Rauch and K.-H. Schäfer**

*Al/Al<sub>2</sub>O<sub>3</sub> composite nanostructures modify neuronal cell Adhesion and growth*

Workshop Engineering of Functional Interfaces 2012; July 16–17, 2012; Zweibrücken

**C. Dufloux**

*Decomposition of tert-butoxyaluminiumdihydrid by plasma enhanced chemical vapour deposition*

Collège Doctorale Franco-Allemand 03-05 (GRK 532): “Physical Methods for the structural Investigation of New Materials”; June 13, 2012, Pétange <Luxembourg>

**C. Dufloux, O. C. Aktas and M. Veith**

*Textured Al-layer by thermal Chemical Vapor Deposition*

Collège Doctorale Franco-Allemand 03-05 (GRK 532): “Physical Methods for the structural Investigation of New Materials”; October 31, 2012; Nancy <France>

**C. Dufloux and M. Veith**

*Comparison of two CVD processes for the decomposition of a tert-butoxyalane*

International Graduate School “GRK 532” Physical Methods for the Structural Investigation of New Materials CDFA-03-05; January 23, 2012; Nohfelden

**J. Lee, M. Martinez Miró and M. Veith**

*Hierarchically patterned surfaces for cell guidance*

International Graduate School “GRK 532” Physical Methods for the Structural Investigation of New Materials CDFA-03-05; January 23, 2012; Nohfelden

**S. Litzemberger and M. Veith**

*The reaction of the alumopolysiloxane*

$[(Ph_2Si)_2O_3]_n Al_4[OH]_4 * 4Et_2O$  with Lewis-acids

International Graduate School “GRK 532” Physical Methods for the Structural Investigation of New Materials CDFA-03-05; January 23, 2012; Nohfelden

**K. Löw, A. Haidar, O. C. Aktas and H. Abdul-Khaliq**

*Cardiovascular implants for treatment of congenital heart and vessel defects*

Workshop on Horizons of Heart care (New Indigo); January 10, 2012; Chennai <India>

**A. May, C. K. Akkan, J. Lee and O. C. Aktas**

*Pulsed laser deposition of ultrathin SiC layers for bio-applications*

Workshop Engineering of Functional Interfaces 2012; July 16–17, 2012; Zweibrücken

**L. K. Schwarz, J. Lee, C. K. Akkan, M. Martinez Miró,**

**O. C. Aktas, M. Veith and K.-H. Schäfer**

*Laser processed hierarchical structures lead to neurite guidance*

Workshop Engineering of Functional Interfaces 2012; July 16–17, 2012; Zweibrücken

**Nano Zell Interaktion****A. Kraegeloh**

*Nanoparticle interactions in the cellular scale*

Kick-off meeting „Implantate/Biom mineralisation“, Universitätsklinikum des Saarlandes; April 20, 2012; Homburg

**A. Kraegeloh**

*Nanosilver and ionic silver: Applications and interactions with bacterial and human cells*

Nanotoxicology 2012; September 4–7, 2012; Beijing <China>

**A. Kraegeloh**

*Nanopartikel in Wechselwirkung mit Zellen: Von der Anwendung bis zur Sicherheit*  
PharmaForum, Congress Park, November 7, 2012; Hanau

**K. Narr**

*A microscopic analysis of gold nanoparticle internalization in A549 cells*  
Nanotoxicology 2012; September 4–7, 2012; Beijing <China>

**K. Narr**

*Interactions of human lung epithelial cells and different-sized gold nanoparticles*  
INASCON 2012; August 3–5, 2012; Saarbrücken

**Nanomere****C. Becker-Willinger**

*Materials developments at INM*  
Luxor Group, Paperworld 2012; January 31, 2012; Frankfurt am Main

**C. Becker-Willinger**

*Tribologische Nanomer-Beschichtung*  
Zollern-BHW Gleitlager GmbH & Co. KG; September 11, 2012; Braunschweig

**C. Becker-Willinger**

*Nanomers®, Nanostructured materials for vestel applications*  
Vestel A.S.; September 17–19, 2012; Manisa <Turkey>

**C. Becker-Willinger**

*New materials for alternative energy supply*  
WERC (Wisconsin Energy Research Consortium); November 19, 2012; Milwaukee <WI, USA>

**C. Becker-Willinger**

*Nanostructured coatings for agricultural engines*  
John Deere; November 20, 2012; Moline <IL, USA>

**C. Becker-Willinger**

*Nanomers for truck applications*  
Navistar; November 21, 2012; Chicago <IL, USA>

**S. Schmitz-Stöwe, M. Opsölder, M. Jochum, M. Aslan and C. Becker-Willinger**  
*Morphology of composite coating materials on gas permeation and corrosion protection*  
EUROCORR 2012; September 9–13, 2012; Istanbul <Turkey>

**S. Schmitz-Stöwe, M. Opsölder, M. Jochum and C. Becker-Willinger**  
*Hochstrukturierte NC-Beschichtung zum Korrosionsschutz auf Stahl*  
Materialica 2012 – Surface Kongress; October 24, 2012; München

**Optische Materialien****P. W. de Oliveira**

*Nanoparticles for optics*  
The Dow Chemical Company; June 13, 2012; Seoul <South Korea>

**P. W. de Oliveira**

*AR-Beschichtung für Solar-Paneele*  
Institut für Chemie, Humboldt-Universität zu Berlin; November 13, 2012; Berlin

**P. W. de Oliveira**

*AR-Beschichtung für Solar-Paneele*  
Institut für Chemie, Humboldt-Universität zu Berlin; November 13, 2012; Berlin

**S. Heusing, M. Lacroix, K. Koehler, F. Hardinghaus, P. Garcia-Juan and P. W. de Oliveira**  
*Improvement of the conductivity of wet-chemically deposited ITO coatings by addition of various metal oxide precursors to the ITO dispersion*  
4th International Symposium on Transparent Conductive Materials, TCM 2012; October 21–26, 2012; Hersonissos <Crete, Greece>

**K. Moh**

*Development of ink for transparent, conductive layer (Third milestone report)*  
LG Innotek Co., Ltd.; October 15, 2012; Saarbrücken

**K. Moh**

*Development of ink for transparent, conductive layer (Final report)*  
LG Innotek Co., Ltd.; December 4, 2012; Ansan <South Korea>

**K. Moh and P. W. de Oliveira**

*Photoreduction of silver*  
LG Innotek Co., Ltd.; February 8, 2012; Seoul <South Korea>

**T. S. Müller**

*Das INM - Neue Materialien mit einem Fokus auf optische Materialien*  
Vorlesung im Rahmen des Juniorstudiums Chemie – Spezielle Themen der Chemie; April 24, 2012; Saarbrücken

**M. Quilitz**

*Das INM - unterwegs im Nanometerbereich*  
Tag der Offenen Tür der Universität des Saarlandes; June 2, 2012; Saarbrücken

**M. Quilitz**

*The INM - Building a bridge between research and applications*  
Transnational Brokerage Event NMP-PPP Call 2013 Workshop, INSA de Lyon; June 12, 2012; Lyon <France>

**Innovative Elektronenmikroskopie****M. Koch**

*Kleinste Dimensionen aus der Nähe*  
Tag der Offenen Tür der Universität des Saarlandes; June 2, 2012; Saarbrücken

**D. Peckys, M. Eder, U. Werner and N. de Jonge**

*Visualization of EGF receptor dimers on wet and intact eukaryotic cells in an environmental scanning electron microscope*  
Conference on In-Situ and Correlative Electron Microscopy; November 6–7, 2012; Saarbrücken

**M. W. P. van de Put, C. C. M. Carcouët, G. de With, N. A. J. Sommerdijk, M. J. Boerakker and N. de Jonge**  
*Biomimetic synthesis of silica structures*  
Conference on In-Situ and Correlative Electron Microscopy; November 6–7, 2012; Saarbrücken

**Modellierung / Simulation**

**R. Balijepalli, R. M. McMeeking, E. Arzt, M. R. Begley and M. Utz**  
*Modeling the effect of geometry on fibrillar adhesion*  
World Congress on Computational Mechanics WCCM 2012; July 8–13, 2012; São Paulo <Brazil>

**D. J. Strauss**

*Support of a patient-specific therapeutical acoustic stimulation in tinnitus by numerical modeling*  
34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS 2012; August 28–September 1, 2012; San Diego <CA, USA>

**D. J. Strauss**

*Modeling the influences of nanoparticles on neural field oscillations in thalamocortical networks*  
34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS 2012; August 28–September 1, 2012; San Diego <CA, USA>

**D. J. Strauss and F. I. Corona-Strauss**

*Circular phase clustering based auto-adaptation for the objective assessment of ABR measurement quality*  
Newborn Hearing Screening 2012 Conference; June 5–7, 2012; Cernobbio <Lake Como, Italy>

**D. J. Strauss and F. I. Corona-Strauss**

*Circular phase clustering based auto-adaptation for the objective assessment of ABR measurement quality*  
Adult Hearing Screening 2012 Conference; June 7–9, 2012; Cernobbio <Lake Como, Italy>



## Programmbereichsungebunden

### C. Jung

*Das INM - unterwegs im Nanometerbereich*  
Tag der Offenen Tür der Universität des Saarlandes; June 2, 2012; Saarbrücken

### R. Rolles

*New Materials to Foster Innovation, the INM approach*  
Business meets Research, Luxinnovation; May 22, 2012; Luxembourg <Luxembourg>

### R. Rolles

*The Leibniz Association*  
WTZ Delegation visit to Korea;  
October 6–12, 2012; Seoul <Korea South>

### R. Rolles

*The German Research Landscape, the Leibniz Association, and the INM*  
KRICT; October 6–12, 2012; Daejeon <Korea South>

### R. Rolles

*New ideas, new materials*  
Wisconsin Energy Research Consortium (WERC);  
November 18–23, 2012; Milwaukee <WI, USA>

### R. Rolles

*Zusammenarbeit Korea-Deutschland: Kurzbericht von der 4. Sitzung des Korean-German Cooperation Committee on Science and Industrial Technology*  
Jahrestagung der Leibniz-Gemeinschaft;  
November 28–30, 2012; Berlin

## IM JB 2011 FEHLEN DIE FOLGENDEN EINGELADENEN WISSENSCHAFTLICHEN VORTRÄGE:

### Funktionelle Oberflächen

#### A. Jagota

*Structure and binding properties of DNA on graphite and carbon nanotubes*  
ESPCI; October, 2011; Paris <France>

#### A. Jagota

*Ordered DNA structures on graphite and carbon nanotubes*  
34th Annual Meeting of the Adhesion Society, 3M Award Session; February 13–16, 2011; Savannah <GA, USA>

#### A. Jagota

*Adhesion selectivity by shape and electrostatic complementarity*  
Gordon Research Conference on the Science of Adhesion; July 24–29, 2011; Lewiston <ME, USA>

## ▶ LEHRVERANSTALTUNGEN / LECTURES

### SOMMERSEMESTER 2012

#### C. Aktas

*Nanomaterials and Energy Applications*  
Vorlesung, Fachhochschule Kaiserslautern / Campus Zweibrücken, 2 SWS

**E. Arzt, J. Adam, C. Aktas, C. Fink-Straube, N. de Jonge, P. W. de Oliveira, B. Reinhard, A. Schneider, I. Weiss**  
*NanoBioMaterialien-2*

Vorlesung mit Übung, Universität des Saarlandes, Saarbrücken, 2 SWS

#### M. Veith

*Seminar für Mitarbeiter*  
Seminar, Universität des Saarlandes, Saarbrücken

#### M. Veith

*AC09 – Materialien aus molekularen Vorstufen*  
Vorlesung, Universität des Saarlandes, Saarbrücken, 2 SWS

#### M. Veith

*Betreuung von Vertiefungspraktika (ACV)*  
Praktika, Universität des Saarlandes, Saarbrücken

#### M. Veith

*Seminar für Doktoranden*  
Seminar, Universität des Saarlandes, Saarbrücken, 1 SWS

#### M. Veith

*Symmetry in Chemistry*  
Vorlesung, (ERASMUS-Programm), Ecole Polytechnique, Paris-Palaiseau

### WINTERSEMESTER 2012/2013

#### E. Arzt

*INM-Kolloquium*  
Kolloquium, Universität des Saarlandes, Saarbrücken, 2 SWS

#### E. Arzt, I. Weiss und MitarbeiterInnen

*NanoBioMaterialien-P*  
Praktikum, Universität des Saarlandes, Saarbrücken, 4 SWS

**E. Arzt, C. Becker-Willinger, A. Kraegeloh, T. Kraus, P. W. de Oliveira, I. Weiss**

*NanoBioMaterialien-1*  
Vorlesung mit Übung, Universität des Saarlandes, Saarbrücken, 2 SWS

#### E. Arzt, E. Kroner, A. Schneider

*Einführung in die Materialwissenschaft für Studierende des Studienganges Mikrotechnologie und Nanostrukturen*  
Vorlesung mit Übung, Universität des Saarlandes, Saarbrücken, 5 SWS

#### M. Eder

*BOT: Modul Botanik für B.Sc./LA Biologie*  
Veranstaltung im Rahmen der Vorlesung Prof. Dr. P. Bauer, Universität des Saarlandes, Saarbrücken

#### M. Veith

*Spezielle Kapitel für Lehramtsstudierende (Seminar Sla1)*  
Betreuung eines Termins mit 2 Studenten, Universität des Saarlandes, Saarbrücken

#### M. Veith

*Seminar für Doktoranden*  
Universität des Saarlandes, Saarbrücken, 1 SWS

#### I. M. Weiss

*Protein- und Enzymreinigung*  
Kurs und Seminar, Bachelorstudiengang Biochemie, Universität Regensburg, 7 + 1 SWS

### Sonstige Lehrveranstaltungen

#### C. Aktas

*GDCh-Kurs Chemische Nanotechnologie*  
Saarbrücken, September 25–26, 2012

## PATENTE / PATENTS

Im Jahr 2012 wurden vier neue Patentanmeldungen hinterlegt, die noch nicht offengelegt worden sind. Es wurden 21 Patente erteilt, davon drei innerhalb von Europa und 18 auf internationaler Ebene. Das INM – Leibniz-Institut für Neue Materialien unterhält somit 89 aktive Patentfamilien.

In 2012, INM has filed four new patent applications which are not yet published. Twentyone patents have been granted. Three of these patents are granted in Europe and eighteen in foreign countries. The INM – Leibniz Institute for New Materials has 89 active patent families.

### ERTEILTE EUROPÄISCHE PATENTE

#### Europäisches Patent 2297168 B1

Titel: „Mischungen von Precusoren zur Herstellung von keramischen Schichten mittels MOCVD“  
Erfinder: Michael Bender, Michael Veith

#### Europäisches Patent 2210106 B1

Titel: „Verwendung von nanostrukturierten Oberflächen und Verfahren zum Anreichern oder Isolieren von zellulären Subpopulationen“  
Erfinder: Frank Narz, Michael Veith

#### Europäisches Patent 2210106 B1

Titel: „Optische Elemente mit Gradientenstruktur“  
Erfinder: Peter William de Oliveira, Marcus Geerkens, Hechun Lin, Peter Rogin, Michael Veith

### ERTEILTE INTERNATIONALE PATENTE

#### Norwegisches Patent Nr. 331461

Stammanmeldungstitel: „Nanostrukturierte Formkörper und Schichten und deren Herstellung über stabile wasserlösliche Vorstufen“  
Erfinder: Ertugrul Arpac, Gerhard Jonschker, Hermann Schirra, Helmut Schmidt

#### Japanisches Patent Nr. 4902900

Stammanmeldungstitel: „Nanoskalige Teilchen mit einem von mindestens zwei Schalen umgebenen eisenoxid-haltigen Kern“  
Erfinder: Andreas Jordan, Christoph Lesniak, Thomas Schiestel, Helmut Schmidt

#### US-Patent Nr. 8,119,221 B2

Stammanmeldungstitel: „Zusammensetzung mit Nichtnewtonschem Verhalten“  
Erfinder: Peter William de Oliveira, Martin Mennig, Helmut Schmidt

#### US-Patent Nr. 8,133,573 B2

Stammanmeldungstitel: „Kratzfestes optisches Mehrschichtsystem auf einem kristallinen Substrat“  
Erfinder: Peter William de Oliveira, Mohammad Jilavi, Martin Mennig, Helmut Schmidt

#### US-Patent Nr. 8,133,315 B2

Stammanmeldungstitel: „Konsolidierungsmittel und dessen Verwendung zur Herstellung von hydrolyse-stabilen Formkörpern und Beschichtungen“  
Erfinder: Klaus Endres, Bernd Reinhard, Helmut Schmidt

#### Kroatisches Patent Nr. 10-1129903

Stammanmeldungstitel: „Isolationsmaterial“  
Erfinder: Klaus Endres, Stefan Goedicke, Bernd Reinhard, Helmut Schmidt

#### Japanisches Patent Nr. 4974459 B2

Stammanmeldungstitel: „Substrate mit photokatalytischer TiO<sub>2</sub>-Schicht“  
Erfinder: Murat Arkasu, Ertugrul Arpac, Helmut Schmidt

#### US-Patent Nr. 8,163,677 B2

Stammanmeldungstitel: „Konsolidierungsmittel und dessen Verwendung zur Konsolidierung von Formkörpern und geologischen Formationen aus porösen oder partikulären Materialien“  
Erfinder: Klaus Endres, Bernd Reinhard, Helmut Schmidt

#### US-Patent Nr. 8,197,889 B2

Stammanmeldungstitel: „Metallische Nanodrähte mit einer Hülle aus Oxid und Herstellungs-verfahren derselben“  
Erfinder: Christian Petersen, Eve Awa Sow, Michael Veith

#### Japanisches Patent Nr. 5025061

Stammanmeldungstitel: „Selbstvernetzende Beschichtungszusammensetzungen auf Basis anorganischer fluorhaltiger Polykondensate“  
Erfinder: Stefan Brück, Christoph Lesniak, Herrmann Schirra, Helmut Schmidt

#### Kanadisches Patent Nr. 101240418

Stammanmeldungstitel: „Substrate mit photokatalytischer TiO<sub>2</sub>-Schicht,“  
Erfinder: Murat Arkasu, Ertugrul Arpac, Helmut Schmidt

#### Japanisches Patent Nr. 4974430 B2

Stammanmeldungstitel: „IR-absorbierende Zusammensetzungen“  
Erfinder: Martin Jost, Ralph Nonninger, Martin Schichtel, Helmut Schmidt

#### Japanisches Patent Nr. 5036560

Stammanmeldungstitel: „Konsolidierungsmittel und dessen Verwendung zur Herstellung von hydrolysestabilen Formkörpern und Beschichtungen“  
Erfinder: Klaus Endres, Bernd Reinhard, Helmut Schmidt

#### Japanisches Patent Nr. 5063111

Stammanmeldungstitel: „Zusammensetzung mit Nichtnewtonschem Verhalten“  
Erfinder: Peter William de Oliveira, Martin Mennig, Helmut Schmidt

#### Japanisches Patent Nr. 5072356

Stammanmeldungstitel: „Abriebfeste optische Schichten und Formkörper“  
Erfinder: Carsten Becker-Willinger, Martin Kluge, Helmut Schmidt

#### Japanisches Patent Nr. 5089690 B2

Stammanmeldungstitel: „Verbundzusammensetzung für mikrostrukturierte Schichten“  
Erfinder: Carsten Becker-Willinger, Etsuko Hino, Pamela Kalmes, Mitsutoshi Noguchi, Norio Ohkuma, Yoshikazu Saito, Michael Veith

#### Japanisches Patent Nr. 5042011

Stammanmeldungstitel: „Amphiphile Nanopartikel“  
Erfinder: Murat Akarsu, Ertugrul Arpac, Helmut Schmidt

#### Japanisches Patent Nr. 5116743

Stammanmeldungstitel: „Nanoskalige Teilchen mit einem von mindestens zwei Schalen umgebenen Eisenoxid-haltigen Kern“  
Erfinder: Andreas Jordan, Christoph Lesniak, Thomas Schiestel, Helmut Schmidt





## ▶ KOOPERATIONEN / COOPERATIONS

### KOOPERATIONEN MIT NATIONALEN INSTITUTIONEN (AUSWAHL) / COOPERATIONS WITH NATIONAL INSTITUTIONS (SELECTION)

Christian-Albrechts-Universität  
Kiel

Deutsches Elektronensynchrotron DESY  
Hamburg

Fachhochschule Kaiserslautern  
Kaiserslautern

Fachhochschule Kaiserslautern  
Zweibrücken

Ferdinand-Braun-Institut für Höchstfrequenz-  
technik (FBH)  
Berlin

Forschungszentrum Borstel, Leibniz-Zentrum  
für Medizin und Biowissenschaften (FZB)  
Borstel

Fraunhofer-Institut für Biomedizinische  
Technik (IBMT)  
St. Ingbert

Fraunhofer-Institut für Elektronenstrahl- und  
Plasmatechnik / Dresden

Fraunhofer-Institut für Solare Energiesysteme (ISE)  
Freiburg i.Br.

Fraunhofer-Institut für Werkstoffmechanik (IWM)  
Freiburg i.Br.

Fraunhofer-Institut für Zerstörungsfreie Prüf-  
verfahren (IZFP)  
Saarbrücken

Friedrich-Alexander-Universität  
Erlangen-Nürnberg

Helmholtz-Institut für Pharmazeutische  
Forschung Saarland (HIPS)  
Saarbrücken

Hochschule für angewandte Wissenschaften  
München

Hochschule für Technik und Wirtschaft  
des Saarlandes (HTW)  
Saarbrücken

Humboldt-Universität  
Berlin

Johannes Gutenberg-Universität  
Mainz

Karlsruher Institut für Technologie (KIT)  
Eggenstein-Leopoldshafen

Leibniz-Institut für Analytische Wissenschaften (ISAS)  
Dortmund und Berlin

Leibniz Institut für Arbeitsforschung an der TU  
Dortmund (IfADo)

Leibniz-Institut für Festkörper- und Werkstoff-  
forschung (IFW)  
Dresden

Leibniz-Institut für Informationsinfrastruktur (FIZ)  
Karlsruhe

Leibniz-Institut für Innovative Mikroelektronik (IHP)  
Frankfurt (Oder)

Leibniz-Institut für Katalyse (LIKAT) / Rostock

Leibniz-Institut für Kristallzüchtung (IKZ) / Berlin

Leibniz-Institut für Oberflächenmodifizierung (IOM)  
Leipzig

Leibniz-Institut für Plasmaforschung und  
Technologie (INP)  
Greifswald

Leibniz-Institut für Polymerforschung (IPF)  
Dresden

Leibniz-Institut für umweltmedizinische Forschung  
(IUF)  
Düsseldorf

Leibniz-Institut für Wissensmedien (IWM)  
Tübingen

Ludwig-Maximilians-Universität  
München

Max-Planck-Institut für Intelligente Systeme  
Stuttgart

Max-Planck-Institut für Polymerforschung  
Mainz

Paul-Drude-Institut für Festkörperelektronik (PDI)  
Berlin

Rheinische Friedrich-Wilhelms-Universität  
Bonn

Ruhr-Universität Bochum  
Bochum

Ruprecht-Karls-Universität  
Heidelberg

Technische Universität Ilmenau  
Ilmenau

Technische Universität Kaiserslautern  
Kaiserslautern

Universität Gießen  
Gießen

Universität Köln  
Köln

Universität Regensburg  
Regensburg

Universität des Saarlandes  
Saarbrücken

Universität Stuttgart  
Stuttgart

Universität Tübingen  
Tübingen

Universität Ulm  
Ulm

Universitätsklinikum des Saarlandes  
Homburg

Weierstraß-Institut für Angewandte Analysis  
und Stochastik (WIAS)  
Berlin

Westfälische Wilhelms-Universität  
Münster

ZeMA - Zentrum für Mechatronik und Auto-  
matisierungstechnik gGmbH  
Saarbrücken

Zentrum für Sonnenenergie- und Wasserstoff-  
Forschung (ZSW) Baden-Württemberg  
Stuttgart

### KOOPERATIONEN MIT INTERNATIONALEN INSTITUTIONEN (AUSWAHL) / COOPERATIONS WITH INTERNATIONAL INSTITUTIONS (SELECTION)

Al Azhar University  
Gaza, Palestine

Brookhaven National Laboratory  
New York, NY, USA

Centre de Recherche Public Henri Tudor  
(CRP Henri Tudor)  
Luxemburg, Luxembourg

Centro Tecnológico de Minas Gerais (CETEC)  
Belo Horizonte, Brasil

CNRS Laboratoire de Chimie de Coordination (LCC)  
Toulouse, France

Cornell University  
Ithaca, NY, USA

Ecole Polytechnique Fédérale de Lausanne (EPFL)  
Lausanne, Switzerland

Ecole Supérieure de Physique et de Chimie  
Industrielles (ESPCI)  
Paris, France

European Synchrotron Radiation Facility  
Grenoble, France

**Flinders University of South Australia**  
Adelaide, Australia

**Hebrew University**  
Rehovot, Israel

**Indian Institute of Science**  
Mumbai, India

**Indian Institute of Technology**  
Kanpur, India

**Indian Institute of Technology**  
Madras, India

**Institut de Biologie Moléculaire des Plantes**  
Straßburg, France

**Instituto de Ceramica y Vidrio**  
Madrid, Spain

**Institut de Recerca en Energia de Catalunya**  
Barcelona, Spain

**Institut National de la Recherche Agronomique**  
Paris, France

**Institut Pasteur**  
Paris, France

**Istanbul Technical University**  
Istanbul, Turkey

**John Innes Centre**  
Colney, Norwich, UK

**KIAT (Korean Institute for Advancement of Technology)**  
Seoul, Republic of Korea

**KIST (Korea Institute of Science and Technology)**  
Seoul, Republic of Korea

**KITECH (Korea Institute of Industrial Technology)**  
Seoul, Republic of Korea

**Kocaeli Üniversitesi**  
Kocaeli, Turkey

**KRICT (Korea Research Institute of Chemical Technology)**  
Seoul, Republic of Korea

**KUT (Korean University of Technology and Education)**  
Cheonan, Republic of Korea

**Lehigh University**  
Bethlehem, PA, USA

**Marmara University**  
Istanbul, Turkey

**McGill University**  
Montreal, Canada

**McMaster University**  
Hamilton, Canada

**Montanauniversität Leoben**  
Leoben, Austria

**Nanoscience Centre**  
Cambridge, UK

**National University of Singapur**  
Singapur, Singapore

**Northwestern University**  
Chicago, IL, USA

**Sandia National Laboratories**  
Albuquerque, NM, USA

**Shahrood University of Technology**  
Shahrood, Iran

**Technion - Israel Institute of Technology**  
Haifa, Israel

**Tohoku University**  
Sendai, Japan

**Universidad Autònoma**  
Barcelona, Spain

**Universidade Araraquara**  
Araraquara, Brasil

**Universidade Sao Paulo**  
Sao Paulo, Brasil

**Université d'Evry**  
Evry, France

**Universiti Teknikal Malaysia Melaka**  
Melaka, Malaysia

**Université de Toulouse**  
Toulouse, France

**Université Paris-Nord XIII**  
Villetaneuse, France

**University College London**  
London, UK

**University of Aberdeen**  
Aberdeen, UK

**University of Alexandria**  
Alexandria, Egypt

**University of California**  
Berkeley, CA, USA

**University of California**  
Santa Barbara, CA, USA

**University of Cambridge**  
Cambridge, UK

**University of Chemical Technology and Metallurgy**  
Sofia, Bulgaria

**University of Illinois**  
Urbana, IL, USA

**University of Ioannina**  
Ioannina, Greece

**University of Massachusetts**  
Amherst, MA, USA

**University of Notre Dame**  
Notre Dame, IN, USA

**University of Nottingham**  
Nottingham, UK

**University of Oxford**  
Oxford, UK

**University of Pennsylvania**  
Philadelphia, PA, USA

**University of Poitiers**  
Poitiers, France

**University of Queensland**  
Brisbane, Australia

**University of Wageningen**  
Wageningen, Netherlands

**University of Warsaw**  
Warsaw, Poland

**University of South Australia**  
Adelaide, Australia

**University of Wyoming**  
Laramie, WY, USA

**University of York**  
York, UK

**VTT Technical Research Centre of Finland**  
Espoo, Finland

**Weizmann Institute of Science**  
Rehovot, Israel

**Zonguldak Karaelmas University**  
Zonguldak, Turkey



## ▶ VERANSTALTUNGEN / EVENTS

*Workshop on Horizons of Heart Care*

Organisation, Ausrichtung

**C. Aktas**

Saarbrücken, January 10, 2012

*Symposium „Neue Perspektiven der Material-synthese und Werkstoffentwicklung“, Teil 2*

Ausrichtung

**E. Arzt**

Saarbrücken, January 12–13, 2012

*1. Workshop des Leibniz-Verbundes Nanotechnologie*

Ausrichtung

**E. Arzt, C. Hartmann, M. Quilitz**

Berlin, January 30–31, 2012

*Besuch der Ministerpräsidentin A. Kramp-Karrenbauer*

Ausrichtung, Präsentationen

**E. Arzt, C. Becker-Willinger, N. de Jonge, C. Hartmann, M. Koch, E. Kroner, K. Moh, A. Kraegeloh**

Saarbrücken, March 9, 2012

*Nanobrücken II – "Hybrid Nanomechanical Testing Techniques"*

Ausrichtung

**E. Arzt, R. Bennewitz, A. Schneider, R. Rolles**

Saarbrücken, March 22–23, 2012

*Treffen der Leibniz-Applikationslabore*

Ausrichtung

**C. Becker-Willinger, R. Rolles**

Saarbrücken, April 17, 2012

*Workshop / Kick-Off-Meeting "Implantate/ Biominalisation"*

Organisation und Vorträge

**C. Aktas, S. Brück, R. Hanselmann, H. Kirchner,**

**A. Kraegeloh, D. Peckys, B. Reinhard, A. Schneider**

Homburg, Universitätskliniken des Saarlandes, April 20, 2012

*Hannover Messe 2012*

Stand und Exponate

**D. Benz, E. Bubel, R. Hanselmann, C. Jung, S. Klein,**

**M. Micciche, T. Müller, M. Quilitz, S. Schmitz-Stöwe**

Hannover, April 23–27, 2012

*Girl's Day*

Organisation, Ausrichtung

**E. Bubel, G. Heppe, M. Koch, S. Siegrist**

Saarbrücken, April 26, 2012

*Tag der Offenen Tür der Universität des Saarlandes*

Vorträge, Führungen

**C. Hartmann, C. Jung, M. Koch, M. Quilitz, A. Schneider**

Saarbrücken, June 2, 2012

*INM Student's Day*

Organisation, Ausrichtung

**T. Kraus, C. Hartmann, M. Quilitz, S. Kiefer, M. Koch,**

**E. Weber und Weitere**

Saarbrücken, June 22, 2012

*Workshop Projektskizzen und Förderanträge:*

*Effektiv und Effizient*

Ausrichtung

**M. Geerkens**

Saarbrücken, June 22, 2012

*Industrieworkshop des CaMPlusQ*

Ausrichtung

**R. Rolles**

Saarbrücken, July 2, 2012

*Kick-Off Meeting „Arbeitskreis Energiespeicher-technologien“*

Organisation, Ausrichtung

**M. Bonnard, R. Hanselmann, P.W. de Oliveira,**

**V. Presser, P. Rogin**

Saarbrücken, July 7, 2012

*INASCON 2012 – International Nanoscience*

*Student Conference*

Mitorganisation

**M. Micciché, N. Peter, M. Zeiger**

Saarbrücken, August 3–5, 2012

*Strategie-Workshop zum Audit berufundfamilie*

Ausrichtung

**C. Fink-Straube**

Saarbrücken, September 6, 2012

*Workshop / "Toxische Substanzen im Wasser"*

Organisation und Vorträge

**E. Arzt, R. Hanselmann, K. Moh, T. Müller**

Dillingen, September 12, 2012

*Auditierungsworkshop zum Audit berufundfamilie*

Ausrichtung

**C. Fink-Straube und Weitere**

Saarbrücken, September 13, 2012

*Workshop Infoveranstaltung Ausgründungen*

Ausrichtung

**M. Geerkens**

Saarbrücken, September 14, 2012

*Woche der Wissenschaften, Ministerium für Bildung des Saarlandes*

Stand und Exponate

**C. Hartmann, T. Müller, M. Quilitz, A. Rutz, W. Seitz**

Saarbrücken, September 17–22, 2012

*Workshop / "Tissue Engineering"*

Organisation und Vorträge

**C. Aktas, R. Hanselmann, A. Kraegeloh, B. Reinhard,**

**A. Schneider, I. Weiss**

Homburg, Universitätskliniken des Saarlandes,

September 24, 2012

*Workshop +composites Composite Day for Industry*

Organisation, Ausrichtung

**S. Brück, C. Hartmann**

Saarbrücken, October 8, 2012

*Materialica 2012*

Stand und Exponate

**M. Opsölder, T. Müller, W. Seitz**

München, October 23–25, 2012

*"Tag der Entwickler und Konstrukteure"*

*der ZPT automotive Saarland*

Stand und Exponate

**S. Brück, C. Aktas**

Kirkel, October 30, 2012

*Conference on In-Situ and Correlative Electron*

Microscopy (CISCeM)

Organisation und Ausrichtung

**N. de Jonge, C. Hartmann**

Saarbrücken, November 6–7, 2012

*PharmaForum*

Stand und Exponate

**A. Kraegeloh, M. Kucki**

Hanau, November 7, 2012

*25-Jahr-Feier des INM*

Ausrichtung

**E. Arzt, C. Hartmann, R. Rolles**

Saarbrücken, November 8, 2012

*8th Japan-Germany Industry Forum 2012*

Stand und Exponate

**R. Hanselmann**

Tokyo, Japan, November 16, 2012

*+composites International Forum*

Organisation, Ausrichtung

**C. Aktas, S. Brück**

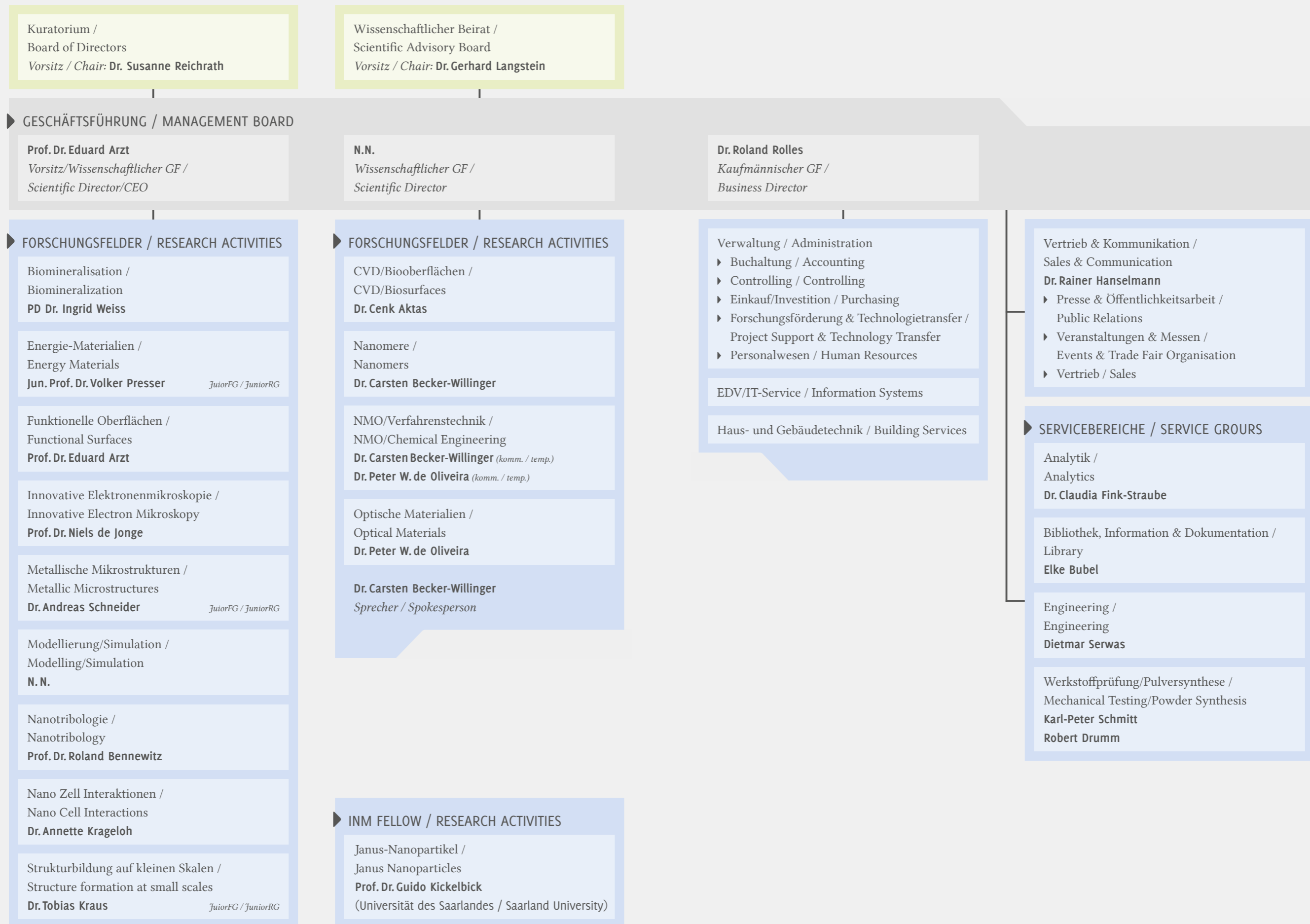
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