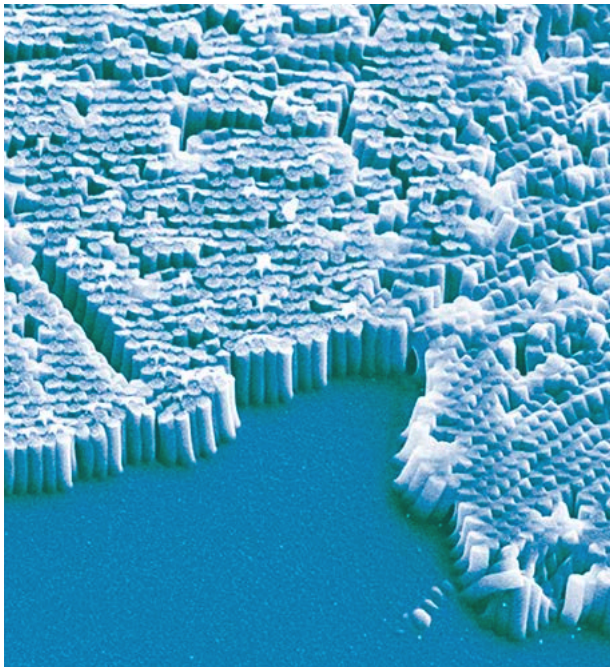
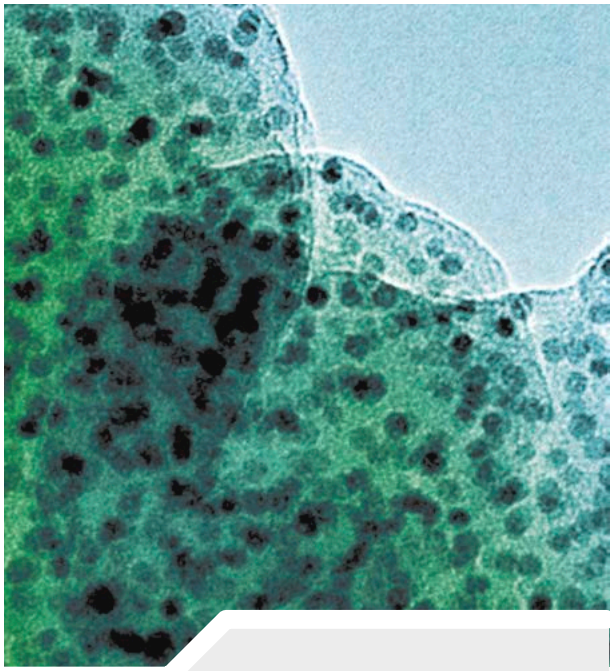
Neues Denken. Neue Materialien.





JAHRESBERICHT 2013
ANNUAL REPORT 2013

Leibniz-Gemeinschaft

INM
Leibniz-Institut für Neue Materialien

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HIGHLIGHTS

FAKTEN UND ZAHLEN / FACTS AND FIGURES

LIEBE FREUNDINNEN UND FREUNDE DES INM,

das INM hat sich auch im Jahr 2013 dynamisch weiterentwickelt und einige herausragende Erfolge zu verzeichnen. Besonders freuen wir uns über die Einwerbung zweier großer Projekte: das Projekt NanoSpekt im BMBF-Nachwuchswettbewerb NanoMatFutur sowie ein ERC Advanced Grant des European Research Council. Beide stellen wir Ihnen in Highlightartikeln vor.

Besonders sichtbar war das Institut durch die Organisation zweier internationaler Veranstaltungen: Die Konferenz *Nanosafety 2013* drehte sich rund um das Thema Nanosicherheit, und das Symposium "New trends in steel making and steel design" beleuchtete aktuelle Entwicklungen der Stahlforschung.

Die enge Verbindung zur Universität des Saarlandes wurde auf personeller Ebene weiter verstärkt. Volker Presser wurde zum Juniorprofessor in der Materialwissenschaft und Niels de Jonge zum Honorarprofessor in der Physik berufen. 2013 fiel auch der Startschuss für den ersten INM Fellow Guido Kickelbick, Professor für Anorganische Festkörperchemie an der Universität des Saarlandes. Roland Rolles, kaufmännischer Geschäftsführer am INM, hat das Institut Ende 2013 nach drei sehr erfolgreichen Jahren verlassen, um die Stelle des Vizepräsidenten für Verwaltung und Wirtschaftsführung an der Universität anzutreten.

Das INM hat sein kürzlich erworbenes Zertifikat „audit berufundfamilie“ im vergangenen Jahr in erste konkrete Maßnahmen umgesetzt. Damit positionieren wir uns als familienfreundlicher Arbeitgeber und unterstützen die Anwerbung von qualifizierten Mitarbeiterinnen und Mitarbeitern.

Nur gemeinsam können Erfolge entstehen. Wir danken daher allen Mitarbeiterinnen und Mitarbeitern für ihr Engagement. Auch unseren Partnern, Förderern und Freunden des Instituts danken wir für ihre Unterstützung.

DEAR FRIENDS OF INM,

INM has seen a dynamical development in 2013, with several extraordinary achievements. Among them, we are proud to present the acquisition of two large grants: the project NanoSpekt in the young academics contest NanoMatFutur (German Federal Ministry of Education and Research) and an ERC Advanced Grant. Both projects are presented below as highlight articles.

Our international visibility has further increased, not least through the organization of two international events: The conference *Nanosafety 2013* dealt with issues of nano and human health; the symposium "New trends in steel making and steel design" highlighted recent developments in steel research.

The close ties to Saarland University were further strengthened through the appointments of Volker Presser as junior professor in materials science and of Niels de Jonge as honorary professor in physics. The first INM fellowship started with Guido Kickelbick, professor for inorganic solid state chemistry at Saarland University. After three very successful years, INM’s business director Roland Rolles left the institute for the position of vice president for administration and finance of Saarland University.

INM’s commitment as a family-friendly organization, as exhibited by the certificate “berufundfamilie”, has led to first implementations in 2013. These measures help position our institute as a modern employer with a competitive edge in hiring well-qualified personnel.

Success requires a sense of togetherness. Therefore we would like to convey our sincere thanks to all our employees for their dedication to INM. The institute is also grateful to its partners, sponsors and friends for their continuing support.

Günter Weber

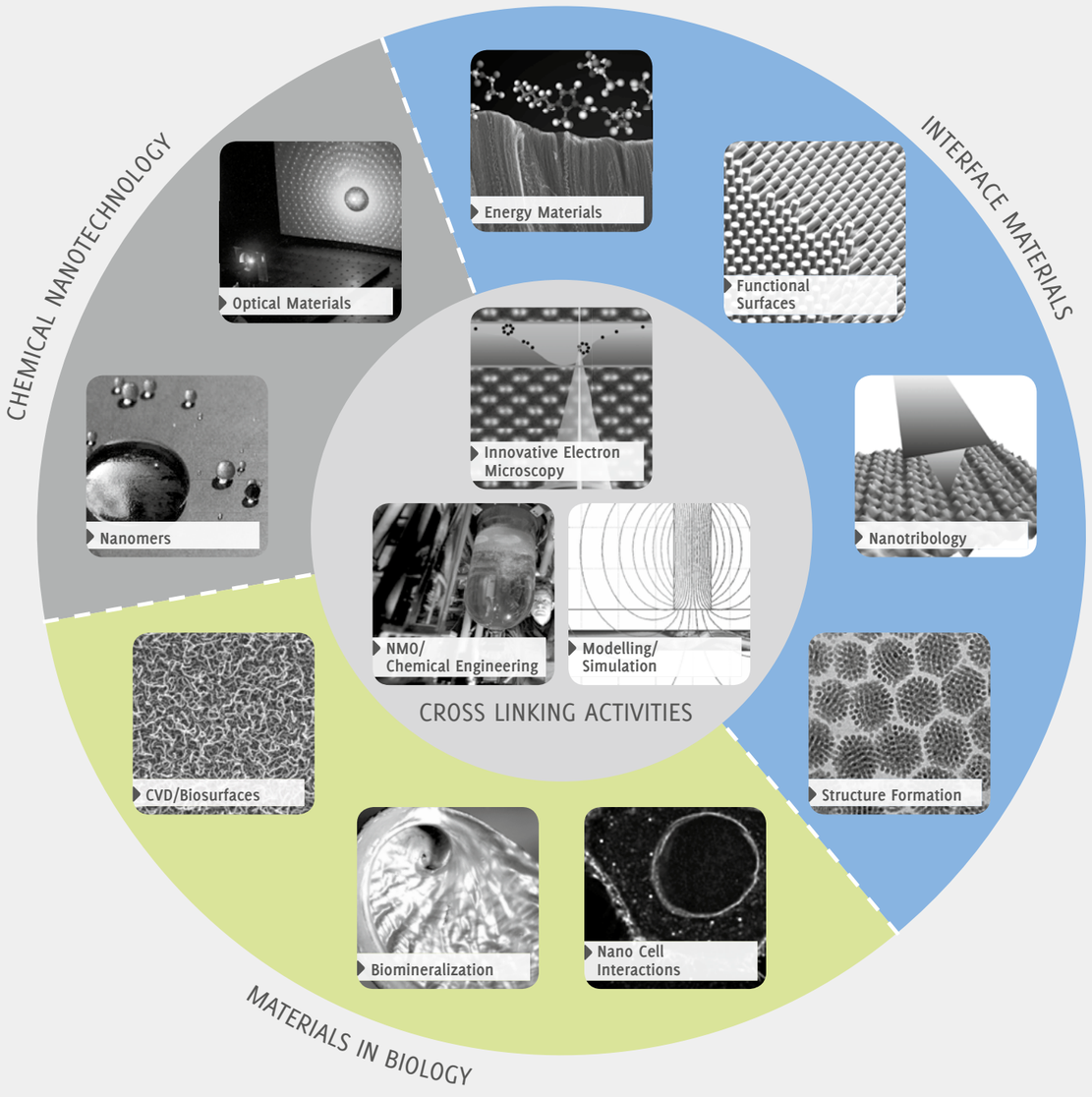
Kaufmännischer Geschäftsführer / Business Director

Prof. Dr. Eduard Arzt

Wissenschaftlicher Geschäftsführer und Vorsitzender der Geschäftsführung / Scientific Director and CEO

GRUPPENBERICHTE / GROUP REPORTS

FORSCHUNGSFELDER / RESEARCH FIELDS



DIE FORSCHUNGSFELDER DES INM

Die Arbeiten des Instituts werden in drei Forschungsfelder und ein *Querschnittsfeld* gruppiert, die thematisch nahestehende Programmbereiche und Juniorforschungsgruppen zusammenfassen:

Grenzflächenmaterialien: Das Feld beschäftigt sich mit neuen Methoden der Oberflächen- und Grenzflächenstrukturierung und erforscht inbesondere physikalische Mechanismen an Oberflächen. Im Vordergrund stehen u. a. neue Materialien zur Energiespeicherung, steuerbare tribologische und adhäsive Phänomene, flexible Schichten für Photovoltaik, sowie Wechselwirkungen zwischen strukturierten Oberflächen und Haut.

Materialien in der Biologie: Die Arbeiten in diesem Feld konzentrieren sich auf die Schnittstelle zwischen Materialwissenschaft und Biologie bzw. Medizin. Schwerpunkte sind die topographische Steuerung der Wechselwirkung mit Zellen bis hin zur Zellprogrammierung, Perspektiven der ressourcen- und umweltschonenden Herstellung von Materialien mittels adaptierter Biomineralisation sowie die Interaktionen zwischen Nanopartikeln und Zellen, Geweben und Organen.

Chemische Nanotechnologie: Das Feld widmet sich nichtmetallisch-anorganischen Hybridmaterialien und ihren funktionellen, insbesondere optischen, tribologischen und protektiven, Eigenschaften. Schwerpunkte sind nasschemische Synthesemethoden und die Nutzung funktionalisierter Nanopartikel. Der Fokus der Arbeiten liegt in der Verwendung der Konzepte für konkrete industrielle Anwendungen.

Querschnittsfeld: Das *Querschnittsfeld* fasst übergreifende Forschungs- und Entwicklungsthemen zusammen, die die Arbeiten der Forschungsfelder methodisch ergänzen. Die Schwerpunkte umfassen hochmoderne innovative Elektronenmikroskopie, Multiskalenmodellierung und Simulation sowie Aktivitäten zum Transfer der Ergebnisse in die Industrie.

THE RESEARCH FIELDS OF INM

The research in the institute is grouped in three research fields and *cross-linking activities.* These research fields merge Program Divisions and Junior Research Groups with similar thematic orientation:

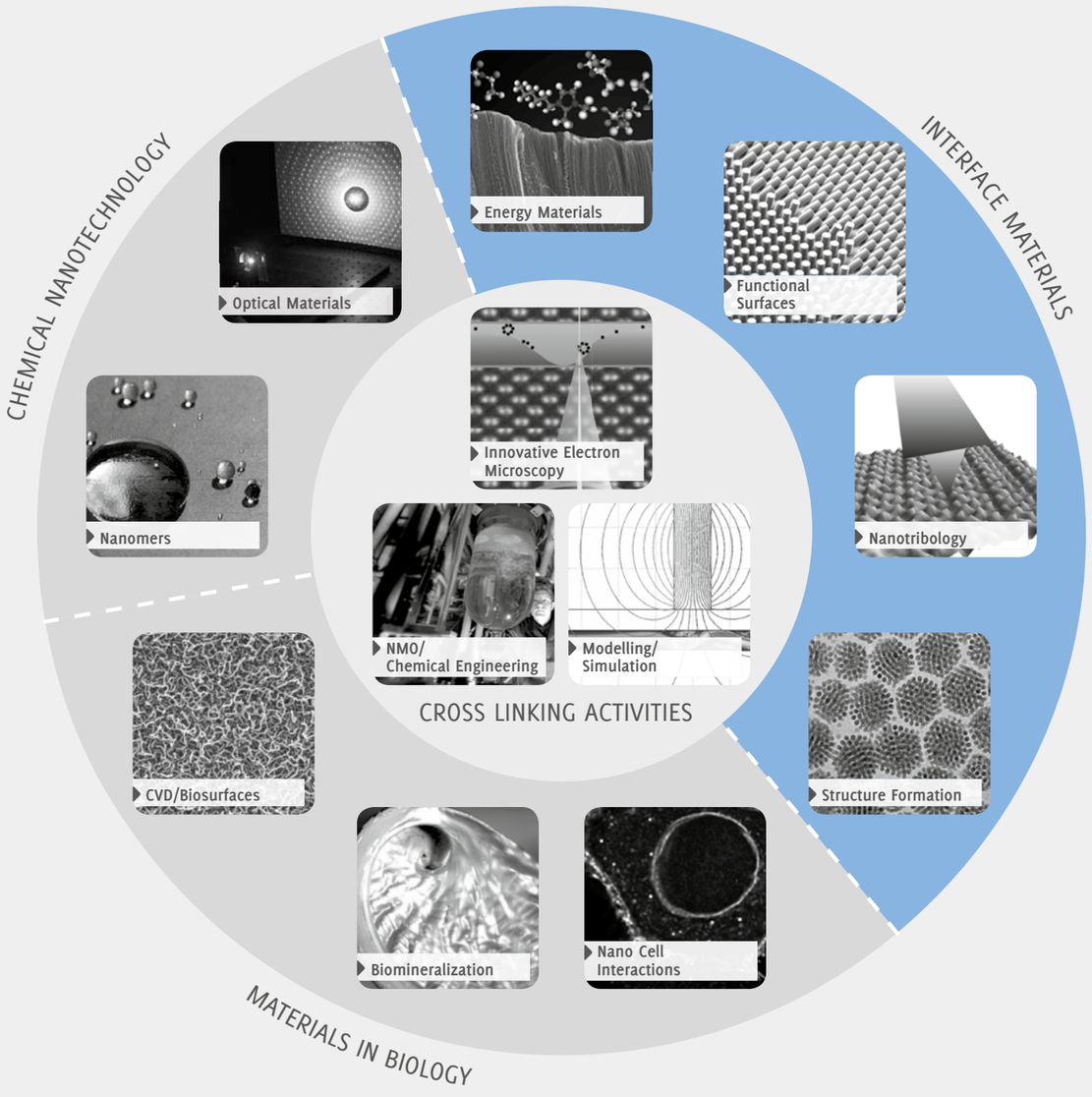
Interface Materials: The research field deals with new methods of surface and interface patterning and investigates especially physical mechanisms at surfaces. It focuses for example on new materials for energy storage, switchable tribologic and adhesive phenomena, flexible coatings for photovoltaics, and on the interaction between structured surfaces and skin.

Materials in Biology: In this research field, the work concentrates on the interface between materials science and biology or medicine. Focus topics comprise the topographic switching of the cell interaction up to cell programming, perspectives of ressource- and environmentally friendly syntheses of materials via adapted biomineralization as well as the interaction between nanoparticles and cells, tissues and organs.

Chemical Nanotechnology: The research field adresses non-metallic-inorganic hybrid materials and their functional, especially optical, tribological, and protective, properties. Key aspects are wetchemical synthesis methods and the use of functionalized nanoparticles. A large focus is on the utilization of concepts for practical applications in industry.

Cross Linking Activities: The area combines comprehensive research and development activities, which methodically complement the competencies of the research areas. Major components are up-to-date innovative electron microscopy, multiscale modeling and simulation and industrial transfer activities.

GRENZFLÄCHENMATERIALIEN / INTERFACE MATERIALS



DAS FORSCHUNGSFELD *GRENZFLÄCHENMATERIALIEN*

Das Forschungsfeld *Grenzflächenmaterialien* befasst sich mit neuen Methoden der Oberflächen- und Grenzflächenstrukturierung und erforscht insbesondere physikalische Mechanismen an Oberflächen. Im Vordergrund stehen neue Materialien zur Energiespeicherung, steuerbare tribologische und adhäsive Phänomene, flexible Schichten für Elektronik und Photovoltaik sowie neuerdings Wechselwirkungen zwischen strukturierten Oberflächen und Haut. Schwerpunktmäßig trägt dieses Forschungsfeld zu den INM-Leitthemen A (Energieanwendungen), B (Medizinische Oberflächen) und C (Tribologische Systeme) bei.

Besondere Erfolge 2013 waren die Einwerbung eines Projekts im NanoMatFutur-Wettbewerb des BMBF durch die Juniorforschungsgruppe *Strukturbildung*, sowie die Einwerbung eines ERC Advanced Grants durch den Programmbereich *Funktionelle Oberflächen*.

Das Forschungsfeld besteht zum 31.12.2013 aus den folgenden zwei Programmbereichen und zwei Juniorforschungsgruppen:

- Juniorforschungsgruppe *Energie-Materialien*, Leitung: Jun.-Prof. Dr. Volker Presser
- Programmbereich *Funktionelle Oberflächen*, Leitung: Prof. Dr. Eduard Arzt, Dr. Elmar Kroner
- Programmbereich *Nanotribologie*, Leitung: Prof. Dr. Roland Bennewitz
- Juniorforschungsgruppe *Strukturbildung*, Leitung: Dr. Tobias Kraus

Die Juniorforschungsgruppe *Metallische Mikrostrukturen* wurde aufgrund des Wechsels des Gruppenleiters in die saarländische Industrie im März 2013 aufgelöst.

THE RESEARCH FIELD *INTERFACE MATERIALS*

The research field *Interface Materials* deals with new methods of surface and interface patterning and investigates especially physical mechanisms at surfaces. It focuses for example on new materials for energy storage, switchable tribologic and adhesive phenomena, flexible coatings for photovoltaics, and on the interaction between structured surfaces and skin. This research field contributes significantly to INM's lead topics A (energy applications), B (medical surfaces) and C (tribological systems).

Special success stories in 2013 are the acquisition of a project in the contest NanoMatFutur of the BMBF (German ministry of education and research) by the Junior Research Group *Structure Formation*, as well as the acquisition of an ERC Advanced Grant by the Program Division *Functional Surfaces*.

The research field *Interface Materials* consists of two Program Divisions and two Junior Research Groups (as of December 31, 2013):

- Junior Research Group *Energy Materials*, Head: Jun.-Prof. Dr. Volker Presser
- Program Division *Functional Surfaces*, Head: Prof. Dr. Eduard Arzt, Dr. Elmar Kroner
- Program Division *Nanotribology*, Head: Prof. Dr. Roland Bennewitz
- Junior Research *Group Structure Formation*, Head: Dr. Tobias Kraus

The Junior Research Group *Metallic Microstructures* was terminated in March 2013 because the group leader accepted an offer of the regional industry.

ENERGIE-MATERIALIEN / ENERGY MATERIALS

JUN.-PROF. DR. VOLKER PRESSER

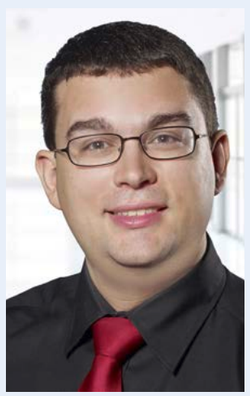
ZIELSETZUNG

Die Juniorforschungsgruppe *Energie-Materialien* erforscht und entwickelt Nanomaterialien für elektrochemische Anwendungen, wie beispielsweise zur elektrochemischen Energiespeicherung oder zur Wasseraufbereitung via kapazitiver Entionisierung. Auf der Materialseite liegt der Schwerpunkt auf hochporösen Kohlenstoffen, die als Pulver, Kugeln, Schäume oder Nanofasern hergestellt werden. Hieraus werden auf der Anwendungsseite vor allem Elektroden für elektrische Doppelschichtkondensatoren entwickelt. Die gezielte, nanoskalige Implementierung von Metalloxiden und Polymeren ermöglicht es, hochleistungsfähige Pseudokondensatoren herzustellen. Hierbei ist die Kombination von hoher Energie- und Leistungsdichte funktionaler Energiespeicher ein wichtiges Ziel der Gruppe. Besondere Bedeutung nimmt die Charakterisierung der elektrochemischen Phänomene ein, die mit *in-situ* Methoden detailliert untersucht werden.

MISSION

Research in the Junior Research Group *Energy Materials* is focused on the synthesis, characterization, and application of nanomaterials for electrochemical applications. Our activities center on the highly efficient storage of electrical energy in electrochemical capacitors (supercapacitors) and water treatment using capacitive deionization (figure). Both applications are based on the electrical double-layer which forms at the interface between electrically charged materials and electrolytes with dissolved ionic species. Carbon nanomaterials are the most important electrode material and we utilize non-porous carbon nanoparticles (carbon onions, carbon black) and nanoporous carbon materials (activated carbons, carbon nanofibers) to obtain electrodes for electrochemical applications. In particular, polymer- and carbide-derived carbons are explored as materials to enable a large array of complex forms (such as beads, fibers, or films) and to precisely tune the pore size distribution with sub-nanometer accuracy. Beyond electrostatic ion electrosorption, Faradaic reactions resulting from nanoscopically implemented metal oxides and polymers within the carbon electrode enable to significantly increase the energy density of electrochemical capacitors. We focus on a comprehensive array of materials characterization techniques and *in-situ* methods to gain novel insights in electrochemical processes. Our contributions extend from basic research, materials synthesis, and the refinement of testing procedures to industrial collaboration and technology development.

Jun.-Prof. Dr. Volker Presser



received his doctorate in mineralogy at the Eberhard-Karls University, Tübingen in 2009. From 2010–2012, he spent a research period at Drexel University, Philadelphia, USA. Since 2012, he has led the Junior Research Group and since 2013, he has been junior professor at Saarland University.

CURRENT WORK

Carbon nanofibers

Ultrafine (< 200 nm) carbide/carbon nanocomposite fibers were derived via electrospinning a sol/gel system. Based on a comprehensive study on the mechanisms involved in the formation of TiC/C nanocomposite fibers, we have extended our scope to NbC/C and ZrC/C fibers. In each individual fiber, nanocrystals with an average size of 20–50 nm are embedded within a matrix of amorphous carbon resulting in free-standing fiber mats. Such nanocomposites fibers will be subjected to selective etching via chlorine treatment to obtain all-carbon fibers with controllable porosity and high surface area. Unlike carbon powder, such free-standing electrodes do not require the addition of polymer binder to minimize dead mass and improve electrical conductivity.

Carbon onion supercapacitors

Carbon onions are multi-shelled concentrically stacked fullerenes that can be derived via vacuum annealing of commercially available nanodiamond powder. This scalable thermal treatment enables a high synthesis yield (> 90% of the carbon is preserved); the annealing temperature controls the resulting sp^2/sp^3 ratio and carbon crystallinity. Crafting functional groups (quinones) on the surface of carbon onions was shown to be a facile method to increase energy density by a factor of 9 compared to conventional carbon onion electrodes used for electrical double-layer capacitors (work in collaboration with Drexel University, Philadelphia, USA).

In-situ electrochemical dilatometry

In-situ electrochemical dilatometry enables us to measure the geometric expansion of carbon electrodes during charge/discharge processes. While batteries are known to expand during ion insertion, electrochemical capacitors have only recently been accepted to show changes in electrode volume upon ion electrosorption. We have shown in the first study on this topic on ionic liquids that the strain may be as high as several volume percent. For supercapacitors this may contribute to ultimate device failure if not taken into account in the cell design; the selective electrode swelling can be used for advanced actuators with long life time and reliable performance (work in collaboration with Tartu University, Estonia and Massachusetts Institute of Technology (MIT), USA).

Concept of capacitive deionization.

OUTLOOK

In 2014, the *Energy Materials* Group will focus on hybrid polymer/carbon and metal oxide/carbon nanocomposites for pseudocapacitors with improved energy density and high power handling ability. We will use carbon nanofibers and carbon onions for electrodes in capacitive deionization units and focus on flow electrodes for scalable energy storage and water treatment applications. Polymer-derived ceramics will play an important role as low-cost electrospinning precursor and in the synthesis of porous carbon beads for flowable carbon slurries. We will advance our *in-situ* electrochemical measurements using synchrotron radiation to investigate ion electrosorption in nanopores with high spatial and temporal resolution.

FUNKTIONELLE OBERFLÄCHEN / FUNCTIONAL SURFACES

PROF. DR. EDUARD ARZT, DR. ELMAR KRONER

ZIELSETZUNG

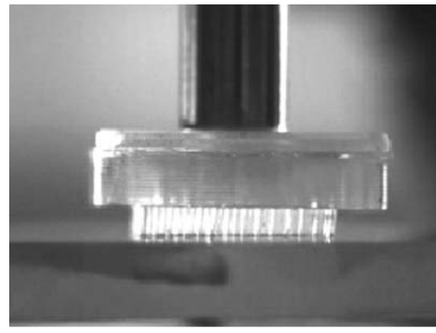
Der Programmbereich *Funktionelle Oberflächen* beschäftigt sich mit der Herstellung und Charakterisierung von mikro- und nanostrukturierten Oberflächen. Die gezielte Kombination von Oberflächenstruktur und Material ermöglicht die Einstellung von physikalischen Eigenschaften. Beispiele dafür sind mechanische, adhäsive oder haptische Eigenschaften. Viele Strukturen sind dabei der Natur nachempfunden, wie zum Beispiel bioinspirierte Haftsysteme nach dem Vorbild von Geckos. Dabei werden Materialien strukturiert, um die Adhäsion gegen verschiedene Oberflächen zu optimieren. Neben den Grundlagen der Adhäsion strukturierter Oberflächen werden zunehmend anwendungsspezifische Fragen bearbeitet. Es wird zum Beispiel untersucht, wie bioinspirierte Haftsysteme auf weichen Oberflächen haften oder wie die Haftsysteme durch einen externen Stimulus geschaltet werden können. Ziel ist es, die Haftsysteme in der Medizintechnik oder in der Robotik einzusetzen.

MISSION

The Program Division *Functional Surfaces* focuses on the preparation and characterization of micro- and nanopatterned surfaces. The combination of materials with specific surface patterns allows tuning physical properties, e.g. mechanical, adhesive or haptic properties. Many surface structures are inspired by nature, for example adhesion systems as in geckos. Materials are patterned to improve and optimize adhesion against different surfaces. Besides basic research on adhesion mechanisms of patterned surfaces we also focus on applications. We investigate how bioinspired adhesives make contact to soft matter, or how adhesive systems can be switched on and off by an external stimulus. The bioinspired adhesion systems are developed for use in biomedical application or in robotics.

Prof. Dr. Eduard Arzt (Head)
is scientific director and chairman (CEO) of INM as well as professor for new materials at Saarland University. He received his doctorate at the University of Vienna, did research, amongst others, in Cambridge/UK, Stanford and at the MIT (USA) and was formerly director at the Max Planck Institute for Metals Research, Stuttgart.

Dr. Elmar Kroner (Vice Head)
studied materials science at the University of Stuttgart and at the Max Planck Institute for Metals Research. He did his doctorate at INM and Saarland University. Since 2011, he has been vice head of the Program Division *Functional Surfaces*.



A robot arm equipped with a gecko-mimicking micropatterned polydimethylsiloxane (PDMS) adhesive has been assembled that can pick and place a glass substrate through reversible dry adhesion.

CURRENT WORK

Continuing efforts have been made to investigate basic principles of adhesion. In recent studies we focused on the influence of viscoelasticity on adhesion (cooperation with Prof. Frick, University of Wyoming, USA). A new material system based on polyacrylates with tunable cross-linking density but constant glass transition temperature was developed. With this new material system, the influence of Young's modulus as well as of viscoelasticity on adhesion was systematically investigated. We found that the controlling mechanisms depend on indenter shape, as expected by theory.

Pressure actuated switchable adhesion mechanisms was further investigated. New studies allowed close investigation of the buckling behavior of single microscopic adhesive pillars. These studies enabled to identify the mechanisms which lead to detachment of the pillars at high compressive preload. Based on these studies, we can now develop new structure geometries allowing an optimized switchability of the adhesion systems.

The focus of our group now increasingly includes application oriented investigations. We recently acquired a 6-axis robot precise to demonstrate to customers an integrated switchable adhesion system for pick & place processes (see insert at right). With this new system we plan to advance our gecomer® technology for industrial production and to test new parameters. For example, the robot allows application of high shear forces and high normal simultaneous forces.

OUTLOOK

In 2014, the structure of the Program Division will be changed due to the acquisition of the ERC Advanced Grant. The Program Division will be renamed into *Functional Microstructures* and will focus on: First, adhesion to soft matter, especially with regard to biomedical application where a strong collaboration with Prof. Schick from Homburg will be established. Second, hierarchical adhesion systems will be further investigated within the DFG SPP1420 Project (collaboration with Junior Research Group *Structure Formation*). Finite element modeling will be applied to gain a deeper insight into mechanisms of adhesion (collaboration with Prof. R. McMeeking, UCSB). Further, haptics, or the sensation of touch will be investigated (collaboration with Prof. Dr. D. Strauss, HTW, and Program Division *Nanotribology*). Finally, mechanical properties of metallic microstructures will be investigated together with the local steel industry of Saarland.

The Program Division will be headed by Prof. E. Arzt and co-headed by Dr. N. Guimard. Upscaling of the gecomer® technology and the adaption of the currently existing systems for industrial needs will be investigated by Dr. K. Moh and Dr. P. W. de Oliveira (Program Division *Optical Materials*). A new Junior Research Group *Switchable Surfaces*, headed by Dr. E. Kroner, will start in 2014. In this group, surfaces will be developed which can switch their surface topography and thus their physical properties by an external stimulus.

NANOTRIBOLOGIE / NANOTRIBOLOGY

PROF. DR. ROLAND BENNEWITZ

ZIELSETZUNG

Der Programmbereich *Nanotribologie* erforscht mechanische Materialeigenschaften aus grundlagenorientierter Sichtweise und konzentriert sich dabei auf mikroskopische Mechanismen. Mit unseren Ergebnissen tragen wir zum Verständnis von Phänomenen wie Reibung, Verschleiß und Haftung sowie zur wissensbasierten Entwicklung neuer Materialien mit speziellen mechanischen Eigenschaften bei. Unsere 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 2013 gehören der Nachweis des Einflusses von Materialschichten unterhalb der Oberfläche auf die Reibung, die Aufklärung von Verschleißmechanismen in Polyetheretherketon (PEEK), sowie der Vergleich der Reibungseigenschaften von metallischen Gläsern und kristallinen Metallen.

Prof. Dr. Roland Bennewitz

is the Head of the Program Division *Nanotribology* and Honorary Professor of Experimental Physics at the Saarland University. He obtained his PhD from the Freie Universität Berlin, did postdoctoral studies at the University of Basel, and held the Canada Research Chair in Experimental Nanomechanics at the McGill University in Montreal.

MISSION

The Program Division *Nanotribology* explores mechanical properties of materials from a fundamental perspective with a focus on microscopic mechanisms. With our results we 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 different length scales. The methods and results of fundamental nanotribology are applied in collaborations, in particular within the INM and with the Saarland University. Examples are joint projects with the Program Division *Nanomers* on composite coatings, with the Program Division *Functional Surfaces* on friction between structured surfaces and fingertips, with the INM Fellow Prof. Karin Jacobs on friction in thin polymer films, and with the research group of Prof. Gerhard Wenz on friction control through macromolecular functionalization (figure).

CURRENT WORK

The following examples describe research results from 2013 which have been published in international research journals:

Subsurface interactions contribute to friction

Van der Waals interactions attract materials at small distances and lead to adhesion between bodies in contact. While friction is usually considered a surface effect, we showed that the interaction with material below the surface also influences friction. In collaboration with the research group of Prof. Karin Jacobs at Saarland University, we studied friction on silicon oxide surfaces of varying thickness and found that thinner oxide produces higher friction. The experimental results are in perfect agreement with a theoretical model, which takes into account the combined interaction with the oxide film and the underlying silicon substrate.

Friction and wear of PEEK

Poly-ether-ether-ketone is a high-performance polymer with an increasing number of applications as a tribomaterial. Macroscopic friction and wear tests characterize the tribological performance, but do not reveal the mechanisms leading to an increase in friction coefficients and to failure of the material. In order to reveal microscopic mechanisms which arise from the interaction with micro-asperities, we have performed systematic scratch experiments with sharp diamond tips. In particular, we identified a transition from ploughing to shearing friction and found that the damage mechanism at the nanometer-scale occurs in form of continuous material deformation, while for micron-scale deformation the material fails through the formation of flakes. The studies have been realized in collaboration with Prof. Alois Schlarb from the Technical University of Kaiserslautern.

Structure vs. Chemistry: Friction and wear of metallic glasses

Metallic glasses are a class of materials with interesting mechanical properties, including a high ability to store elastic energy. Plastic processes in metallic glasses occur on a local scale due to the absence of long-range order. We have compared the frictional properties of a Pt- based metallic glass and of crystalline platinum. Interestingly, differences between the materials occur only when the probing tip penetrates the surface. For sliding on top of the surfaces we detected differences only when tip material underwent a chemical reaction, in particular the formation of a platinum silicide.

OUTLOOK

The Program Division *Nanotribology* will continue to investigate the role of surface structure for the control of friction and wear. The externally funded projects range from fundamental studies of friction on clean metals through the effects of macromolecular functionalization to the mechanical properties of metallic glasses. In a novel approach, we will record the neural response to friction of micro-structured materials against the fingertip in order to establish an objective measure in the emerging field of scientific study of touch and feel of materials.

Preparation of a gold single crystal for functionalization with macromolecules.

STRUKTURBILDUNG / STRUCTURE FORMATION

DR. TOBIAS KRAUS

ZIELSETZUNG

Die Juniorforschungsgruppe *Strukturbildung* befasst sich mit der gezielten Anordnung von Partikeln in Materialien. Sie sucht Methoden, um die Anordnung der Partikel zu beeinflussen und Materialien mit geordneter, vorhersagbarer Mikrostruktur gezielt und effizient herzustellen. 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 die Herstellung partikelhaltiger Materialien.

MISSION

The Junior Research Group *Structure Formation* is concerned with the arrangement of particles in materials. It searches methods to bias the particle distribution 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 for studying technologically relevant, industrially well-established coating methods such as doctor blading and for adjusting them for the handling of particles. We collaborate with other research groups and industrial partners to improve the production of particle-containing materials.

Dr. Tobias Kraus

studied chemical engineering at the TU Munich. He did research at the MIT, Cambridge, USA, and at the Université de Neuchâtel. For his PhD thesis he went to the ETH Zurich and the IBM research lab nearby. From 2008 he established the Junior Research Group *Structure Formation* at the INM.

CURRENT RESEARCH

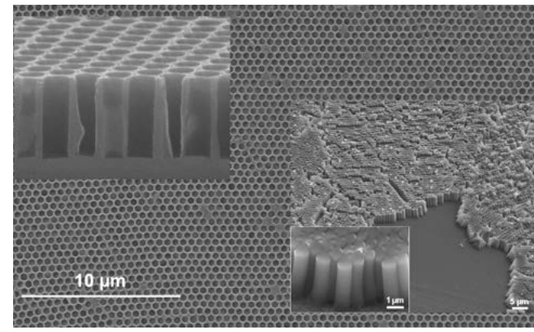
In 2013, methods for particle-based structuring of surfaces were developed. The importance of ligands and surfactants in particle assembly processes became apparent. Nanocomposites for electronic applications came into focus.

Particle-based surface micromachining

Increasingly many functional surfaces are based on designed microstructures: bioinspired adhesives feature arrays of pillars on their surface, infrared-reflecting windows have sub-micron metal patches, and densely packed pillars detect toxins. Conventionally, such structures have been fabricated using optical lithography or imprint techniques. We developed alternative patterning methods based on particle monolayers with self-assembled, regular structures. Polymer spheres were emulsion-polymerized, deposited by convective assembly, and transferred into the underlying substrate by etching and deposition. In a project in the DFG's SPP1420 (collaboration with Program Division *Functional Surfaces*) we used the resulting surfaces to mold polymer fibers as Gecko-like adhesives (figure). Applications in optics and sensing are currently under investigation.

NANOCOMPOSITES FOR ELECTRONICS AND PHOTOVOLTAICS

Combinations of inorganic nanoparticles and organic molecules are candidates for robust electronic materials that can be used in printed electronics and large-area, low-cost photovoltaics. A critical prerequisite is the defined distribution of particles and defined interfaces between the particles inside active layers. A recent grant in the "NanoMatFutur" program of BMBF will let us apply the techniques and insights of the last years to create new particle-based electronic materials.



A dense array of sub-micron holes in silicon fabricated by particle-based surface micromachining. Such hole arrays are used in a collaboration with *Functional Surfaces* to create bioinspired adhesives in a project in the DFG's SPP1420 (inset, lower right).

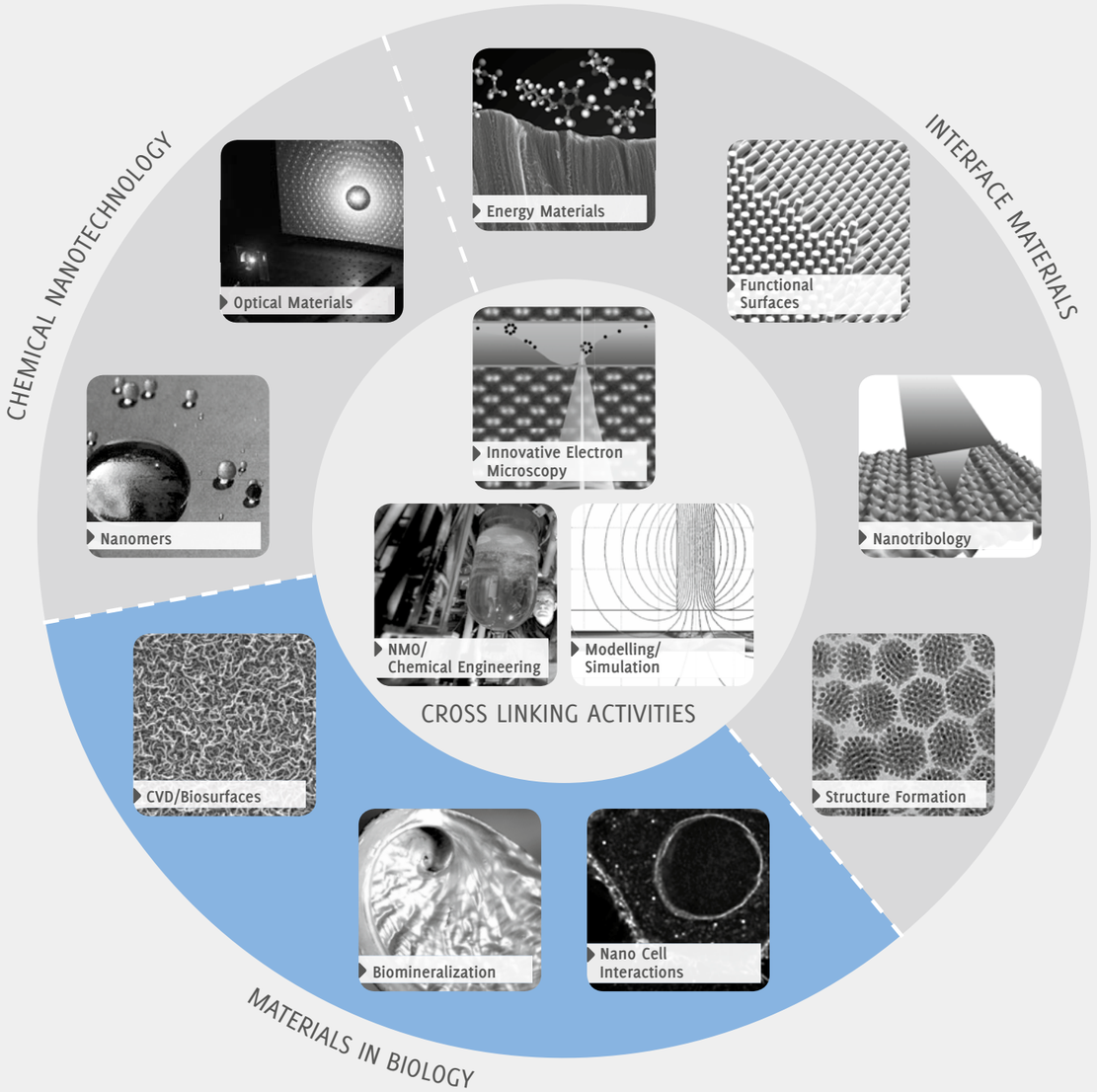
Ligands and surfactants in particle assembly

Surfactants and ligands are molecules that populate the surfaces of nanoparticles and emulsion droplets. They stabilize the dispersions and allowed us to tune their properties. Less well-studied is their role in the agglomeration and assembly of particles in functional materials. Results obtained in our group indicate that this role often governs agglomerate structure. For example, particles can be assembled into "supraparticles" with defined structures inside emulsion droplets. Experiments performed in 2013 prove that whether the resulting structures are regular or disordered depends on the surfactants stabilizing the emulsion. In so-called "Pickering emulsions", nanoparticles adsorb at liquid-liquid interfaces and stabilize emulsions. High-quality supraparticles require the exact opposite: emulsions in which no particles migrate to liquid-liquid interfaces but remain caught inside the droplets.

OUTLOOK

The Junior Research Group *Structure Formation* has grown into a well-established unit that links basic research in colloidal and surface chemistry and chemical engineering to material synthesis. New projects connect us to other activities at INM: In the project "AggloTox", we collaborate with the Program Division *Nano Cell Interactions* to understand and design agglomeration in physiological environments. A project with the Program Division *Biomineralization* and LMU Munich seeks artificial models of biomineralized, amorphous precursor films. A BMBF project in collaboration with the Program Division *Optical Materials* and Siemens continues successfully.

MATERIALIEN IN DER BIOLOGIE / MATERIALS IN BIOLOGY



DAS FORSCHUNGSFELD *MATERIALIEN IN DER BIOLOGIE*

Im Forschungsfeld *Materialien in der Biologie* werden Forschungs- und Entwicklungsarbeiten betrieben, deren Themen sich auf die Schnittstelle zwischen Materialwissenschaft und Biologie bzw. Medizin konzentrieren. Schwerpunkte sind die topographische Steuerung der Wechselwirkung mit Zellen bis hin zur Zellprogrammierung, Perspektiven der ressourcen- und umweltschonenden Herstellung von Materialien mittels adaptierter Biomineralisation sowie die Interaktionen zwischen nanopartikulären Substanzen und Zellen, Geweben und Organen. Diese Themen erfordern in besonders hohem Maße die fruchtbare Wechselwirkung zwischen verschiedenen Disziplinen. Das INM ist für die Bearbeitung dieser Fragen aufgrund der stark interdisziplinären Ausrichtung besonders prädestiniert. Das Forschungsfeld trägt schwerpunktmäßig zu den INM-Leitthemen B (Medizinische Oberflächen) und D (Nanosicherheit/Nano-Bio) bei.

Ein besonderer Erfolg des Jahres 2013 bestand im weiteren Ausbau des Leibniz-Forschungsverbundes *Nanosicherheit*, der vom INM koordiniert wird (Programmbereich *Nano Zell Interaktionen*). In diesem Zusammenhang stellt die in Saarbrücken veranstaltete Konferenz *Nanosafety 2013* ein besonderes Highlight dar.

Das Forschungsfeld besteht zum 31.12.2013 aus drei Programmbereichen:

- Programmbereich *Biomineralisation*, Leitung: PD Dr. Ingrid Weiss
- Programmbereich *CVD/Biooberflächen*, Leitung: Dr. Cenk Aktas
- Programmbereich *Nano Zell Interaktionen*, Leitung: Dr. Annette Kraegeloh

THE RESEARCH FIELD *MATERIALS IN BIOLOGY*

In the research field *Materials in Biology*, the research and development activities concentrate on the interface between materials science and biology or medicine. Focus areas comprise the impact of topographic features on the interaction with cells up to cell programming, perspectives of resource- and environmentally friendly synthesis of materials by adapted biomineralization as well as the interactions between nanoparticles and cells, tissues and organs. These topics require to a large extent interaction between various disciplines. The INM is therefore very well suited to work on such interdisciplinary questions. The research field contributes especially to INM's lead topics B (Medical surfaces) and D (Nanosafety /Nano-Bio).

In 2013 the Leibniz Research Alliance *Nanosafety*, coordinated by INM (Program Division *Nano Cell Interactions*), was developed further. In this regard the conference *Nanosafety 2013*, which was hosted in Saarbruecken, represented a highlight.

The research field combines three Program Divisions:

- Program Division *Biomineralization*, Head: PD Dr. Ingrid Weiss
- Program Division *CVD/Biosurfaces*, Head: Dr. Cenk Aktas
- Program Division *Nano Cell Interactions*, Head: Dr. Annette Kraegeloh

BIOMINERALISATION / BIOMINERALIZATION

PD DR. INGRID M. WEISS

ZIELSETZUNG

Der Programmbereich *Biomineralisation* stellt sich der Herausforderung, die Prinzipien komplex aufgebauter Materialien lebender Organismen auf technologisch herstellbare Multifunktions-Materialien zu übertragen. Im Laufe der Evolution wurden molekulare Grundlagen gelegt, um beispielsweise mechanische Stabilität mit Beständigkeit gegenüber Chemikalien und Witterungseinflüssen zu kombinieren. Basierend auf den Erkenntnissen über diese Materialien lassen sich nun auch neue Wege im Hinblick auf die Verwertung natürlicher Ressourcen verfolgen. Im Jahr 2013 gelang es uns erstmals, chemischen und enzymatischen Selbstorganisationsprozessen an der Grenzfläche zwischen Organismen und organisch-anorganischen Mineralkompositen auf die Spur zu kommen. Einen weiteren zukünftigen Schwerpunkt unserer Forschung bildet die kostengünstige Nutzung natürlicher Ressourcen in ökologischen Stoffkreisläufen, um umwelt- und sozialverträgliche Wertschöpfungsketten zu generieren.

PD Dr. Ingrid M. Weiss

received her doctorate in biophysics at the TU Munich. After a postdoctoral stay at The Weizmann Institute of Science, Israel, she performed her Habilitation at the University of Regensburg. She is Privatdozent for biochemistry at the University of Regensburg and since 2008, she has led the Program Division at INM.

MISSION

The Program Division *Biomineralization* focuses on fundamental molecular phenomena underlying a number of problems associated with complex materials formed by living organisms. While in classical materials science, the way from the recipe or formula to, for example, a composite material or high-performance alloy is first established/recorded and then processed, natural materials formed by creatures carry the recipe for their formation inherently within their evolutionary history, perfectly adapted to the organism and its environment. Our aim is to extract these recipes in order to transfer them in a reasonably effective way into materials science. In 2013, we elucidated for the first time a simple and elegant mechanism that explains nano-scale self-regulation of polymer synthesis as a function of mineralization. This mechanism, in turn, can lead to fine-tuned mineralized structures of several hierarchical levels as frequently observed in many composite materials of natural origin. Based on such fundamental insights, we hope to be able to lay the foundations for new materials with versatile and ecologically compatible structure-function relationships.

CURRENT RESEARCH

Bioinspired materials

Natural resources can serve in many ways for developing new functional materials, especially in the field of nano-structured materials. Recently, it was discovered that nano-structured wrinkled PDMS substrates with controlled density of defects are also useful in liquid systems to gain control over mineral nucleation and growth. Especially for calcium carbonate systems, this is the key enabling technology to fundamental and relevant biomineralization research *in vitro*. The wrinkle defects are a prerequisite for studying the pH-dependent function of bioinspired peptides involved in organizing the biomineralizing interface of mollusc shells.

Structure-function relationships in natural biomineral composites

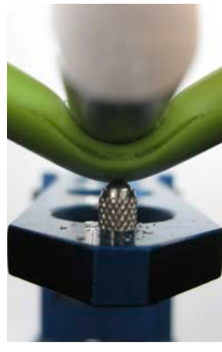
Our strongest expertises is the investigation of enzymatic processes at the tissue-mineral interface when new minerals are deposited and transformed. In collaboration with the Center for NanoScience (CeNS), LMU Munich, and the University of Regensburg we identified pH-dependent molecular interactions of an enzyme involved in the formation of the organic matrix in mollusc shells. The switchable assembly of protein domains in the presence of artificial surfaces and natural biominerals suggests a robust formation mechanism, which is also suitable for introducing hierarchy in the nano- and micro-structure of natural organic-inorganic composites. Our insights were obtained by conventional molecular biochemical techniques and atomic force microscopy in combination with immunological methods applied to isolated nacre platelets for the first time.

Mechanically stimulated biomass

Biomass derived from plants such as *Sorghum* or *Acacia* invader bushes are increasingly important as raw materials for new sustainable composite materials based on inorganic binders as currently developed at INM. Regarding plant biomass in general, our obtained results demonstrate that mechanical movements during plant growth interfere with both, the tissue architecture and the mechanical strength of the plant cell wall (figure). Molecular insights into the underlying regulatory networks will be useful to develop ecological strategies for improving the property profiles of renewable materials.

OUTLOOK

The Program Division *Biomineralization* at INM combines inspiration from two fundamentally different directions: From the formation mechanisms of biological materials such as pearls or peacock feathers, and, from current materials science approaches such as micro- and nanostructured *interface materials*. Our daily interaction between these two research fields challenges us to develop unique design strategies towards tunable molecular promoters for the generation of new composite materials. Our goal will be reached when biotechnological man-made materials gain their function by means of hierarchy and inbuilt processing recipes. This knowledge could serve to implement environmentally-compatible standards of living, also for the long-term benefit of our planet Earth.



This image shows Sorghum plants grown under laboratory conditions (middle) and investigated by three-point bending tests (right). Image courtesy: P. Denezhkin (middle), A. Pohl (right).

CVD/BIOOBERFLÄCHEN / CVD/BIOSURFACES

DR. CENK AKTAS

ZIELSETZUNG

Im Programmbereich *CVD/Biooberflächen* werden funktionelle, strukturierte Nanomaterialien über das Bottom-Up-Prinzip aus metallorganischen Precursor-Molekülen hergestellt. Der erste, zentrale Prozessschritt ist hierbei die Gasphasenabscheidung von dünnen Schichten über CVD- oder PVD-Verfahren. Anschließend werden hauptsächlich verschiedene Laserverfahren verwendet, um die Schichten in 2D und 3D zu strukturieren. Zur anwendungsspezifischen Funktionalisierung werden auch nass-chemische Methoden eingesetzt, bei denen im INM ein breites Hintergrundwissen vorhanden ist. Neben der Herstellung nimmt die Untersuchung und Charakterisierung der neuen nanostrukturierten Oberflächen für künftige Anwendungen einen großen Umfang ein. Das Hauptinteresse liegt dabei auf dem Einsatz als intelligente Oberflächen auf medizinischen Implantaten. In 2013 wurden im Programmbereich mehrere interdisziplinäre Forschungsprojekte durchgeführt, von denen einige im Folgenden näher beschrieben werden.

Dr. Cenk Aktas

received his BSc and his MSc in materials science at the Middle East Technical University, Turkey, and the University of Kiel. He completed his postgraduate studies on nanomaterials and gained his doctorate for materials science at Saarland University. Since 2010, he has been head of the Program Division *CVD/Biosurfaces*.

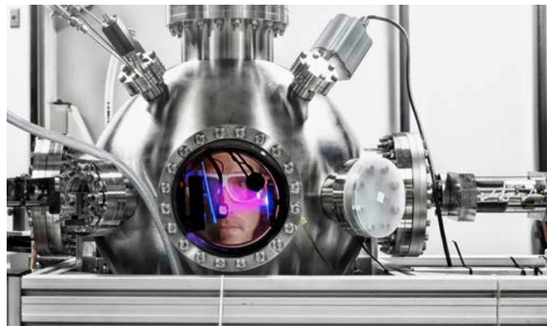
MISSION

The Program Division *CVD/Biosurfaces* specializes on 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 deposition and modification with INM`s strong background in wet-chemical synthesis (figure). Besides the synthesis, the group is focused on understanding the characteristics of nanomaterials for potential applications such as biomedical coatings. Topography driven adhesion, proliferation and differentiation of cells are our main interests.

CURRENT WORK

Ultra-thin nanocomposite layers by pulsed laser deposition (PLD)

Ultra-thin (10–20 nm) Au-Al_2O_3 and Ag-Al_2O_3 nanocomposite films were produced by pulsed laser deposition system (PLD). The group developed its own PLD system which is capable of coating thin films of different material combinations using *"multi-component target"* and *"multi-beam"* approaches. A new method is developed to homogenize the thickness distribution and to achieve ultra-thin nanocomposite layers. By using plasma formation on the target induced by a micro-lens array laser, material is homogenized in terms of the intensity distribution. This prevents the uncontrolled ablation of materials from the target surface. The evolution of the morphology of the deposited metallic nanocrystals in ceramic matrix is followed by high-resolution transmission electron microscopy (in collaboration with the Program Division *Innovative Electron Microscopy*. The effect of the substrate temperature and the laser fluency on the morphology, size distribution and filling factor are studied in detail. The aim is to extend the use of this novel approach for synthesis of multicomponent complex nanocomposite layers composed of nanoparticles with well-defined geometry and narrow size distribution.



Custom designed deposition chamber which combines PLD, E-beam and thermal evaporation methods.

Gradient surfaces for fast screening of mesenchymal stem cells

The group developed a novel surface incorporating a nano-topography gradient to enable a high throughput and fast analysis for studying stem cell differentiation by nanostructures. In collaboration with Mawson Institute, Adelaide/Australia, we showed that the topography gradient composed of 0D to 1D nanostructures is an effective tool to screen the adhesion and proliferation of mesenchymal stem cells. In addition, we produced a difference in the amount of calcium phosphate deposition by altering the surface topography. This is seen as a hint of topographic control of the differentiation into osteoblast. The effect of the gradient surface on the genetic will be studied in detail in the future (BMBF project).

Laser interference patterning of implant surfaces

The Program Division has studied the fabrication of hierarchical structures (periodic microstructures on 1D nanostructures) by means of direct laser interference patterning. Prior to laser patterning, substrates were coated with 1D alumina nanostructures by chemical vapor deposition (CVD). Afterwards, a nanosecond pulsed Nd:YAG laser at 355 nm wavelength was used to produce microstructures with grating periods ranging from 1 to 10 µm. The high-energy laser induces a strong re-coil pressure over the substrate (constructive interference) due to ultra-fast melting and evaporation from the surface. During fast cooling, the surface contracts and forms an ultra-porous morphology. On the other hand, the former 1D morphology is preserved in non-treated regions (destructive interference). Such hierarchical structures are of interest for various implants. While sub-cellular interactions are governed by the nanostructures, periodic microstructures lead to alignment and directed proliferation of cells. We showed that such a surface is an effective tool to control the axonal guidance in neurons (in collaboration with FH Kaiserslautern).

OUTLOOK

In 2014, the Program Division *CVD/Biosurfaces* will intensify its studies in the field of cell-surface interactions. The group will focus on a systematic study to explore the effects of geometry, interspacing and size distribution of surface features on the cellular response in addition to the size effect. In this context, the close collaboration with the Saarland University Faculty of Medicine will be continued for *ex-vivo* and *in-vivo* analysis. Beside the biomedical applications, the Program Division plans to use its expertise in thin film technology for other industrial applications.

NANO ZELL INTERAKTIONEN / NANO CELL INTERACTIONS

DR. ANNETTE KRAEGELOH

ZIELSETZUNG

Im Programmbereich *Nano Zell Interaktionen* geht es vor dem Hintergrund einer möglichen Toxizität technisch hergestellter nanoskaliger Partikel um deren Wechselwirkungen mit Zellen menschlicher Herkunft. Ziel ist es aufzuklären, welche Mechanismen die Aufnahme und Lokalisation der Partikel vermitteln und welche Parameter die Struktur und Biochemie der Zellen beeinflussen. Als Untersuchungsmodell werden Nanopartikel aus anorganischen Materialien gezielt hergestellt und charakterisiert. Den Partikeleigenschaften unter experimentell relevanten Bedingungen wird besondere Aufmerksamkeit gewidmet. Zur Lokalisation von Partikeln und Zellstrukturen werden vor allem lichtmikroskopische Techniken eingesetzt. Eine Besonderheit der Gruppe ist der Einsatz der hochauflösenden Stimulated Emission Depletion (STED) - Mikroskopie für diesen Zweck (Abbildung). Zur Analyse der Zellantwort werden darüber hinaus chemische, biochemische und molekularbiologische Techniken verwendet.

MISSION

The Program Division *Nano Cell Interactions* explores the interactions between cells of human origin and engineered nanoparticles (NPs), motivated by the potential toxicity of these materials. The aim of the research is to elucidate mechanisms that affect uptake or location of particles and to define parameters influencing structure and biochemistry of the cells. For this reason, well-defined inorganic NPs are prepared and characterized, addressing the state of the particles as well as their interactions with biologically relevant molecules. In order to localize particles and cellular structures, light microscopy is used. In particular the application of super high resolution Stimulated Emission Depletion (STED) microscopy for "nanotoxicological" questions is a distinctive feature of the group (figure). For analysis of cellular responses chemical, biochemical, and molecular biology techniques are applied.

Dr. Annette Kraegeloh

The graduated biologist received her doctorate at the University of Bonn. At INM she first started to work with biomedical applications of nanomaterials. Since 2008, she has been head of the Program Division *Nano Cell Interactions*. She is coordinator of the new Leibniz Research Alliance Nanosafety.

CURRENT WORK

Distribution of gold nanoparticles within human alveolar epithelial cells

The intracellular distribution of three sizes (3, 8, and 15 nm) of gold nanoparticles covered by a polymer shell was analyzed in a doctoral project. The cells were exposed to relevant non-cytotoxic particle concentrations. The particles accumulated in the perinuclear region by active transport mediated by the microtubule cytoskeleton. In contrast to larger particles, 3 nm particles showed a more random cellular distribution. Exposure of A549 cells to the gold nanoparticles induced an increased activity of the cytoskeleton, resulting in membrane ruffling, formation of blebs on the cell surface, and formation of large intracellular vesicles. Light and electron microscopy were applied to localize and correlate fluorescence signals with the presence of gold cores.

Leica TCS SP5-STED system for investigation of nano cell interactions.

Implementation of mechanical strain in a cell culture model

In conventional cell culture models used to investigate the effects of nanoparticles on human cells, the cells are grown on more or less stiff surfaces. This neglects the fact that in their natural environment most cells are exposed to mechanical stimuli. Alveolar cells, for example, are subjected to a reversible stretch imposed by breathing. Mechanical stimuli of lung epithelial cells affect molecular processes as well as the formation and secretion of lung surfactant. Our investigations have shown that nanoparticles in living A549 cells are associated with cellular structures involved in this secretion process. In the frame of a doctoral research study that started in 2013, the relation of mechanical strain and nanoparticle effects on surfactant secretion are studied in detail. As a start, the stretch model has been successfully established.

"Nanosafety2013"

One important activity of the Program Division *Nano Cell Interactions* (together with colleagues from the Program Division *Optical Materials*) was the organization of the *Nanosafety 2013* conference. This successful event was hosted by INM in cooperation with the "Leibniz Research Alliance Nanosafety" and is further described in the Highlight section.

Focus projects

In 2013, INM for the first time launched the INM focus project competition. The Program Division *Nano Cell Interactions* takes part in two initiatives, adding biological expertise:

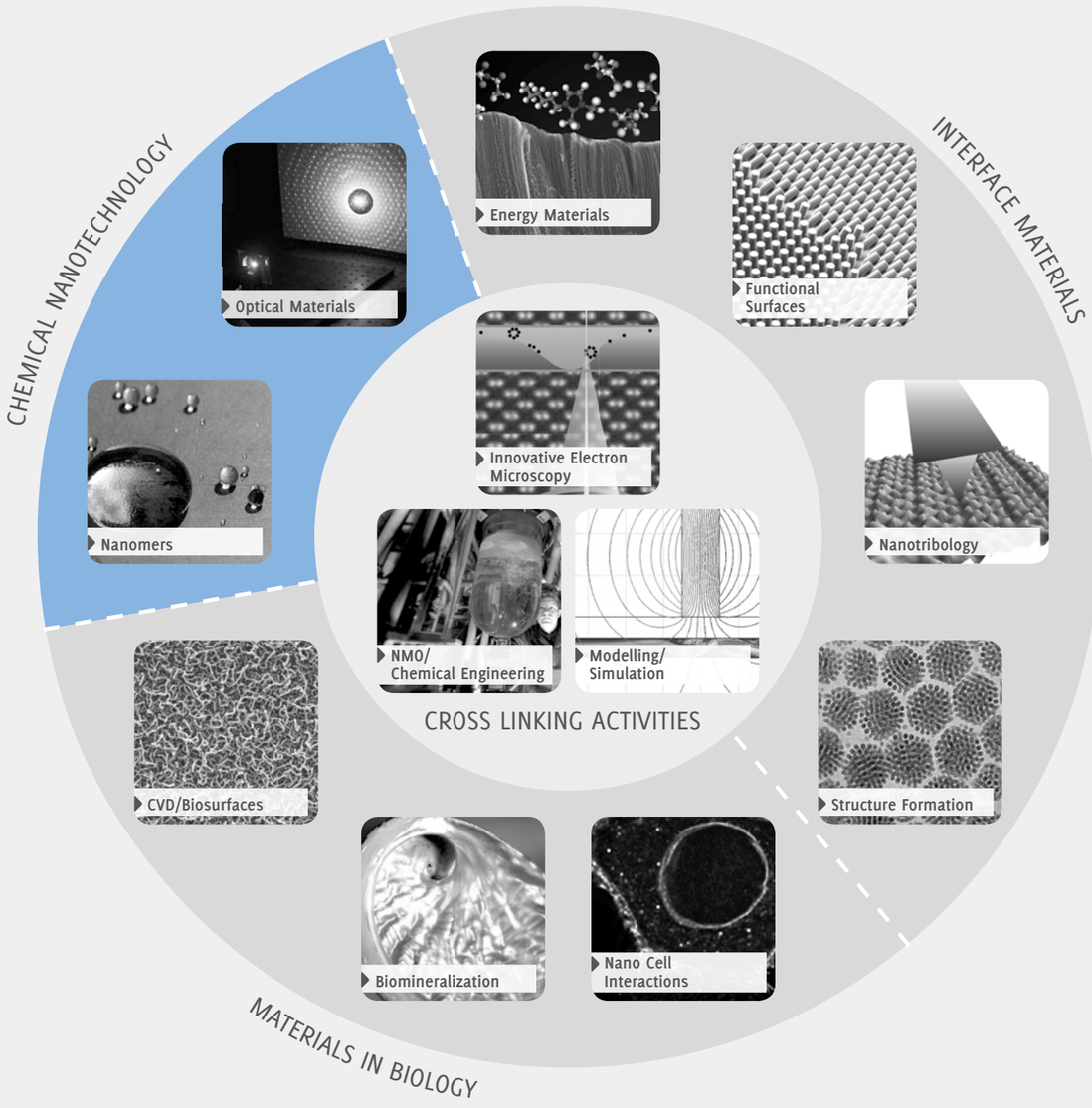
"AggloTox – defined particle agglomerates for nanotoxicity studies" is led by the Junior Research Group *Structure Formation*. The agglomeration status of nanoparticles might contribute to the degree of toxicity. AggloTox addresses this issue by thorough characterization of nanoparticle agglomeration under experimentally and physiologically relevant conditions.

"Envision – Multiscale Textured Biomaterial Membranes for Vascular System Implants" is a joint project with the Junior Research Group *Energy Materials*. It aims to develop new concepts for the surface of implants based on technologies of INM.

OUTLOOK

Future studies aim to decipher the relationship between particle properties and local particle dose, as well as location and interaction partners. Also, the impact of low nanoparticle concentrations on specific cell-functions will be examined, focusing on alveolar cells. More generally, the impact of material surfaces on cell-behavior will be analyzed using relevant cell-types. A further focus will be on material effects on DNA and chromosome integrity.

CHEMISCHE NANOTECHNOLOGIE / CHEMICAL NANOTECHNOLOGY



DAS FORSCHUNGSFELD *CHEMISCHE NANOTECHNOLOGIE*

Das Forschungsfeld *Chemische Nanotechnologie* widmet sich nichtmetallisch-anorganischen Hybridmaterialien, vorwiegend als Schichten und Beschichtungen, und ihren funktionellen Eigenschaften. Schwerpunkte sind nasschemische Synthesemethoden und die Nutzung von funktionalisierten Nanopartikeln. Der Fokus der Arbeiten liegt in der Nutzbarmachung der Konzepte für konkrete industrielle Anwendungen. Die Materialien werden für den Einsatz beispielsweise in den Bereichen Elektronik, Medizintechnik, Optik, Automobil, Displays, erneuerbare Energien sowie Maschinenbau und Elektrotechnik entwickelt.

Dieses Forschungsfeld trägt schwerpunktmäßig zu den INM-Leitthemen A (Energieanwendungen), C (Tribologische Systeme) und D (Nanosicherheit/ Nano-Bio) bei.

Besondere Erfolge im Jahr 2013 beinhalteten eine Lizenzvergabe zu Touch-Screen Anwendungen (Programmbereich *Optische Materialien*).

Das Forschungsfeld besteht aus zwei Programmbereichen:

- Programmbereich *Nanomere*, Leitung: Dr. Carsten Becker-Willinger
- Programmbereich *Optische Materialien*, Leitung: Dr. Peter W. de Oliveira

THE RESEARCH FIELD *CHEMICAL NANOTECHNOLOGY*

The research field *Chemical Nanotechnology* adresses non-metallic-inorganic hybrid materials and their functional, especially optical, tribological, and protective, properties. Key aspects are wetchemical synthesis methods and the use of functionalized nanoparticles. A large focus is on the utilization of concepts for practical applications in industry. The materials were developed for applications for example in electronics, medicine, optics, automotive, display technology, renewable energies as well as construction and electrical engineering.

This research field contributes significantly to INM's lead topics A (Energy applications), C (Tribological systems) and D (Nanosafety/Nano-Bio).

Special success stories in 2013 comprise a licence for touch-screen applications (Program Division *Optical Materials*).

The research field consists of two Program Divisions:

- Program Division *Nanomers*, Head: Dr. Carsten Becker-Willinger
- Program Division *Optical Materials*, Head: Dr. Peter W. de Oliveira

NANOMERE / NANOMERS

DR.-ING. CARSTEN BECKER-WILLINGER

ZIELSETZUNG

Der Programmbereich *Nanomere* erforscht Struktur-Eigenschaftsbeziehungen in Komposit- und Nanokompositmaterialien und entwickelt daraus multifunktionelle, vielfältig einsetzbare, Werkstoffe. Funktionelle Submikrometer- und Nanopartikel helfen bei der Erzeugung neuer Werkstoffeigenschaften in organischen Polymeren und organisch-anorganischen Hybridpolymeren. Die eingebrachten, zumeist anorganischen Partikel ermöglichen den Transfer ihrer intrinsischen Eigenschaften in beschichtungsfähige Systeme und kompakte Materialien. Dabei wird eine Verarbeitbarkeit angestrebt, die – orientiert an industriell etablierten Techniken – einen späteren Transfer in die Anwendung ermöglicht. Erzielbare Funktionen sind Kontrolle von Reibung, Korrosionsschutz sowie Abriebfestigkeit kombiniert mit weiteren Eigenschaften.

MISSION

The Program Division *Nanomers* investigates structure-property relationships in composite- and nanocomposite materials and develops multifunctional materials for a variety of applications. Functional submicron- and nanoparticles assist in generating novel material properties for example in organic polymers or in organic-inorganic hybrid polymers. The incorporated inorganic particles impart their respective intrinsic properties to coatable systems or compact materials. A degree of processability is aspired which is oriented at the industrially established technologies thus simplifying a transfer into application. Examples for functionalities achieved are control of friction, protection against corrosion or abrasion combined with other properties.

CURRENT WORK

A primary research focus is set on corrosion protection coatings for steel and aluminum alloys. It deals with highly structured composite layers that exhibit excellent barrier properties against diffusion of corrosive substances and high thermo-dynamic stability at the metal/coating interface. Both principles are used as a basis for projects with industrial partners. The final applications of the coating materials are in oil, gas as well as in the automotive industry. The corrosion behavior is investigated with standardized tests such as salt spray, condense climate and autoclave tests. In parallel, local corrosion mechanisms are monitored with Scanning Kelvin Probe (SKP) and Scanning Vibration Electrode (SVET) techniques (figure). Electrochemical impedance spectroscopy (EIS) is used to analyze the electrolyte / material interface of barrier type coatings in detail.

Dr.-Ing. Carsten Becker-Willinger

studied chemistry at the Albert-Ludwigs-University in Freiburg with the major macromolecular chemistry. From 1993 to 1998, he worked on his doctoral thesis at the INM with Prof. H. Schmidt. In 2001, he became head of the Program Division *Nanomers*.

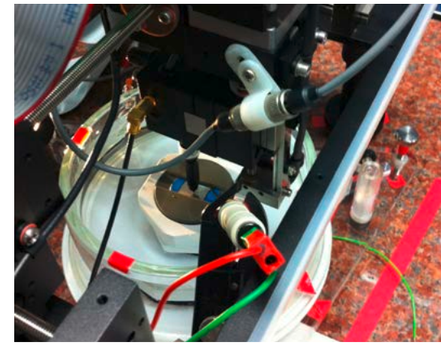
Additionally, doped nanoparticles are used in electrical insulation layers for copper spirals in power transformer applications. In 2013, a special UV-LED curing unit was developed and built allowing for fast curing of the insulation layers. The results showed that special emphasis has to be placed on the pre-treatment of the copper parts and UV illumination characteristics in order to fully cover the edges of the copper element. The project will be finalised in 2014.

The European part of the EU-project CuVito ("Nanostructured copper coatings, based on Vitolane technology, for antimicrobial applications") with seven partners from Europe and Mexico was completed at the end of 2013. The project resulted in two patent applications on protecting structured colloids and on anti-microbial effects. Final tests in the partner labs were performed on coatings containing small amounts of INM's copper colloids. Coated textiles and coated push plates are now under investigation in field tests. The last phase of the European part of the project comprised the development of a proof of concept device and the dissemination of the project results. For this reason the consortium organized a session on nanostructured coatings during the International Materials Research Congress (IMRC) 2013 in Mexico. During the implementation activities of the industrial partners the INM will provide appropriate support.

Research dealing with thermoplastic composites for foil applications with improved gas barrier properties was completed. The composites consist of platelets with high aspect ratio and thermoplastic polyurethanes as model systems. The platelets were finely dispersed and oriented in the polymer matrix using compounding techniques. The results highlighted important basic concepts that influence the morphology of polymer matrix-platelet composites, providing helpful routes to improve the material's performance in future developments.

OUTLOOK

Within INM's focus project competition, the project FLAKELUB investigates the friction mechanisms responsible for the observed synergistic lubrication effect when platelet shaped particles are added to classical low friction coatings. The project will start in 2014 and will be performed in collaboration with the Program Division *Nanotribology*. In 2014, the EU-project WELDAPRIME will be launched. This project will focus on the development of zinc free weld-able primer for steel. In the field of corrosion protection new synthesis routes for nanoparticulate corrosion inhibitors will be developed to improve active protection mechanisms in coating systems.



New scanning vibration electrode technique (SVET) established at INM to investigate localized corrosion phenomena.

OPTISCHE MATERIALIEN / OPTICAL MATERIALS

DR. PETER WILLIAM DE OLIVEIRA

ZIELSETZUNG

Der Programmbereich *Optische Materialien* ist mit der Entwicklung neuer Materialien zur optischen Funktionalisierung von Oberflächen befasst. 2013 wurden Industrieprojekte und öffentlich geförderte Projekte mit diversen nationalen und internationalen Partnern durchgeführt. Im Fokus der Forschung stand die Herstellung nanopartikulärer Beschichtungen, die die Ausbreitung des Lichts beeinflussen können. Effekte wie Beugung und Streuung, die durch die Brechwertanpassung von Nanopartikeln und Matrizes hervorgerufen wurden, finden in Lichtmanagementschichten für OLEDs Anwendung. Auch Schichten aus transparenten, leitfähigen Oxiden, wie Indiumzinnoxid oder Aluminiumzinkoxid, für die Anwendung in Displays, gedruckter Elektronik und Sensorik wurden 2013 intensiv erforscht. Für Anwendungen in der Medizin wurden szintillierende Partikel für bildgebende Röntgendetektoren und das Einbringen neutral photochromer Farbstoffe in flexible und faltbare Kunststoffmaterialien für Intraokularlinsen untersucht.

Dr. Peter William de Oliveira

has been head of the Program Division *Optical Materials* since 2005. He studied physics in Brazil and – after obtaining his master degree – started to work at the INM. In his doctoral thesis he adressed diffractive micro-optical components in nanocomposite materials.

MISSION

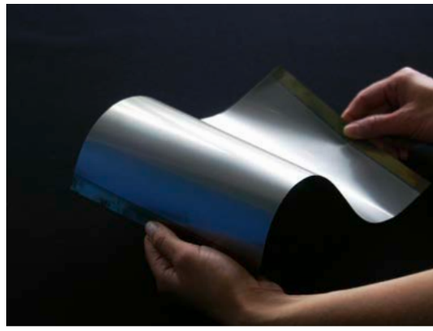
A major topic of the Program Division *Optical Materials* is glass and the improvement of its properties as well as the increase of its functionality by glassy, organic-inorganic or ceramic coatings. A second topic is new optical materials based on nanocomposites. Thus, novel properties can be "imported" into materials via nanoparticles with the materials remaining transparent. This method requires an exact control of the surface properties of the particles. A third topic is the development of glassy coatings on metals. In addition to materials development, all three areas depend on the development of economic coating techniques leading to high quality results.

CURRENT RESEARCH

In 2013, the focus of the basic research activities of the Program Division *Optical Materials* was mainly on the development of materials with photoactivity. Fluorescent ceramic particles are employed for secure printing to be used in documents, and for the authentication of products. To achieve this, research was started to develop a method for characterizing the fluorescence kinetics of rare earth doped fluoride powders. Beside the measurement setup, the development comprises also suitable protocols for measurement and data analysis. The method was tested on cubic sodium yttrium fluoride doped with neodymium, serving as a model material. The research on solar absorbers started in 2009 and was optimized in 2013. It will contribute to the next generation of mass production of alternative solar cells like Copper-Indium-Gallium-Selenide (CIGS) (figure).

Printing of electroluminescence lamps

Zinc sulfide (ZnS) nanoparticles were synthesized and doped with copper and manganese to produce blue or green lamps. The effects of the dopant concentration on the sulfides and the changes in luminescence spectrum were studied. We fabricated electroluminescence (EL) devices working with AC voltage on various glass and flexible substrates. The novel structure contains a single layer of ZnS:Cu,Mn(Cl) powder phosphorus which is embedded in an ITO matrix with one surface exposed. A layer of conductive nanostructures directly contacts the phosphor layer.



Stainless steel foil coated with a glass like system for flexible CIGS solar cells.

Development of light management coatings on float glass for optimized out-coupling from OLEDs

Two strategies for the improvement of out-coupling were followed. The first solution uses already pretreated glass with a thick high-refractive-index coating. The coating thickness could be adjusted between 3 and 7µm, the refractive index reaching values as high as 1.72. Temperature stability was obtained for 30 min at 200°C. The second solution was developed for flat float glass; according to simulations the high refractive index coating was filled with a defined volume percentage of silica particles with a mean diameter of 320nm as scattering centers. Coating of flat and pretreated glass samples was possible and a thickness of 5µm and a refractive index of 1.68 were achieved. OLEDs were successfully prepared with both solutions, and experiments with fluorescent coatings indicated an improvement for out-coupling by a factor of 2–3.

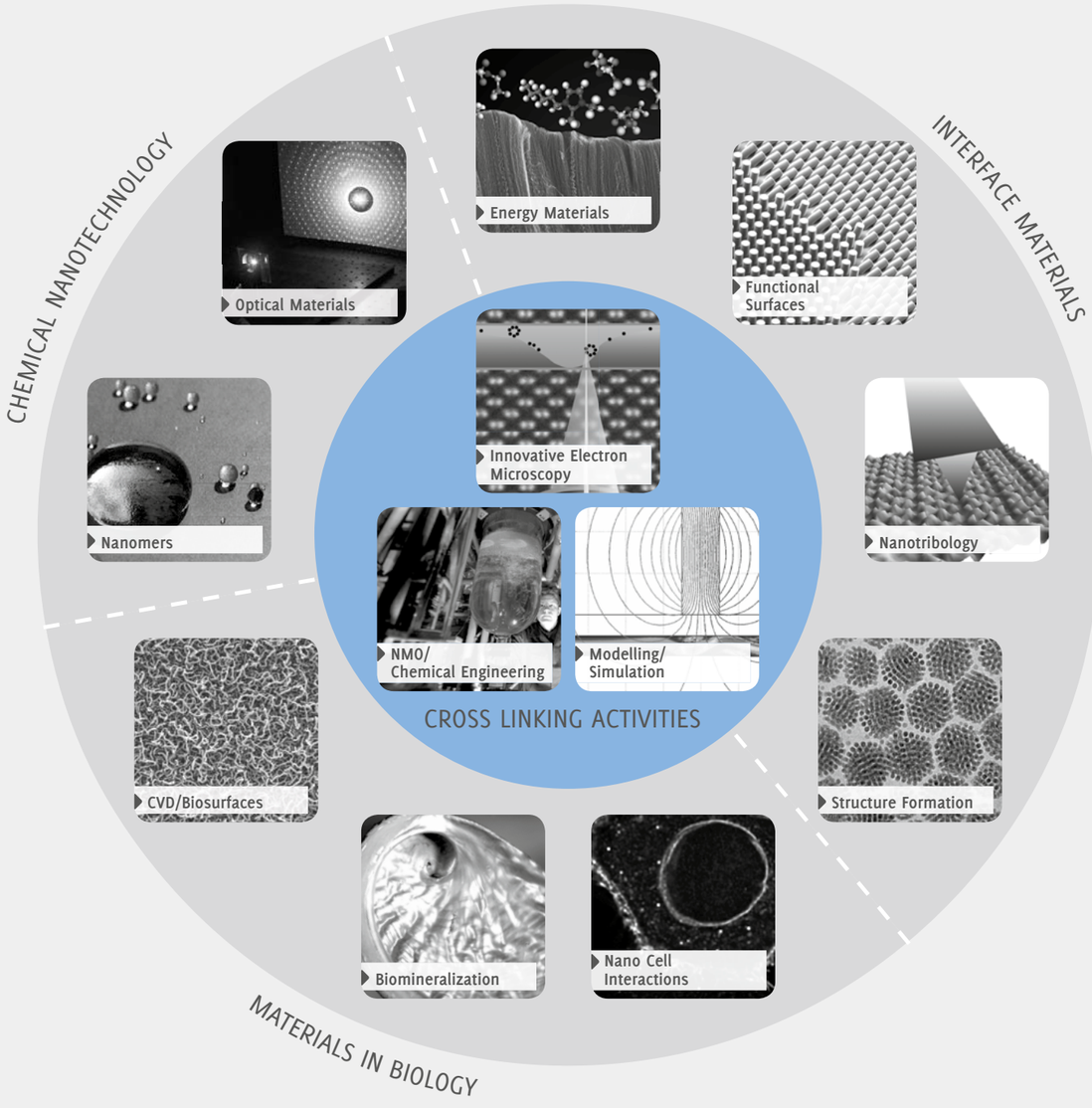
Development of new and improved tools for real-time monitoring of nanoparticle properties – PROJECT INSIGHT

The European project INSIGHT is focused on the development of new instrumentation for nanometrology, aiming at the determination of characteristic data like shape, size and composition of nanoparticles in-line during the manufacturing process. The data will be obtained by applying improved or new detection principles of processes like ultrasound, Raman spectroscopy, direct visualization etc. and collected under a common user interface. A joint understanding of treatment and characterization of nanomaterials has to be established for a final validation of the novel tools.

OUTLOOK

The combination of optical effects, material development and processing has been a core strategy of the Program Division *Optical Materials*. It has contributed to the sustainability of the technological platform and the balance between basic and applied research. Our long term goal is to understand how material development can be used to access new optical effects as basis for new products as well as to use the processing development to transfer this technologies to the market.

QUERSCHNITTSFELD / CROSS LINKING ACTIVITIES



QUERSCHNITTSFELD

Im *Querschnittsfeld* sind übergreifende Forschungs- und Entwicklungsthemen zusammengefasst, die die Arbeit der anderen Programmbereiche unterstützen sollen. Hierunter fallen auch alle Aktivitäten, die über Servicearbeiten hinaus eigene wissenschaftliche Forschungen beinhalten. So wendet der Programmbereich *Innovative Elektronenmikroskopie* die elektronenmikroskopische Methodik auf neue materialwissenschaftliche und biologische Fragestellungen an. Die Arbeiten des Programmbereichs *Modellierung/Simulation* zielen auf Forschungsarbeiten, die methodische Beiträge zu anderen Forschungsfeldern leisten. Der Programmbereich *NMO/Verfahrenstechnik* unterstützt primär die Entwicklung von Verfahren zur Aufskalierung von Synthese- und Beschichtungsmethoden.

Besondere Erfolge in 2013 beinhalten die Einwerbung eines Projekts im Leibniz-Wettbewerb (Programmbereich *Innovative Elektronenmikroskopie*).

Das Forschungsfeld besteht aus drei Programmbereichen:

- Programmbereich *Innovative Elektronenmikroskopie*, Leitung: Prof. Dr. Niels de Jonge
- Programmbereich *Modellierung/Simulation*, Leitung: N.N.
- Programmbereich *NMO/Verfahrenstechnik*, kommissarische Leitung: Dr. Carsten Becker-Willinger und Dr. Peter W. de Oliveira

CROSS LINKING ACTIVITIES

The area combines comprehensive research and development activities, which are supposed to methodically complement the competencies of the research fields. Among these activities, independent scientific research is of particular importance. For example the Program Division *Innovative Electron Microscopy* works on the application of electron microscopic techniques to material-related and biological problems. The work of the Program Division *Modelling/Simulation* aims at research providing a methodic contribution to other Program Divisions. The Program Division *NMO/Chemical Engineering* primarily supports the development of methods for up-scaling synthesis or coating methods to the pilot plant scale.

Special success in 2013 included the acquisition of a project in the competitive program of the Leibniz Association (Program Division *Innovative Electron Microscopy*).

The area consists of three Program Divisions:

- Program Division *Innovative Electron Microscopy*, Head: Prof. Dr. Niels de Jonge
- Program Division *Modelling/Simulation*, Head: N.N.
- Program Division *NMO/Chemical Engineering*, temporarily headed by Dr. Carsten Becker-Willinger and Dr. Peter W. de Oliveira

INNOVATIVE ELEKTRONENMIKROSKOPIE / INNOVATIVE ELECTRON MICROSCOPY

PROF. DR. NIELS DE JONGE

ZIELSETZUNG

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

Prof. Dr. Niels de Jonge

is a biophysicist working on biological electron microscopy and nanotechnology. He has been head of the Program Division since 2012 and since 2013, Honorary Professor of Experimental Physics at Saarland University. He is also Adjoint Assistant Professor of Biophysics at the Vanderbilt University School of Medicine, USA.

MISSION

The Program Division *Innovative Electron Microscopy* (IEM) conducts interdisciplinary research at the interface of bio-nanotechnology, materials science, cell biology, physics of electron microscopy (EM), and image processing. The group also provides service for nanoscale analysis of materials using electron microscopy and X-ray diffraction (figure).

CURRENT WORK

Aberration-corrected STEM

The INM has recently acquired a state-of-the-art aberration-corrected scanning transmission electron microscope (STEM; 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 to 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. Our 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 because of the greatly reduced depth of field in an aberration-corrected STEM.

Loading of a sample in the environmental scanning electron microscope for a service project.

Liquid STEM

The group recently developed a novel method to image whole eukaryotic cells in liquid using a microfluidic chamber for STEM. Eukaryotic cells in liquid are enclosed within a thickness of up to 10 µm 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.

Collaborations

Various collaborations exist with research groups in Europe, such as Prof. F. Mücklich (Saarland University), Prof. P. Slusallek (DFKI, Saarbrücken) including the joint supervision of a Ph. D student, Prof. V. Flockerzi (Saarland University), Dr. Korf (DFKZ, Heidelberg), Prof. N. Sommerdijk (Eindhoven University, Netherlands), and Prof. Dr. K. P. de Jong (University of Utrecht, Netherlands). Furthermore, there are ongoing research projects with Prof. A. K. Kenworthy, Vanderbilt University School of Medicine, Nashville, TN, USA. Collaboration exists with the small US business Protochips Inc, NC, USA.

OUTLOOK

The group is well equipped to conduct research at the international forefront of electron microscopy both in the areas of biology/biophysics, and materials science, including also energy science. A new research project entitled "Electron microscopy of labeled protein complex subunits in whole cells in aqueous environment" funded by the Leibniz Association will start in 2014. It can be expected that several other grants on electron microscopy in liquids and on aberration-corrected 3D STEM will be funded in the near future.

MODELLIERUNG/SIMULATION / MODELLING/SIMULATION

N.N.

ZIELSETZUNG

Aufgabe des Programmbereichs ist die Erstellung von Modellen und Simulationen. Zukünftig sollen auch verstärkt eigene Forschungsprojekte betrieben werden. Im Jahr 2013 wurden zwei Forschungsprojekte in enger Verzahnung mit anderen Gruppen 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 Projekt *TriboBrain* befasst sich mit der Identifizierung und Analyse hirnelektrischer Antwortpotentiale, welche im Zuge tribologischer Experimente zwischen dem menschlichen Finger und unterschiedlichsten Materialien gewonnen werden.

MISSION

The Program Division is supposed to prepare models and perform simulations. In the future, the division will increasingly perform its own research projects.

CURRENT RESEARCH

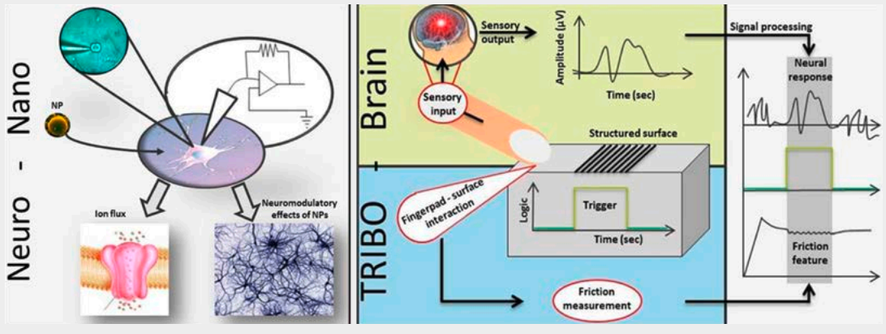
NeuroNano (with Program Division *Nano Cell Interactions*)

The purpose of the present modeling study was to develop a computational multiscale model that links the neuronal activity of a single neuron in the high-resolution domain of the well-established Hodgkin-Huxley model across a circuitry of such neurons up to neural field potentials generated by those neurons. Such models allow to investigate how small changes, e.g. synaptic coupling, channel activation, etc., induced by pharmaceutical agents or nanoparticles may influence more macroscopic potentials quasi *in vivo*. The model input was based on own patch-clamp data of nanoparticle cell interactions. After successfully being able to model neural fields originating from Hodgkin-Huxley type neurons, another object was to close the loop between field potentials and its generators: we investigated how the neural field potentials influence the spike generation in neurons that are physically located within these fields, if this feedback causes relevant changes in the underlying neuronal signaling within the circuit, and if this is strong enough to cause observable changes in the generated field potentials themselves. Due to our patch-clamp data, the linear model is also able to forecast the depth that nanoparticles, brought in contact with a few cells in the network, have on neural field potentials. We found the emerging field potentials of a basic two-dimensional, two-layer model to be extensively diversified after assuming feedback to pyramidal neurons. The field potentials have strong effects on the action potential generation of neurons that are exposed to those fields. Applying this developed model to simulate the effects nanoparticles affecting cells in small scale have on field potentials of much higher scale, we found that nanoparticles in thalamic tissue may cause distortions in cortical field potentials. This linear model may subserve as basic approach to estimate the spatiotemporal dynamics of cortical field potentials on a very small cortical patch that may be electrophysiologically measurable. Such models are important for a further understanding of possible benefits and risks of the exposure of neuronal structures to NPs, thus being relevant for nanotoxicology.

TriboBrain – Identifying neural response to tribological stimuli (with Program Divisions *Nanotribology* and *Functional Surfaces*)

The relation between materials properties and structure on one hand and grip and feel upon touch on the other hand is an emerging field of science, often referred to as haptics. The relation has so far been explored mostly by psychometric tests of individuals rather than by measurable physiological signals reflecting the haptic perception. Here we propose an innovative new approach to the design of haptic materials by the objective assessment of the brain dynamics induced by frictional touch.

Up to date to carry out an electrophysiological study with respect to haptic perception, no ubiquitous experimental setup is available. Thus, a haptic based human-machine-interface (HbHMI) called *TriboBrain* has been developed. It is in the nature of human being that haptic information is gathered through active exploration of objects by the hand where thousands of receptors detect and convert external information. But vice versa information can also be transferred in a passive tactile manner through specified conditions which are not defined by the human being. Therefore, *TriboBrain* is built up in a way that both passive and active surface texture tasks are possible to be performed. The system allows one to present different structures in a controlled manner and provides an interface connecting the system to an electroencephalographic (EEG) recording stage. Thus, we are able to study neurophysiological events and evaluate whether their appearance can be correlated to the tribological signals and ultimately to the surface material and structure. Preliminary results for the stimulation of the fingertip sliding over self-designed blocks divided into no structure/structure/no structure parts show a clear correlation between the onset of the structured surface area and EEG signals. To gap the bridge, multisensory integration such in haptic interfaces can be validated due to modeling and simulation strategies. Here we can evaluate whether the strategies used are optimal conditioned or compare gathered data against the optimal integration model.



NMO/VERFAHRENSTECHNIK / NMO/CHEMICAL ENGINEERING

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

ZIELSETZUNG

Das Anwendungszentrum *NMO/Verfahrenstechnik* ist die Schnittstelle für den Transfer materialtechnischer Entwicklungen aus dem INM in die Industrie. *NMO* entwickelt spezifische, materialangepasste Applikationsmethoden basierend auf technisch verfügbaren Verfahren für Kooperationspartner des INM aus der Industrie und führt auf Kundenwunsch auch die Maßstabvergrößerung chemischer Synthesen inklusive Qualitätssicherungsprogramm durch. Weiterhin unterstützt das Anwendungszentrum im Rahmen von F&E-Projekten mit der Industrie den modularen Aufbau von Prozessequipment, das nach erfolgreichem Abschluss der jeweiligen Projektphase an den Kooperationspartner übergeben werden kann.

MISSION

The application centre *NMO/Chemical Engineering* is the interface for the transfer of material technologies from the INM into the industry. The *NMO* develops specifically designed and material adapted application methods based on technical available methods for cooperation partners from industry. On customers' request, the *NMO* also takes up the task of up-scaling chemical synthesis processes including quality assuring measures. Furthermore in the frame of R&D projects, the *NMO* supports the modular construction of process related equipment, which can be transferred to the cooperation partners after the end of the project phase.

Dr. Carsten Becker-Willinger

studied chemistry at the Albert-Ludwigs-University in Freiburg with a focus on macromolecular chemistry. From 1993 to 1998, he worked on his doctoral thesis at the INM with Prof. H. Schmidt. In 2001, he became head of the Program Division *Nanomers*.

Dr. Peter William de Oliveira

studied physics in Brazil and – after obtaining his master degree – started to work at the INM. In his doctoral thesis he adressed diffractive micro-optical components in nanocomposite materials. He has been head of the Program Division *Optical Materials* since 2005.

CURRENT WORK

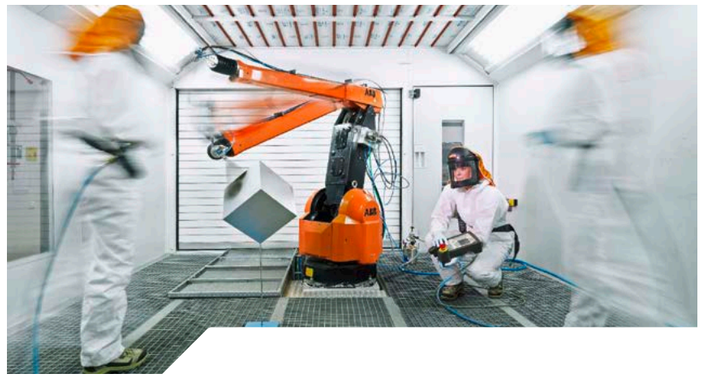
In the past year several process developments in the framework of technology phases of bilateral projects between INM and the industry have been performed in the application centre *NMO/Chemical Engineering*.

One field of activity comprises the coating of internal surfaces of steel tubes with corrosion protection coatings. In this work a new coating head has been successfully tested on a six axis robotic system which allows the application of an increased coating thickness using coating liquids having a higher solid content. With the newly developed procedure many samples from the project partner have been coated for an extended testing program. All the substrates could be pre-cleaned with a newly installed sand-blasting equipment which is in operation since the mid of 2013.

On the roll-to-roll coating machine a new slot coating head designed by the Service Group *Engineering* in cooperation with the Program Division *Optical Materials* has been installed and successfully used to manufacture anti-reflective coatings on polymer foils.

In the coating process portfolio a new tumble spray coating machine has been installed that allows the simultaneous spray coating and drying for coating deposition on tip material. It will be used in 2014 to develop a coating process for corrosion protection on screws. The standardized testing equipment has been expanded by the implementation of a Kesternich test used in automotive industry and by a temperature shock test that allows the test of the cyclic thermal stability of complete devices as for example used in electronic industry.

In addition to this, a lot of sampling work has been performed for potential industrial customers. Industry partners from very different branches send their parts for coating with materials from the INM technology platform shelf in order to show basic effects and to provide starting points for cooperation in research and development.

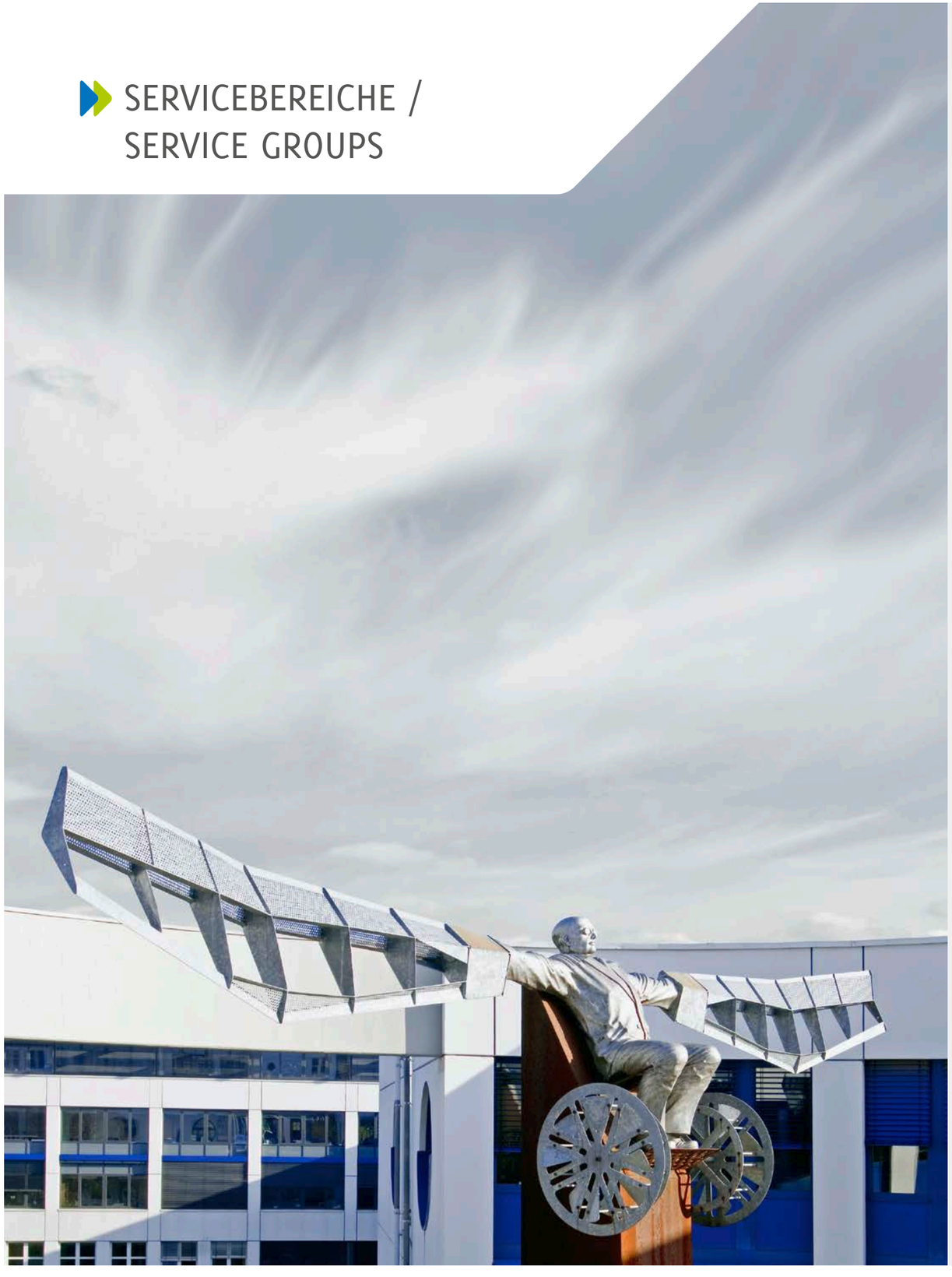


Trommel-spray coating equipment for tip material.

OUTLOOK

In the past years, several rearrangements have been performed at *NMO* that led to a significant streamlining. To promote the technical activities it is envisaged to perform technology development in various R&D-projects with industry such as for example process development for wet chemical coatings for the protection of electronic devices used in automotive industry and tip material coatings for environmentally friendly corrosion protection on metal parts.

SERVICEBEREICHE / SERVICE GROUPS



SERVICEBEREICHE

Die Forschungsfelder werden in ihrer Arbeit von vier Servicebereichen unterstützt:

Der Servicebereich *Analytik* unterstützt die Programmbereiche durch ein breites Spektrum analytischer Dienstleistungen, etwa in der Atomspektrometrie, Chromatographie und hochauflösenden Kernresonanz-Spektroskopie (NMR). Die Arbeiten umfassen neben Routinemessungen die Optimierung von Messmethoden und die Entwicklung komplexer Analysemethoden.

Die *Bibliothek* des INM erbringt Serviceleistungen im Bereich Information, Dokumentation, Recherche und Dokumentlieferung. Hauptaufgabe ist die effektive Literatur- und Informationsversorgung der Beschäftigten des INM. Daneben ist sie zentrale Dokumentationsstelle, pflegt die INM-Publikationsdatenbank und gibt jährlich die INM-Jahresbibliographie heraus.

Der Servicebereich *Engineering* entwickelt und stellt Anlagen und Komponenten für die Programmbereiche her. In enger Kooperation mit den wissenschaftlichen Bereichen werden die Konzepte entwickelt, die Umsetzung erfolgt in den Werkstätten durch weitestgehend eigene Produktion. Dabei reicht die Bandbreite von kleinen Laborgeräten bis zu großen Pilotanlagen.

Die *Werkstoffprüfung* ermittelt Werkstoffkenngrößen unter mechanischen, thermischen oder chemischen Beanspruchungen. Neben mechanischen Charakterisierungsverfahren werden thermische Charakterisierungsverfahren und Infrarotspektroskopie angeboten. Im Bereich der *Pulversynthese* stehen die Synthese von Nanopartikeln sowie das Up-Scaling bis in den Technikumsmaßstab im Vordergrund.

SERVICE GROUPS

Four Service Groups support the research fields in their work:

The Service Group *Analytics* supports the research fields by providing analytical tools and knowledge. For this purpose a variety of methods for preparation and analysis are available, such as chemical extraction techniques, element analysis, chromatography and structure determination with high-resolution NMR spectroscopy. The tasks range from standard characterization procedures to the optimization of characterization methods and the development of complex new analysis routes.

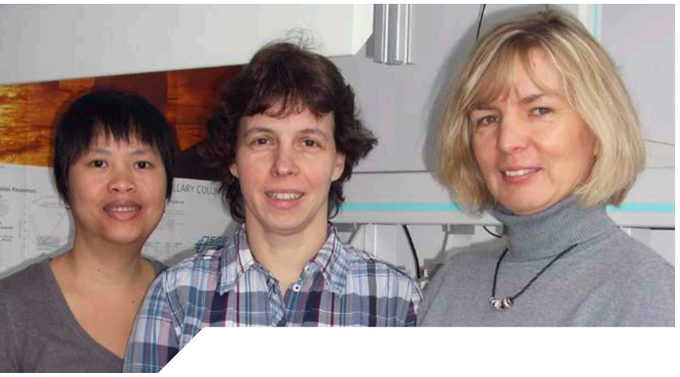
The *Library* of the INM provides services in the area of information and documentation. Its main task is the supply of information to the INM´s employees. At the same time it is also the center for documentation of the publications and presentations by the staff, and edits INM´s annual bibliography.

The Service Group *Engineering* deals with the development and construction of devices and components for the program divisions. In close cooperation with the scientific departments the concepts are developed, based on which the constructions are carried out. The implementation is in most cases performed in the institute´s own workshop. The output of the group ranges from small laboratory scale equipment to pilot plant scale devices.

The Service Group *Materials Testing/Powder Synthesis* investigates parameters of material samples under mechanical, thermic or chemical loads. Besides mechanical characterization, thermal characterization techniques and infrared spectroscopy are available. In the field of *powder synthesis* the syntheses of nanoparticles as well as the up-scaling to pilot plant scale are in the focus of the activities.

ANALYTIK / ANALYTICS

DR. CLAUDIA FINK-STRAUBE



Der Servicebereich *Analytik* hat die Aufgabe, die wissenschaftlichen Programmbereiche durch die Bereitstellung leistungsfähiger, analytischer Methoden zu unterstützen. In direkter Abstimmung mit den Auftraggebern werden die erforderlichen analytischen Messmethoden erarbeitet und an die konkreten Fragestellungen angepasst.

Derzeit stehen folgende Präparations- und Analysemethoden zur Verfügung:

- Aufschlusstechniken für anorganische und -organische Proben, wie Säure-/Schmelzaufschluss, Mikrowellenaufschluss und Hochdruckaufschluss.
- Moderne Verfahren zur Trennung und Analyse von flüchtigen und löslichen organischen Stoffgemischen mit Chromatographie (GC-MS, HPLC, GPC).
- Strukturaufklärung mit hochauflösender Kernresonanz-Spektroskopie (NMR).
- Komplettes Sortiment zur Element-Analytik, beispielsweise Atomemissionsspektrometrie mit induktiv gekoppeltem Plasma (ICP OES) und hochauflösende Kontinuum-Strahler
- Atomabsorptionsspektrometrie (AAS) mit Flammen- und Graphitrohrtechnik.

ARBEITEN 2013

Neben den analytischen Fragestellungen für die wissenschaftlichen Programmbereiche des Institutes wurden im Berichtszeitraum ca. 10 % aller Analysenaufträge für Kooperationen mit der Universität bearbeitet.

Beispiele aus bearbeiteten Projekten:

- Quantitative Silber-Bestimmung antimikrobieller Wundpflaster nach Auslaugung in Wasser und künstlichem Schweiß mit GFAAS.
- Vergleichende Untersuchungen zur Kupferfreisetzung in E. coli K12 Zellmedien nach Deposition auf verschiedenen Kupferoberflächen mit GFAAS.
- Qualitative Fettsäuren-Analytik in Aragonit-Plättchen mit GC-MS.
- Ermittlung der mittleren Molekulargewichte von Sol-Gel-Materialien verschiedener Synthesestufen mit GPC.
- Quantitative Untersuchungen zur Metallverteilung archäologischer Holzproben mit ICP OES nach Mikrowellenaufschluss.

AUSBLICK

Aufgaben im Jahr 2014 werden etwa die Ermittlung des Silber-Auslaugverhaltens von antimikrobiellen Haushaltstüchern mit ICP OES sowie die Quantifizierung der Molekulargewichtsverteilungen in Sol-Gel-Materialien mit GPC sein.

BIBLIOTHEK, INFORMATION & DOKUMENTATION / LIBRARY, INFORMATION & SERVICES

ELKE BUBEL

Die *Bibliothek* des INM ist eine wissenschaftliche Spezialbibliothek und erbringt Serviceleistungen im Bereich Information und Dokumentation. Sie ist die zentrale Dokumentationsstelle für die Publikationen und Vorträge des INM. Sie pflegt die INM-Publikationsdatenbank und gibt jährlich in gedruckter Form die INM-Jahresbibliographie heraus. Die *Bibliothek* ist öffentlich zugänglich.

ARBEITEN 2013

AK Bibliotheken und Informationseinrichtungen der Leibniz-Gemeinschaft

Die *INM-Bibliothek* ist aktiv im Sprecherrat des Arbeitskreises „Bibliotheken und Informationseinrichtungen“ der Leibniz-Gemeinschaft vertreten. Sie ist maßgeblich bei der Koordination des Arbeitskreises, der Organisation von Fortbildungen und der Jahrestagung, der Bildung von Einkaufsgemeinschaften sowie der Kontaktpflege zu den bibliothekarischen Gremien der Allianz beteiligt.

Elektronische Lizenzen

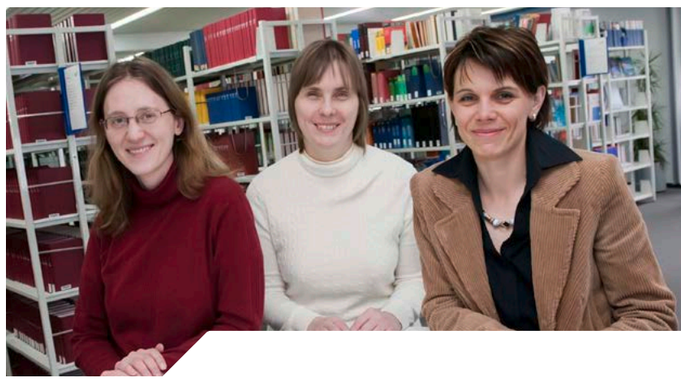
Elektronische Zeitschriften und Datenbanken bezieht die *INM-Bibliothek* über Verlags-, Konsortial- sowie National- und Allianz-Lizenzen. Bestehende Konsortialverträge innerhalb der Leibniz-Gemeinschaft wurden verlängert, neue Verträge geprüft und abgeschlossen. 2013 wurden außerdem Strukturen zum Erwerb von E-Books geschaffen.

INM-Publikationen und Open-Access (OA)

INM-Publikationen, die den Open-Access-Kriterien entsprechen, werden auf LeibnizOpen, dem OA-Repositorium der Leibniz-Gemeinschaft, veröffentlicht. 2013 wurde eine Kooperationsvereinbarung mit der Zentralbibliothek für Medizin (ZB MED) Köln und dem Springer-Verlag vorbereitet: Über eine Prepay-Membership erhalten INM-Autorinnen und -Autoren künftig Rabatte bei OA-Publikationsgebühren des Springer-Verlages.

AUSBLICK

Künftige Themen sind die konsortiale Erwerbung von elektronischen Informationsprodukten, neue Open-Access basierte Publikationsmodelle sowie die Verbesserung der Zugriffsmöglichkeiten von außen auf elektronische Ressourcen der *INM-Bibliothek*.



ENGINEERING / ENGINEERING

DIETMAR SERWAS

AUFGABE DES SERVICEBEREICHS

Mit der Entwicklung und Herstellung wissenschaftlicher Anlagen und Komponenten für die Grundlagenforschung und im Rahmen von Projekten ist der Servicebereich *Engineering* schwerpunktmäßig Dienstleister für die Programmbereiche des INM. Die Bandbreite der Arbeiten reicht hierbei von kleinen Laborgeräten bis hin zu großen Pilotanlagen. Aus den Vorgaben der Forschung werden in enger Verzahnung mit den wissenschaftlichen Bereichen die Konzepte entwickelt, aus denen die Konstruktionen erstellt werden. Die Umsetzung erfolgt in den Werkstätten durch weitestgehend eigene Produktion. Dies beinhaltet sowohl die mechanische Fertigung der Einzelteile, als auch die Entwicklung von Steuerungen und Software bis hin zum Zusammenbau von kompletten Anlagen. Ein weiteres Arbeitsgebiet ist die Messwerterfassung zur Charakterisierung elektrischer Materialeigenschaften. Zur Bewerkstelligung dieser Arbeiten stehen als Ausrüstungen unter anderem CATIA-V5-CAD/CAM-Arbeitsplätze, 5-Achs-HSC-Präzisionsfräsmaschine, sowie SPS-Programmiergeräte zur Verfügung. Im Rahmen einer Kooperation werden die Werkstattarbeiten für den Lehrstuhl „Technische Physik“ der Universität des Saarlandes durchgeführt. Außerdem hat die Ausbildung einen hohen Stellenwert, was sich im Auszubildendenanteil in der Gruppe von 20 % spiegelt.

ARBEITEN 2013

- Um die Temperaturschwankungen aus der Umgebung auszugleichen, wurde der Arbeitsraum der HSC-Präzisionsfräsmaschine zur Steigerung der Genauigkeit mit einer Temperierung ausgestattet.
- Bau eines Ofensystems mit Chlorgas, Wasserstoff und Ammoniakversorgung.
- Herstellung von Teilen aus Titan im mikro mechanischen Bereich.
- Kombinierter Leitfähigkeits- und pH-Messumformer für CDI-Zelle.

AUSBLICK

Als Schwerpunkte in 2014 sind die Einführung einer neuen Software für Werkstattarbeiten und die Auftragsverwaltung sowie die weitere Vertiefung im Arbeitsgebiet der Mikromechanik geplant.

WERKSTOFFPRÜFUNG/PULVERSYNTHESE / MATERIALS TESTING /POWDER SYNTHESIS

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.

Neben den mechanischen Charakterisierungsverfahren werden thermische Charakterisierungsverfahren wie Dilatometrie, DTA/DSC sowie die Simultane Thermo-Analyse (STA), eine Kombination von Thermogravimetrie mit DTA/DSC und 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 werden zudem Untersuchungen zum Dispergierverhalten von nanoskaligen Partikeln in flüssigen und pastösen Medien durchgeführt.

ARBEITEN 2013

Ein wesentliches Projekt war die Konzeption einer inversen Tauchbeschichtung. In Zusammenarbeit mit dem Programmbereich *Optische Materialien* wurde eine neuartige Beschichtungstechnologie basierend auf einer Universalprüfmaschine konzeptioniert. In der ersten Ausbauvariante sollen dabei Flachglasscheiben bis 1,70 m Länge homogen einseitig beschichtet werden können. Das neuartige Verfahren erlaubt eine Reduzierung der benötigten Menge an Beschichtungssol auf wenige Milliliter pro Quadratmeter Beschichtungsfläche.

HIGHLIGHTS

NANOPOROUS CARBONS FOR CAPACITIVE DEIONIZATION OF BRACKISH WATER

V. PRESSER, D. WEINGARTH, J. S. ATCHISON, S. PORADA

Porous carbon

Pore size distribution

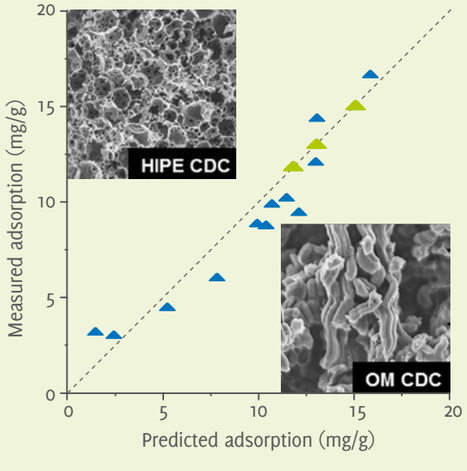
ζ-function

Predicted salt adsorpttion capacity

Capacitive deionization

Capacitive deionization (CDI) is an emerging technology for the energy efficient removal of salt from water by electrosorptive ion immobilization. CDI has emerged as a highly attractive technology for low salt concentration as commonly found, for example, at coastal lines, estuaries, or mangroves. The Junior Research Group *Energy Materials*, in collaboration with Wetsus Centre of Excellence for Sustainable Water Technology (the Netherlands; Dr. P. M. Biesheuvel) and the Technical University in Dresden (Prof. S. Kaskel) has now established a comprehensive understanding of the role of nanopores (i.e., pores smaller than 1 nm) in porous carbons. Until recently, such small pores were deemed detrimental to the performance of CDI systems because of largely overlapping electrical double layers and impeded ion mobility.

In our work, we have shown that nanopores are not only relevant for ion electrosorption in aqueous media, but are much more effective for salt removal. Compared to mesopores (i.e., pores between 2 and 50 nm), the salt removal capacity of pores smaller than 0.8 nm is enhanced by a factor of 5 and for pores between 0.8 and 1.0 nm by a factor of 3. Establishing the pore size dependent salt removal, it was possible to establish the first predictive model for CDI. Our model was calibrated by using three micro- and mesoporous carbide-derived carbons with tuned pore structure. The analysis was based on easy-to-obtain porosity data derived from nitrogen gas sorption analysis so that our model can be used as a facile tool to guide the development of porous carbons for CDI. We also show that a higher packing of carbon particles in the CDI electrodes severely influences the salt removal kinetics and an optimum can be found for a packing density of around 40%. The results were published in: Energy & Environmental Science (2013, 6, 3700–3712) and Progress in Materials Science (2013, 58, 1388–1442).



Contact: Jun.-Prof. Dr. Volker Presser
Junior Research Group *Energy Materials*

Fig. 1: Concept of capacitive deionization (CDI) for the generation of drinking water.
Fig. 2: Concept of our CDI model and parity plot for predicted and measured salt removal. Carbide-derived carbons (diamonds), literature data (triangles).

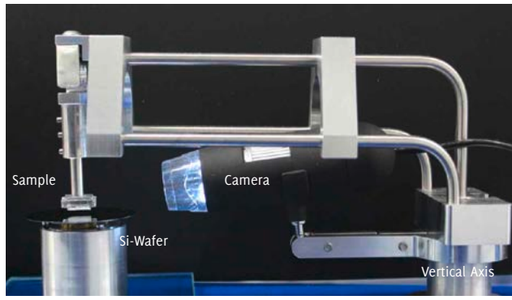
PRESSURE-ACTUATED GECKO STRUCTURES

E. KRONER, J. BLAU, D. PARETKAR, E. ARZT

Handling processes in robotics require a mechanism that allows grab and release of objects, for example in assembly processes or for sorting of different products. Current systems are often based on mechanical grabbers or vacuum based suction systems. However, mechanical grabbers tend to damage sensitive surfaces and vacuum systems cannot be applied to all surface geometries and consume a significant amount of energy. There is thus an urgent need for the use of switchable adhesives in production lines.

Scientists in the *Functional Surfaces* Group have developed pressure actuated adhesion systems. These bioinspired adhesives are equipped with rubber elastic surface structures, which are inspired by the adhesive structures of geckos. The special structure allows switching between an adhesive and a non-adhesive state by applying various compressive preloads; for instance, if the adhesive is brought into contact with a surface at low pressure, the structures adhere and the object can be lifted. If a high compressive pressure is applied, the structures bend and lose contact, which results in a release of the object. Thus, the system allows for picking and placing objects by varying the compressive load. The soft structures allow for the handling of sensitive surfaces and fragile objects without damaging them. The attachment system does not require energy for adherence and can be easily implemented into existing robotic systems. Further, the adhesive system is easy to clean and shows excellent reversibility.

A robotic system has been equipped with a switchable adhesive system for demonstration. The robot is capable of lifting objects with a mass of more than 100 g using an adhesive pad of 1 cm² area. High-cycle testing has shown that more than 50.000 pick and release steps can be realized without any measureable loss in performance. This new bio-inspired adhesion system is now ready for use in industrial application.



Contact: Dr. Elmar Kroner
Program Division *Functional Surfaces*

Fig. 1: Demonstrator for reversible pick & place process of a silicon wafer.
Fig. 2: Silicon Wafer lifted using the bioinspired switchable adhesion system.

DENSE ARRAYS OF SUB-MICRON HOLES IN SILICON WAFERS

D. BRODOCEANU, R. ELNATHAN*, B. PRIETO-SIMÓN*, N.H. VOELCKER*, T. KRAUS
*) Mawson Institute, University of South Australia

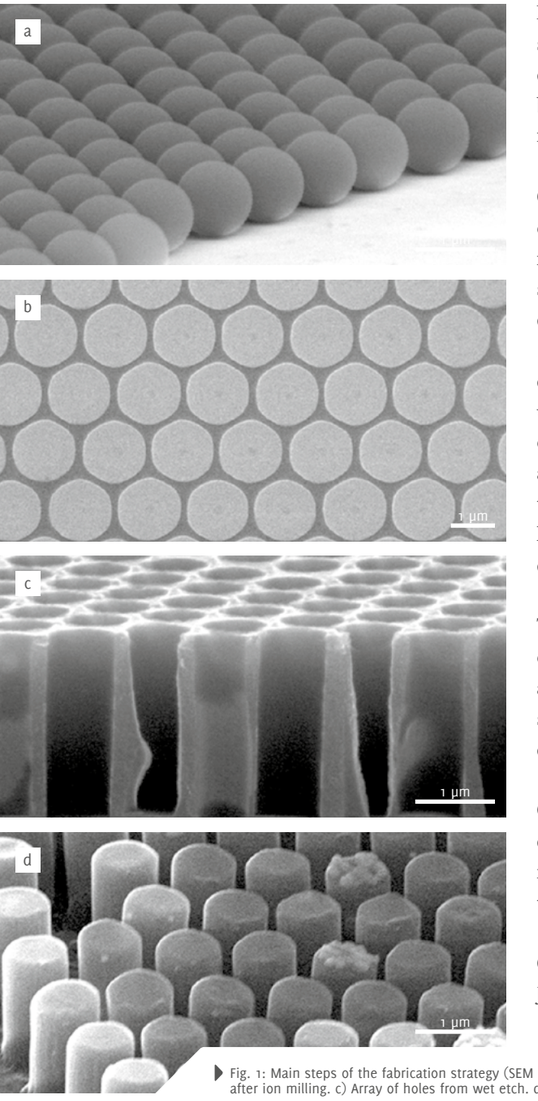


Fig. 1: Main steps of the fabrication strategy (SEM micrographs): a) Polystyrene particles assembled on a gold-coated Si wafer. b) Array of gold disks after ion milling. c) Array of holes from wet etch. d) Array of polymer pillars from replica molding (hot embossing) using the silicon templates.

Inexpensive yet reliable routes for fabrication of regular arrays of submicron holes on square centimeter areas can improve the production and performance of solar cells, plasmonic devices, Li-ion batteries, biosensors as well as masters for replica molding for biomimetic functional surfaces.

Our group develops particle-based methods to fabricate dense arrays of straight holes with high aspect ratio in silicon. Figure 1 shows the main technological steps. Polymer particles are convectively self-assembled on a gold-coated silicon wafer (Fig.1a) and ion-milled, yielding well-defined metal disks with excellent long-range order (Fig. 1b). The disks are subsequently used as catalysts in a metal-assisted chemical etching (MACE) process to achieve deep holes in silicon, with vertical walls and flat bottoms (Fig. 1c). Spacing and diameter D of the holes (200 nm < D < 3 µm) depend on the polymer particle size and the duration and intensity of the ion mill process. The depth of the holes depends on the wet etching time. Ordered arrays of vertical holes with aspect ratios up to 6 have been demonstrated, unusually deep for wet-etched discontinuous structures.

The ordered porous silicon material is suitable for replica molding of both polydimethylsiloxane (PDMS) and other polymers (Fig. 1d) and yields fibres that we assess for the use as bioinspired adherent structures. Other applications for sensors and optical purposes are currently under investigation.

Compared to other fabrication techniques such as photolithography, e-beam lithography or nanoimprinting, the method presented here requires little equipment and no lithographic steps. We will scale it to larger areas for future applications.

Contact: Dr. Tobias Kraus
Junior Research Group *Structure Formation*

STIGMERGIC BEHAVIOR IN BIOMINERALIZATION

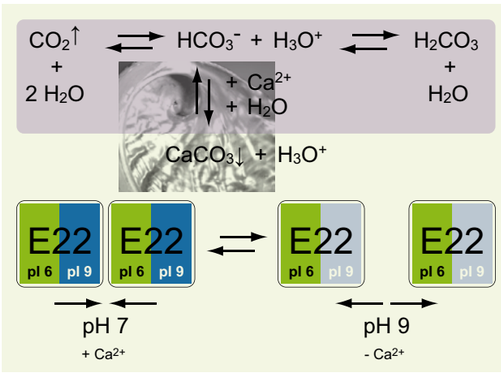
I. M. WEISS

The question of how molluscs exert control over the three-dimensional micro-textures of their ceramic shells is still far from being solved. The mollusc chitin synthase, an enzyme located next to biomineralizing interfaces, recently provided new mechanistic insights: A small part of the enzyme, we call it E22, which is usually exposed to the mineralization site in the living organism, was biotechnologically synthesized and purified in a soluble form. It turned out that this protein formed agglomerates with decreasing pH, whereas monomers are only stable at pH 9. Taking into account that the precipitation of calcium carbonate from solution is intimately linked to a shift in pH, one can imagine that cyclic pH-changes ranging from pH 7 to pH 9 may always occur at the site of mineralization. How would an organism deal with the situation?

Let's assume that chitin, the organic template of mollusc shells, is controlled by switchable assembly and disassembly of enzymes into hexagonal structures: In the case of E22, switchability would be linked to pH as the fundamental parameter for mineral precipitation in solution and CO_2 partial pressure (Fig. 1). The E22, also pH-dependent, performs directed assembly on structured mineral surfaces (Fig. 2). Hence, enzyme regulation would involve all states of matter.

Taken together, our experiments suggest robust communication between biopolymerization of chitin and dynamic mineral templates. This enzyme has the potential to fulfill the criteria for stigmergic behavior – a form of indirect communication – in biomineralization. In this, all sorts of various molecular components finally end up in very few evolutionary advantageous textures, which are more than the sum of their parts.

Contact: PD Dr. Ingrid Weiss
Program Division *Biomineralization*



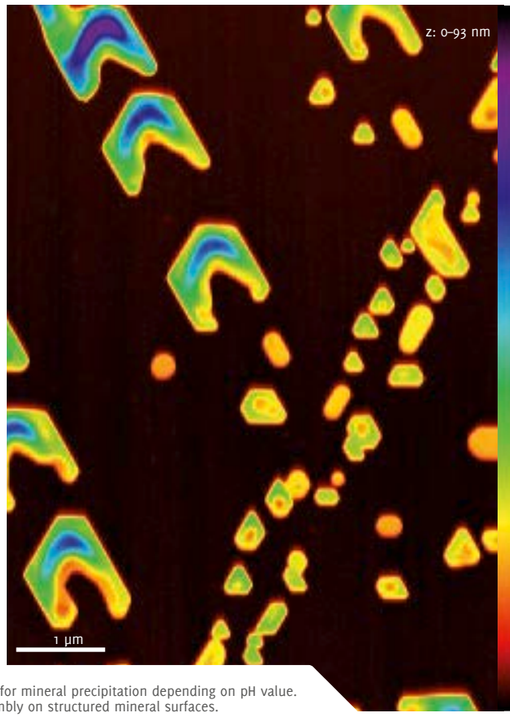
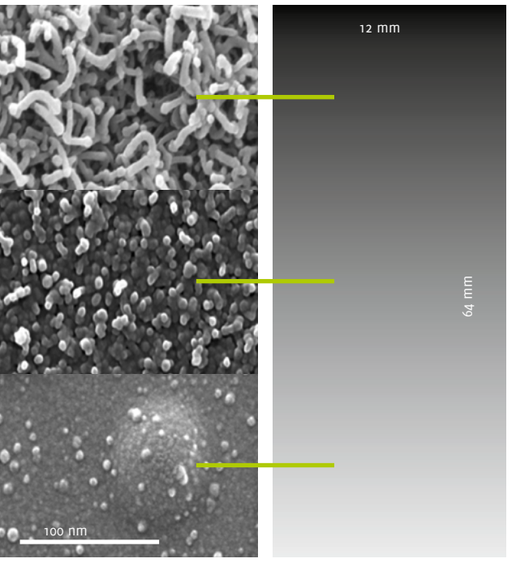


Fig. 1: Switchability of E22 assembly for mineral precipitation depending on pH value.
Fig. 2: Example of directed E22 assembly on structured mineral surfaces.

NANOSTRUCTURES FOR SCREENING STEM CELL PROLIFERATION AND DIFFERENTIATION

C. AKTAS, M. MARTINEZ, C. DUFLOUX, M. VEITH, N. VOELCKER*
*) Mawson Institute, University of South Australia



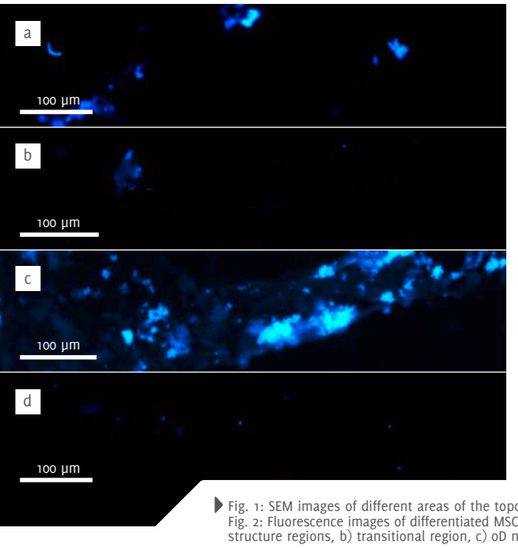


Fig. 1: SEM images of different areas of the topography gradient (scale bar = 100 nm).
Fig. 2: Fluorescence images of differentiated MSCs stained with calcein blue on a) 1D nanostructure regions, b) transitional region, c) 0D nanoparticle region, d) glass control.

Recent studies show that nano-scaled topography of the substrate influences the morphology, alignment, migration, and proliferation of the cell. The proven impact of nanotopography on basic cell function and gene expression indicates that it might be possible to direct even cell differentiation by surface features. A common approach to study the effect of the nanotopography on stem cell differentiation is to prepare different surface structures by systematically altering their geometrical features. The time-consuming processing and analysis of several substrates with various surface topographies seriously limits the success of studies carried out on topography-induced differentiation. Incorporating topographic gradients on the same substrate can serve as a high-throughput and much faster analysis tool. In this context, we developed a novel topography gradient (Fig. 1) by introducing nanostructures with aspect ratios (AR) varying between 1–15 on the same substrate. Afterwards we cultured mesenchymal stem cells (MSCs) harvested from the bone marrow of Wistar rats. Our quantitative results show clearly that while MSCs proliferate well on 0D nanostructures region (AR≈1), the surface topography of 1D nanostructures (AR>30) and transitional regions (AR≈10–30) hinder the growth and proliferation of cells. Such an approach is effective in screening the adhesion and proliferation of MSCs. In addition, the highest calcein blue level is observed on 0D nanostructured regions (Fig. 2), a clear indication of surface enhanced osteogenesis. In this context, our gradient topography concept is an effective tool to screen both adhesion and differentiation of MSCs.

Contact: Dr. Cenk Aktas
Program Division *CVD/Biosurfaces*

EU-PROJECT CUVITO: NEW ANTI-MICROBIAL NANOPARTICLES AND COATINGS

M. BUKOWSKI, B. ALI, M. JOCHUM, D. BENTZ, C. BECKER-WILLINGER

Hygienic coatings are interesting for many applications where surfaces are in contact with microbes usually requiring intensive disinfection. Copper containing coatings have a high potential to improve the hygienic situation for such type of surfaces.

In the framework of the project CuVito, funded by the European Union, a new synthesis route was established leading to specially surface modified Cu-colloids as controlled release containers to provide long time anti-microbial activity when introduced as an additive for hygienic coatings. Copper nanoparticles with a particle size of 5–20 nm were synthesized following an environmentally friendly and scalable chemical reduction method using ascorbic acid as reducing agent. It was shown that the cross-flow filtration provided an effective tool to achieve Cu-colloids with controllable oxidation ability with no residues from undesired by-products or impurities. To ensure dispersibility the surface of the particles was modified using mercapto functionalized silsesquioxane.

Bulk materials and transparent coatings on stainless steel were realized by dispersing 0.5–1 wt% of the surface modified Cu-colloids in a UV curable polymer matrix based on cycloaliphatic epoxides. Additionally, the Cu-colloids were successfully dispersed in polyurethane matrix based powder coatings via a compounding process followed by jet-milling. The powders were homogeneously applied on metallic substrates by corona spraying. Preliminary tests with the unmodified copper nanoparticles and with Cu-colloids containing epoxy resins showed promising results against S. aureus, P. aeruginosa, and fungi.

The project work resulted in the application of two patents from INM. For ongoing dissemination of the results the CuVito technology will be further pursued and promoted together with project partners.

Contact: Dr. Carsten Becker-Willinger
Program Division *Nanomers*

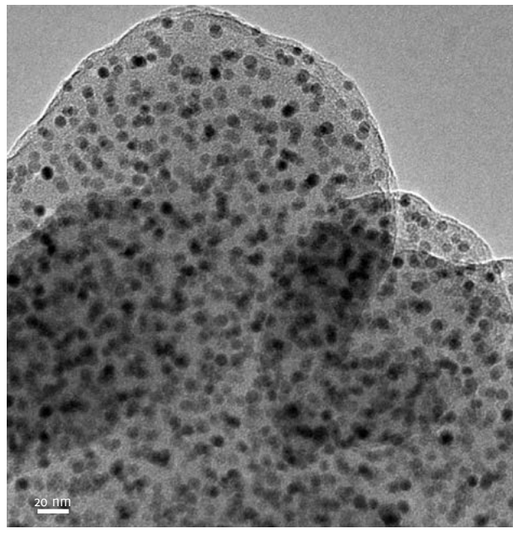
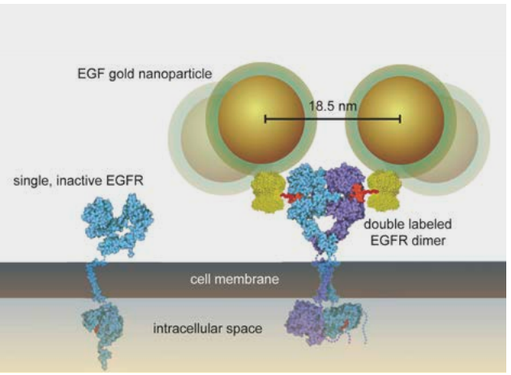
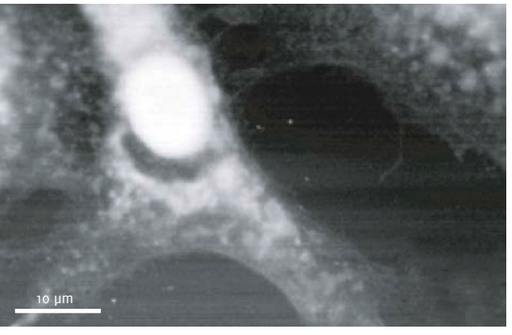


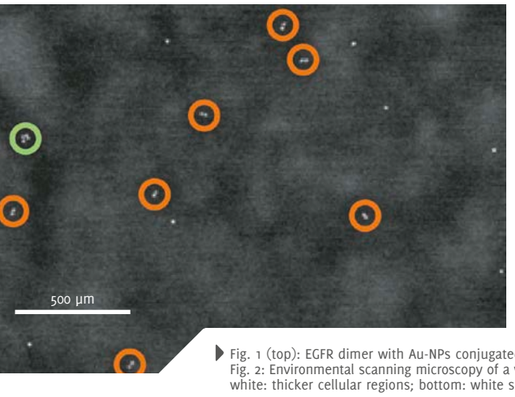
Fig. 1: Transmission electron microscopy (TEM) of copper nanoparticles. The sizes of the particles are 5–20 nm on average
Fig. 2: Transparent epoxy resin bulks, filled with 1 wt% copper nanoparticles

NANOPARTICLES REVEAL MECHANISMS OF CANCER CELL GROWTH IN WHOLE CELLS

D. PECKYS, N. DE JONGE







In case of healthy cells the cell growth is strictly controlled. On the contrary the cell division in cancer cells is uncontrolled because natural cell death is suspended. This happens because too many receptors for the epidermal growth factor (EGF), which are found on the surface of the cell, join to form pairs. These pairs start a signal chain into the cell, culminating in unrestricted growth. With a new microscopy technique developed at the INM it has been possible for the first time to directly image this receptor pairing in human cancer cells by using gold nanoparticles as specific markers.

The results were recently published in the online journal *Scientific Reports* of the Nature group (Scientific Reports, 3 (2013), 2626-1-6). Prior to this study it has never been possible to image the mechanism of pairing in individual receptors in whole cells in liquid environment. Up to now, biochemical methods have been used in which the cells are completely destroyed. In contrast, the locations of the individual receptors in the intact cell are directly visible in the micrographs recorded with the new method, so that, for example, the EGF receptor pair formation can be studied cell-by-cell.

In our published work, the EGF receptor was marked using gold nanoparticles with a diameter of around 10 nm. Data was then collected from representative regions of fifteen different cells. A special technique was used involving environmental scanning electron microscopy to image these cells intact and in a liquid environment. This is not possible with conventional electron microcopy requiring the samples to be prepared into thin sections and transferred into vacuum. A spatial resolution of 3 nm, sufficient to recognize the individual markers, was achieved. A data analysis procedure was developed to automatically detect the marker locations. Finally, the arrangement of the receptor as individual receptors, in pairs or in smaller groups was studied.

Contact: Prof. Dr. Niels de Jonge
Program Division *Innovative Electron Microscopy*

Fig. 1 (top): EGFR dimer with Au-NPs conjugated to the epidermal growth factor.
Fig. 2: Environmental scanning microscopy of a whole fixed and hydrated A549 cell (middle: overview image, grey: cell contours, white: thicker cellular regions; bottom: white spots: gold nanoparticle, circles: dimers and larger clusters).

JANUS NANOPARTICLES

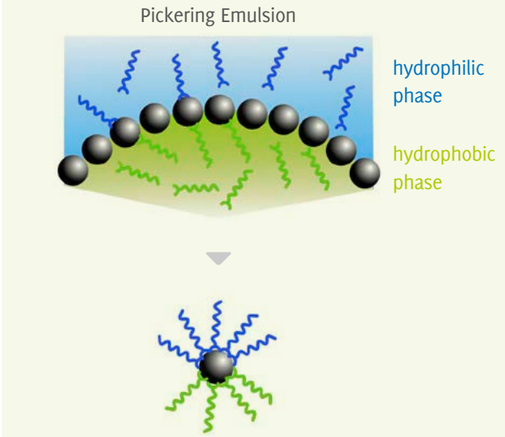
K. ABERSFELDER, P. W. DE OLIVEIRA, G. KICKELBICK*
*) INM Fellow since 2013

Janus particles are a new class of nanoparticles that show two different compartments on their surface. The anisotropic surface modification may result in different reactivity, polarity, or charges of the two surface sites. The surface-functionalization is carried out at the interphase of an emulsion stabilized by the nanoparticles. The setup offers three benefits: It provides two different environments, larger quantities of nanoparticles can be functionalized, and two compartments can be modified in a single step. In our primary project, metal oxide and silica particles will be functionalized in a Pickering emulsion (Fig. 1), using perfluorinated alkyl chains as modifiers for the surface-functionalization. Thus, we focus on the behavior of the modified particles in composite materials. We expect that the oil as well as water repellent fluorinated coating of the particles provide a driving force for self-assembly within the composite and especially on its surface.

The modification of the SiO_2 particles turned out to be a major challenge due to their restrained reactivity towards alkoxysilane coupling agents usually applied. Therefore, it was necessary to “freeze” the particles on the interphase to allow long reaction periods. For this purpose, we used a liquid wax, which solidified with cooling to room temperature and kept the particles trapped on the interphase (Fig. 2).

The modification of the trapped silica particles with perfluorinated surfactants is currently under investigation. Coupling agents with more reactive anchor groups are also used for surface-functionalization. Magnetite particles, which allow novel routes to switchable materials by external electromagnetic fields, are also under investigation.

Contact: Prof. Dr. G. Kickelbick
Saarland University



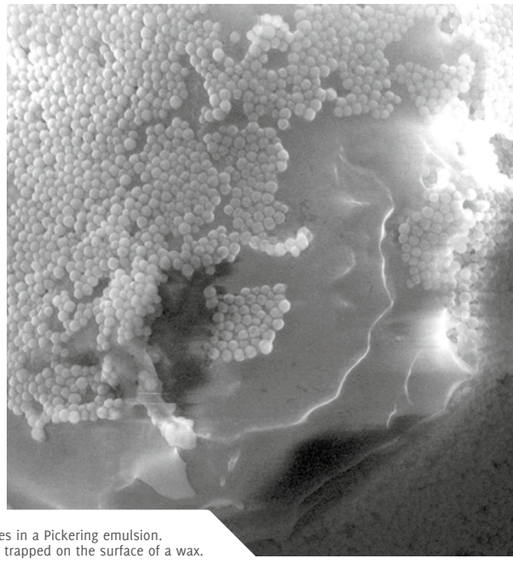
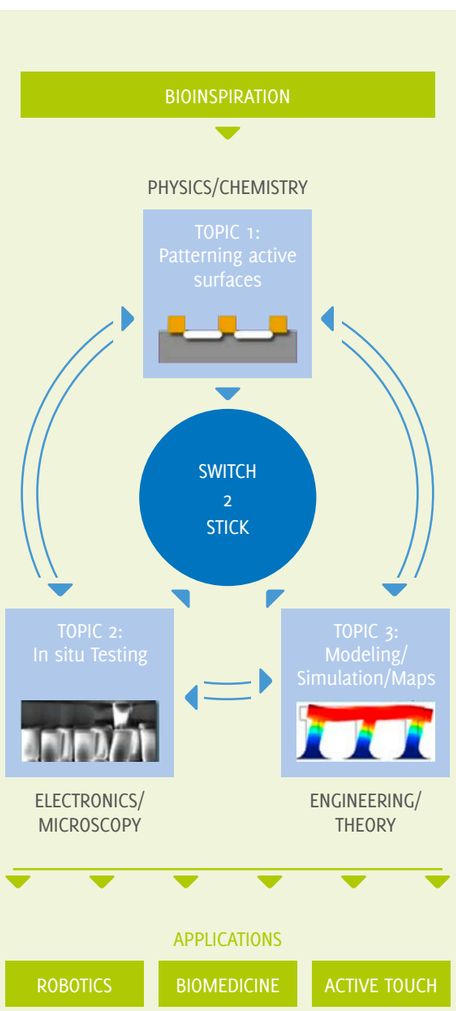


Fig. 1: Preparation of Janus Nanoparticles in a Pickering emulsion.
Fig. 2: REM image of the silica particles trapped on the surface of a wax.

ERC ADVANCED GRANT “SWITCH2STICK”

E. ARZT



In the Program Division *Functional Surfaces*, an ERC Advanced Grant on “Engineering of biomimetic surfaces” was awarded to Prof. Arzt in 2013. Few examples of biological inspiration have so far made it into successful technical applications. The project “switch2stick” aims to close this gap by conducting an ambitious interdisciplinary programme: the creation and investigation of three-dimensional (3D) surface structures – inspired by insects, spiders and geckoes – for active control of mechanical functions such as adhesion, delicate grasp and touch.

The new challenge addressed by the project is to design active, switchable 3D micropatterns whose stickiness can be tuned at will and modified on demand. The resulting features will bend or tilt in response to external stimuli (especially temperature, electric field and stress) and thereby create a responsive material surface.

Emphasis will also be placed on the largely neglected topic of interaction with soft, compliant objects, with a view to creating future opportunities for interaction with soft matter and skin. A particular strength of the project will be the strong link between state-of-the-art fabrication, *in-situ* testing and advanced modelling and simulation, leading further to new multifunctional design rules for targeted applications.

Such switchable micropatterns will open up new opportunities in various technologies: robotic grippers with careful, benign “touch” of delicate objects, medical adhesives that become sticky on reaching body temperature, and active devices that can respond and send signals to touching fingers. The project will thus lay the scientific foundations for innovative devices and solutions.

The project will run from 2014 to 2018 and amounts in total to ca. 2.5 million Euros.

Contact: Prof. Dr. Eduard Arzt
Program Division *Functional Surfaces*

Fig. 1: The “switch2stick” project covers fabrication of active micro- and nanopatterned surfaces, their characterization, and modelling. This will lead to new applications in robotics, biomedicine and haptics.

PROJECT NANOSPEKT

T. KRAUS, L. GONZÁLEZ-GARCÍA, G. KANELIDIS, B. HAAS, J. MAURER

Since the end of 2013, the BMBF funds a new research project as part of the federal “NanoMatFutur” initiative. The project *NanoSpekt* will be situated in the Junior Research Group *Structure Formation*.

Transparent, flexible materials for electronic devices are the focus of this project. A team consisting of two PostDocs, two PhD students and a technician under the lead of Tobias Kraus develops new nanocomposites that exploit scaling effects of nanoparticles like optical transparency and ease of sintering. In electronic materials, the exact distribution of nanoparticles in layers is critical. *NanoSpekt* will introduce new, wet processing schemes to provide improved control over the particle distribution.

In wet processing, structure formation is more complex than in traditional vacuum deposition. Different forces act on dispersed particles and molecules; hydrodynamics, solubility and capillarity act in successive steps that define the final structure. Much accrued experience exists for practical coating problems: printing and impregnation are crafts with long traditions. *NanoSpekt* is based on scientific results of the last years on the mechanisms of nanoparticle layer deposition. Observation and tuning of coating processes *in situ* will be used to assemble particles into optimal microstructures. Structural and functional analysis of the deposited layers will provide the data needed to optimize process parameters towards functional composites.

The new group brings together chemists, materials scientists and engineers. Their tight collaboration will help to establish new links, for example between the chemistry of nanoparticles and the properties of materials based on them. It will form a solid base of scientific understanding to create practically relevant process rules for a rapidly growing and economically promising field.

Contact: Dr. Tobias Kraus
Junior Research Group *Structure Formation*

NANOSAFETY 2013

A. KRAEGELOH

Nanomaterials increasingly influence a broad range of industrial sectors, from energy, optics, electronics to food and biomedicine. Therefore questions about nanosafety are rapidly gaining importance. The conference *Nanosafety 2013* addressed this important topic. It was held from November 20th to 22nd at the Saarbruecken Castle. The event was opened by the INM chairman (Eduard Arzt) along with representatives of the State Chancellery of Saarland (Susanne Reichrath), the Federal Ministry of Education and Research (BMBF, Frank Wolf) and the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU, Anke Jesse).

Six major topics were discussed during seven oral and two poster sessions:

- Nano-objects: characterization techniques and standardization
- Human health: *in vitro*, *ex vivo*, and *in vivo* testing
- Environmental impact of nanomaterials
- Detection and quantification of nano-objects in living systems
- Modelling and prediction of nanomaterials effects
- Safety, current regulation and social/ethical aspects

In addition, three workshops served to deepen the topics “nano-object characterization”, “detection and toxic effects of nano-objects”, and “future needs in nanosafety”. Overall, the contributions covered questions from basic research, like the intracellular transport of nanoparticles or the formation of the nanoparticle-protein corona, to aspects of regulatory relevance, such as e.g. risk assessment of nanomaterials under European Regulations. A focus was also set on material characterization in the regulatory context. The discussions revealed a need for further matching the interests of academia, regulators and industry.

117 participants from more than twenty countries attended the *Nanosafety 2013* conference. The conference was organized by INM together with the Leibniz Research Alliance Nanosafety, an initiative of six Leibniz-institutes established in 2012. A strong contribution was also given by INM and its partners within the EU project “Insight”.

AUDIT CAREERANDFAMILIY – FIRST YEAR OF IMPLEMENTATION

C. FINK-STRAUBE

In December 2012, the INM was granted the audit certification careerandfamily by the Hertie Foundation. This document certifies the commitment to a process of continued development of its family-oriented human resources policy by implementation of a comprehensive range of family-friendly measures by the time of the follow-up audit in 2015.

In the context of the audit process, the INM aims to increase its attractiveness as employer and to enhance the job satisfaction of its employees by family-oriented frame conditions and offers. In order to achieve these goals, a comprehensive catalogue of measures was passed within the frame of an objective agreement. This covers the following topics: working time and location, organization of work, information & communication, management, personnel development, cash-value benefits as well as a service for families.

In the first report period, a special emphasis was put on communication and information via various media such as intranet, internet, blackboards, and internal meetings. Important achievements were, for example, the completion of a company agreement for a flexible organization of the working time, the family-oriented scheduling of the INM colloquium as well as the seminar for executives on the subject "family-oriented management style”.

The first annual report on the activities was evaluated positive and the INM was attested a goal-oriented and successful implementation process. Two measures were given a "best practice" character: the creation of an audit-shelf in the INM *library* and the weekly open office of both the audit and the equal opportunities team.

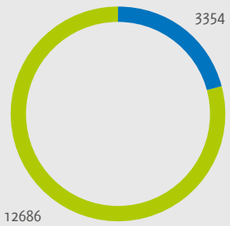
In 2014, a major focal point will be on child care, such as the establishment of a parent-child-office, the assistance with short-term care, and holiday care programs.

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 im Haushaltsjahr 2013 eine gemeinsame Förderung durch den Bund und die Länder erhalten. Diese belief sich auf 16.040 T€; hiervon 12.686 T€ zur Finanzierung von Personal- und Sachaufwendungen, sowie 3.354 T€ für erforderliche Neu- und Ersatzinvestitionen. Gegenüber dem Vorjahr erfolgte entsprechend der Beschlusslage der Gemeinsamen Wissenschaftskonferenz eine Erhöhung des Kernhaushalts um 5%.



- Zuwendungen 2013 zur Finanzierung der Investitionsausgaben in T€ / budget 2013 for financing personnel and materials expenses in k€
- Zuwendungen 2013 zur Finanzierung von Personal- und Sachaufwendungen in T€ / budget 2013 for financing investment spendings in k€

Im Geschäftsjahr 2013 erzielte das INM eigene Erlöse aus Forschung und Entwicklung sowie sonstige betriebliche Erträge in Höhe von 3.777 T€. Im Rahmen öffentlicher Projektfinanzierungen erzielte das INM im Jahr 2013 Erlöse in Höhe von 2.445 T€. Die Industrieerlöse aus Forschung und Entwicklung sowie aus Lizenzvereinbarungen beliefen sich auf 1.039 T€. Sonstige Erlöse und betriebliche Erträge in Höhe von 293 T€ resultierten überwiegend aus der Weiterbelastung von Gebäude-, Patent- und sonstigen Kosten.

Der Gesamtumsatz 2013 der Gesellschaft betrug 18.975 T€ und liegt damit geringfügig höher als im Vorjahr. Weitere Zuwendungsmittel des Haushaltsjahres 2013 in Höhe von 842 T€ sind für das Geschäftsjahr 2014 gebunden.

Die Bilanzsumme der Gesellschaft zum 31. Dezember 2013 beträgt 25.320 T€; gegenüber dem Vorjahr eine Erhöhung um 2.210 T€. Sowohl für das Anlagevermögen, als auch für das Umlaufvermögen ist gegenüber dem Bilanzstichtag des Vorjahres eine Erhöhung festzustellen. Die Investitionstätigkeit der Gesellschaft (3.628 T€) überstieg im Geschäftsjahr 2013 erneut die Abschreibungen in Höhe von 3.026 T€. Die Verbindlichkeiten der Gesellschaft beliefen sich zum Bilanzstichtag auf 3.040 T€, gegenüber dem Vorjahr eine Steigerung um 1.559 T€. Diese ist in erster Linie durch höhere Verbindlichkeiten gegenüber der öffentlichen Hand begründet.

PERSONALENTWICKLUNG

Die Anzahl der Beschäftigten belief sich im Durchschnitt des Jahres 2013 auf 197 Mitarbeiterinnen und Mitarbeiter. Hiervon waren 66 wissenschaftliche und graduierte Mitarbeiter/innen, 18 Doktorand/innen, 48 Beschäftigte in den Bereichen Labor, Technik und Service sowie 23 studentische und wissenschaftliche Hilfskräfte. In den Bereichen Verwaltung und Sekretariate waren 34 Mitarbeiterinnen und Mitarbeiter beschäftigt. Des Weiteren befanden sich im Jahresdurchschnitt 2013 acht Azubis in der Ausbildung.

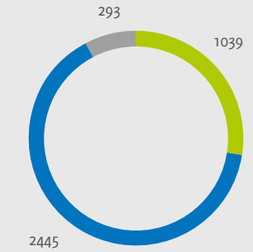
FINANCIAL AND INCOME SITUATION OF THE CORPORATION

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 2013. This amounted to 16,040 k€; 12,686 k€ of those were used for financing personnel and materials expenses and 3,354 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 2013, INM generated own proceeds from research grants and contracts as well as from other operating income amounting to 3,777 k€. From public grants, INM generated proceeds amounting to 2,445 k€ in 2013. Industrial contacts and patents/licences generated 1,039 k€. Other income amounting to 293 k€ resulted mainly from the cost transfer for expenditures on buildings, patents and others.

In 2013, the total turnover of the corporation added up to 18,975 k€ and is therefore slightly higher than in the previous year. Further funding of the financial year 2013 amounting to 842 k€ is committed for the business year 2014.

The balance sheet total of the corporation is 25,320 k€ on December 31, 2013, which is an increase of 2,210 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 3,628 k€ exceeded again the write-offs amounting to 3,026 k€

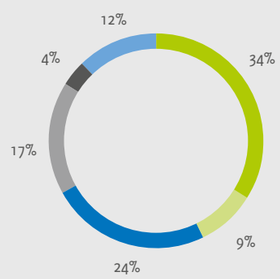


- Industrieerlöse aus FuE und Lizenzvereinbarungen 2013 in T€ / Industrial income (contracts and licences) 2013 in k€
- Erlöse aus öffentlicher Projektfinanzierung 2013 in T€ / public grants 2013 in k€
- Sonstige Erlöse und betriebliche Erträge 2013 in T€ / other funds 2013 in k€

in the financial year 2013. The liabilities of the corporation amounted to 3,040 k€ on the balance sheet date, showing an increase of 1,559 k€ compared to the previous year. This is mainly based on higher liabilities towards public authorities.

PERSONNEL DEVELOPMENT

The average number of employees totalled 197 in 2013. This total included 66 scientific and graduate employees, 18 doctoral candidates and 48 employees in the laboratories and the technical services as well as 23 graduate assistants. 34 employees worked in the administration and secretarial offices. Furthermore, eight apprentices were in vocational education in the course of the year 2013.



- wissenschaftliche/graduierte Mitarbeiter / scientific/graduated employees
- Doktoranden / PhD candidates
- techn. Mitarbeiter/Servicemitarbeiter / technical workers/services
- Verwaltung/Sekretariate / administration/secretariats
- Auszubildende / apprentices
- Hilfskräfte / scientific assistants

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Bayer MaterialScience AG, Leverkusen

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Robert Bosch GmbH, Stuttgart

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Universität Freiburg, Freiburg

Prof. Dr. Gerhard Wenz
Universität des Saarlandes, Saarbrücken

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Mitglied im Editorial Board: *Niche: Journal of Cellular Therapy and Regenerative Medicine*

Mitglied im Biomaterials Committee – The Scientific and Technological Research Council of Turkey

Reviewer bei Zeitschriften: *Biomaterials, Langmuir, Materials Science and Engineering C, Physica Statu Solidi, Journal of Cellular Therapy and Regenerative Medicine, Applied Surface Science*

Prof. Dr. Eduard Arzt

Professor für Neue Materialien, Universität des Saarlandes, Saarbrücken

Mitglied der Nationalen Akademie der Wissenschaften Leopoldina

Korrespondierendes Mitglied der Österreichischen Akademie der Wissenschaften

Vorsitz, Leibniz-Netzwerk Nano, Leibniz-Gemeinschaft

Sprecher, Leibniz-Forschungsverbund Nano-Sicherheit, Leibniz-Gemeinschaft

Mitglied, Aufsichtsrat des LKR Leichtmetallkompetenzzentrum Ranshofen GmbH

Mitglied, Wissenschaftlicher Beirat der Alfried Krupp von Bohlen und Halbach Stiftung, Essen

Mitglied, Doktorandenauswahlgremium, Deutsche Telekom-Stiftung, Bonn

Mitglied, Beirat der ProcessNet Fachgruppe Nanotechnologie, DECHEMA

Mitglied, International Scientific Advisory Board, COMET K2 Zentrum für Integrated Research in Materials, Processing and Product Engineering, Leoben

Mitglied, Energiebeirat, Ministerium für Wirtschaft, Arbeit, Energie und Verkehr des Saarlandes

Mitglied, Erweiterungskommission des Senatsausschuss für Strategische Vorhaben (SAS) der Leibniz-Gemeinschaft (2013/2014)

Mitglied, Berufungskommission „Professur für Metallurgie“, Universität des Saarlandes

Mitglied, Berufungskommission „Professur Materialsynthese und Werkstoffentwicklung“, Universität des Saarlandes

Organisator des Symposiums “New frontiers of steel making and steel design”, Saarbrücken, Nov. 11–12, 2013

Herausgeber/Editor der Reviewzeitschrift *Progress in Materials Science*, Oxford, UK

Mitglied im Editorial Board / Advisory Board der Zeitschriften*: Advanced Engineering Materials, International Journal of Materials Research, Materials Science and Engineering C: Materials for Biological Applications, Journal of Surfaces and Interfaces in Materials*

Gutachtertätigkeit für (Auswahl): Alexander von Humboldt-Stiftung, Alfried Krupp von Bohlen und Halbach-Stiftung, Deutsche Forschungsgemeinschaft, Ecole Polytechnique Fédérale de Lausanne/Schweiz, IIT Kanpur/Indien, University of Cambridge/UK

Reviewer für Zeitschriften (Auswahl): *Advanced Functional Materials, Advanced Materials, Advanced Materials Research, Journal of the Royal Society Interface, Langmuir, Nano Letters, Proceedings of the National Academy of Sciences of the United States of America, The Journal of Adhesion*

Prof. Dr. Roland Bennewitz

Honorarprofessor der Universität des Saarlandes, Saarbrücken

Berufung in das Prüfungsamt für das Lehramt an Schulen

Mitglied der Kommission zur Erarbeitung einer Internationalisierungsstrategie der Universität des Saarlands

Mitglied des Beirats der Evangelischen Studierendengemeinde Saarbrücken

Deutsches Mitglied des Management Committee des EU COST Network „Nanotribology“

Mitglied im Advisory Board, DFG-Graduiertenkolleg „In situ Mikroskopie mit Elektronen, Röntgenstrahlen, und Rastersonden“ (GRK 1896), Universität Erlangen

Gutachtertätigkeit für: Deutsche Forschungsgemeinschaft, Indian Institute of Science Education and Research, Swiss National Science Foundation

Reviewer bei Zeitschriften: *Physical Review B, Physical Review Letters, Beilstein Nano, Friction, Nanotechnology, Tribology letters, ACS Nano, Langmuir*

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Sprecherin Arbeitskreis Bibliotheken und Informationseinrichtungen der Leibniz-Gemeinschaft

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Adjoint Assistant Professor of Biophysics, Department of Molecular Physiology and Biophysics, Vanderbilt University School of Medicine, Nashville, TN, USA

Honorarprofessor der Universität des Saarlandes, Saarbrücken

Mitglied im Editorial Board von Microscopy and Microanalysis

Gutachtertätigkeit für: Danish Agency for Science, Technology and Innovation, National Institute of Health, Small Business Innovation Research (SBIR) Grants

Reviewer 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*

Dr. Annette Kraegeloh

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

Koordinatorin, Forschungsverbund Nanosicherheit der Leibniz-Gemeinschaft

Gutachtertätigkeit für: BMBF, Leopoldina – Nationale Akademie der Wissenschaften

Reviewer bei Zeitschriften*: Small, Eur. J Pharm and Biopharm, ACS Applied Materials and Interfaces, Journal of Biomaterials Applications, Nanomedicine published by Future Medicine*

Dr. Tobias Kraus

Ko-Vorsitzender des Arbeitskreises „Grenzflächen: statisch und dynamisch“ im Fachausschuss Bioinspirierte und interaktive Materialien der Deutschen Gesellschaft für Materialkunde

Session Chair, Nanosafety 2013, Saarbrücken, Germany, November 20–22, 2013

Reviewer bei Zeitschriften: *Langmuir, PhysChemChemPhys, JCIS, ACS Applied Materials & Interfaces, Optical Materials, Applied Physics Letters, Colloids and Surfaces A*

Dr. Elmar Kroner

Reviewer bei Zeitschriften: *ACS Cemistry of Materials, ACS Applied Materials & Interfaces, Advanced Materials, Advanced Functional Materials, Small*

Dr. 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

Aktive Teilnahme am DGM-Fachausschuss Bioinspirierte und interaktive Materialien

Jun.-Prof. Dr. Volker Presser

Juniorprofessor für Nanotechnologie Funktionaler Energiespeichermaterialien, Universität des Saarlandes, Saarbrücken

Mitglied, Scientific Committee of IAP 2014 – International Conference on Interfaces against Pollution, Leeuwarden, Netherlands, May 25–28, 2014

Symposium Organizer, 65th Annual Meeting of the International Society of Electrochemistry (ISE), Lausanne, Schweiz, August 31 – September 5, 2014

Gutachtertätigkeit: University of Pretoria, National Research Foundation, Südafrika

Reviewer bei Zeitschriften: *American Ceramic Society, Advanced Healthcare Materials, Advanced Functional Materials, AIP Advances, Advanced Materials, Analytical Letters, Applied Physics Letters, Carbon, Chemie Ingenieur Technik, ChemSusChem, Desalination, Electrochemistry Communications, Electrochimica Acta, Eenergy and Environmental Science, Ionics, Journal of Power Sources, Journal of Physical Chemistry Letters, Materials Chemistry and Physics, Physical Chemistry Chemical Physics, Physics and Chemistry of Solids, Scientific Reports, Sensors & Actuators: B. Chemical, Separation and Purification Technology*

Dr. Mario Quilitz

Koordinator des Leibniz-Netzwerkes Nano

Mitarbeit beim Strategischen Forschungsverbund Nanosicherheit der Leibniz-Gemeinschaft

Reviewer bei Zeitschriften*: International Journal of Nanomedicine, Materials Chemistry and Physics, Solid State Ionics*

Dr. Roland Rolles

Mitglied im Beirat der Lucie-Bolte-Stiftung

Mitglied im Beirat des cc-NanoBioNet e.V.

AUSZEICHNUNGEN / AWARDS

Dr. Herbert Schmid

Reviewer bei Zeitschriften: *Ultramicroscopy; Z. Angewandte Chemie; Appl. Phys. Letters; J. Europ. Ceram. Soc.*

Dr. Andreas Schneider

Reviewer bei Zeitschriften: *Tribology International, Physica Status Solidi (a), Acta Materialia*

PD Dr. habil. Ingrid Weiss

Privat-Dozentin für Biochemie, Universität Regensburg

Stellvertretende Leiterin des Arbeitskreises „Vom Gen zum Material“ im Fachausschuss „Bioinspirierte Materialien“ der Deutschen Gesellschaft für Materialkunde (DGM)

Advisory Board Member, EPSRC – Engineering and Physical Sciences Research Council, U.K. (Programme: MIB – The Interface between Materials and Biology “Hard-soft matter interfaces: from understanding to engineering”)

Session Chair “Measurement of biological / bioinspired materials”, EuroMAT, Sevilla, Spain, September 12, 2013

Gutachtertätigkeit für: Baden-Württemberg Stiftung, BSF – United States-Israel Binational Science Foundation, NSF – National Science Foundation, REA – European Commission – Research Executive Agency

Reviewer bei Zeitschriften*: Advanced Functional Materials, Advanced Materials, Comparative Biochemistry and Physiology, Crystal Growth & Design, EvoDevo, Flora, Gene, International Journal of Agricultural Sciences , International Journal of Medicine and Medical Sciences, International Journal of Nanomedicine, Journal of Biomaterials Applications, Journal of Colloid and Interface Science, Journal of Structural Biology, Journal of the Royal Society Interface, Marine Ecology Progress Series, PLoS ONE, Protoplasma, Trends in Plant Science*

Prof. Dr. Eduard Arzt
ERC Advanced Grant, European Research Foundation

Sarah Fischer
Stipendium UdS-Mobil,
Universität des Saarlandes / DAAD

Lena Funke
MINT-Exzellenzstipendium, Manfred Lautenschläger-Stiftung

Dr. Florian Hausen
Forschungsstipendium, Deutsche Forschungsgemeinschaft

Dr. Tobias Kraus
Preisträger im Nachwuchswettbewerb „Innovatoren unter 35“, Technology Review

Dr. Tobias Kraus
Preisträger im BMBF-Nachwuchswettbewerb NanoMatFutur

Dr. Tobias Kraus
Auswahl zum 15. German-American Frontiers of Engineering Symposium, Alexander von Humboldt-Stiftung und National Academy of Engineering (NAE), USA

Mariana Viegas Greco de Oliveira
Poster Award 3rd Prize, Euro BioMat Weimar

Jun.-Prof. Dr. Volker Presser
Heinz Maier-Leibnitz-Preis, Deutsche Forschungsgemeinschaft

Jun.-Prof. Dr. Volker Presser
Ross Coffin Purdy Award, American Ceramic Society

Dr. Eva Weber
Minerva-Stipendium, Max-Planck-Gesellschaft

Marco Zeiger
Best Talk Award, Inascon 2013

DISSERTATIONEN / DOCTORAL THESES

Böse, Katharina
Interactions of 3 nm, 8 nm, and 15 nm gold particles with human alveolar epithelial cells: a microscopy study
Universität des Saarlandes, Saarbrücken,
Prof. Dr. A. K. Kiemer / Dr. A. Kraegeloh

Hausen, Florian
Elektrochemische Kontrolle von Reibung auf Goldoberflächen in wässrigen Elektrolyten und ionischen Flüssigkeiten
Universität des Saarlandes, Saarbrücken,
Prof. Dr. R. Bennewitz

Lee, Juseok
Synthesis of biphasic Al/Al_2O_3 nanostructures under microgravity and laser structuring on Al/Al_2O_3 surfaces for selective cell guidance
Universität des Saarlandes, Saarbrücken,
Prof. Dr. Dr. h.c. M. Veith

Martinez Miró, Marina
Topographical control and characterization of Al/Al_2O_3 nanowire coatings for improved osseointegration of implant materials
Universität des Saarlandes, Saarbrücken,
Prof. Dr. Dr. h.c. M. Veith

Wählisch, Felix
Skalenübergreifendes tribologisches Verhalten von hierarchisch strukturierten biologischen und technologischen Materialien
Universität des Saarlandes, Saarbrücken,
Prof. Dr. R. Bennewitz

Weber, Eva
Expression of biomineralization proteins in bacteria and plants
Universität des Saarlandes, Saarbrücken,
Prof. Dr. P. Bauer / PD Dr. I. Weiss

ABSCHLUSSARBEITEN / THESES

DIPLOMARBEITEN AM INM / DIPLOMA THESES AT INM

Utzig, Thomas
Plättchenverstärkte Polymermatrixkomposite: Folien mit hoher Barrierewirkung nach natürlichem Vorbild
Universität des Saarlandes, Saarbrücken,
Prof. Dr. E. Arzt

BACHELORARBEITEN AM INM / BACHELOR THESES AT INM

Dörr, Tobias
Kontrollierte Strukturierung von Oberflächen als Basis für leitfähige und transparente Schichten unter Anwendung von Emulsionen
Universität des Saarlandes, Saarbrücken,
Prof. Dr. G. Kickelbick

Funke, Lena
Electrospinning of ultrafine niobium carbide-carbon composite fibers
Universität des Saarlandes, Saarbrücken,
Jun.-Prof. V. Presser

Galon, Christian
Kontakt-Resonanz-AFM an metallischen Gläsern
Universität des Saarlandes, Saarbrücken,
Prof. Dr. R. Bennewitz

Samet, Kamelia
Bioinspired adhesion systems for skin
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

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

Isaías-Camacho, Emilio U.
Objective assessment of human-car-interfaces using electroencephalographic correlates of cognitive processing
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

Nichita, Alexandra
Selektive auditorischie Aufmerksamkeit – objektive und subjektive Analyse verschiedener Hörgeräteeinstellungen bei normalhörenden Probanden
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

Salafzoon, Narsis
Linking the Hodgkin-Huxley model to neural field oscillations using computational upscaling
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

Staudt, Niclas Fabian
Numerische Simulation der Synchronisation einer Neuronenpopulation bei Tinnitus Aurium
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

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

Brauner, Ulrike H.
Macroscopic correlates of neural plasticity in cochlear implant users
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

Rekrut, Maurice
Design of an embedded and integrated system for a multinoise threshold equalising noise test
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

Ruckert, Jonathan
A computational BCN model for the evaluation of optimal notch bandwidth in an acoustic stimulation for the suppression of spontaneous neural activity
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

Weinert, Manuel
Non-invasive bioimpedance based assessment of vocal fold movements
HTW, Saarbrücken, Prof. Dr. Dr. D. J. Strauss

DOKTORANDEN / DOCTORAL STUDENTS

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

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

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

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

Boiko, M. Sc. Viktoriia, Prof. Dr. E. Arzt

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

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

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

Haas, M. Sc. Beate, Prof. Dr. E. Arzt

Jochem, M. Sc. Aljosha-Rakim, Prof. Dr. E. Arzt

Jochum, Dipl.-Chem. Marlon, Prof. Dr. Dr. h.c. M. Veith, Universität des Saarlandes

Jung, M. Sc. Jennifer, Prof. Dr. A. Kiemer, Universität des Saarlandes

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

Kasper, Dipl.-Chem. Christoph, Prof. Dr. Dr. h.c. M. Veith, Universität des Saarlandes

Kister, M. Sc. Thomas, Prof. Dr. E. Arzt

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

Nadig, Dipl.-Chem. Sandra, Prof. Dr. Dr. h.c. M. Veith, Universität des Saarlandes

Özgün, M. Sc. Novaf, Prof. Dr. Dr. D. Strauss, HTW

Sahin, Dipl.-Chem. Fadime, Prof. Dr. Dr. h.c. M. Veith, Universität des Saarlandes

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

GASTAUFENTHALTE / VISITING SCIENTISTS AND STUDENTS

Agarwal, Neha, Indien

Allen, Riley, USA

Braovac, Susan, Kanada

Bravo Mutlló, Axel, Spanien

Dörr, Tobias, Deutschland

Dykstra, Jouke, Niederlande

Elnathan, Dr. Roey, Israel

Fleck, Prof. Dr. Norman Andrew, Großbritannien

Gilmore, Ryan, USA

Griesshaber, Dr. Erika, Deutschland

Ingremeau, Marina Anais, Frankreich

Javed, Adnan, Indien

Jones, Aquil, USA

Kaasik, Friedrich, Estland

Kirchner, Prof. Dr. Helmut, Frankreich

Kuppili, Venkata Sree Charan, Indien

Langenstein, Matthew, USA

Lee, Yoonjoo, Südkorea

Lee, Hae Ri, Südkorea

Legros, Dr. Marc, Frankreich

McBride, Alexander, USA

McMeeking, Prof. Dr. Robert, USA

Medina Clavijo, Bentejui, Spanien

Naguib Abdelmalak, Michael, Ägypten

Sadowski, Victoria M., USA

Sans Palacios, Gerard, Spanien

Vakifahmetoglu, Prof. Dr. Cekdar, Türkei

Viegas Greco de Oliveira, Mariana, Brasilien

Völcker, Prof. Dr. Nicolas Hans, Australien

PUBLIKATIONEN / PUBLICATIONS

Im Jahr 2013 wurden insgesamt 135 Publikationen veröffentlicht, davon 93 Publikationen in referierten Zeitschriften und 42 sonstige Publikationen. Es wurden 56 Poster präsentiert. (Stand: 31.03.2014)

In 2013, 135 publications were published, therefrom 93 publications in peer-reviewed journals and 42 other publications. 56 posters were shown. (As of 31.03.2014)

REFERIERTE PUBLIKATIONEN

GRENZFLÄCHENMATERIALIEN / INTERFACE MATERIALS

Energie-Materialien / Energy Materials

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Pseudocapacitance and performance stability of quinone-coated carbon onions
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In situ tracking of the nanoscale expansion of porous carbon electrodes
Energ Environ Sci 2013, 6, (1), 225–231 [11.653 (2012)]

P. M. Biesheuvel, S. Porada and V. Presser
Comment on "Carbon nanotube/graphene composite for enhanced capacitive deionization performance" by Y. Wimalasiri and L. Zou
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J. W. Campos, M. Beidaghi, K. B. Hatzell, C. R. Dennison, B. Musci, V. Presser, E. C. Kumbur and Y. G. Gogotsi
Investigation of carbon materials for use as a flowable electrode in electrochemical flow capacitors
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B. Dyatkin, V. Presser, M. Heon, M. R. Lukatskaya, M. Beidaghi and Y. G. Gogotsi
Development of a green supercapacitor composed entirely of environmentally friendly materials
ChemSusChem 2013, 6, (12), 2269–2280 [07.475 (2012)]

G. Feng, S. Li, J. S. Atchison, V. Presser and P. T. Cummings
Molecular Insights into Carbon Nanotube Supercapacitors: Capacitance Independent of Voltage and Temperature
J Phys Chem C 2013, 117, (18), 9178–9186 [04.814 (2012)]

G. Feng, S. Li, V. Presser and P. T. Cummings
Molecular insights into carbon supercapacitors based on room-temperature ionic liquids
J Phys Chem Lett 2013, 4, (19), 3367–3376 [06.585 (2012)]

A. C. Forse, J. M. Griffin, H. Wang, N. M. Trease, V. Presser, Y. G. Gogotsi, P. Simon and C. P. Grey
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F. Kaasik, T. Tamm, M. M. Hantel, E. Perre, A. Aabloo, E. Lust, M. Z. Bazant and V. Presser
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Electrochem Commun 2013, 34, 196–199 [04.425 (2012)]

M. V. Kharlamova, V. N. Mochalin, M. R. Lukatskaya, J. Niu, V. Presser, S. Mikhalovsky and Y. G. Gogotsi
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Mater Express 2013, 3, (1), 1–10 [01.341 (2012)]

M. D. Levi, S. Sigalov, G. Salitra, R. Elazari, D. Aurbach, L. Daikhin and V. Presser
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J Phys Chem C 2013, 117, (3), 1247–1256 [04.814 (2012)]

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S. Porada, L. Borchardt, M. Oschatz, M. Bryjak, J. S. Atchison, K. J. Keesman, S. Kaskel, P. M. Biesheuvel and V. Presser
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C. T. Bauer, A. Wonn, D. Brodoceanu, P. Born, E. Kroner and T. Kraus
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J. Brandt, N. K. Guimard, C. Barner-Kowollik, F. G. Schmidt and A. Lederer
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Detachment behavior of mushroom-shaped fibrillar adhesive surfaces in peel testing
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A. S. Schneider, C. P. Frick, E. Arzt, W. J. Clegg and S. Korte
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J. Lee, L. K. Schwarz, C. K. Akkan, M. Martinez Miró, O. Torrents Abad, K.-H. Schäfer, M. Veith and O. C. Aktas
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A. C. Martin, N. Lakhera, A. L. DiRienzo, D. L. Safranski, A. S. Schneider, C. M. Yakacki and C. P. Frick
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F. Wang, J. Zhao, P. Huang, A. S. Schneider, T. J. Lu and K. W. Xu
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Nanotribology of clean and modified gold surfaces
J Mater Res 2013, 28, (10), 1279–1288 [01.713 (2012)]

K. Brörmann, I. Barel, M. Urbakh and R. Bennewitz
Friction on a microstructured elastomer surface
Tribol Lett 2013, 50, (1), 3–15 [01.743 (2012)]

A. Caron, D. V. Louzguine-Luzguin and R. Bennewitz
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ACS Appl Mater Inter 2013, 5, (21), 11341–11347 [05.008 (2012)]

G. Cohen, E. Halpern, S. U. Nanayakkara, J. M. Luther, C. Held, R. Bennewitz, A. Boag and Y. Rosenwaks
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Surf Sci 2013, 607, (1), 20–24 [01.838 (2012)]

M. Lessel, P. Loskill, F. Hausen, N. N. Gosvami, R. Bennewitz and K. Jacobs
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C. Teuchert, C. Michel, F. Hausen, D.-Y. Park, H. W. Beckham and G. Wenz
Cylindrical polymer brushes by atom transfer radical polymerization from cyclodextrin-PEG polyrotaxanes: Synthesis and mechanical stability
Macromolecules 2013, 46, (1), 2–7 [05.521 (2012)]

F. Wählisch, J. Hoth, C. Held, T. Seyller and R. Bennewitz
Friction and atomic-layer-scale wear of graphitic lubricants on SiC(0001) in dry sliding
Wear 2013, 300, (1-2), 78–81 [01.262 (2012)]

Strukturbildung / Structure Formation

C. T. Bauer, A. Wonn, D. Brodoceanu, P. Born, E. Kroner and T. Kraus
Size and shape evolution of PS particle layers during etching
Bioinspired, Biomimetic and Nanobiomaterials 2013, 2, 3, 130–140 [-]

P. Born and T. Kraus
Ligand-dominated temperature dependence of agglomeration kinetics and morphology in alkyl-thiol-coated gold nanoparticles
Phys Rev E 2013, 87, (6), 062313 [02.313 (2012)]

D. Brodoceanu, C. Fang, N. H. Voelcker, C. T. Bauer, A. Wonn, E. Kroner, E. Arzt and T. Kraus
Fabrication of metal nanoparticle arrays by controlled decomposition of polymer particles
Nanotechnology 2013, 24, (8), 085304 [03.842 (2012)]

C. Fang, D. Brodoceanu, T. Kraus and N. H. Voelcker
Templated silver nanocube arrays for single-molecule SERS detection
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T. Kraus, D. Brodoceanu, N. Pazos-Perez and A. Fery
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Adv Funct Mater 2013, 23, (36), 4529–4541 [09.765 (2012)]

T. Kraus and N. de Jonge
Dendritic gold nanowire growth observed in liquid with transmission electron microscopy
Langmuir 2013, 29, (26), 8427–8432 [04.187 (2012)]

MATERIALIEN IN DER BIOLOGIE / MATERIALS IN BIOLOGY

Biomineralisation / Biomineralization

M. Lazar and H. O. K. Kirchner
Dislocation loops in anisotropic elasticity: displacement field, stress function tensor and interaction energy
Philos Mag 2013, 93, (1–3), 174–185 [01.596 (2012)]

M.-L. Lemloh, F. Marin, F. Herbst, L. Plasseraud, M. Schweikert, J. Baier, J. Bill and F. Brümmer
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J Struc Biol 2013, 181, (2), 155–161 [03.361 (2012)]

A. Sengupta Ghatak, M. Koch, C. Guth and I. M. Weiss
Peptide induced crystallization of calcium carbonate on wrinkle patterned substrate: Implications for chitin formation in molluscs
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On the function of chitin synthase extracellular domains in biomineralization
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CVD/Biooberflächen / CVD/Biosurfaces

C. K. Akkan, M. Hammadeh, S. Brück, H. Park, M. Veith, H. Abdul-Khaliq and O. C. Aktas
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O. C. Aktas, J. Lee, M. Martinez Miró, A. Barnoush and M. Veith
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J. Altmayer, S. Barth and S. Mathur
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Guidance of glial cells and neurites from dorsal root ganglia by laser induced periodic patterning of biphasic core/shell nanowires
Phys Status Solidi A 2013, 210, (5), 952–956 [01.469 (2012)]

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Mit N-Methylpiperidin stabilisierte Halogenalane
Z Anorg Allg Chem 2013, 639, (2), 312–318 [01.163 (2012)]

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Optische Materialien / Optical Materials

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The impact of trioxadecanoic acid on the performance of dye sensitized solar cells based titanium oxide nanoparticles
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Oxygen sensing properties of zinc oxide nanowires, nanorods, and nanoflowers: The effect of morphology and temperature
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QUERSCHNITTSBEREICHE / CROSS LINKING ACTIVITIES

Innovative Elektronenmikroskopie / Innovative Electron Microscopy

N. Al-Dahoudi, A. Al-Kahlout, S. Heusing, P. Herbeck-Engel, R. Karos and P. W. de Oliveira
Indium doped zinc oxide nanopowders for transparent conducting coatings on glass substrates
J Sol-Gel Sci Techn 2013, 67, (3), 556–564 [01.660 (2012)]

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E. Arzt and R. Rolles
Neuorientierung eines öffentlichen Forschungsinstituts – das Beispiel INM
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SONSTIGE VERÖFFENTLICHUNGEN / OTHER PUBLICATIONS

GRENZFLÄCHENMATERIALIEN / INTERFACE MATERIALS

Energie-Materialien / Energy Materials

J. S. Atchison and V. Presser
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Funktionelle Oberflächen / Functional Surfaces

M. Jesbeer, D. Paretkar, E. Kroner, E. Arzt and A. Ghatak
Design of a two-phase adhesive for wet and dry adhesion
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E. Kroner and E. Arzt
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Metallische Mikrostrukturen / Metallic Microstructures

N. Lakhera, A. Graucob, A. S. Schneider, E. Kroner, C. M. Yakacki and C. P. Frick
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Strukturbildung / Structure Formation

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Biomineralisation / Biomineralization

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CVD/Biooberflächen / CVD/Biosurfaces

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A. Kraegeloh and E. Arzt
Proceedings of Nanosafety 2013, held November 20–22, 2013, Saarbrücken
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QUERSCHNITTSBEREICHE / CROSS LINKING ACTIVITIES

Innovative Elektronenmikroskopie / Innovative Electron Microscopy

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Modellierung/Simulation / Modelling/Simulation

F. I. Corona-Strauss and D. J. Strauss
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Geschäftsführung / Management Board

E. Arzt
Dr. Herbert Karl Schmid
Int J Mater Res 2013, 104, (9), 919–920 [00.691 (2012)]

POSTER / POSTERS

GRENZFLÄCHENMATERIALIEN / INTERFACE MATERIALS

Energie-Materialien / Energy Materials

J. Aquil, J. S. Atchison and V. Presser
Characterization of electrospun carbon fibers
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

J. S. Atchison, C. L. Schauer and V. Presser
Interactions at boundaries: Exploring surface area, length scales, and pore volume phenomena in nanofibrous assemblies
246th American Chemical Society National Meeting & Exposition (ACS), September 08–12, 2013, Indianapolis <IN, USA>

J. E. Dykstra, P. M. Biesheuvel, J. S. Atchison and V. Presser
The effect of ion mobility on pH fluctuations in capacitive deionization
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

L. Funke, J. S. Atchison and V. Presser
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Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

R. Gilmore, J. E. Dykstra, J. S. Atchison and V. Presser
Engineering a capacitive deionization system
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

M. Langenstein, J. S. Atchison, I. Grobelsek and V. Presser
Core-shell electrospinning composite materials
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

A. McBride, D. Weingarth, E. Perre, J. S. Atchison and V. Presser
Investigating charge induced expansion of porous carbon electrodes in ionic liquids
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

V. M. Sadowski, J. S. Atchison and V. Presser
Electrospun separators for application in supercapacitors
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

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Filling of electrospun ultrafine carbon fiber electrodes with carbon onions
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

Funktionelle Oberflächen / Functional Surfaces

R. Balijepalli, E. Kroner, E. Arzt, R. M. McMeeking and M. R. Begley
Modeling the delamination of fibrils using Dugdale cohesive zones
Doktorandentag der NTF III, Universität des Saarlandes, November 13, 2013, Saarbrücken

C. T. Bauer, E. Kroner, D. Brodoceanu, T. Kraus and E. Arzt
Hierarchical dry adhesives
Doktorandentag der NTF III, Universität des Saarlandes, November 13, 2013, Saarbrücken

M. Frensemeier, J. S. Kaiser, E. Kroner, A. S. Schneider and E. Arzt
Switchable adhesion on NiTi-polymer hybrid shape memory surfaces
Leibniz-Doktoranden-Forum der Sektion D, June 06–07, 2013, Berlin

M. Frensemeier, J. S. Kaiser, E. Kroner, A. S. Schneider and E. Arzt
Switchable adhesion on NiTi-polymer hybrid shape memory surfaces
Gordon Research Conference, Science of Adhesion, July 14–19, 2013, South Hadley <MA, USA>

M. Frensemeier, J. S. Kaiser, E. Kroner, A. S. Schneider and E. Arzt
Switchable adhesion on NiTi-polymer hybrid shape memory surfaces
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken
1st prize graduate poster

N. K. Guimard, J. Ho, J. Brandt, C. Y. Lin, M. Namazian, J. O. Mueller, K. K. Oehlenschlaeger, S. Hilf, A. Lederer, F. G. Schmidt, M. L. Coote and C. Barner-Kowollik
Harnessing entropy to direct the bonding/debonding of polymer systems based on reversibly chemistry
SCM-6, 6th International Symposium on the Separation and Characterization of Natural and Synthetic Macromolecules, February 06–08, 2013, Dresden

J. S. Kaiser, K. Samet, E. Arzt and E. Kroner
Multifunctional mesostructured surfaces for medical application
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

J. S. Kaiser, K. Samet, E. Arzt and E. Kroner
Multifunctional mesostructured surfaces for medical application
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Multifunctional mesostructured surfaces for medical application
The Adhesion Society's 36th Annual Meeting, February 28-March 06, 2013, Daytona Beach <FL, USA>

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E. Kroner, M. Micciché and E. Arzt
Lessons from adhesion tests on single macroscopic elastomeric pillars
Gordon Research Conference, Science of Adhesion 2013, July 14–19, 2013, South Hadley <MA, USA>

Metallische Mikrostrukturen / Metallic Microstructures

M. Frensemeier, J. S. Kaiser, E. Kroner, A. S. Schneider and E. Arzt
Switchable adhesion on NiTi-polymer hybrid shape memory surfaces
Leibniz-Doktoranden-Forum der Sektion D, June 06–07, 2013, Berlin

M. V. G. Oliveira, N. J. Peter, F. Wählisch, A. S. Schneider, M.-L. Lemloh, R. Bennewitz and I. M. Weiss
Surface preparation for mechanical analysis of interfaces in nacre
Euro BioMat 2013, April 23–24, 2013, Weimar
Poster Award 3rd Prize

Nanotribologie / Nanotribology

J. Blass, B. Bozna, F. Hausen, M. Albrecht, G. Wenz and R. Bennewitz
Single host-guest interactions on self-assembled monolayers mediated by ditopic guest molecules
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J. Blass, F. Hausen, M. Albrecht, A. Hermsdörfer, O. Köhler, C. Müller, G. Wenz, C. Ziegler and R. Bennewitz
Scanning Force Microscopy applied to protein adhesion and nano-assemblies
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G. Cohen, E. Halpern, S. U. Nanayakkara, J. M. Luther, C. Held, R. Bennewitz, A. Boag and Y. Rosenwaks
Reconstruction of Kelvin probe force microscopy images
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M. V. G. Oliveira, N. J. Peter, F. Wählisch, A. S. Schneider, M.-L. Lemloh, R. Bennewitz and I. M. Weiss
Surface preparation for mechanical analysis of interfaces in nacre
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Poster Award 3rd Prize

Strukturbildung / Structure Formation

R. Allen, M.-L. Lemloh, I. M. Weiss and T. Kraus
Synthesis and stabilization of amorphous calcium carbonate nanoparticles
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

C. T. Bauer, E. Kroner, D. Brodoceanu, T. Kraus and E. Arzt
Hierarchical dry adhesives
Doktorandentag der NTF III, Universität des Saarlandes, November 13, 2013, Saarbrücken

D. Gerstner and T. Kraus
Nanoparticle agglomeration in flow
5th international SAXS User Meeting, September 11–13, 2013, Karlsruhe

A.-R. Jochem, G. N. Ankah, C. Cavelius, S. Elsenberg, U. Rösch, C. Johann and T. Kraus
Characterization of gold and silica nanoparticles with field-flow fractionation and off-line analysis
Nanosafety 2013, November 20–22, 2013, Saarbrücken

A.-R. Jochem, C. Cavelius, S. Elsenberg, U. Rösch, C. Johann and T. Kraus
Nanoparticle-membrane interactions in FlFFF
International Symposium on Field- and Flow-based Separations, FFF 2013, June 30-July 04, 2013, Pau <France>

T. Kraus
How patchy are our nanoparticles?
GRC Conference on Self-Assembly & Supramolecular Chemistry, May 05–10, 2013, Les Diablerets <Switzerland>

T. Kraus and D. Gerstner
Nanoparticle agglomeration in a flow processing system
ECIS 2013 – 27th Conference of the European Colloid and Interface Society, September 01–06, 2013, Sofia <Bulgaria>

J. Lacava, A.-A. Ouali and T. Kraus
Role of surfactant in evaporating emulsion containing nanoparticles
46th Biennial Meeting of the German Colloid Society "Morphological Transformations and Responses in Colloidal Systems", September 23–25, 2013, Paderborn

J. Lacava, A.-A. Ouali and T. Kraus
Role of surfactant in the stability of emulsion containing nanoparticle
46th Biennial Meeting of the German Colloid Society "Morphological Transformations and Responses in Colloidal Systems", September 23–25, 2013, Paderborn

MATERIALIEN IN DER BIOLOGIE / MATERIALS IN BIOLOGY

Biomineralisation / Biomineralization

R. Allen, M.-L. Lemloh, I. M. Weiss and T. Kraus
Synthesis and stabilization of amorphous calcium carbonate nanoparticles
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

M. V. G. Oliveira, N. J. Peter, F. Wählisch, A. S. Schneider, M.-L. Lemloh, R. Bennewitz and I. M. Weiss
Surface preparation for mechanical analysis of interfaces in nacre
Euro BioMat 2013, April 23–24, 2013, Weimar
Poster Award 3rd Prize

A. Pohl, M.-L. Lemloh, E. Weber, M. Zeiger, P. Bauer, I. M. Weiss and A. S. Schneider
Structure-property relationships in mechanically stimulated sorghum bicolor stalks
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

CVD/Biooberflächen / CVD/Biosurfaces

A. A. Ali
Organoplatinum (ii) complexes with 2-acetylthiophene thiosemicarbazone synthesis & antitumor activity
GRK – International Graduate School , Physical Chemistry of Biofunctional Molecular Assemblies, October 10, 2013, Nancy <France>

M. Martinez Miró, K. Löw, A. Haidar, J. Schütt, D. Anschütz, G. Duruksu, E. Karaöz, H. Abdul-Khaliq, A. Subrahmanyam, M. Veith and O. C. Aktas
New surfaces for cardiovascular implants
EU-India Science and Technology Cooperation Days 2013, October 10, 2013, Paris <France>

Nano Zell Interaktionen / Nano Cell Interactions

A.-R. Jochem, G. N. Ankah, C. Cavelius, S. Elsenberg, U. Rösch, C. Johann and T. Kraus
Characterization of gold and silica nanoparticles with field-flow fractionation and off-line analysis
Nanosafety 2013, November 20–22, 2013, Saarbrücken

A.-R. Jochem, C. Cavelius, S. Elsenberg, U. Rösch, C. Johann and T. Kraus
Nanoparticle-membrane interactions in FlFFF
International Symposium on Field- and Flow-based Separations, FFF 2013, June 30-July 04, 2013, Pau <France>

T. Jung, C. Cavelius, H. Schirra, D. Kreischer, A. Kurz, A. Schwarz, A. Kraegeloh and R. Danzebrink
Nanoscale contrast agents: synthesis, modification and characterization
3. Clustertreffen der BMBF-Fördermaßnahmen NanoCare and NanoNature, Dechema, January 14–15, 2013, Frankfurt am Main

A. Kraegeloh, S. Kiefer and C. Fink-Straube
Silver content, silver release, and bioactivity of silver-based products
Nanosafety 2013, November 21–22, 2013, Saarbrücken

M. Kucki, C. Cavelius and A. Kraegeloh
Nanoscale contrast agents: microscopical analysis of particle uptake and intracellular localisation
3. Clustertreffen der BMBF-Fördermaßnahmen NanoCare and NanoNature, Dechema, January 14–15, 2013, Frankfurt am Main

M. Kucki, C. Cavelius and A. Kraegeloh
Nanoscale contrast agents – Particle uptake, subcellular distribution and morphological effects
BioNanoMed 2013, 4th International Congress Nanotechnology, Medicine & Biology, March 13–15, 2013, Krems <Austria>

H. Peuschel, T. Ruckelshausen, C. Cavelius and A. Kraegeloh
Microscopy study on the interaction of silica nanoparticles with lung epithelial cells
Carbon Black Symposium, Forschungszentrum Borstel, October 24–25, 2013, Hamburg

H. Peuschel, T. Ruckelshausen and A. Kraegeloh
Quantification of the uptake of amorphous silica nanoparticles in lung epithelial cells via processing of microscopic images
10th International Particle Toxicology Conference, June 04–07, 2013, Düsseldorf

T. Ruckelshausen, H. Peuschel, C. Cavelius and A. Kraegeloh
Using STED-microscopy and image processing to investigate the uptake of silica nanoparticles in lung epithelial cells
Nanosafety 2013, November 20–22, 2013, Saarbrücken

T. Ruckelshausen, H. Peuschel, C. Cavelius and A. Kraegeloh
STED-microscopy and image processing for quantification of silica nanoparticles internalized by lung epithelial cells
High Resolution Imaging & Applications, Mini-Symposium, Institut Pasteur, December 05, 2013, Paris <France>

T. Ruckelshausen, H. Peuschel and A. Kraegeloh
Quantitative analysis of internalized silica nanoparticles in lung epithelial cells (A549) via image processing of microscopy images
Focus on Microscopy, March 24–27, 2013, Maastricht <Netherlands>

CHEMISCHE NANOTECHNOLOGIE / CHEMICAL NANOTECHNOLOGY

Nanomere / Nanomers

M. Jochum, C. Becker-Willinger and M. Veith
Scratch resistant transparent powder coating
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

Optische Materialien / Optical Materials

S. Heusing, P. Rogin, M. Lacroix, F. Hardinghaus, P. Garcia-Juan and P. W. Oliveira
Gravure printed ITO coatings on foil
Printed Electronics EUROPE 2013, April 17–18, 2013, Berlin

M. Quilitz
Forschung auf dem Campus: Das INM
Tag der Offenen Tür der Universität des Saarlandes, June 22, 2013, Saarbrücken

M. Quilitz
Nanotechnology in the Leibniz Association
EuroNanoForum 2013, June 18–20, 2013, Dublin <Ireland>

M. Quilitz and E. Arzt
Nanotechnology in the Leibniz Association – The Leibniz Network Nano
Nanosafety 2013, November 21–22, 2013, Saarbrücken

J. Tamara
Laser cladding of copper and silver
INASCON 2013, August 19–22, 2013, London <UK>

QUERSCHNITTSBEREICHE / CROSS LINKING ACTIVITIES

Innovative Elektronenmikroskopie / Innovative Electron Microsopy

S.-M. Hühne, J. Garling, H. K. Schmid, W. Assenmacher and W. Mader
HAADF-STEM Imaging and Simulation of $(Sb_{1/3}Zn_{2/3})GaO_3(ZnO)_3$
Microscopy Conference, August 25–30, 2013, Regensburg

M. Langenstein, J. S. Atchison, I. Grobelsek and V. Presser
Core-shell electrospinning composite materials
Research Poster Exhibition: Energy Research, August 08, 2013, Saarbrücken

D. B. Peckys and N. de Jonge
Environmental scanning electron microscopy applied to visualize and quantify gold nanoparticle storage in whole, hydrated lung cancer cells
Microscopy Conference, August 25–30, 2013, Regensburg

D. B. Peckys, U. Werner and N. de Jonge
Detection of epidermal growth factor receptor dimers on wet and intact eukaryotic cells in an environmental scanning electron microscope
Microsc. Microanal., August 04–08, 2013, Indianapolis <IN, USA>

G. Schaan, S.-M. Hühne, H. K. Schmid and W. Mader
Investigations of Sn-doped ZnO nanowires with multiple inversion domain boundaries
Microscopy Conference, August 25–30, 2013, Regensburg

H. K. Schmid, P. Longo and W. Mader
Characterization of nanostructured materials by structural and spectroscopic imaging in Cs-corrected TEM/STEM
Microscopy Conference, August 25–30, 2013, Regensburg

K. Song, H. K. Schmid, V. Srot, E. Gilardi, G. Gregori, J. Maier and P. A. van Aken
Structure and chemistry of CeO_2*/YSZ interfaces investigated by TEM/STEM*
Microscopy Conference, August 25–30, 2013, Regensburg

Modellierung/Simulation / Modelliung/Simulation

R. Balijepalli, E. Kroner, E. Arzt, R. M. McMeeking and M. R. Begley
Modeling the delamination of fibrils using Dugdale cohesive zones
Doktorandentag der NTF III, Universität des Saarlandes, November 13, 2013, Saarbrücken

PROGRAMMBEREICHSUNGEBUNDEN / NOT LINKED TO A PROGRAM DIVISION

Analytik / Analytics

A. Kraegeloh, S. Kiefer and C. Fink-Straube
Silver content, silver release, and bioactivity of silver-based products
Nanosafety 2013, November 21–22, 2013, Saarbrücken

SUPPLEMENT 2012

Im Jahresbericht 2012 fehlen die folgenden Veröffentlichungen und Poster:

In the Annual Report 2012, the following publications and posters are missing:

SONSTIGE VERÖFFENTLICHUNGEN / OTHER PUBLICATIONS

Bibliothek, Information & Dokumentation / Library, Information & Services

E. Bubel, N. Elsner, P. König, H. Müller, N. Nikitina, M. Quilitz, S. Rehme, A. Rettinger and M. Schwantner
Text Mining für den Ontologieaufbau
In: Data Analysis, Machine Learning and Knowledge Discovery, The 36th Annual Conference of the German Classification Society (GfKl), August 01–03, 2012, Hildesheim, Springer, (2012), p 154

Nano Zell Interaktionen / Nano Cell Interactions

M. Kucki
Detection and semi-quantification of endotoxin contaminations in nanoparticle suspensions – Limulus amebocyte lysate (LAL) Gel Clot Assay
2012, 13 S.

Optische Materialien / Optical Materials

E. Bubel, N. Elsner, P. König, H. Müller, N. Nikitina, M. Quilitz, S. Rehme, A. Rettinger and M. Schwantner
Text Mining für den Ontologieaufbau
In: Data Analysis, Machine Learning and Knowledge Discovery, The 36th Annual Conference of the German Classification Society (GfKl), August 01–03, 2012, Hildesheim, Springer, (2012), p 154

POSTER / POSTERS

Nano Zell Interaktionen / Nano Cell Interactions

M. Kucki, C. Cavelius and A. Kraegeloh
The devil is in the details – endotoxin-detection in nanoparticle formulations
SENN2012 – International Congress on Safety of Engineered Nanoparticles and Nanotechnologies, October 28–31, 2012, Helsinki <Finland>

M. Kucki, C. Cavelius, S. Schmidt and A. Kraegeloh
Nanoskalige Kontrastmittel: Endotoxin-Bestimmung und mikroskopische Darstellung
2. Clustertreffen der BMBF-Fördermaßnahmen NanoCare and NanoNature, Dechema, March 13–14, 2012, Frankfurt am Main

H. Peuschel, C. Cavelius, A.-R. Jochem and A. Kraegeloh
Cytotoxicity testing of silica nanoparticles in the presents of different proteins
SENN2012 – International Congress on Safety of Engineered Nanoparticles and Nanotechnologies, October 28–31, 2012, Helsinki <Finland>

Strukturbildung / Structure Formation

D. Brodoceanu, C. Fang, N. H. Voelcker, M. Karg and T. Kraus
Metal nanoparticle arrays by controlled decomposition of polymer particles
MICROTAS, 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Ginowan City, October 28-November 01, 2012, Okinawa <Japan>

D. Gerstner and T. Kraus
Nanoparticle assembly in a modular fluidic system
MICROTAS, 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Ginowan City, October 28-November 01, 2012, Okinawa <Japan>

J. Lacava, P. Born and T. Kraus
Self-assembly of nanoparticles into clusters inside emulsion droplet microreactors
MICROTAS, 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Ginowan City, October 28-November 01, 2012, Okinawa <Japan>

VORTRÄGE / TALKS

Im Jahr 2013 wurden insgesamt 147 Vorträge gehalten, davon 87 eingeladene wissenschaftliche Vorträge und 60 sonstige Vorträge. (Stand: 31.03.2014)

In 2013, 147 talks were given, therefrom 87 invited talks and 60 other talks. (As of 31.03.2014)

EINGELADENE VORTRÄGE / INVITED TALKS

GRENZFLÄCHENMATERIALIEN / INTERFACE MATERIALS

Energie-Materialien / Energy Materials

J. S. Atchison and V. Presser
Carbon materials by chlorine treatment of Precursor-Derviced Ceramics (PDC)s
10th Pacific Rim Conference on Ceramic and Glass Technology; June 02–07, 2013; San Diego <CA, USA>

V. Presser
Supercapacitor, pseudocapacitor, flow capacitor advanced electrochemical energy storage
Materials for Energy Efficiency in Transport (MEET) – Research Conference; March 07–08, 2013; Bath <UK>

V. Presser
Carbon and carbide nanomaterials for energy & gas storage and water purification
Seminar at Bath University; March 11, 2013; Bath <UK>

V. Presser
Microporous carbide-derived carbons and carbon nanomaterials
HySSMat Workshop; April 15, 2013; Saarbrücken

V. Presser
Carbide-derived carbons and model carbon nanomaterials
Studium Research Consortium; July 03–05, 2013; Tours <France>

V. Presser
Advanced electrochemical nanomaterials, future materials for safety
KIST-Workshop: Future Materials and Safety for establishing European-Korean Research; October 15–16, 2013; Saarbrücken

V. Presser
Fortschritte in der Materialforschung: Ausblick auf den Elektrochemischen Energiespeicher der Zukunft
3. Fachkonferenz: Energiespeicher für Deutschland; April 22–23, 2013; Düsseldorf

Funktionelle Oberflächen / Functional Surfaces

E. Arzt
Bioinspirierte schaltbare Haftsysteme – Von van-der-Waals-Kräften zu ersten Anwendungen
GDCh-Vortrag; January 31, 2013; Bayreuth

E. Arzt
Der Leibniz Forschungsverbund Nanosicherheit
Leibniz-Gemeinschaft, Treffen des Präsidenten mit den Leibniz-Forschungsverbünden; March 26, 2013; Berlin

E. Arzt
Das INM Leibniz-Institut für Neue Materialien
Rotary Club; April 11, 2013; Saarbrücken

E. Arzt
Bioinspired gripping devices
Discussion Meeting "Challenges and Prospects of Soft Matter at Interfaces", IRTG / Soft Matter Science; April 24, 2013; Schluchsee

E. Arzt
Adhesion mechanisms in micropatterned dry adhesives with hierarchical structure
Begutachtungskolloquium, Schwerpunktprogramm SPP1420/3; May 28, 2013; Potsdam-Golm

E. Arzt
Bio-inspired micropatterned surfaces for interaction with soft matter
WE Heraeus Seminar, Physikzentrum; July 01, 2013; Bad Honnef

E. Arzt
Biomimetic micropatterned surfaces with enhanced functionality
International Conference on Computational Modelling of Nanostructured Materials (ICCMNM); September 05, 2013; Frankfurt am Main

E. Arzt
New functional surfaces: Exploiting size effects
Plenary Lecture, Euromat 2013; September 11, 2013; Sevilla <Spain>

E. Arzt
Micropatterned surfaces with switchable functionality: the "gecko effect" and its applications
Van Horn Distinguished Lecture 1, Case Western Reserve University; September 17, 2013; Cleveland <OH, USA>

E. Arzt
Strength, adhesion and sound: size effects in materials and structures
Van Horn Distinguished Lecture 2, Case Western Reserve University; September 18, 2013; Cleveland <OH, USA>

E. Arzt
New functional surfaces from fundamentals to applications: An overview of research at INM
Van Horn Distinguished Lecture 3, Case Western Reserve University; September 19, 2013; Cleveland <OH, USA>

E. Arzt
Neue Materialien – Forschung zwischen Neugier und Nutzen
Semestereröffnung, Universität des Saarlandes; October 14, 2013; Saarbrücken

E. Arzt
New functional surfaces: exploiting size effects in science and application
Euromat 2013; Plenary Lecture; September 11, 2013; Sevilla <Spain>

E. Arzt
Size effects in functional surfaces
The INT Physics Days, Symposium für Prof. Dr. Herbert Gleiter; November 15, 2013; Karlsruhe

E. Arzt
Bioinspired adhesive systems: from ideas to applications
International Workshop on Flow, Fracture, Interfaces in Soft Heterogeneous Materials, Michelin Materials Science Chair at ESPCI – École supérieure de physique et de chimie industrielles de la ville de Paris; December 10, 2013; Paris <France>

J. Blau and E. Kroner
Bioinspirierte Haftsysteme nach dem Vorbild des Geckos
7. Tagung feinwerktechnische Konstruktion; November 06, 2013; Dresden

M. Frensemeier, J. S. Kaiser, A. S. Schneider, E. Kroner and E. Arzt
Switchable adhesion in NiTi/PDMS hybrid systems via two way shape memory surfaces
Gordon Research Seminar, Science of Adhesion; July 13–14, 2013; South Hadley <MA, USA>

M. Frensemeier, E. Kroner and E. Arzt
Switchable adhesion via two way shape memory surfaces
Leibniz-Doktoranden-Forum der Sektion D; June 06–07, 2013; Berlin

E. Kroner and E. Arzt
Bioinspired adhesives: Adhesion tests on single macroscopic elastomeric pillars
KIST-Workshop: Future Materials and Safety for establishing European-Korean Research; October 15, 2013; Saarbrücken

Metallische Mikrostrukturen / Metallic Microstructures

M. Frensemeier, E. Kroner and E. Arzt
Switchable adhesion via two way shape memory surfaces
Leibniz-Doktoranden-Forum der Sektion D; June 06–07, 2013; Berlin

A. S. Schneider, C. P. Frick, N. J. Peter, F. Wählisch, I. M. Weiss and E. Arzt
Micro-/Nanomechanical characterization of metals and biomaterials
Friedrich-Alexander-Universität Erlangen-Nürnberg, Technische Fakultät, Lehrstuhl für Allgemeine Werkstoffeigenschaften, (Prof. Mathias Göken); January 10, 2013; Erlangen

A. S. Schneider, C. P. Frick, N. J. Peter, F. Wählisch, I. M. Weiss and E. Arzt
Micro-/Nanomechanical characterization of metals and biomaterials
Ludwig-Maximilians-Universität, Department für Geo- und Umweltwissenschaften Sektion Kristallographie (Prof. Wolfgang Schmahl); January 11, 2013; München

Nanotribologie / Nanotribology

R. Bennewitz
Microscopic friction mechanisms on metal surfaces
DPG-Frühjahrstagung; March 11–15, 2013; Regensburg
Keynote talk

R. Bennewitz
Identifying contact interactions in adhesion and friction
The Adhesion Society's 36th Annual Meeting; March 03–06, 2013; Daytona Beach <FL, USA>

R. Bennewitz
Recent progress in electrochemical friction force microscopy
Seminar at the School of Chemical Science and Engineering, Royal Institute of Technology; April 18, 2013; Stockholm <Sweden>

R. Bennewitz
Towards a molecular control of friction
Spring 2013 Seminar, Lehigh University, Department of Chemical Engineering; February 27, 2013; Bethlehem <PA, USA>

R. Bennewitz
Nanoscale friction on gold – from the basics to electrochemical modification
Seminar, Department of Mechanical Engineering and Applied Mechanics, University of Pennsylvania; February 25, 2013; Philadelphia <PA, USA>

R. Bennewitz
Low friction on metals – glide planes and molecular lubricants
AVS 60th International Symposium and Exhibition; October 27-November 01, 2013; Long Beach <CA, USA>

R. Bennewitz
Hochauflösende Rasterkraftmikroskopie – von der Verschleißanalyse bis zur Aufklärung mikroskopischer Schmiermechanismen
Symposium „Nanotribologie", Tribologie-Fachtagung; September 30-October 02, 2013; Göttingen

R. Bennewitz
Nanotribologie auf Kupfer – Reibung und Verschleiß auf atomarer Skala
Seminar des Deutschen Kupferinstituts „Oberflächentechnik und Beschichtung"; October 15–16, 2013; Duisburg

R. Bennewitz, P. Egberts, F. Hausen, J. Hoth, B. Soorali and A. Caron
Force spectroscopy at the molecular scale: from single dislocations to liquid layers
Nanomeasure 2013; June 25–26, 2013; Warsaw <Poland>

F. Hausen and R. Bennewitz
Controllability of friction at the solid-liquid interface in an electrochemical environment
AG Hartmann, Universität des Saarlandes; May 17, 2013; Saarbrücken

F. Hausen and R. Bennewitz
Controllability of friction at the solid-liquid interface in an electrochemical environment
Symposium on Ionic Liquid Interfaces; March 22, 2013; Oxford <UK>

Strukturbildung / Structure Formation

T. Kraus
Agglomeration and adsorption of colloidal particles. From an unpredictable nuisance to rational material synthesis
Universität Bayreuth, Vortragsreihe im Rahmen des SFB 840; August 28, 2013; Bayreuth

T. Kraus
Bridging the gap between self-assembly and hybrid materials: from particle dispersions to rational arrangements
German-American Frontiers of Engineering Symposium; April 26–28, 2013; Irvine <CA, USA>

T. Kraus
Das INM – Leibniz-Institut für Neue Materialien gGmbH. Ein kurzer Überblick.
DGM Arbeitskreistreffen Interaktive und adaptive Materialien; March 06, 2013; Straubing

T. Kraus
From particles to materials – from colloidal to materials science
Anorganisch-Chemisches Kolloquium, Universität zu Köln; April 10, 2013; Köln

T. Kraus
On the formation of microstructure in functional nanoparticle-polymer composites
Université Pierre et Marie Curie; September 26, 2013; Paris <France>

T. Kraus
Particle films, clusters and supercrystals: science and process engineering of nanoparticle self-assembly
PECSA, Université de Paris; February 05, 2013; Paris <France>

MATERIALIEN IN DER BIOLOGIE / MATERIALS IN BIOLOGY

Biomineralisation / Biomineralization

I. M. Weiss, M.-L. Lemloh, E. Weber, A. S. Schneider, M. Kellermeier and H. Cölfen
Molecular and cellular design features in nacre
EUROMAT 2013, European Congress and Exhibition on Advanced Materials and Processes; September 11–13, 2013; Sevilla <Spain>, Keynote

CVD/Biooberflächen / CVD/Biosurfaces

O. C. Aktas
Nanostructured materials for bioemdical applications
Nanobiotechnology Conference; October 03, 2013; Istanbul <Turkey>

O. C. Aktas
Nanostructured materials for implant applications
KIST-Workshop: Future Materials and Safety for establishing European-Korean Research; October 15–16, 2013; Saarbrücken

O. C. Aktas, A. May and A. A. Ali
Nanostrukturierte Oberflächen für biomedizinische Anwendungen
22. Diskussionstagung Anorganisch-Technische Chemie, DECHEMA-Haus; February 28-March 01, 2013; Frankfurt am Main

M. Martinez Miró, W. Metzger, J. Lee, M. Oberringer, T. Pohlemann, M. Veith and O. C. Aktas
Al/Al_2O_3 NWs for bone implant applications
EMRS – Fall Meeting; September 17, 2013; Warsaw <Poland>

A. Subrahmanyam and O. C. Aktas
HEARTSEN: Surface engineered coatings on mechanical heart valves: diagnostics of thrombosis
EU-India Science and Technology Cooperation Days 2013; October 10, 2013; Paris <France>

M. Veith
Bienfaits et Risques de la Nano-Téchnologie
Union des Français de Sarre, Villa Europa; May 06, 2013; Saarbrücken

M. Veith
Symmetry in Materials
Ecole Polytechnique; June 07, 2013; Paris <France>

Nano Zell Interaktionen / Nano Cell Interactions

A. Kraegeloh
NanoKon – systematische Bewertung der Gesundheitsauswirkungen nanoskaliger Kontrastmittel
NanoMed Workshop, Friedrich-Schiller-Universität; June 12, 2013; Jena

A. Kraegeloh
Nanoparticle interactions on a cellular scale
KIST-Workshop: Future Materials and Safety for establishing European-Korean Research; October 15–16, 2013; Saarbrücken

A. Kraegeloh, C. Cavelius, H. Peuschel, K. Böse and M. Kucki
Nanoparticle interactions on a cellular scale
Carbon Black Symposium, Forschungszentrum Borstel; October 24–25, 2013; Hamburg

M. Kucki
NanoKon – systematische Bewertung der Gesundheitsauswirkungen nanoskaliger Kontrastmittel
Clustertreffen der BMBF-Fördermaßnahmen NanoCare und NanoNature; January 14–15, 2013; Frankfurt am Main

CHEMISCHE NANOTECHNOLOGIE / CHEMICAL NANOTECHNOLOGY

Nanomere / Nanomers

D. Bentz and C. Becker-Willinger
Nanomers® – Nanocomposite coatings
KIST-Workshop: Future Materials and Safety for establishing European-Korean Research; October 15, 2013; Saarbrücken

D. Bentz, C. Kasper, F. Hollmann and C. Becker-Willinger
Fine textured tribological composite materails with multifunctional properties
XXII International Materials Research Congress 2013; August 11–15, 2013; Cancun <Mexico>

Optische Materialien / Optical Materials

J. Adam
$BaTiO_3$-Nanopartikel – ferroelektrische Informationsspeicher?
Sommerkolloquium des Instituts für Gesteinshüttenkunde der RWTH Aachen zum Thema ‚Eigenschaften und Verhalten partikulärer Materie'; June 20, 2013; Aachen

J. Adam
Ferroelectric nanoparticles and printable ferroelectric composites
NANO Seminar – Ecole d'ingénieurs et d'architectes; Réseau nanotechnologies du Canton de Fribourg; December 11, 2013; Fribourg <Switzerland>

M. Amlung
New materials for displays and printed electronics
TechDay – LG; September 17, 2013; Zürich

S. Heusing and P. W. de Oliveira
Gedruckte ITO Schichten auf Folie

Workshop „Transparente leitfähige Materialien (TCO/TCM) – Festkörperphysikalische Grundlagen und Technologien“ der EFDS (Europäische Forschungsgesellschaft Dünne Schichten e.V.); June 04–05, 2013; Dresden

P. König
DNA in Optical Systems
KIST-Workshop: Future Materials and Safety for establishing European-Korean Research; October 15, 2013; Saarbrücken

QUERSCHNITTSBEREICHE / CROSS LINKING ACTIVITIES

Innovative Elektronenmikroskopie / Innovative Electron Microscopy

N. de Jonge
Liquid and 3D scanning transmission electron microscopy of whole eukaryotic cells
25th Symposium on Plasma Physics and Radiation Technology; March 05–06, 2013; Lunteren <Netherlands>

N. de Jonge
Liquid scanning transmission electron microscopy: studying protein complexes in whole cells in their native aqueous environment
NorTEMnet: Workshop on Advanced Transmission Electron Microscopy, Chalmers University of Technology; March 25–27, 2013; Gothenburg <Sweden>

N. de Jonge
Electron microscopy of eukaryotic cells in liquid
LiMMS Workshop on the frontiers of nanoscience and biosystems; May 16–17, 2013; Paris <France>

N. de Jonge
Imaging labeled protein complex subunits in whole eukaryotic cells in liquid
German Cancer Research Center; June 07, 2013; Heidelberg

N. de Jonge
Electron microscopy of eukaryotic cells in liquid
ISOPOW – International Symposium on Properties of Water; August 19–23, 2013; Fiskebäckskil <Sweden>

N. de Jonge
Imaging labeled protein complex subunits in whole eukaryotic cells in their native aqueous environment
New opportunities for In-situ techniques and instruments, Microscopy and Microanalysis 2013 Meeting; August 04–08, 2013; Indianapolis <IN, USA>

N. de Jonge
Scanning transmission electron microscopy of whole eukaryotic cells in liquid and outlook on in situ studies of functional materials
Pre-meeting for the electron microscopy in liquids and gases focus interest group, Microscopy and Microanalysis 2013 Meeting; August 04–08, 2013; Indianapolis <IN, USA>

N. de Jonge
Three-dimensional transmission electron microcopy of whole eukaryotic cells
11th European Congress of Stereology and Image Analysis; July 08–12, 2013; Kaiserslautern

N. de Jonge
Imaging labeled protein complex subunits in whole eukaryotic cells in liquid
Super Imaging 2013 Conference; December 02, 2013; Hamamatsu City <Japan>

N. de Jonge
Scanning transmission electron microscopy of whole eukaryotic cells in liquid and in-situ studies of functional materials
Lecture at the Biomedical Research Institute in AIST; November 30, 2013; Tsukuba <Japan>

D. B. Peckys and N. de Jonge
Scanning transmission electron microscopy of gold nanoparticles in whole eukaryotic cells in water
13th Meeting of the French Microscopy Society (SFMu); July 02–05, 2013; Nantes <France>

T. Schuh
Spin dynamics of atoms and clusters on surfaces
Prof. Hartmann, Gruppenseminar, Universität des Saarlandes; January 18, 2013; Saarbrücken

NMO/Verfahrenstechnik / NMO/Chemical Engineering

A. K. Schlarb
10 Years of Nanocomposite Research, What is Next?
National Nanotechnology Center NANOTEC; March 19, 2013; Bangkok <Thailand>

A. K. Schlarb
Challenges and opportunities of polymer-based nanocomposites
Rajamangala University of Technology Thanyaburi (RMUTT); March 19, 2013; Thanyaburi <Thailand>

A. K. Schlarb
Challenges in the compounding and processing of thermoplastic nanocomposites
2013 Taishan Academic Forum TAF; November 14–16, 2013; Qingdao <China>

A. K. Schlarb
Composites
Department of Metallurgical Engineering, Chulalongkorn University; July 03, 2013; Bangkok <Thailand>

A. K. Schlarb
The influence of nano-sized fillers on the processing, morphology, and properties of semi-crystalline polymers especially polypropylene
29th International Conference of the Polymer Processing Society (PPS-29); July 15–19, 2013; Nürnberg

A. K. Schlarb
On the crystallization and morphology of filled polypropylene
Prince of Songkla University; March 26, 2013; Hat Yai <Thailand>

A. K. Schlarb
On the crystallization and morphology of polypropylene filled with nanosized SiO2 and cotton-based cellulose
Chulalongkorn University; March 22, 2013; Bangkok <Thailand>

A. K. Schlarb
On the crystallization and morphology of semi-crystalline polymeric nanocomposites
Suranaree University of Technology SUT; March 20, 2013; Nakhon Ratchasima <Thailand>

PROGRAMMBEREICHSUNGEBUNDEN / NOT LINKED TO A PROGRAM DIVISION

Vertrieb & Kommunikation / Sales & Communication

R. Hanselmann
EESaar – eine saarländische Initiative
Energiegipfel; Kaiserslautern

R. Hanselmann
Energiespeicher: Gestern – Heute und Morgen
Vorstandssitzung des VEWSaar; August 27, 2013; Neunkirchen-Kohlhof

Geschäftsführung / Management Board

M. Veith
Nanotechnologie et nouveaux matériaux pour la santé et dans le contexte de l’énergie – Nanotechnologie und Neue Materialien im Fokus der Energiewende
«Petit Déjeuner Débat» mit Minister Heiko Maas; June 20, 2013; Paris <France>

SONSTIGE VORTRÄGE / OTHER TALKS

GRENZFLÄCHENMATERIALIEN / INTERFACE MATERIALS

Energie-Materialien / Energy Materials

D. M. Anjos, J. K. McDonough, E. Perre, G. M. Brown, S. H. Overbury, Y. G. Gogotsi and V. Presser
Pseudocapacitance and performance stability of quinone-coated carbon onions
5th International Conference on Carbon for Energy Storage / Conversion and Environment Protection (CESEP); September 23–26, 2013; Mühlheim

J. S. Atchison, L. M. Funke and V. Presser
Synthesis of titanium carbide, zirconium carbide and niobium carbide nanofibers
246th American Chemical Society National Meeting & Exposition (ACS); September 08–12, 2013; Indianapolis <IN, USA>

N. Balke, J. Black, T. M. Arruda, M. Heon, P. C. Hillesheim, V. Presser, S. Dai, Y. G. Gogotsi and S. V. Kalinin
Nanoscale characterization of ion transport across the solid-liquid interface of electrochemical double-layer capacitors using scanning probe microscopy
2013 MRS Spring Meeting, Symposium G: Electrochemical Interfaces for Energy Storage and Conversion-Fundamental Insights from Experiments and Computations; April 01–05, 2013; San Francisco <CA, USA>

B. Dyatkin, V. Presser and Y. G. Gogotsi
Modification of surface chemistry and graphitic ordering of porous carbide-derived carbons for supercapacitor electrodes using vacuum annealing
2013 MRS Spring Meeting, Symposium F: Materials for Vehicular and Grid Energy Storage; April 01–05, 2013; San Francisco <CA, USA>

B. Dyatkin, V. Presser, M. Heon, M. Beidaghi and Y. G. Gogotsi
Development of a “green” supercapacitor based entirely on disposable, environmentally benign materials
2013 MRS Spring Meeting, Symposium K: Materials for Sustainable Development; April 01–05, 2013; San Francisco <CA, USA>

L. Funke, J. S. Atchison and V. Presser
Electrospinning of ultrafine carbide fibers as precursors for electrical double layer capacitors
International Nanoscience Student Conference (INASCON); August 19–22, 2013; London <UK>

Funktionelle Oberflächen / Functional Surfaces

N. K. Guimard, J. Ho, J. Brandt, C. Y. Lin, M. Namazian, J. O. Mueller, K. K. Oehlenschlaeger, S. Hilf, A. Lederer, F. G. Schmidt, M. L. Coote and C. Barner-Kowollik
Harnessing entropy to direct the bonding/debonding of polymer systems based on reversibly chemistry
European Polymer Congress-EPF; June 16–21, 2013; Pisa <Italy>

J. S. Kaiser, K. Samet, E. Kroner and E. Arzt
Bioinspired adhesion systems for medical application
Doktorandentag der Physik, Universität des Saarlandes; April 25–26, 2013; Saarbrücken

E. Kroner and E. Arzt
Lessons from adhesion tests on single macroscopic elastomeric pillars
The Adhesion Society's 36th Annual Meeting; March 03–06, 2013; Daytona Beach <FL, USA>

O. Torrents Abad
Influence of test temperature on the size effect of bcc metal pillars
INASCON 2013; August 19–22, 2013; London <UK>

O. Torrents Abad
Influence of test temperature on the size effect of bcc metal pillars
Nanobrücken – Nanomechanical Testing Workshop and Hysitron User Meeting; March 20, 2013; Dresden

Nanotribologie / Nanotribology

M. Albrecht, G. Wenz and R. Bennewitz
Single host-guest interactions of self-assembled monolayers on activated silicon
PhD Student's Day; April 25–26, 2013; Saarbrücken

R. Bennewitz, F. Hausen, J. Sweeney, R. Hayes, G. B. Webber, F. Endres, M. W. Rutland and R. Atkin
Electrochemical control of lubrication by ionic liquids
40th Leeds-Lyon Symposium on Tribology & Tribochemistry Forum 2013; September 04–06, 2013; Lyon <France>

J. Blass, F. Hausen, M. Albrecht, G. Wenz and R. Bennewitz
Single host-guest interactions of self-assembled monolayers on activated silicon
PhD Student's Day; April 25–26, 2013; Saarbrücken

J. Blass, F. Hausen, M. Lessel, P. Loskill, M. Albrecht, N. N. Gosvami, G. Wenz, K. Jacobs and R. Bennewitz
Friction force microscopy on activated silicon surface
DPG-Frühjahrstagung; March 11–15, 2013; Regensburg

A. Caron, D. V. Louzguine-Luzgin and R. Bennewitz
Chemical effects on the frictional characteristics of Pt(111) and a Pt-based metallic glass
DPG-Frühjahrstagung; March 11–15, 2013; Regensburg

F. Hausen, J. Hoth, J. Sweeney, R. Hayes, G. B. Webber, F. Endres, M. W. Rutland, R. Bennewitz and R. Atkin
Electrochemical control of friction in an ionic liquid
DPG-Frühjahrstagung; March 11–15, 2013; Regensburg

J. Hoth, F. Hausen and R. Bennewitz
Nanotribology with ionic liquids
PhD Student's Day; April 25–26, 2013; Saarbrücken

A. Klemenz, L. Pastewka, A. Caron, B. Soorali Ganeshamurty, R. Bennewitz and M. Moseler
Wear of supported graphene
WTC 2013 – 5th World Tribology Congress; September 08–13, 2013; Trieste <Italy>

F. Wählisch, J. Hoth, C. Held, T. Seyller and R. Bennewitz
Friction and atomic-scale wear of graphitic lubricants on SiC(0001) in dry sliding
DPG-Frühjahrstagung; March 11–15, 2013; Regensburg

Strukturbildung / Structure Formation

D. Brodoceanu and T. Kraus
High aspect ratio molds for bioinspired adhesion surfaces
EUROMAT 2013; September 08–13, 2013; Sevilla <Spain>

D. Gerstner, P. Born and T. Kraus
Nanoparticle agglomeration in flow
9th Zsigmondy Colloquium; March 06–08, 2013; Essen

D. Gerstner, P. Born and T. Kraus
Nanoparticle assembly in a modular fluidic system
DPG-Frühjahrstagung; March 11–15, 2013; Regensburg

A.-R. Jochem, G. N. Ankah, C. Cavelius, C. Johann, S. Elsenberg, U. Rösch and T. Kraus
Investigation of nanoparticle-membrane interactions in FIFFF
1st Workshop on Field-Flow Fractionation – Mass Spectrometry; September 26–27, 2013; Wien

J. Lacava and T. Kraus
Self-assembly of nanoparticles into supraparticles inside emulsion droplets
Third International Conference on Multifunctional, Hybrid and Nanomaterials (Hybrid Materials 2013); March 03–07, 2013; Sorrento <Italy>

MATERIALIEN IN DER BIOLOGIE / MATERIALS IN BIOLOGY

Biomineralisation / Biomineralization

M.-L. Lemloh, F. Brümmer, J. Bill, F. Marin and I. M. Weiss
The ciliate coleps hirtus as a unique cell-biological model for biomineralization
12th BIOMIN – International Symposium on Biomineralization; August 27–30, 2013; Freiberg

M.-L. Lemloh, F. Brümmer, J. Bill, F. Marin and I. M. Weiss
Hierarchical structures formed by amorphous minerals
EUROMAT 2013, European Congress and Exhibition on Advanced Materials and Processes; September 11–13, 2013; Sevilla <Spain>

M.-L. Lemloh, F. Brümmer, J. Bill, F. Marin and I. M. Weiss
Biomineralization and material characterization in invertebrates
106th Annual Meeting of the German Zoological Society; September 13–16, 2013; München

N. J. Peter, I. M. Weiss, E. Griesshaber and A. S. Schneider
Correlation of optically observed super-structure, mechanical performance and microstructure in the red abalone's shell
12th BIOMIN – International Symposium on Biomineralization; August 27–30, 2013; Freiberg

I. M. Weiss
Controlled biomineralization – An evolutionary perspective
Chemiedozententagung 2013; March 11–13, 2013; Berlin

I. M. Weiss
Pioneering applications of biomineralization-GFP fusion proteins
Euro BioMAT 2013; April 23–24, 2013; Weimar

CVD/Biooberflächen / CVD/Biosurfaces

C. K. Akkan, A. May and O. C. Aktas
Functional nanofilms by matrix shaped pulsed laser deposition
E-MRS 2013 Spring Meeting; May 27–31, 2013; Strasbourg <France>

C. K. Akkan, A. May, M. Lambert, N. Agarwal, O. C. Aktas and M. Veith
Laser surface modification of materials
GRK – International Graduate School , Physical Chemistry of Biofunctional Molecular Assemblies; October 10, 2013; Nancy <France>

O. C. Aktas
Nanostructured surfaces for biomedical applications
HeartSEN; January 27–30, 2013; Istanbul <Turkey>

O. C. Aktas
Innovative Anwendungen von Verbundwerkstoffen
+ Composite, Technologietrend Verbundwerkstoffe; August 01, 2013; Saarbrücken

O. C. Aktas
laser assisted micro- and nano structuring Ti_6Al_4V-surfaces for dental implant applications
Jahrestagung der Deutschen Gesellschaft für Biomaterialien; September 27, 2013; Erlangen

S. Brück
Synthesis and characterization of nanoparticles for medical application
HeartSEN; January 27–30, 2013; Istanbul <Turkey>

S. Brück
Verbundwerkstoffe: Märkte, Trends, Geschäftsprognosen
+ Composite, Technologietrend Verbundwerkstoffe; August 01, 2013; Saarbrücken

J. Lee, M. Martinez Miró, C. K. Akkan, W. Metzger, M. Veith and O. C. Aktas
Anisotropic wetting and controlled cell migration on laser patterned biphasic nanowires
EU-Korea Conference of Science and Technology (EKC); July 24–26, 2013; Brighton <UK>

K. Löw, A. Haidar, M. Martinez Miró, D. Anschütz, J. Schütt, O. C. Aktas, M. Veith and H. Abdul-Khaliq
Surface modification of cardiovascular implants
HeartSEN; January 27–30, 2013; Istanbul <Turkey>

M. Martinez Miró
CVD and 7Life Science
Doktorandentag der Chemie, Universität des Saarlandes; July 17, 2013; Saarbrücken

M. Martinez Miró, J. Lee, O. C. Aktas and M. Veith
Topographical control and characterization of Al/Al_2O_3 nanowire coatings for improved osseointegration of implant materials
GRK – International Graduate School, Physical Chemistry of Biofunctional Molecular Assemblies CDFA-01–13; April 25–26, 2013; Saarbrücken

M. Martinez Miró, F. Soldera, J. Lee, F. Mücklich, O. C. Aktas and M. Veith
3D modeling of biomimetic Al/Al2O3 nanoporous coatings for bone implant applications
EUROMAT; September 13, 2013; Sevilla <Spain>

A. May, C. K. Akkan, M. V. G. Oliveira, A. S. Schneider and O. C. Aktas
Laser assisted micro- and nano structuring and nitriding of Ti_6Al_4V-surfaces for medical applications
EUROMAT; September 11, 2013; Sevilla <Spain>

F. Sahin
Reaction behavior of the bicyclic compound $Al_2[(OPh_2Si)_2O]_3 * 2\ Et_2O$
GRK – International Graduate School, Physical Chemistry of Biofunctional Molecular Assemblies; October 11, 2013; Nancy <France>

Nano Zell Interaktionen / Nano Cell Interactions

A.-R. Jochem, G. N. Ankah, C. Cavelius, C. Johann, S. Elsenberg, U. Rösch and T. Kraus
Investigation of nanoparticle-membrane interactions in FIFFF
1st Workshop on Field-Flow Fractionation – Mass Spectrometry; September 26–27, 2013; Wien

H. Peuschel and A. Kraegeloh
Vorstellung und Besprechung der aktuellen Ergebnisse – Aufnahme von NP in Tumorzellen
Universitätsklinikum des Saarlandes, Seminar Klinik für Neurochirurgie; March 19, 2013; Homburg

CHEMISCHE NANOTECHNOLOGIE / CHEMICAL NANOTECHNOLOGY

Nanomere / Nanomers

B. Ali, M. Bukowski and C. Becker-Willinger
Synthesis and purification of copper nanoparticles with antimicrobial activity prepared by chemical reduction method
XXII International Materials Research Congress 2013; August 11–15, 2013; Cancun <Mexico>

C. Becker-Willinger
Multifunktionale Beschichtungen für industrielle Anwendungen
Hannover Messe. tech transfer – Gateway2Innovation; April 08–12, 2013; Hannover

M. Bukowski, B. Ali and C. Becker-Willinger
UV-curable coatings with anti-microbial properties
XXII International Materials Research Congress 2013; August 11–15, 2013; Cancun <Mexico>

M. Bukowski, M. Jochum and C. Becker-Willinger
Hygienic surfaces based on copper containing powder coatings
XXII International Materials Research Congress 2013; August 11–15, 2013; Cancun <Mexico>

Optische Materialien / Optical Materials

K. Moh and P. W. de Oliveira
Optical materials for display and printed electronics
Hannover Messe. tech transfer – Gateway2Innovation; April 08–12, 2013; Hannover

M. Quilitz
Das INM – von der Grundlagenforschung bis zur Pilotfertigung
Hannover Messe. Forum MicroTechnology – Innovations for Industry; April 08–12, 2013; Hannover

M. Quilitz
Nanotechnologie in der Leibniz-Gemeinschaft
Hannover Messe. tech transfer – Gateway2Innovation; April 08–12, 2013; Hannover

M. Quilitz
Das INM – Von der Grundlagenforschung bis zur Pilotlinienfertigung
64. Internationale Saarmesse; April 21, 2013; Saarbrücken

M. Quilitz
Was ist Nano(technologie)?
InnoZ Merzig; February 07, 2013; Merzig

M. Quilitz
Einstein und Co. – Was ist eigentlich Wissenschaft und was macht ein Forscher?
InnoZ Merzig; May 17, 2013; Merzig

QUERSCHNITTSBEREICHE / CROSS LINKING ACTIVITIES

Innovative Elektronenmikroskopie / Innovative Electron Microscopy

D. B. Peckys and N. de Jonge
Environmental scanning electron microscopy for the study of gold nanoparticle uptake in whole cells
Microsc. Microanal.; August 04–08, 2013; Indianapolis <IN, USA>

D. B. Peckys and N. de Jonge
Rapid examination of gold nanoparticle uptake in whole cells by environmental scanning electron microscopy
Nanosafety 2013; November 20–22, 2013; Saarbrücken

PROGRAMMBEREICHSUNGEBUNDEN / NOT LINKED TO A PROGRAM DIVISION

Analytik / Analytics

R. Ivanov, T. Brumbarova, A. Blum, A.-M. Jantke, C. Fink-Straube and P. Bauer
SORTING NEXIN1 is required for modulating the trafficking and stability of the Arabidopsis IRON-REGULATED TRANSPORTER1
PLANTCELL Revision Acknowledgment

Vertrieb & Kommunikation / Sales & Communication

R. Hanselmann
Energieland Saar – Die Energiewende als Chance für das Saarland
Staatskanzlei des Saarlandes; August 29, 2013; Saarbrücken

SUPPLEMENT 2012

Im Jahresbericht 2012 fehlen die folgenden Vorträge:

In the Annual Report 2012, the following talks are missing:

EINGELADENE VORTRÄGE / INVITED TALKS

Nano Zell Interaktionen / Nano Cell Interactions

A. Kraegeloh
Nanopartikel in Wechselwirkung mit Zellen: Von der Anwendung bis zur Sicherheit
PharmaForum; November 07, 2012; Hanau

A. Kraegeloh
Nanoparticles in interaction with cells: Insights by microscopic, chemical and biological analyses
University of New South Wales; October 11, 2012; Sydney <Australia>

A. Kraegeloh
Nano Cell interactions: microscopic, chemical and biological analyses
International Workshop on the Risk Assessment of Manufactured Nanomaterials; October 08–09, 2012; Adelaide <Australia>

Strukturbildung / Structure Formation

T. Kraus
From disorder to order to function in particle deposition
Friedrich-Alexander-Universität Erlangen-Nürnberg; November 28, 2012; Erlangen

T. Kraus
How to sort a colloid: assembling nanoparticles into regular structures
Ludwig-Maximilians-Universität; December 14, 2012; München

T. Kraus
Particle films, clusters and supercrystals: science and process engineering of nanoparticle self-assembly
Université du Luxembourg; December 18, 2012; Belvaux <Luxembourg>

SONSTIGE VORTRÄGE / OTHER TALKS

Nano Zell Interaktionen / Nano Cell Interactions

T. Ruckelshausen and A. Kraegeloh
Analysis of the effects of nanoparticles in human lung epithelial cells and their potential cytotoxicity
Huygens Deconvolution Course, SVI; September 21–22, 2012; Hilversum <The Netherlands>

Strukturbildung / Structure Formation

D. Gerstner and T. Kraus
Nanoparticle agglomeration in a flow process
International Nanoscience Conference 2012; August 03–05, 2012; Saarbrücken

D. Gerstner and T. Kraus
Nanoparticle assembly in a molecular fluidic system
The 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences; October 28-November 01, 2012; Okinawa <Japan>

T. Kraus
Selbstanordnung trifft Mikrofabrikation: unkonventionelle Strukturierung von Grenzflächen mit Partikeln
DGM-Fachausschuss „Polymerwerkstoffe“ und „Bioinspirierte & Interaktive Materialien“, Max-Planck-Institut für Kolloid- und Grenzflächenforschung; November 08–09, 2012; Potsdam

PATENTE / PATENTS

Im Jahr 2013 wurden fünf neue Patentanmeldungen hinterlegt, die noch nicht offengelegt worden sind. Es wurden 18 Patente erteilt, davon zwei innerhalb von Europa und 16 auf internationaler Ebene. Das INM – Leibniz-Institut für Neue Materialien unterhält somit 90 aktive Patentfamilien.

In 2013, INM has filed five new patent applications which are not yet published. Eighteen patents have been granted. Two of these patents have been granted in Europe and sixteen internationally. Thus the INM – Leibniz Institute for New Materials has 90 active patent families.

ERTEILTE EUROPÄISCHE PATENTE / PATENTS GRANTED IN EUROPE

Europäisches Patent Nr. 1996753 B1
Titel: *„Metallische Nanodrähte mit einer Hülle aus Oxid und Herstellungsverfahren derselben“*
Erfinder: Christian Petersen, Eve Awa Sow, Michael Veith;

Europäisches Patent Nr. 2432735 B1
Titel: *„Zusammensetzung und Verfahren zur Herstellung von ITO-Pulvern oder ITO-Beschichtungen“*
Erfinder: Carsten Bubel, Peter de Oliveira, Michael Veith;

ERTEILTE INTERNATIONALE PATENTE / PATENTS GRANTED INTERNATIONALLY

Japanisches Patent Nr. 5191128
Titel: *„Abriebbeständige und alkalibeständige Beschichtungen oder Formkörper mit Niedrigenergieoberfläche“*
Erfinder: Murat Akarsu, Ertugrul Arpac, Helmut Schmidt;

Japanisches Patent Nr. 5197565
Titel: *„Metallische Nanodrähte mit einer Hülle aus Oxid und Herstellungsverfahren derselben“*
Erfinder: Christian Petersen, Eva Awa Sow, Michael Veith;

US Patent Nr. 8382463
Titel: *„Verfahren und Vorrichtung zur Herstellung von strukturierten optischen Materialien“*
Erfinder: Martin Amlung, Peter de Oliveira, Michael Groß, Peter Rogin, Michael Veith

Japanisches Patent Nr. 5210140 INM-22
Titel: *„Beschichtete anorganische Pigmente, Verfahren zu deren Herstellung und deren Verwendung“*
Erfinder: Axel Kalleder, Martin Mennig, Helmut Schmidt;

US Patent Nr. 8388859
Titel: *„Abriebfeste optische Schichten und Formkörper“*
Erfinder: Carsten Becker-Willinger, Martin Kluke, Helmut Schmidt;

US Patent Nr. 8389592
Titel: *„Optische Elemente mit Gradientenstruktur“*
Erfinder: Peter de Oliveira, Marcus Geerkens, Hechun Lin, Peter Rogin, Michael Veith;

JapanischesPatent Nr. 5215515
Titel: *„Substrat mit einem abriebfesten Diffusionssperrschichtsystem“*
Erfinder: Peter de Oliveira, Martin Mennig, Helmut Schmidt;

Japanisches Patent Nr. 5279159
Titel: *„Verfahren zur Herstellung eines mikrostrukturierten Oberflächenreliefs durch Prägen thixotroper Schichten“*
Erfinder: Peter de Oliveira, Andreas Gier, Nora Laryea, Martin Mennig, Bruno Schäfer, Helmut Schmidt, Stefan Sapeur;

Taiwanesisches Patent Nr. I402311
Titel: *„Kompositzusammensetzung für mikrogemusterte Schichten mit hohem Relaxationsvermögen, hoher chemischer Beständigkeit und mechanischer Stabilität“*
Erfinder: Carsten Becker-Willinger, Etsuko Hino, Pamela Kalmes, Mitsutoshi Noguchi, Norio Ohkuma, Yoshikazu Saito, Helmut Schmidt;

US Patent Nr. 8497051
Titel: *„Verfahren und Zusammensetzung zur Herstellung optischer Elemente mit Gradientenstruktur“*
Erfinder: Peter de Oliveira, Jenny Kampka, Peter König, Annette Kraegeloh, Michael Veith;

Japanisches Patent Nr. 5351820
Titel: *„Liquid repellent, alkali resistant coating composition and coating suitable for pattern forming“*
Erfinder: Carsten Becker-Willinger, Pamela Kalmes, Helmut Schmidt;

Polnisches Patent Nr. PL213503
Titel: *„Nanostrukturierte Formkörper und Schichten und deren Herstellung über stabile wasserlösliche Vorstufen“*
Erfinder: Ertogrul Arpac, Gerhard Jonschker, Hermann Schirra, Helmut Schmidt;

US Patent Nr. 8535796
Titel: *„Kompositzusammensetzung für mikrogemusterte Schichten mit hohem Relaxationsvermögen, hoher chemischer Beständigkeit und mechanischer Stabilität“*
Erfinder: Carsten Becker-Willinger, Etsuko Hino, Pamela Kalmes, Mitsutoshi Noguchi, Norio Ohkuma, Yoshikazu Saito, Helmut Schmidt;

Koreanisches Patent Nr. 1013137010
Titel: *„Abriebbeständige und alkalibeständige Beschichtungen oder Formkörper mit Niedrigenergieoberfläche“*
Erfinder: Murat Akarsu, Ertugrul Arpac, Helmut Schmidt;

Koreanisches Patent Nr. 101317049
Titel: *„Amphiphile Nanopartikel“*
Erfinder: Murat Akarsu, Ertugrul Arpac, Helmut Schmidt;

Japanisches Patent Nr. 5403914
Titel: *„Kompositzusammensetzung für mikrogemusterte Schichten mit hohem Relaxationsvermögen, hoher chemischer Beständigkeit und mechanischer Stabilität“*
Erfinder: Carsten Becker-Willinger, Etsuko Hino, Pamela Kalmes, Mitsutoshi Noguchi, Norio Ohkuma, Yoshikazu Saito, Helmut Schmidt;

LEHRVERANSTALTUNGEN / LECTURES

WINTERSEMESTER 2012 / 2013

C. Aktas
Chemical Nanotechnology
Fachhochschule Kaiserslautern, Campus Zweibrücken, Vorlesung, 2 SWS

E. Arzt
INM-Kolloquium
Universität des Saarlandes, Saarbrücken, Kolloquium, 2 SWS

E. Arzt und Mitarbeiter/innen
Einführung in die Materialwissenschaft für (Studierende der) Mikrotechnologie und Nanostrukturen
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 5 SWS

E. Arzt und Mitarbeiter/innen
NanoBioMaterialien-1
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 2 SWS

E. Arzt und Mitarbeiter/innen
NanoBioMaterialien-P
Universität des Saarlandes, Saarbrücken, Praktikum, 4 SWS

M. Eder (Lehrveranstaltung Prof. Dr. P. Bauer)
BOT: Modul Botanik für B.sc./LA Biologie
Universität des Saarlandes, Saarbrücken, Vorlesung, 2 SWS

I. M. Weiss
Protein- und Enzymreinigung
Universität Regensburg, Kurs und Seminar, 7+1 SWS

V. Presser
Grundlagen der Thermodynamik
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 4 SWS

V. Presser (mit Prof. Hempelmann)
Werkstoffe für effiziente Energienutzung
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 4 SWS

SOMMERSEMESTER 2013

C. Aktas
Nanomaterials
Fachhochschule Kaiserslautern, Campus Zweibrücken, Vorlesung, 2 SWS

E. Arzt
INM-Kolloquium
Universität des Saarlandes, Saarbrücken, Kolloquium, 2 SWS

E. Arzt und Mitarbeiter/innen
NanoBioMaterialien-2
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 2 SWS

R. Bennewitz
Nanomechanik – Physikalisches Wahlpflichtfach
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 4 SWS

WINTERSEMESTER 2013 / 2014

C. Aktas
Chemical Nanotechnology
Fachhochschule Kaiserslautern, Campus Zweibrücken, Vorlesung, 2 SWS

E. Arzt
INM-Kolloquium
Universität des Saarlandes, Saarbrücken, Kolloquium, 2 SWS

E. Arzt und Mitarbeiter/innen
Einführung in die Materialwissenschaft für (Studierende der) Mikrotechnologie und Nanostrukturen
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 5 SWS

E. Arzt und Mitarbeiter/innen
NanoBioMaterialien-1
Universität des Saarlandes, Saarbrücken, Vorlesung / Übung, 2 SWS

E. Arzt und Mitarbeiter/innen
NanoBioMaterialien-P
Universität des Saarlandes, Saarbrücken, Praktikum, 4 SWS

I. M. Weiss
Protein- und Enzymreinigung
Universität Regensburg, Kurs und Seminar, 7+1 SWS

VORTRÄGE IM INM-KOLLOQUIUM / TALKS WITHIN THE INM COLLOQUIUM

Dr. Valeska Ting, University of Bath, UK
Practical evaluation of nanoporous materials for hydrogen storage
16.01.2013, Host: Jun.-Prof. Dr. Volker Presser

Prof. Dr. Georg Papastavrou, Universität Bayreuth
Probing surface interactions by direct force measurements: From specific interactions in polysaccharide films to particle manipulation by potentiostatic control
06.02.2013, Host: Dr. Tobias Kraus

Prof. Dr. Bart Jan Ravoo, Westfälische Wilhelms-Universität Münster
Functional Surfaces by Microcontact Chemistry
24.04.2013, Host: Prof. Dr. Roland Bennewitz

Dr. Stephan E. Wolf, Max-Planck-Institut für Polymerforschung, Mainz
Nonclassical Crystallization in vivo? Liquid-amorphous Mineral Phases and their Potential Role in the Synthesis of Biomimetic Nanocomposite Materials
08.05.2013, Host: Prof. Dr. Eduard Arzt

Prof. Dr. Jannik C. Meyer, Universität Wien, Österreich
Exploring low-dimensional nano-carbon materials by high-resolution microscopy
21.05.2013, Host: Prof. Dr. Niels de Jonge

Dr. Lucio Isa, Laboratory for Surface Science and Technology, Eidgenössische Technische Hochschule Zürich, Schweiz
Nano- and Microparticle Self-Assembly at Liquid Interfaces: Unraveling the Basis for the Fabrication of Novel Two-Dimensional Materials
05.06.2013, Host: Dr. Tobias Kraus

Prof. Dr. Gerhard Welsch, Case Western Reserve University, Cleveland, Ohio, USA
Materials for Energy Storage – Focus on Electrolytic Capacitors
07.06.2013, Host: Prof. Dr. Eduard Arzt

Prof. Dr. Scott R. White, University of Illinois at Urbana-Champaign, USA
Autonomous Materials Systems: From Self-Healing to Regeneration
12.06.2013, Host: Prof. Dr. Eduard Arzt

Prof. Dr. Helmut Cölfen, Universität Konstanz
Non Classical Crystallization: From Sea Urchin Spines to Fracture Resistant Cement
19.06.2013, Host: PD Dr. Ingrid Weiss

Prof. Dr. Joachim Rädler, Ludwig-Maximilians-Universität München
Time-Lapse Microscopy in Single-Cell Micro-Arrays – Gene-Expression, Cell Fate Decisions and Cell Migration
26.06.2013, Host: PD Dr. Ingrid Weiss

Dr. Christian Greiner, Institute of Applied Materials (IAM), KIT Karlsruhe
Tribologically loaded materials: Laser surface texturing and microstructure evolution
10.07.2013, Host: Prof. Dr. Eduard Arzt

Dr. Mirabbos Hojamberdiev, Tokyo Institute of Technology, Japan
Preparation of Porous Materials-Supported Photocatalysts for Energy and Environmental Applications
17.10.2013, Host: Dr. Tobias Kraus

Prof. Dr. Krijn de Jong, Utrecht University, The Netherlands
Nanostructured catalysts for the conversion of synthesis gas
30.10.2013, Host: Prof. Dr. Niels de Jonge

Prof. Dr. Michael J. Demkowicz, Massachusetts Institute of Technology (MIT), Cambridge, USA
Design of helium resistant materials using reduced order mesoscale models
06.11.2013, Host: Prof. Dr. Eduard Arzt

Prof. Dr. Sybrand van der Zwaag, Delft University of Technology, The Netherlands
The Computational Design of New (Ultra) High Strength Stainless Steels for Room and High Temperature Use
12.11.2013, Host: Prof. Dr. Eduard Arzt

Prof. Dr. Johannes Richardi, Université Pierre et Marie Curie, Paris / Jussieu, France
Atomistic Simulations of the Interaction of Gold Nanocrystals
27.11.2013, Host: Dr. Tobias Kraus

Prof. Dr. Joerg Lahann, University of Michigan, Ann Arbor, USA
Multifunctional Polymer Particles Enabled by Compartmentalization
02.12.2013, Host: Dr. Tobias Kraus

Prof. Dr. Karsten König, Universität des Saarlandes und Jenlab GmbH, Saarbrücken
Optical Manufacturing of Sub-100-NM Structures and in Vivo Testing of Nanoparticles
11.12.2013, Host: Prof. Dr. Eduard Arzt

Dipl.-Ing. René Hensel, Leibniz-Institut für Polymerforschung Dresden und Max Bergman Center of Biomaterials Dresden
Robust omniphobic surfaces by mimicking the springtail skin morphology
13.12.2013, Host: Dr. Tobias Kraus

VERANSTALTUNGEN / EVENTS

Neujahrsempfang der Wirtschaftsjunioren Saar
Ausrichtung, Vortrag, Führung, Exponate
R. Rolles, M. Koch, K. Moh, M. Quilitz, W. Seitz
Saarbrücken, January 14, 2013

Nano Tech 2013
Stand und Exponate
R. Hanselmann, T. Müller, S. Nishikawa
Tokyo, January 30 – February 01, 2013

Nanotechnologie im Alltag
Organisation, Vortrag, Versuche
K. Fries, T. Müller, M. Quilitz, S. Schumacher
Merzig, February 07, 2013

Hannover Messe 2013
Stand und Exponate
R. Rolles, M. Quilitz, W. Seitz, T. Müller, S. Schmitz-Stöwe, J. Blau, R. Hanselmann, M. Frensemeyer, D. Bentz, K. Moh
Hannover, April 08 – 12, 2013

INM – KIST Europe Workshop
Organisation
R. Hanselmann, M. Quilitz
Saarbrücken, April 18, 2013

Girls' Day
Organisation, Ausrichtung
E. Bubel, S. Siegrist, M. Koch, G. Heppe
Saarbrücken, April 25, 2013

Wirtschaftsjunioren: Nanotechnologiestandort Saarland
Präsentation von Exponaten
R. Hanselmann
Berlin, May 16, 2013

Verleihung des Bayer Early Excellence in Science Award an Jun.-Prof. Dr. Volker Presser
Organisation, Ausrichtung, Führung
E. Arzt, R. Rolles, C. Hartmann, J. Atchison
Saarbrücken, May 17, 2013

Tag der offenen Tür an der Universität des Saarlandes
Vorträge, Führungen
C. Hartmann, M. Koch, T. Müller, M. Quilitz
Saarbrücken, June 22, 2013

Workshop im Projekt „NanoKon"
Ausrichtung
A. Kraegeloh
Saarbrücken, June 24, 2013

Besuch von Vertretern der Industrie- und Handelskammern Frankreichs
Organisation, Ausrichtung
R. Rolles, M. Quilitz
Saarbrücken, July 2, 2013

„Astronauten am INM"
Organisation, Ausrichtung, Exponate, Führung
E. Arzt, R. Rolles, C. Hartmann, M. Amlung, J. Blau, M. Jochum, J. Lee, T. Schuh
Saarbrücken, July 3, 2013

Auftaktveranstaltung „Auf zu neuen Horizonten"
Stand, Poster
C. Becker-Willinger, D. Bentz, S. Schmitz-Stöwe, B. Ali
Saarbrücken, July 3, 2013

Nano Korea
Stand und Information
R. Hanselmann, K. Moh, P. Oliveira
Seoul, July 10 – 12, 2013

Research day: „energy research – research energy"
Organisation, Ausrichtung
V. Presser, J. Atchison
Saarbrücken, August 8, 2013

XXII International Materials Research Congress (IMRC) 2013, Symposium "Nanotechnology-Enhanced Coatings"
Organisation
C. Becker-Willinger, D. Bentz, B. Ali, M. Bukowski
Cancun, Mexico, August 11–15, 2013

Infoveranstaltung für MentoMINT
Vorträge, Führungen
J. Blass, C. Hartmann, M. Quilitz, D. Weingarth
Saarbrücken, August 23, 2013

+Composite Europe
Stand und Information
S. Brück
Stuttgart, September 17 – 19, 2013

14. Jahrestagung des Arbeitskreises der Bibliotheken und Informationseinrichtungen der Leibniz-Gemeinschaft
Organisation in Kooperation mit Sprecherrat AK Bibliotheken und MBI Berlin-Adlershof
E. Bubel, C. Hartmann
Max-Born-Institut, Berlin-Adlershof,
September 25 – 27, 2013

Workshop +composite
Organisation, Ausrichtung
C. Aktas, S. Brück
Saarbrücken, October 10 – 11, 2013

Besuch der Führungskräfte der saarländischen Landesverwaltung
Organisation, Ausrichtung
R. Rolles, M. Quilitz, T. Schuh, D. Weingarth
Saarbrücken, October 11, 2013

INM – KIST Europe Workshop "Future Materials and Safety"
Organisation
E. Arzt, R. Hanselmann, M. Quilitz
Saarbrücken, October 15 –16, 2013

Materialica
Stand und Exponate
T. Müller, S. Schmitz-Stöwe, W. Seitz
München, October 15 – 17, 2013

Eurofinish
Stand und Exponate
T. Müller, D. Bentz, W. Seitz
Gent, October 23 – 24, 2013

Eurice-Workshop Horizon 2020 – Industrielle Technologien
Ausrichtung, Vortrag
R. Rolles, C. Hartmann, C. Becker-Willinger
Saarbrücken, October 30, 2013

Symposium "New Trends in Steel Making and Steel Design"
Organisation und Ausrichtung
E. Arzt, M. Quilitz, C. Sauer, M. Bonnard
Saarbrücken, November 11 – 12, 2013

Konferenz „Nanosafety 2013"
Organisation und Ausrichtung
E. Arzt, A. Kraegeloh, K. Moh, T. Müller, H. Peuschel, C. Hartmann, M. Quilitz, E. Bubel, K. Broschart und weitere
Saarbrücken, November 20 – 22, 2013

Kick-Off-Meeting „Agglomeration und Anordnung von Nanopartikeln in eingeschränkter Geometrie"
Organisation, Ausrichtung
T. Kraus, J. Lacava, T. Kister
Saarbrücken, November 21, 2013

Besuch der Landesgruppe des Deutschen Bibliotheksverbands
Organisation, Ausrichtung
E. Bubel
Saarbrücken, November 25, 2013

Treffen des Leibniz Netzwerk nano
Organisation
E. Arzt, M. Quilitz
Berlin, November 28, 2013

Treffen des Forschungsverbunds Nanosicherheit
Organisation
E. Arzt, A. Kraegeloh, M. Quilitz
Berlin, November 28, 2013

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Stand: 31.12.2013 / As of: 31.12.2013

IMPRESSUM / IMPRINT

Nanomer und Gecomer sind vom INM eingetragene Markennamen.

Für den Inhalt verantwortlich: Prof. Dr. Eduard Arzt, Günter Weber

Redaktion: Dr. Mario Quilitz, Dr. Christina Sauer-Hormann
Korrektur: Dr. J. Atchison, Dr. D. Bentz, M. Bonnard, K. Broschart, Dr. A. Caron, M. Groh, C. Hartmann, Dr. M. L. Lemloh, Dr. K. Moh, Dr. E. Perre, Dr. H. Peuschel, Dr. D. Weingarth

Layout / Satz: Dipl.-Designerin Nicole Bies, HDW Werbeagentur GmbH, Saarbrücken

Druck: Farbraum Druckproduktion GmbH, Saarbrücken

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Campus D2 2 · 66123 Saarbrücken · www.inm-gmbh.de
Geschäftsführer: Prof. Dr. Eduard Arzt (Vorsitz), Günter Weber

ISSN: 1864-255x