Multicomponent Materials

Currently, the Multicomponent Materials group headed by Prof. Franz Faupel (formerly Chair for Multicomponent Materials) participates actively in three Collaborative Research Centers (SFBs) and has third party funds of about 3.57 million euro from the German Research Foundation (DFG), the BMBF (Ministry for Education and Research), the AIF (Working Group Industrial Research) and others. The achievements presented in this report would have been impossible without the contributions of the 15 PhD students, all of whom except one have been supported by external sources. Concerning the scientific output, more then 25 publications were published in international peer reviewed journals during the last year. Hence, only a few aspects of the present research can be discussed in the following.

Please refer to our website http://www.tf.uni-kiel.de/matwis/matv/ for further details and the papers listed below. More information on the different research topics are also given in previous Almanac editions which can be downloaded from our website.

A particularly outstanding result was the development of a new fully integrable magnetic field sensor which has been featured as a Research Highlight in "Nature" and numerous other newstickers and journals including "Advanced Engineering Materials" and "Physik Journal". The sensor was developed within the Collaborative Research Center SFB 855 on magneto-electric nanocomposites for medical applications together with other groups from electrical engineering (Prof. R. Knöchel) and materials science (Prof. E. Quandt and Prof. R. Adelung).

Like in the year before, working in three Collaborative Research Centers, the group strongly benefited from the joint interdisciplinary work with partners ranging from fundamental physics and organic chemistry to electrical engineering and medicine. This is why we were particularly pleased with the very positive reevaluation of the Collaborative Research Center SFB 677 - Function by Switching - which received funding for another four years with the possibility of a third extension. Our project "Photoswitchable Metal-Polymer Nanocomposites" got a top ranking. Many new results on formation of nanoparticles in plasmas were also obtained in our joint project “Plasma Processes for the Depression of Nanostructured Composite Materials” within the Collaborative Research Center SFB TR 24 on complex plasmas together with the group of Prof. Kersten from the physics department of the CAU. The Collaborative Research Center SFB 855 on magneto-electric nanocomposites for medical applications was already mentioned above in connection with our Research Highlight in Nature. Much research was also performed outside the three collaborative research centers, e.g., within the DFG priority program “Polymer-solid contacts: Interfaces and Interphases” and several other projects. The group also performed investigations at large scale facilities particularly at the Electron storage ring BESSY in Berlin and at the positron beam facility of the Research Reactor Garching. In addition, various projects were carried out with industry. Besides direct cooperation with companies, joint work with industry was performed within projects of the BMBF and the AIF.

The group was strongly involved in teaching and took great effort to inspire pupils for materials science and engineering in various ways including visits to schools in Schleswig-Holstein. After his deanship, Prof. Faupel took a sabbatical during WS 2010/2011.

Results

a) A fully integrable magnetic field sensing concept based on the delta-E effect

A vast range of modern technology, from cars to smartphones, is based on magnetic field sensors. To measure magnetic fields numerous principles are already known, each with its specific advantages and disadvantages. Parameters like size, weight, sensitivity and costs are of importance depending on the application of the sensor. We investigated a new sensor concept which is based on the so-called delta-E effect. This effect describes the softening of a magnetic material upon application of an external magnetic field. Such a material is for example the metallic glass FeCoSiB which is known to exhibit a high delta-E effect. To demonstrate our measurement principle, a commercial micro-cantilever made of silicon was coated with FeCoSiB. The cantilever, which is usually utilized for atomic force microscopy, can be mechanically excited.
The resulting oscillation depends on the stiffness of the cantilever. Thus, the oscillation changes when the FeCoSiB coating softens due to the presence of a magnetic field. Accordingly, the magnetic field can be measured by monitoring the change in oscillation amplitude. This concept yields several advantages: it can detect a broad range of magnetic field frequencies, it does not need a cooling since it operates at room temperature and it is fully integrable, which makes it suitable for incorporation in existing micro-electronics. Our report on the sensor in *Applied Physics Letters* was featured by the highly renowned journal *Nature* as a research highlight due to the versatility of the concept. As mentioned above, the sensor was developed within the Collaborative Research Center SFB 855.

**Fig. 1**: The sensor is based on established MEMS technology, giving it high application potential. The 125 µm long cantilever beam is barely visible on the left side of the chip.

**b) Nanocomposites for functional applications**

A main activity of our group during the last years centers around functional nanocomposites which consist of metallic nanoparticles embedded in an insulating matrix, either polymeric or ceramic in nature. The size of the nanoparticles is in between that of atoms and macroscopic materials and thus gives rise to new properties not observed in conventional materials which are explored in a broad range of applications ranging from high frequency magnetic materials to antimicrobial coatings. The nanocomposites are mostly deposited as thin films by vapor phase deposition methods, in particular evaporation and sputtering from solid targets. During the last year, plasma polymerization and physically enhanced chemical vapor deposition (PECVD) have also been employed in a joint project of the above mentioned Collaborative Research Center SFB TR 24. This transregional collaborative research centre of the universities of Greifswald and Kiel addresses fundamentals of complex plasmas. As part of the TR 24 our group established a joint project with Prof. Kersten from the department of physics of the CAU, focusing on the use of plasma processes for the deposition of nanostructured composite materials. Very interesting results were obtained within this project of the transregio. A self built gas aggregation cluster source (see Almanac 2010) was used to deposit 5 nm small cobalt clusters with a very narrow size distribution. Silver clusters created by the cluster source were successfully embedded into a plasma polymer created by an RF plasma from Hexamethyldisiloxane (HMDSO) monomer. It was demonstrated that the silver clusters are not altered by the plasma process and that their filling factor in the composite can be varied over a broad range. This opens up a new path for the generation of functional nanocomposites.
The gas aggregation cluster source was also used for a joint project with Prof. Hynek Biederman from Prague University. Hosting a PhD student as a guest scientist from his group, we worked on the preparation and characterization of nanoparticles which were obtained by reactive sputtering of titanium with the gas aggregation cluster source (see Fig. 2). It was observed that a small amount of oxygen is crucial for nucleation and growth of the nanoparticles. In an oxygen-rich environment, titania nanoparticles were generated which exhibited a very high photocatalytic activity. Current work now focuses on improving the mechanical stability of the coating for photocatalytic application.

![Fig. 2: Scanning electron micrograph image of titanium dioxide nanoparticle film deposited with the gas aggregation cluster source.](image)

Nanocomposites also play a key role in our projects within the Collaborative Research Center SFB 677 “Function by Switching” which are now carried out jointly with Prof. Elbahri (see also his report) in the second funding period. Here, the nanocomposites are combined with photoswitchable molecules. These so-called chromophores change their properties reversibly upon irradiation with light of two different wavelengths. Very interesting new electro-optical properties arise through interactions between chromophores and the so-called surface plasmon resonance of the metallic nanoparticles. As described in the Almanac 2006 these resonances are collective oscillations of the conduction electrons in the electrical field vector of electromagnetic radiation. Our recent major progress in this field is reported in many publications listed in the Almanac 2010 and below.

In several projects we explore the large specific surface area of the finely dispersed nanoparticles and the strong influence of the surface or interfacial energy on the material’s properties. This is particularly the case in antibacterial coatings with nanoparticles of silver and other noble metals. In such coatings a high metal ion release rate is strived for because the antimicrobial activity originates from the released metal ions. This research has been supported by the World Gold Council and is carried out in cooperation with Prof. Padschan from the Institute of Infection Medicine of the University Hospital Schleswig-Holstein/Campus Kiel. Toxicity of nanoparticles is studied in cooperation with PD Röhl from the Institute of Toxicity of the CAU. In addition, among other partners, we cooperate with Prof. Grundmeier from the Chemistry Department of the University at Paderborn in a joint DFG project.

Antimicrobial nanocomposites have been studied intensively with respect to their medical applicability, for example as functional coatings for implants. For such applications understanding of the so-called therapeutic window is essential in
order to achieve a therapeutic effect without inflicting undesired damage to the treated organism. In a systematic study conducted in close cooperation with PD Dr. Röhl Prof. Podschun much progress in the understanding of the therapeutic window in antimicrobial nanocomposites was achieved. It was found that the toxicity of silver for human cells and bacteria differs strongly for silver in solution and silver at surfaces, respectively. While in solution only a small therapeutic window exists in which silver is sufficiently toxic against bacteria but non-toxic to human cells the situation is much more favorable at surfaces of silver containing nanocomposite coatings. Here, human cells grow essentially undisturbed up to fairly high silver loadings of the coatings, and the toxicity for human cells can roughly be estimated by the measured silver release of the coating into distilled water. Bacteria, on the other hand, were already killed at fairly low silver loadings. This at first sight surprising observation could be understood considering the different metabolisms of human cells and bacteria. The fast metabolism of bacteria gives rise to a significant reduction of the pH value of the surrounding. A lowered pH value leads in turn to an enhanced silver release from the coating (see Fig. 3). Thus, due to their fast and acidic metabolism bacteria themselves induce the locally increased silver release rate that finally kills them. Human cells, on the other hand, survive on a similar coating thanks to their comparatively slower metabolism. This naturally occurring larger therapeutic window is advantageous for the biocompatibility of nanocomposite coatings for implants or other medical devices.

![Fig. 3: Sketch of working principle of antimicrobial Ag/TiO₂ nanocomposite coating. Cells grow on the coating while the metabolism of bacteria leads to enhanced silver release and death of bacteria.](image)

The group also investigates various other functional properties of nanocomposites with metallic nanoparticles and an organic or ceramic matrix. Interested readers are referred to the attached list of publications and earlier Almanac editions. Concerning optical and plasmonic properties and so-called metamaterials, we refer to the Almanac chapter of Prof. Elbahri who initiated some exiting new applications pursued together with our group.

c) Storage stability of epoxies

Epoxies are versatile adhesives with many applications from automotive industry to hobby sailboats. Usually, the two components of an epoxy, namely resin and hardener, are mixed immediately before usage. This mixing can deteriorate the properties of an epoxy due to inclusions of air bubbles or inhomogenous and non-stochiometric compositions. The project “Nanomodule” funded by the Ministry of Education and Research (BMBF) aimed at the development of one-component systems which circumvent this problem by releasing a reaction initiator into the mixture of resin and hardener during first heating. The initiator is carried by nanoparticles, the so-called module. Suitable module/initiator combinations were tested and lead to several promising cured systems which were selected for subsequent optimization. However, the mechanisms determining storage stability of non-reacted mixtures at room temperature were not understood. Within the BMBF project, among other subjects, we monitored changes in microscopic free volume during crosslinking in order to investigate the curing reaction. Based on positron annihilation lifetime spectroscopy (PALS, see Almanac 2009) we developed a method to follow the reaction in-situ at elevated temperatures. A mathematic model was introduced to extrapolate the experimental results to room temperature. Comparison with reference measurements at room temperature confirmed the reliability of our approach. Thus we could significantly contribute to the development and the understanding of one-component epoxides with improved performance.

c) Metallic glasses and glass forming undercooled metallic melts
Metallic glasses are mixtures of metals and non-metals which can be employed in a vast range of applications from ultra-thin electronic housings to biodegradable implants. Although the appearance of metallic glasses resembles that of ordinary metals, their atomic structure differs completely. While the atoms in a conventional metal arrange in a periodic lattice, there is no such order in metallic glasses. This disordered state, which is similar to a frozen liquid, can be created by rapid quenching of a melt. However, only for certain mixtures of elements the glassy state will be accessible with technically reasonable cooling rates. During the last years, we investigated the diffusion behavior, glass forming ability, and the transition from the undercooled melt to the glassy state. Details were reported in the Almanac 2010 and previous editions.

d) Polymer-solid contacts

Within the DFG priority program “Polymer-solid contacts: Interfaces and Interphases” which was co-initiated by Prof. Faupel, we studied the structure and formation of interfaces between plastics and solid materials like metals and ceramics, which are important in many technical applications including polymer nanocomposites where solid nanoparticles are embedded in a polymer matrix. We refer to the Almanac 2010, our website, and the list of publications for more information.

Personnel

Head of the group: Prof. Dr. F. Faupel; Secretary: N. Gühlke (50%), Dipl.-Chem. S. Kastaun (50%)
Technical Staff: Dipl.-Ing. (FH) R. Kloth, C. Ochmann, Dipl.-Ing. (FH) S. Rehders
Scientific Staff:
M.Sc. A. M. Ahadi 01.01.-31.12.2011 Fellowship Iran
  Functional nanocomposites
M.Sc. N. Alissawi 01.01.-31.12.2011 DFG
  Ag-ion transfer
M.Sc. S. W. Basuki 01.02.-31.12.2011 DFG
  Diffusion in complex melts
  TEM
Dipl.-Phys. B. Gojdka 01.01.-31.12.2011 SFB 855, CAU
  Magneto-electric nanocomposites
Dipl.-Phys. S. Harms 01.01.-31.12.2011 DFG SSP 1369
  Polymer-solid interfaces
M.Sc. B. Henkel 01.10.-31.12.2011 BMBF
  Functional nanocomposites
Dipl.-Phys. T. Hrkac 01.01.-30.11.2011 BMBF, BMWI, CAU
  Functional materials
Dr. S. Jebril 01.01.-30.09.2011 BMWI
  PolyMet
M. Sc. M. Keshavarz Hedayati 01.01.-31.12.2011 CAU, with Prof. Elbahri
  Optical nanocomposites
M.Sc. T. Koschine 01.01.-31.12.2011 BMBF
Positron beam, polymers

M.Sc. A. Kulkarni 01.01.-31.12.2011 SFB 677, CAU
Functional nanocomposites

Dipl.-Ing. K. Meurisch 01.01.-31.12.2011 CAU, SFB 855
Magneto-electric nanocomposites

M.Sc. C. Ohrt 01.08.-31.12.2011 DFG SPP 1369
Polymer-Solid-Interphases

Dipl.-Chem. C. Pakula 01.01.-31.10.2011 SFB 677
Functional nanocomposites

Dipl.-Phys. T. Peter 01.01.-31.12.2011 SFB TR24
Nanoparticles from plasmas

M.Sc. O. Polonsky 01.09.-30.11.2011 SFB TR24, visiting scientist
Nanoparticles from plasmas

Prof. Dr. K. Rätzke 01.01.-31.12.2011 CAU
Supercooled melts, positron annihilation

M.Sc. V. Schneider 01.-31.12.2011 SFB 677
Photoswitchable Nanocomposites

M.Sc. M.Q. Shaikh 01.01.-30.03.2011 visiting scientist
Free volume in epoxies

Dr. T. Strunskus 01.01.-31.12.2011 SFB 855
Functional nanocomposites

M.Sc. J. Xiong 01.01.-31.12.2011 Fellowship China
Functional nanocomposites

Dr. V. Zaporojtschenko 01.01.-31.12.2011 CAU
Functional nanocomposites

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Lectures, Seminars, and Laboratory Course Offers

Winter 2010/2011

Werkstoffe (Metalle), 2 (+1) hrs Lecture (+ Exercises)/Week,
M. Keshavarz Hedayati

Advanced Organic Materials, 2 hrs Seminar/Week,
T. Strunskus

Übungen zur Physik I, 2 hrs Seminar/Week,
K. Rätzke

Advanced Materials A - Metals, 2 (+1) hrs Lecture (+ Exercises)/Week,
K. Rätzke (+ N. Alissawi)

Advanced Materials A - Polymers, 2 (+1) hrs Lecture (+ Exercises)/Week,
T. Strunskus (+ D. Gedamu)

Thin Films II, 2 (+ 1) hrs Lecture (+ Exercises)/Week,
K. Rätzke (+ T. Peters)

Einführung in die Materialwissenschaft 1, 2 hrs Lecture/Week,
K. Rätzke (+ O. Riemenschneider)

Summer 2011

Advanced Solid State Physics, 2 hrs Seminar/Week,
K. Rätzke

Einführung in die Materialwissenschaft II, 2 hrs Lecture/Week,
K. Rätzke (+ O. Riemenschneider)

Advanced Metallic Materials, 2 hrs Seminar/Week,
F. Faupel

Functional Nanomaterials / Functional Nanocomposites, 2 hrs Seminar/Week,
V. Zaporojtchenko

Seminar for Members of the Chair for Multicomponent Materials and interested guests, 2 hrs Seminar/Week,
F. Faupel

Übungen zur Physik II, 2 hrs Exercise/Week,
K. Rätzke

Seminar for Members Group of Rätzke, 2 hrs Seminar/Week,
K. Rätzke

Seminar for Members Group for Nanocomposites, 2 hrs Seminar/Week,
V. Zaporojtchenko

Winter 2011/2012

Einführung in die Vakuumtechnik, 2 (+ 1) hrs Lecture (+ Exercises)/Week,
V. Zaporojtchenko

Advanced Organic Materials, 2 hrs Seminar/Week,
F. Faupel

Übungen zur Physik I, 2 hrs Seminar/Week,
K. Rätzke

Thin Films, 4 (+ 1) hrs Lecture (+ Exercises)/Week,
K. Rätzke (+ T. Peter)

Einführung in die Materialwissenschaft 1, 2 hrs Lecture/Week,
K. Rätzke (+ O. Riemenschneider)

Werkstoffe - Metalle, 2 hrs Lecture/Week,
F. Faupel

Solid State Physics 1, 2 hrs Lecture/Week,
F. Faupel

Vakuum Technology, 2 (+ 1) hrs Lecture (+ Exercises)/Week,
V. Zaporojtchenko
Seminar for Members Group for Nanocomposites, 2 hrs Seminar/Week,
V. Zaporozchenko
Seminar for Members Group of Rätzke, 2 hrs Seminar/Week,
K. Rätzke
Seminar for Members of the Chair for Multicomponent Materials, 2 hrs Seminar/Week,
F. Faupel

Third-Party Funds

DFG SFB 677/1, Funktion durch Schalten: Kombination von schaltbaren Polymeren und Nanokompositen nahe der Perkolationsschwelle, 01.07.2007-30.06.2011 (237.600 Euro)

DFG SFB 677/1, Funktion durch Schalten: Komposite aus Polymeric matrix und ferromagnetischen Formgedächtnis-Nanopartikeln als magnetische Schalter, 01.07.2007-30.06.2011 (211.640 Euro)

DFG, Einfluss der Verhinderung der Kollagen-Degradation durch MMPs auf den Dentin-Klebeverbund, 04.10.2007-31.01.2011 (25.944 Euro)


DFG, Magnetic nanocomposites for rf applications in mobile communication, 15.09.2008-07.10.2011 (129.566 Euro)

DFG, SFB TR24, Grundlagen komplexer Plasmen: Plasmaprozesse zur Abscheidung von nanostrukturierten Kompositmaterialien, 01.07.2009-30.06.2013 (287.640 Euro)

AIF, PolyMet-Polymer-Metalloxid-Kompositschichten für flexible optische Schichtsysteme, PolyMet-Kiel: Polymer-Metalloxid-Schichtabscheidung und Charakterisierung, 01.11.2009-31.10.2011 (175.000 Euro)

DFG SFB 855, Magnetoelektrische Verbundwerkstoffe - biomagnetische Schnittstellen der Zukunft:
Gasphasenabscheidung von magnetoelektrischen O-3 Nanokompositen, 01.01.2010-31.12.2013 (635.280 Euro)

DFG, Ion transfer reactions at Ag-nanoparticle/polymer interfaces, 17.02.2010-17.02.2012 (190.424 Euro)

BMBF, Nano-Purification - Entwicklung fortschrittlicher Materialien und Verfahren zur Wasser- und Abwasserbehandlung mittels funktioneller Nanokomposite, 01.05.2010-30.04.2013 (221.004 Euro)


China Scholarship Council, Stipendium für Jian Xiong für 4 Jahre, 15.11.2010-15.11.2014 (48.000 Euro)

Iran Government, Stipendium für Amir Mohammad Ahadi für 3 Jahre, 25.11.2010-25.03.2014 (45.000 Euro)

DFG, Verteilung des freien Volumens an Polymer-Festkörper-Grenzflächen, 25.02.2011-25.02.2014 (257.800 Euro)

DFG, Structural Arrest in Multicomponent Glass-forming Zr-melts, 06.04.2011-06.04.2014 (278.450 Euro)

AvH, Stipendium für Prof. Dr. Amita Chandra für 1 Monat, 26.05.-20.06.2011 (2.300 Euro)

DFG SFB 677/2, Funktion durch Schalten: Photoschaltbare Metall-Polymer-Nanokomposite, 01.07.2011-30.06.2015 (363.220 Euro)

KHS Plasmax GmbH, Untersuchung diverser Beschichtungen auf PET Proben mit Hilfe der Photonenelektronenspektroskopie (ESCA), 26.09.-24.10.2011 (1.870 Euro)


Condias GmbH, Analyse von NbC-Schichten, 01.03.-30.04.2011 (500 Euro)

Further Cooperation, Consulting, and Technology Transfer

University:

Prof. M. Bauer, F. Tuczek, O. Magnussen, Prof. W. Herges: Combination of switchable molecules and nanocomposites close to the percolation threshold (SFB „Function by Switching“)

Dr. Peter Budd, Manchester School of Chemistry, The University of Manchester, Manchester UK, Polymer Membranes
Prof. Dr. A. Chandra, Dehli, India, Conductance and free volume in polymer electrolyte composites
Prof. Dr. G. Dollinger, Dr. W. Egger, Bundeswehr University, Munich, PLEPS at FRM II
Prof. Drusch, Food Processing Technology and Materials Science, TU Berlin, Encapsulation of food products
Prof. Dr. M. Elbahri, Institute for Material Science: several topics with hybrid organic/inorganic materials
Prof. Dr. M. Es-Souni, FH Kiel, Characterisation of Functional Materials
Prof. Dr. G. Grundmeier, Paderborn University, Silver Release from Nanocomposites
Prof. Dr. H. Herges, Organic Chemistry, Prof. Dr. F. Tuczek, Alnorganic Chemistry, Kiel University, and other partners, NEXAFS investigations at the Berlin synchrotron BESSY, Berlin
Dr. Chr. Hugenschmidt, TU Munich and FRM II, NEPOMUC
Prof. Dr. M. Kern, Dental Clinic, Kiel University, Antibacterial Coatings
Prof. R. Knöchel, Institute for Electrical Engineering and Information Technology, magnetic high frequency materials (DFG project)
Prof. Dr. P. Müller-Buschbaum, Technical University Munich, PALS-Thin Films and preparation of DFG proposal “Growth of sputtered metal on organic surfaces” with Roth (DESY)
Prof. Dr. R. Podschen, Institute for Infection Medicine, Kiel University, Antibacterial Coatings
Prof. Dr. W. Possart, Saarbruecken University, BMBF project Nanomodule
Prof. Dr. E. Quandt, Inorganic Functional Materials, Faculty of Engineering, Functional magnetic nanocomposites
PD Dr. C. Röhl, Prof. Dr. J. Sievers, Institute for Toxicology and Pharmacology for Natural Scientists, Toxicological effects of metallic nanoparticles on human cells
Dr. Y. Serfert, Food Technology, Kiel University, XPS measurements
Prof. Dr. C. Staudt, Düsseldorf, Block copolymers
Prof. Dr. F. Tuczek, Institute for Inorganic Chemistry, Kiel University, Self-assembled monolayers
Prof. Dr. Y. Yampol’skii, A. V. Topchiev Institute of Petrochemical Synthesis, Laboratory of Membrane Gas Separation, Russian Academy of Sciences, Moscow, Positron annihilation and membrane polymers

Research Institutes:
Dr. D. K. Avasthi, Materials Science Group, Nuclear Science Centre New Delhi, India, High energy ion beam effects in polymer-metal nanocomposites
PD Dr. A. Hartwig, Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Bremen, PALS on functionalized nanoparticles
Prof. Dr. A. Meyer, Dr. Fan Yang, DLR, Köln, Diffusion in glass forming metallic melts
Dr. Thomas Neubert, Fraunhofer-Institute for Surface Engineering and Thin Films (IST), Braunschweig, Polymer-metal oxide composite layers for flexible optical coating systems
Dr. G. Schneider, FRZ Jülich and FRM II, silica nanocomposites

Industry:
Diploma, Bachelor and Master Theses

S. Rößler, Lichtinduzierte schaltbare Effekte in leitfähigen Polymeren, 25.01.2011
N.C. Aslandere, Investigation of the Silver and Cobalt Thin Films deposited by a Cluster Source, 15.02.2011
S. Dollinger, Positronen-Annihilations-Lebensdauer-Spektroskopie zur Bestimmung des freien Volumens in Epoxid-Silica-Nanokompositen, 21.03.2011
C. Ohrt, Untersuchung des freien Volumens in Polyethylenpropylen-Silsesquioxan-Polymer-Nanokompositen mittels Positronenannihilationslebenszeit-Spektroskopie, 25.07.2011
I. Kocabas, Study of Silver Ion release from two dimensional (2D) Silver-Gold Nanoparticle Array, 01.08.2011
B. Gothe (extern), Synthese von langzeitstabilen, siebdruckfähigen Sol-Gel-Lacken für dekorative Kochfeldbeschichtungen, 02.09.2011
T. Waldmann (extern), Entwicklung eines Herstellungsprozesses für Folien aus Titan über die Pulvermetallurgische Route sowie die Analyse und Optimierung der Materialeigenschaften, 14.11.2011
T. Jurgeleit (extern), Chemische Reinigung von KRS-5 Kristallen durch erneutes Aufschmelzen mit Zusatzstoffen, 14.11.2011
Y. Mekonnen, Multi-walled Carbon Nanotube based photo-switchable sensors, 24.11.2011
H. Cárdenas (extern), Characterization of Thermal Cyclic Deformation Behavior of Nuclear Power Plant Components as a Contribution to Fatigue Assessment, 12.12.2011

Dissertations / Postdoctoral Lecture Qualifications

V.S.K. Chekravdarhula, Vapor phase deposition of functional nanocomposite thin films and their modification by ion beam irradiation, 21.04.2011
C. Pakula, Untersuchung Chromophore enthaltender Polymer/Metall-Nanokomposite für elektro-optische Anwendungen, 03.11.2011
T. Hrkac, Maßgeschneiderte biokompatible Silber/Titania-Nanokomposite für antimikrobielle Anwendungen, 18.11.2011
Published in 2011


Advances in Top-Down and Bottom-Up Nanofabrication Techniques: Applications and Future Prospects, Advances in Colloid and Interface Science, (2011)

M. Jamali, M. Keshavarz Hadayati, A.U. Zillohu, M. Elbahri, Photoresponsive Transparent Conductive Metal with a Photobleaching Nose, Advanced Materials, 23, 4243 - 4243 (2011)


Patent Applications

F. Faupel, R. Adelung, M. Elbahri, Verfahren zur Nanostrukturverzierung mittels spinodaler Entnetzung, European Patent Office, 25.10.2011, PVA 7060 / 08 0847 695.7 - 1215

M. Elbahri, M. Keshavarz Hadayati, V. Zaporojtchenko, T. Strunskus, F. Faupel, Absorberschicht für den VIS- und/oder NIR-Spektoralbereich, German Patent and Trade Mark Office (GTO), 19.09.2011, DE 10 2011113571.9


Presentations

F. Faupel, Neue Werkstoffe durch Nanotechnologie (Invited talk), Johann-Heinrich-Voss-Schule, Eutin, Germany, 17.-17.01.2011


T. Peter, M. Wegner, S. Bornholdt, V. Zaporojtchenko, T. Strunskus, H. Kersten, F. Faupel, Nanocomposite thin films prepared by plasma polymerization and high pressure magnetron sputtering (Poster), Plasmatechnologie PT 15, Stuttgart, Germany, 28.02.-02.03.2011


M. Keshavarz Hadayati, M. Jamali, T. Strunskus, V. Zaporojtchenko, F. Faupel, M. Elbahri, New transparent conductive metal based on polymer composite (Talk), DPG-Frühjahrstagung 2011, Dresden, Germany, 13.-18.03.2011


K. Meurisch, R. Johns, E. Woltermann, T. Strunskus, V. Zaporojtchenko, F. Faupel, Magnetoelectric FeCoBSi/PVDF
N. Alissawi, V. Zaporozhchenko, T. Strunskus, D. Garbe-Schönberg, F. Faupel, Study of the silver ion release from antimicrobial nanosilver (nAg)/PTEE two dimensional (2D) model (Poster), DPG-Frühjahrstagung 2011, Dresden, Germany, 13.-18.03.2011


R. Khalil, R. Abdelaziz, T. Strunskus, F. Faupel, M. Elbahri, A study on nanocomposites made of a conducting polymer and metallic nanoparticles (Poster), DPG-Frühjahrstagung 2011, Dresden, Germany, 13.-18.03.2011

T. Peter, M. Wegner, T. Strunskus, V. Zaporozhchenko, S. Bornholdt, H. Kersten, F. Faupel, Nanocomposites prepared by plasma polymerisation and cluster deposition (Poster), DPG-Frühjahrstagung 2011, Dresden, Germany, 13.-18.03.2011


S. Harms, K. Körtzke, F. Faupel, G. Schneider, L. Willner, D. Richter, Free Volume of interphases in model nanocomposites studied by positron annihilation lifetime spectroscopy (Talk), DPG-Frühjahrstagung 2011, Dresden, Germany, 13.-18.03.2011


K. Lakshmi Kolipaka, V. Brüser, A. Quade, H. Wulff, F. Faupel, Hybrid PVD/PECVD fabrication and structural investigations of Cobalt-amorphous SiCNH nanocomposites (Talk), DPG-Frühjahrstagung 2011, Kiel, Germany, 29.-31.03.2011

T. Peter, V. Zaporozhchenko, S. Rehders, T. Strunskus, S. Bornholdt, H. Kersten, F. Faupel, Formation of Nanocomposites by cluster deposition and plasma polymerization (Talk), DPG-Frühjahrstagung 2011, Kiel, Germany, 29.-31.03.2011

B. Gojdka, Study of Cobalt nanoparticles and films fabricated by high-rate cluster source (Talk), German-Czech Workshop: Formation of Nanoparticles in Plasmas, St. Peter-Ording, Germany, 04.-06.04.2011

T. Peter, Preparation of nanocomposite films by cluster beam deposition and plasma polymerization (Talk), German-Czech Workshop: Formation of Nanoparticles in Plasmas, St. Peter-Ording, Germany, 04.-06.04.2011

V. Zaporozhchenko, Early stage of the cluster growth on untreated and ion treated polymer surfaces (Talk), German-Czech Workshop: Formation of Nanoparticles in Plasmas, St. Peter-Ording, Germany, 04.-06.04.2011

V. Zaporozhchenko, Photocatalytic properties of TiO$_2$ films modified with Ag and Au nanoparticles (Talk), E-MRS Spring Meeting, Nizza, France, 09.-13.05.2011

V. Zaporozhchenko, C. Pakula, T. Strunskus, S. W. Basuki, R. Herges, F. Faupel, Metal-MWCNT/polymer nanocomposite thin films with reversible photoswitchable properties (Talk), E-MRS Spring Meeting, Nizza, France, 09.-13.05.2011

V. Keuter, et. al., nanoPurification - Entwicklung fortschrittlicher Materialien und Verfahren zur Wasser- und Abwasserbehandlung mittels funktionaler Nanokomposite (Talk and Poster), Clustertreffen der BMBF-Fördermaßnahme NanaCare und NanoNature, Frankfurt, Germany, 10.-11.05.2011

M. Keshavarz Hedayati, M. Elbahri, T. Strunskus, V. Zaporozhchenko, F. Faupel, Perfect plasmonic absorber at visible
F. Faupel, Metal-Polymer nanocomposites for functional applications (Invited talk), Chinesisch-Deutsches Symposium, Berlin, Germany, 30.-31.05.2011
S. Harms, K. Rätzke, F. Faupel, Free volume in thin polymeric films and biomaterials probed by a slow positron beam (Talk), Workshop, München, Germany, 03.-05.05.2011
I. Strunskus, V. Zaporojtchenko, F. Faupel, Nanocomposites for Functional Applications (Invited talk), New Indigo Workshop, Saarbrücken, Germany, 04.-05.07.2011
K. Rätzke, A. Bartsch, F. Faupel, A. Meyer, Diffusion and Viscosity in Undercooled Metallic Liquids (Invited talk), Workshop, Köln, Germany, 07.-09.07.2011
T. Hasegawa, T. Strunskus, V. Zaporojtchenko, F. Faupel, M. Mizuhata, Solvent effect on optical properties of solvated Nafion membrane with Ag dispersion by photoreduction (Poster), 59th Materials tailoring, Karuizawa, Japan, 25.-29.07.2011
K. Rätzke, S. Harms, C. Ohrt, F. Faupel, Positron annihilation and free volume in Polymer-solid interfaces and in nanocomposites (Invited talk), University of Potsdam, Institute of Physics and Astronomy, Experimental Physics, Golm, Germany, 24.08.2011
F. Faupel, Vapor phase deposition of polymer nanocomposites for functional applications (Invited talk), PAMS 2011 (Plasma Applications in Material Sciences) / Sommerschule Greifswald, Greifswald, Germany, 26.08.2011
F. Faupel, Surface modification of polymers by low energy ions and plasmas (Invited talk), PAMS 2011 (Plasma Applications in Material Sciences) / Sommerschule Greifswald, Greifswald, Germany, 26.08.2011
K. Rätzke, S. Harms, F. Faupel, Free Volume of interphases in model nanocomposites studied by positron annihilation lifetime spectroscopy (Invited talk), 10th International Workshop on Positron and Positronium Chemistry (PPC10), Smolenice, Slowakai, 05.-09.09.2011
V. Zaporojtchenko, C. Pakula, S. W. Basuki, D. Zargarani, R. Herges, F. Faupel, Functional photoswitchable polymer nanocomposites (Talk), Nanoworkshop 2011 (5th Workshop on Polymer/Metal Nanocomposites), Bari, Italy, 20.-22.09.2011
T. Strunskus, T. Peter, V. Zaporojtchenko, F. Faupel, Preparation of nanocomposite films by cluster beam deposition and plasma polymerization (Talk), Internationaler Workshop des TR 24, Potsdam, Germany, 26.-28.09.2011
V. Zaporojtchenko, Functional metal-polymer nanocomposites (Invited talk), Kolloquium at the School of Microelectronics, Fudan University, Shanghai, China, 10.-15.10.2011
M. Keshavarz Hedayati, F. Faupel, M. Elbahri, Plasmonic metamaterials: From high transparency to complete absorption of light (Poster), 491. Wilhelm und Else Heraeus-Seminar, Bad Honnef, Germany, 16.-19.10.2011
S. Harms, K. Rätzke, F. Faupel, Freies Volumen in Polymer-Festkörper Interphasen und in Nanokompositen (Invited talk), DGBM Fachausschuß, Dautphetal, Germany, 03.-04.11.2011
M. Keshavarz Hedayati, A smart plasmonic transparent conductor with a gas sensing ability (Talk), Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, Geesthacht, Germany, 11.11.2011
Further Activities and Events

Selected Honorary Activities of Prof. Faupel:

- Coordinator of the North German Initiative Nanomaterials (NINa),
- Principle Editor of the Journal of Materials Research, edited by the Materials Research Society (MRS),
- Editor of the encyclopedia RÖMPP online, Thieme Chemistry,
- Member of the Advisory Board of Diffusion and Defect Data,
- Member of the DGM Scientific Advisory Board, German Material Research Society,
- Member of the Program Committee of the DFG SPP 1369 Priority Program “Polymer-Solid Interfaces, Thin Films, and Interphases – from Molecular View to Continuum”,
- Member of the managing committee of the SFB855 “Magnetoelectric Composites – Future Biomagnetic Interfaces”,
- Member of the Societas Christina Albertina,
- Member of the HWT (Hochschule-Wirtschaft-Transfer)-Jury of the ISH (Innovation Foundation Schleswig-Holstein),
- Member of the Steering Committee of the CAU Focal Point of Support “Nano and surface science”,
- Member of the Steering Committee Quality Management of the CAU,
- Member of KARE (Kiel Alliance of Research and Education),
- Member of the Organizing Committee of the German-Czech Workshop “Formation of Nanoparticles in Plasmas” (SFB TR24),
- Member of the International Advisory Committee of the 5th International Conference on Electroactive Polymers: Materials and Devices (ICEP-2012),

In addition to the activities listed above, Prof. Faupel was involved in many evaluations for the German Science Foundation (DFG), scientific journals, and other institutions in Germany and abroad.

Highlights:

The work „Fully integrable magnetic field sensor based on delta-E effect” by B. Gojdka et al., Appl. Phys. Lett. 99, 223502 (2011), was presented as a Research Highlight in the journal Nature, 480, 155 (08 December 2011).