

## Multicomponent Materials

The main research activities of the Chair for Multicomponent Materials are functional nanocomposites, metal-polymer interfaces, polymer surface modifications by low energy ions, glass transition and diffusion in metallic and organic glass formers including thin films and confined systems, as well as investigation of nanostructural properties by means of positron annihilation. Here, only a few aspects can be discussed. For more details we refer to our homepage at <http://www.tf.uni-kiel.de/matwis/matv/> and the more than 200 publications listed there.

A special highlight last year were the results on diffusion and viscous flow in metallic Zr-based melts. They provide new insight into the excellent glass forming ability of these systems, which are also highly relevant for applications. In particular, it was shown, that a rigid Zr network prevails even in the equilibrium melt.

Concerning the functional nanocomposites, emphasis was placed originally on polymer-based materials containing metallic nanoparticles which were produced by physical vapor deposition. Applications range from high frequency core materials to optical filters and antibacterial coatings. During the last year, ceramic matrices such as TiO<sub>2</sub> and other materials were increasingly used.

The group is involved in the Collaborative Research Center SFB 677 - Function by Switching with 2 projects and carried out extensive preparatory work for the new SFB 855 on magneto-electric nanocomposites for medical applications and for the 2nd period of the Collaborative Research Center Transregio 24 on complex plasmas.

Like in the years before, the Chair for Multicomponent Materials also cooperated intensively with industry. Details cannot be presented here. Sennheiser electronics, the World Gold Council, and o.m.t. in Lübeck were important partners.

In addition to research, the group was strongly involved in teaching and took great effort to inspire pupils for materials science and engineering.

Since July 2008 Prof. Faupel is Dean of the Faculty of engineering.

### Results

#### a) Functional nanocomposites

Nanocomposites for different applications are investigated in several projects. They consist of metallic nanoparticles embedded in an insulating matrix, either polymeric or ceramic in nature. The majority of nanocomposites are polymer based, the nanocomposites are deposited as thin films by physical vapor phase deposition methods, in particular evaporation and sputtering from solid targets. Due to the small size of the metallic nanoparticles in the range of a few nanometers the composites exhibit interesting optical, electrical and magnetic properties. The large specific area of the finely dispersed particles can be also very advantageous, e.g., in applications as antibacterial coatings.

Several ongoing projects deal with the preparation of magnetic particles in insulating matrices, like the preparation of high frequency core materials reported in the last almanac. The challenge in the preparation is to obtain a high dispersion of the metal particles in the matrix while suppressing chemical reactions at the interface of the reactive metals which would lead to a degradation of the magnetic properties.

In the high frequency core materials, the metallic nanostructures embedded in an insulating matrix effectively eliminate eddy currents. In a different application, magnetic nanoparticles in an insulating matrix allow to tune the resistivity of the composite by an external magnetic field. The relative change is measured as tunneling magnetoresistance (TMR) effect. The TMR effect is caused by changes in the quantum mechanical tunneling probability of electrons between the magnetic nanoparticles. Fig. 1 shows a typical example of a measured TMR effect for FeCo nanoparticles embedded in a TiO<sub>2</sub> matrix prepared by sputter deposition. The achieved so-called granular TMR effect is already quite good for such

type of composites, which can be prepared by a simple low-cost process which is well compatible with processes used in microelectronics.

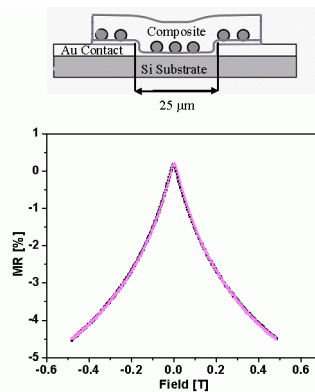


Fig. 1: TMR effect of a FeCo nanocomposit prepared by a sputter deposition process. The top of the figure shows the configuration of the sample used for the measurement.

Nanocomposites also show interesting optical properties caused by the plasmon resonance of the metallic nanoparticles. As described in the Almanac 2006 these are collective oscillations of the conduction electrons in the electrical field vector of electromagnetic radiation. The physical vapor deposition methods allow the preparation of metallic alloy nanoparticles in polymeric matrices, where the composition can be varied over the whole range. This makes possible tuning of the resonance frequency. Fig. 2 shows an example for an  $Ag_xAu_{1-x}$  alloy. The plasmon resonance shifts to higher wavelength with increasing Au fraction. The plasmon resonance intensity goes through a minimum at about  $x = 0.4$  because of enhanced scattering of the conduction electrons in alloys. The plasmon resonances in nanocomposites have a host of applications (see ealier reports).

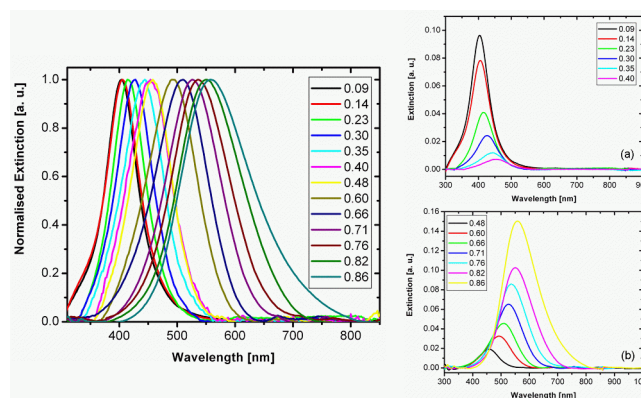


Fig. 2: UV-Vis spectra of  $Ag_xAu_{1-x}$  nanoparticles in a polymer matrix for different alloy compositions. The resonance frequency can be tuned over a large range.

Another focus in the nanocomposit research was the investigation of silver nanocomposite coatings. We have developed a coating process based on a vapor phase co-deposition of noble metals and polymers or ceramics to protect a surface against growth of bacteria by depositing a thin nanocomposite film. In research supported by the World Gold Council we observed that trace amounts of gold enhance the antibacterial activity of the nanocomposites, but only if the gold is deposited as separate particles. We studied the silver release from the nanoparticles in different configurations and different media to create composite coatings with the ability to tune the release of biocidal metal ions, thus also minimizing possible human toxicity. Toxicity of silver nanoparticles are studied in cooperation with C. Röhl from the institute of toxicity of the CAU. Direct visualization of growth of bacteria on the surface is made by fluorescence microscopy of test specimens

after treatment with fluorescent stains in cooperation with R. Podschun from the institute of infection medicine of the University Hospital Schleswig-Holstein/ Campus Kiel. Fig. 3 shows an example how a Ag/TiO<sub>2</sub> nanocomposite thin film works effectively to prevent the growth of bacteria.

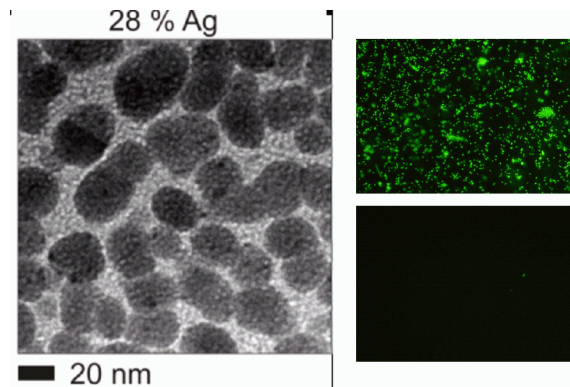


Fig. 3: Demonstration of the antibacterial effectiveness of a Ag/TiO<sub>2</sub> nanocomposite thin film coating. On pure TiO<sub>2</sub> (antibactericide with UV light) the growth of bacteria leads to a pronounced green fluorescence, whereas the addition of 28% Ag into the TiO<sub>2</sub> completely prevents bacterial growth also in the absence of UV light.

#### b) Diffusion and Viscous Flow in Bulk Glass Forming Alloys

Conventional metallic glasses, frequently prepared by rapid quenching, are known for many years and used, e.g., as soft-magnetic materials, for theft protections and hard coatings. Bulk metallic glasses allow much lower cooling rates and hence manufacturing in the undercooled liquid. Hence viscosity and diffusion are key quantities for technological applications and the basic diffusion mechanism also very are interesting for basic understanding of glass formation and crystallization. The Stokes-Einstein equation describes the relation between diffusion and viscosity and it is known for many decades. However, its range of validity is still under debate, in particular for glass forming metallic melts. Therefore, extending earlier radiotracer experiments in the glass forming Pd-Cu-Ni-P system, we systematically investigated the temperature dependence of diffusion of all constituents of the alloy. Comparison with published data on viscosity allows one to check the range of validity of the Stokes-Einstein equation and to see, which, if any, constituents of the alloy determines the viscosity. Our first experiments showed that phosphorus, copper, and nickel are not relevant for the viscosity. However, our recent work on palladium demonstrated that the diffusivity in the under cooled melt is orders of magnitude smaller than the above mentioned elements and perfectly reflects the behavior of the viscosity. Therefore, for the first time in a glass forming metallic system the decoupling of the diffusivity of the constituents in the under cooled melt could be identified and the element, which determines the viscosity, could be identified. This allows verification of recent theoretical models like the Mode Coupling Theory. In contrast, we showed that in Zr-Ti-Cu-Ni-Be alloys, the Stokes-Einstein equation even fails in the equilibrium melt, and only holds for Zr diffusion, which is still decoupled from diffusion of the lighter elements about 50 K above the melting temperature. This shows that a rigid Zr network prevails in the equilibrium melt, in accordance with predictions of computer simulations, and suggests the existence of a second critical temperature in the Mode Coupling Theory at higher temperatures which is currently under discussion.

#### c) Free volume in polymeric membranes

The free volume, i.e. the unoccupied space between the polymer chains, is a key property determining properties like viscoelasticity or permeability and selectivity in membranes. Positron annihilation is a method employed by the Chair for Multicomponent Materials to determine relative concentration and size of free volume holes on the atomic scale from the lifetime of positrons, the anti-particles of electrons. During the last years we extended our research in this area, which is financially supported by DFG and BMBF. The basic research includes national and international partners, whereas within the BMBF project 'Nanomodule' we also cooperate with several industrial partners. Key result within the last year regarding membranes was the discovery of an unusual temperature dependence of the free volume in TEFLON AF, a high free volume

membrane material. It was explained in terms of increased mobility of side-groups. Further work on block-copolymer membranes was performed together with the GKSS Research Center Geesthacht on PEBA, a Block-Copolymer, where adding a low molecular weight polyethylene glycol increased permeability and selectivity without affecting the free volume significantly. Within a large BMBF project with various industrial partners and we established positron annihilation lifetime spectroscopy as a very sensitive method to follow curing of epoxies. Additionally, the Johnson-Mehl-Avrami-Kolmogorov kinetic equation was applied to extrapolate accelerated tests of shelf storage stability to lower temperatures. The latter is important for the development of new, nanocomposite based epoxies.

#### d) Participation in Collaborative Research Centers (SFBs) and other activities

In a project within the SFB 677 we incorporated light switchable molecules in nanocomposites. A new experimental setup allows a controlled exposure of the samples by polarized and monochromatized light. The switching of electrical resistivity and capacitance was successfully established and experiments focus on optimizing the properties. In a 2nd project, as illustrated above for the TMR effect, the preparation of magnetic nanocomposites has been established, and the use of magnetostrictive effects for switching of different properties of the composit is currently under investigation. This work will be also preparatory for a new SFB 855, where composites of magnetostrictive alloys with piezoelectric matrices will be used for the development of very sensitive magnetic sensors for e.g. medical applications. The group also contributes a joint project together with Prof. Kersten from the Physics Department on deposition of nanocomposites via plasmas to the 2nd period of the SFB-TR24 on complex plasmas.

In the investigation of surface glass transition temperatures by embedding of metal clusters into polymer films (see Almanac 2003) an astonishing high decrease compared to the bulk glass transition temperature was observed for polycarbonates. The mechanism of the embedding was further explored and a correlation with the polymer persistence length was observed. More detailed investigations of the mechanism are currently performed.

#### Staff

Head of the group: Prof. Dr. F. Faupel; Secretary: Dipl.-Chem. S. Kastaun, DFG, overhead (50%), Dipl.-Geol. B. Minten (50%), C. Otte-Hüls (50%)

Technical Staff: Dipl.-Ing. (FH) R. Kloth, Dipl.-Ing. (FH) S. Rehders

##### Scientific Staff:

Dipl.-Ing. A. Bartsch Glass-forming melts	01.01.-31.12.2008	DFG
M. Sc. V.S.K. Chakravadhanula Optical nanocomposites	01.01.-31.12.2008	CAU, DFG DST
Dipl.-Ing. D. Ehlers Free volume in membrane polymers	15.07.-14.11.2008 (50%)	DFG
Dipl.-Ing. C. Hanisch Functional nanocomposites	01.01.-31.12.2008	DFG SFB 677
Dipl.-Phys. S. Harms Polymer-solid interfaces	01.07.-31.12.2008	DFG SSP 1369
Dipl.-Ing. M. Heidenblut Polymerprojekt	01.01.-31.12.2008	external, Infineon
Dipl.-Phys. T. Hrkac Solarics	01.01.-31.12.2008	o.m.t. GmbH

Dr.-Ing. J. Kruse Membrane polymers	15.02.-31.03.2008 (50%)	DFG
M.Sc. A. Kulkarni High-frequency magnetic nanocomposites	01.01.-31.12.2008	DFG SFB 677
Dr. L. Li Functional nanocomposites	01.01.-29.02.2008	AvH-fellowship
Dipl.-Chem. C. Pakula Functional nanocomposites	01.07.-31.12.2008 (50%)	DFG SFB 677
Priv. Doz. K. Rätzke Supercooled melts, positron annihilation	01.01.-31.12.2008	CAU
Dr.-Ing. M. Scharnberg Metallization of organic semiconductors	01.01.-31.12.2008	CAU
M.Sc. M.Q. Shaikh Free volume in epoxies	01.01.-31.12.2008	BMBF, CAU
Dr. T. Strunskus Functional nanocomposites	01.01.-31.12.2008 (50%)	DFG
Dr. V. Zaporojtchenko Functional nanocomposites	01.01.-31.12.2008	CAU

## Lectures, Seminars and Laboratories

### *Winter 2007/2008*

Einführung in die Materialwissenschaft I, 2 Std. Vorlesung/Woche,  
K. Rätzke (+ K. Dolgner)

Laboratory Course: Scientific Methods, 4 Std. Praktikum/Woche,  
K. Dolgner (+ W. Jäger, W. Weppner, V. Zaporojtchenko, H. Föll, H. Takele)

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

Einführung in die metallischen Werkstoffe, 2 Std. Vorlesung/Woche,  
F. Faupel

Einführung in die Vakuumtechnik (VAKTECH), 2 Std. Vorlesung/Woche,  
V. Zaporojtchenko

Metals I, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
F. Faupel (+ V.S.K. Chakravadhanula)

Polymers II, 2 Std. Vorlesung/Woche,  
M. Scharnberg

Seminar Polymers II, 1 Std. Seminar/Woche,  
M. Scharnberg

Solid State Physics I, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
F. Faupel (+ S. Jebril)

Thin Films II, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
K. Rätzke (+ T. Hrkac)

*Summer 2008*

Metals II, 2 Std. Vorlesung/Woche,  
F. Faupel

Seminar Metals II, 1 Std. Seminar/Woche,  
K. Rätzke

Solid State Physics II, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
F. Faupel (+ S. Jebril)

Thin Films I, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
K. Rätzke (+ T. Hrkac)

Einführung in die Materialwissenschaft II, 2 Std. Vorlesung/Woche,  
K. Rätzke (+ D. Dolgner)

Laboratory Course: Scientific Methods, 4 Std. Praktikum/Woche,  
F. Faupel (+ H. Föll, W. Jäger, W. Weppner)

Vacuum Technology and Materials, 1 Std. Vorlesung/Woche,  
V. Zaporojtchenko

Seminar für Festkörperphysik und Materialwissenschaften, 2 Std. Seminar/Woche,  
R. Berndt (+ F. Faupel, W. Jäger, L. Kipp, O. Magnussen)

*Winter 2008/2009*

Metals I, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
F. Faupel (+ V.S.K. Chakravadhanula)

Polymers II, 2 Std. Vorlesung/Woche,  
M. Scharnberg

Seminar Polymers II, 1 Std. Seminar/Woche,  
M. Scharnberg

Thin Films II, 2 (+ 1) Std. Vorlesung (+ Übungen)/Woche,  
K. Rätzke (+ T. Hrkac)

Einführung in die Materialwissenschaft I, 2 Std. Vorlesung/Woche,  
K. Rätzke (+ K. Dolgner)

Laboratory Course: Scientific Methods, 4 Std. Praktikum/Woche,  
K. Dolgner (+ W. Jäger, W. Weppner, V. Zaporojtchenko, H. Föll, H. Takele)

Seminar for Members of the Chair for Multicomponent Materials and interested guests, 2 Std. Seminar/Woche,  
V. Zaporojtchenko (+ F. Faupel)

Einführung in die metallischen Werkstoffe, 2 Std. Vorlesung/Woche,  
F. Faupel

Einführung in die Vakuumtechnik (VAKTECH), 2 Std. Vorlesung/Woche,  
V. Zaporojtchenko


**Third-Party Funds**

- GKSS, *Virtuelles Institut: Asymmetric structure for polymer electrolyte fuel cell*, 01.09.2004-31.05.2008 (6.000 EUR)
- DFG, *Preparation of optical functional nanocomposites of polymer based metallic nanoparticles*, 01.05.2005-31.07.2008 (180.990 EUR)
- DFG, *OFET: Korrelation von Metallwachstum auf molekularen organischen Halbleitern und elektronischen Eigenschaften*, 01.09.2005-18.06.2008 (71.771 EUR)
- DFG, *Slowly diffusing elements in bulk amorphous alloys*, 01.09.2005-18.06.2008 (61.995 EUR)
- o.m.t., *Solarics*, 01.02.2006-31.01.2009 (270.070 EUR)
- DFG DST, *Formation of metallic nanostructures in organic matrix by vapour and plasma phase deposition and its modification by swift heavy Iron Irradiation*, 01.03.2006-31.03.2009 (77.130 EUR)
- DFG DST, *Formation of metallic nanostructures in organic matrix by vapour and plasma phase deposition and its modification by swift heavy Iron Irradiation*, 01.03.2006-31.12.2008 (68.730 EUR)
- DFG, *Magnetic nanocomposites for rf applications in mobile communication*, 01.06.2006-30.11.2008 (161.405 EUR)
- DFG, *Diffusion in glasbildenden Metallschmelzen vom Gleichgewichtszustand bis zum kalorischen Glasübergang*, 15.09.2006-30.04.2009 (130.295 EUR)
- BMBF, *Verbundprojekt: Entwicklung vernetzungssteuernder Nanomodule mit controlled Release-Funktion für Polymerharz-Systeme mit erhöhter Lagerstabilität und reduzierter Härtungstemperatur*, 01.11.2006-31.10.2009 (100.227 EUR)
- AvH, *Fine Tuning Specific Properties of Polymer-Metal Nanocomposites Near Percolation Threshold (Stipendium für L. Li)*, 01.01.2007-30.06.2008 (60.200 EUR)
- DFG, SFB, *Kombination von schaltbaren Polymeren und Nanokompositen nahe der Perkolationschwelle*, 01.07.2007-30.06.2011 (216.000 EUR)
- DFG, SFB, *Overhead-Mittel zum Projekt "Kombination von schaltbaren Polymeren und Nanokompositen nahe der Perkolationschwelle"*, 01.07.2007-30.06.2011 (21.600 EUR)
- DFG, *Komposite aus Polymermatrix und ferromagnetischen Formgedächtnis-Nanopartikeln als magnetische Schalter*, 01.07.2007-30.06.2011 (192.400 EUR)
- DFG, *Overhead-Mittel zum Projekt "Komposite aus Polymermatrix und ferromagnetischen Formgedächtnis-Nanopartikeln als magnetische Schalter"*, 01.07.2007-30.06.2011 (19.240 EUR)
- World Gold Council, *Improvement of antibacterial coatings by incorporation of gold nanoparticles*, 15.12.2007-15.12.2008 (48.122 EUR)
- iwis motorsysteme, *Abscheidung und Charakterisierung von Polymerschichten auf Stahlzylindern*, 01.02.-01.03.2008 (1.000 EUR)
- DFG, *Verteilung des Freien Volumens an Polymer-Festkörper- Grenzflächen ( inkl. Programmpauschale )*, 04.04.2008-04.04.2011 (230.710 EUR)
- Sennheiser, *Beschichtung von Elektroden mit Teflon - Elektretschichten*, 14.04.-26.05.2008 (3.500 EUR)
- GKSS, *Messungen für Positronen Lebenszeitspektroskopie*, 03.06.2008 (800 EUR)
- Fraunhofer-Institut für Solare Energiesysteme ISE, *Untersuchung SiO<sub>x</sub>/PO<sub>y</sub> Proben*, 21.07.-26.08.2008 (990 EUR)
- Heidelberger Druckmaschinen, *Untersuchung an Drucktinten*, 22.07.2008 (5.000 EUR)
- DFG, *Magnetic nanocomposites for rf applications in mobile communication*, 15.09.2008-15.03.2010 (130.197 EUR)


**Other Cooperation, and Technology Transfer**

*University:*

Prof. M. Bauer, F. Tuzek, O. Magnussen, Prof. W. Herges: *Kombination von schaltbaren Molekülen und Nanokompositen nahe der Perkolationschwelle (SFB „Funktion durch Schalten“)*

Prof. W. Bensch, Institut für Anorganische Chemie: Komposite aus Polymermatrix und ferromagnetischen Formgedächtnis-Nanopartikeln als magnetische Schalter (SFB „Funktion durch Schalten“ )

Dr. Peter Budd, Manchester School of Chemistry, The University of Manchester, Manchester UK, Polymermembranen

Prof. Dr. S. Deki, Kobe, Japan, Optische Nanokomposite

Dr. G. Dlubek, ITA Institute for Innovative Technologies, Universität Halle, Positronenvernichtung in nichtmolekularen Substanzen

Prof. Dr. M. Es-Souni, FH Kiel, Ferroelektrische Schichten und Grenzflächen zu Metallen, Magnetische Nanodrähte

Prof. U. Hilleringmann, Universität Paderborn, Elektretschichten für organische Feldeffekt-Transistoren

Prof. Dr. M. Kern und Prof. Dr. K. Ludwig, Zahnmedizin, Universität Kiel, AFM, XPS und Kontaktwinkelmessungen an Zähnen

Prof. Dr. L. Kipp, Experimentelle und Angewandte Physik der Universität Kiel, Eigenschaften von Schichtkristallen und organische Materialien, Photoemission an Organischen Molekülkristallen

Dr. G. V. Kornich, Zaporozhye National Technical University, Ukraine, Computersimulation zum Sputtern von Clustern

Prof. Dr. W. Lang, IMSAS, Universität Bremen, Silizium-Elektret-Mikrophone

Prof. Dr. O. Magnussen, Institut für Experimentelle und Angewandte Physik, Elektrodeposition auf Schichtkristallen

Dr. J. Pflaum, Universität Stuttgart, Organische kristalline Halbleiter

Prof. Dr. R. Podschun, Institut für Infektionsmedizin, Universität Kiel, antibakterielle Beschickung

Prof. Dr. W. Possart, Universität Saarbrücken, BMBF-Projekt, Nanomodule

Prof. Dr. E. Quandt, Anorganische Funktionsmaterialien, CAU, Komposite aus Polymermatrix und ferromagnetischen Formgedächtnis-Nanopartikeln als magnetische Schalter (SFB „Funktion durch Schalten“ )

Dr. C. Röhl, Prof. Dr. J. Sievers, Anatomisches Institut, Toxikologische Auswirkung von metallischen Nanopartikeln auf menschliche Zellen

Prof. Dr. V. Shantarovich, N.Semenov Institute of Chemical Physics, Russian Academy of Sciences, Moskau, Positronenvernichtung und Membranpolymere

Prof. S. Tougaard, Physics Institut, University of Southern Denmark, Embedding of nanocluster in polymers

Prof. Dr. F. Tuzcek, Institut für Anorganische Chemie, CAU Kiel, Self-assembled monolayers

Prof. Wendorf, Universität Marburg, Teflonbeschichtung von Nanofasern

Prof. Dr. M. Wessling, Membrane Technology Group, Universität Twente, Niederlande, Freies Volumen in PPO-Nanokompositen

Prof. Dr. Y. Yampolskii, A.V. Topchiev Institute of Petrochemical Synthesis, Laboratory of Membrane Gas Separation, Russian Academy of Sciences, Moskau, Positronenvernichtung und Membranpolymere

*Research Institutes:*

Dr. D. K. Avasthi, Materials Science Group, Nuclear Science Centre New Delhi, India, High energy ion beam effects in polymer-metal nanocomposites

Prof. Dr. Dietmar Fink, Hahn-Meitner-Institut, Berlin, High energy ion beam effects in polymer-metal nanocomposites

Dr. D. Fritsch und Prof. Dr. V. Abetz, Institut für Polymerforschung, GKSS-Forschungszentrum Geesthacht, Freies Volumen in Polymeren mit intrinsischer Mikroporosität

Prof. Dr. G. Grundmeier, Max-Planck Institut, Düsseldorf, Antibakterielle Beschichtungen

Prof. Dr. D. Hofmann, Dr. M. Heuchel, GKSS, Teltow, Positronenvernichtung und Auswertung von MD Simulationen in Membranpolymeren

Prof. Dr. A. Meyer, Dr. A. Griesche, DLR, Köln, Probenherstellung in Projekten zu Diffusion in Pd-Cu-Ni-P Legierungen

Dr. M. Noeske, Fraunhofer-Institut für Fertigungstechnik und Angewandte Materialforschung, IFAM Bremen, BMBF-Projekt, Nanomodule und PALS an Polymer-Kompositen

Prof. Dr. K.V. Peinemann, GKSS, Geesthacht, Freies Volumen und Permeabilität in Spezialpolymeren

Prof. Schwarz, Dr. Drusch, Lebensmitteltechnologie, Kiel, Verkapselung von Lebensmitteln

#### *Industry:*

Degussa AG, BMBF-Projekt, Nanomodule

Infineon, Regensburg, externe Promotion

ISH, Förderprogramm Organische Nanometalle

Kömmerling Chemische Fabrik GmbH, BMBF-Projekt, Nanomodule

o.m.t. Lübeck, Photoaktive Schichten

Ormecon, Ammersbek, Organische Nanometalle

Sennheiser Electronic KG Wedemark, Elektrete

Siemens AG, BMBF-Projekt, Nanomodule, Projekt Organische Leuchtdioden

Sika Tivoli GmbH, BMBF-Projekt, Nanomodule

Wöhlk, Schönkirchen, Oberflächenmodifikationen von Kontaktlinsen

World Gold Council, G.R.O.W., Improvement of antibacterial coatings by incorporation of gold nanoparticles

### **Diploma, Bachelor and Master Theses**

D. Ehlers, *Untersuchung des Freien Volumens von Polymermembranen mittels Positronenannihilationslebensdauerspektroskopie*, 09.06.2008

S. C. Schulz, *Untersuchung der elektrischen und strukturellen Eigenschaften von Gold-Polymer-Nanokompositen nahe der Perkolationschwelle*, 01.08.2008

H. Acar (external), *Metamaterials Theory SRR Design and Comparison of Simulations*, 25.08.2008

K. Meurisch, *Herstellung piezoelektrischer Nylon 11-Dünnschichten durch thermisches Verdampfen*, 17.09.2008

### **Dissertations / Postdoctoral Lecture Qualifications**

H. Greve, *Magnetische Metall/Polymer Nanokomposite für Hochfrequenzanwendungen*, 05.02.2008

H. Takele, *Optical and Electrical Properties of Metal-Polymer Nanocomposites Prepared by Vapor-Phase Co-evaporation*, 14.03.2008

K. Dolgner, *Gezieltes Design von Edelmetall-Polycarbonat-Grenzflächen durch Einbetten von metallischen Nanopartikeln*, 17.07.2008

Published in 2008

- K. Hoppe, W. Fahrner, R. Fink, S. Dhamodoran, A. Petrov, A. Chandra, A. Saad, F. Faupel, V.S.K. Chakravadhanula, V. Zaporojtchenko, *An Ion Track Based Approach to Nano- and Micro-Electronics*, Nuclear Inst. and Methods in Physics Research, Section B (NIMB): Beam Interactions with Materials and Atoms, **266(8)**, 1642 - 1646 (2008)
- Y. K. Mishra, V.S.K. Chakravadhanula, U. Schuermann, H. Kumar, D. Kabiraj, S. Ghosh, V. Zaporojtchenko, D. K. Avasthi, F. Faupel, *Controlled reduction of size of Ag nanoparticles embedded in Teflon matrix by MeV ion irradiation*, Nuclear Inst. and Methods in Physics Research, Section B (NIMB): Beam Interactions with Materials and Atoms, **266(8)**, 1804 - 1809 (2008)
- V.S.K. Chakravadhanula, M. Elbahri, U. Schuermann, H. Takele, H. Greve, V. Zaporojtchenko, F. Faupel, *Equal intensity double plasmon resonance of bimetallic quasi-nanocomposites based on sandwich geometry*, Nanotechnology, **19(22)**, 225302 - 225302 (2008)
- F. Faupel, V. Zaporojtchenko, T. Strunskus, H. Greve, U. Schuermann, H. Takele, C. Hanisch, V.S.K. Chakravadhanula, N. Ni, A. Gerber, E. Quandt, R. Podschun, *Functional polymer nanocomposites*, Polymer and Polymer Composites (invited review), **16(8)**, 471 - 481 (2008)
- M. Scharnberg, R. Adelung, F. Faupel, *Influence of top layer geometries on the electronic properties of pentacene and diindenoperylene thin films*, Physica Status Solidi A, **205(3)**, 578 - 590 (2008)
- H. Takele, A. Kulkarni, S. Jebri, V.S.K. Chakravadhanula, C. Hanisch, T. Strunskus, V. Zaporojtchenko, F. Faupel, *Plasmonic properties of vapor-deposited polymer composites containing Ag nanoparticles and their changes upon annealing*, Journal of Physics D: Applied Physics, **41(12)**, 125409 - 125409 (2008)
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## Patent Applications

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- M. Scharnberg, K. Rätzke, *Staunen, Forschen und Lernen: Materialwissenschaften in Kiel (talk)*, Friedrich-Schiller-Gymnasium, Preetz, Deutschland, 18.03.2008
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- K. Rätzke, *Positronium zur Untersuchung weicher Materie (talk)*, Miniworkshop, Dresden, Deutschland, 01.-02.04.2008
- F. Faupel, *Neue Werkstoffe durch Nanotechnologie (invited talk)*, Schleswig-Holsteinische Universitäts-Gesellschaft, Ratzeburg, Deutschland, 10.04.2008
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- K. Rätzke, B. Shaik, F. Faupel, *Freies Volumen und Lagerstabilität von Epoxiden (talk)*, BMBF Meilenstein Meeting, Saarbrücken, Deutschland, 07.-08.05.2008
- K. Rätzke, *Free volume in membrane materials (talk)*, 9th International Workshop on Positron and Positronium Chemistry (PPC 9), Wuhan, China, 11.-15.05.2008
- F. Faupel, *Neue Werkstoffe durch Nanotechnologie (invited talk)*, Schleswig-Holsteinische Universitäts-Gesellschaft, Altenholz/Kiel, Deutschland, 15.05.2008
- T. Strunskus, *XPS, NEXAFS and IRRAS: fundamentals and Examples (invited talk)*, Sonderforschungsbereich 677, Summer School Salzau, Salzau, Deutschland, 20.-21.05.2008
- F. Faupel, K. Rätzke, V. Zöllmer, A. Bartsch, *Diffusion und viskoses Fließen in Glas bildenden metallischen Legierungen (invited talk)*, Glastag, Mainz, Deutschland, 30.05.2008
- F. Faupel, V. Zaporojtchenko, H. Greve, U. Schürmann, H. Takele, C. Hanisch, V.S.K. Chakravadhanula, *Polymer-metal nanocomposites for functional applications (invited talk)*, 3rd International Conference, Acireale, Italien, 08.-13.06.2008
- V. Zaporojtchenko, T. Strunskus, V.S.K. Chakravadhanula, F. Faupel, C. Roehl, R. Podschun, *Highly efficient antibacterial nanocomposite coatings with noble metal nanoparticles (talk)*, Nanobio Europe 2008, Barcelona, Spanien, 09.-13.06.2008
- K. Rätzke, *Free volume distribution at polymer-solid interfaces (talk)*, Kick-off-Meeting SPP 1369, Frankfurt, Deutschland, 13.06.2008
- V.S.K. Chakravadhanula, V.G. Kotnur, A. Kulkarni, Y.K. Mishra, D.K. Avasthi, D. Fink, V. Zaporojtchenko, F. Faupel, *SHI induced changes in the optical properties of Ag/Au - TiO<sub>2</sub> based nanocomposites prepared by co-sputtering (talk)*, Advanced Nano Materials, Averio, Portugal, 22.-25.06.2008
- K. Rätzke, *Temperature dependence of positron lifetime in a polymer of intrinsic microporosity (talk)*, International Congress on Membranes and Membrane Processes ( ICOM 2008), Honolulu, Hawaii, 14.-18.07.2008
- M. Scharnberg, *Einführung in die Materialwissenschaften (talk)*, Schulbesuch aus Plön in Kiel, Kiel, Deutschland, 16.07.2008
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- V.S.K. Chakravadhanula, *Emerging technologies of Nanomaterials and Nanotechnology: Its future (talk)*, Joggiah Institute of Technology, Narasapur, Indien, 15.09.2008
- V.S.K. Chakravadhanula, *Metal-polymer/oxide nanocomposites for functional applications and opportunities for studying in Germany with special regard to Materials science (talk)*, Swarna Andhra Institute of Technology, Narasapur, Indien, 15.09.2008
- V.S.K. Chakravadhanula, *Metal-polymer/oxide nanocomposites for functional applications and opportunities for studying in Germany with special regard to Materials science (talk)*, Osmania University, Hyderabad, Indien, 18.09.2008

- F. Faupel, *Neue Werkstoffe durch Nanotechnologie (invited talk)*, Schleswig-Holsteinische Universitäts-Gesellschaft, Bürgerhaus, Kronshagen/Kiel, Deutschland, 18.09.2008
- F. Faupel, V. Zaporojtchenko, H. Greve, U. Schürmann, H. Takele, C. Hanisch, V.S.K. Chakravadhanula, A. Kulkarni, A. Gerber, E. Quandt, R. Podschun, *Polymer nanocomposites for functional applications (invited talk)*, Second International Conference on Polymer Blends, Composites, IPNS, Membranes, Polyelectrolytes and Gels: Macro to Nano Scales (ICBC 2008), Kottayam, Kerela, Indien, 24.09.2008
- F. Faupel, V. Zaporojtchenko, H. Greve, U. Schürmann, H. Takele, C. Hanisch, V.S.K. Chakravadhanula, A. Kulkarni, A. Gerber, E. Quandt, R. Podschun, *Polymer nanocomposites for functional applications (invited talk)*, Polymeric Materials 2008, Halle, Deutschland, 24.-26.09.2008
- F. Faupel, V. Zaporojtchenko, U. Schürmann, H. Takele, C. Hanisch, V.S.K. Chakravadhanula, A. Kulkarni, A. Gerber, E. Quandt, R. Podschun, *Polymer nanocomposites for functional applications (invited talk)*, Advances in Polymer Technology (APT 2008), Kochi, Kerela, Indien, 27.09.2008
- F. Faupel, V. Zaporojtchenko, H. Greve, U. Schürmann, H. Takele, C. Hanisch, V.S.K. Chakravadhanula, A. Kulkarni, *Polymer nanocomposites for functional applications (invited talk)*, Bundesanstalt für Materialforschung und -prüfung, Berlin, Deutschland, 09.10.2008
- F. Faupel, V. Zaporojtchenko, C. Hanisch, V.S.K. Chakravadhanula, A. Kulkarni, H. Greve, U. Schürmann, A. Gerber, E. Quandt, R. Podschun, *Functional Applications of Polymer Nanocomposites close to the percolation threshold (invited talk)*, Third International Conference on Electroactive Polymers: Materials and Devices (ICEP 2008), Jaipur, Indien, 12.10.2008
- H. Kersten, F. Faupel, *Metallische Nanopartikel in Polymerschichten: Potentiale der Plasmatechnik (talk)*, 16. Neues Dresdner Vakuumtechnisches Kolloquium, Dresden, Deutschland, 16.-17.10.2008
- V. Zaporojtchenko, R. Podschun, V.S.K. Chakravadhanula, V.G. Kotnur, T. Strunskus, C. Roehl, F. Faupel, *Nanocomposite films with embedded noble metal and alloy nanoparticles. Antimicrobial properties and toxicity (talk)*, NanoSmat 2008, Barcelona, Spanien, 20.-21.10.2008
- K. Rätzke, *Diffusion and viscosity in undercooled metallic melts (invited talk)*, Diffusion in Materials (DIMAT) 2008, Costa Teguse, Spanien, 28.-31.10.2008
- K. Rätzke, F. Faupel, *Free volume in polymeric membranes (talk)*, DGM Fachauschuß, Kassel, Deutschland, 06.-07.11.2008
- F. Faupel, *Polymer-metal nanocomposites for functional applications (invited talk)*, Institutskolloquium Forschungszentrum Dresden-Rossendorf, Dresden, Deutschland, 12.-13.11.2008
- F. Faupel, *Neue Werkstoffe durch Nanotechnologie (invited talk)*, Schleswig-Holsteinische Universitäts-Gesellschaft, Trittau, Deutschland, 25.11.2008
- F. Faupel, *Grundlagen der Magnetostriktion (talk)*, Workshop des SFB 855, Sehlendorf, Deutschland, 18.-19.12.2008

## Other Activities and Events

### Selected Honorary Activities of Prof. Faupel:

Dean of the Technical Faculty of Engineering (Technische Fakultät der CAU),

Coordinator of the *North German Initiative Nanomaterials (NINa)*,

Principle Editor of the *Journal of Materials Research*, edited by the *Materials Research Society (MRS)*,

Member of the Editorial Advisory Board of the *Journal of Adhesion Science and Technology*,

Member of the des Advisory Board of *Diffusion and Defect Data*,

Vice Chair of the Technical Consulting Board of the *GKSS-Forschungszentrum Geesthacht*,

Member of the Program Committee of the DFG Priority Program "Polymer-Solid Interfaces, Thin Films, and Interphases -

