INSTITUT FÜR PHYSIK

MONTANUNIVERSITÄT LEOBEN

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ANNUAL REPORT

2009

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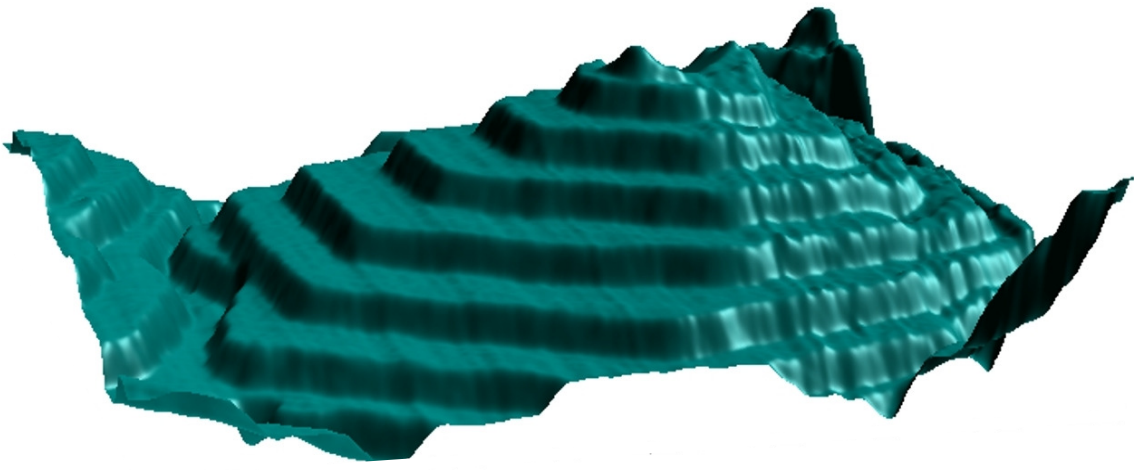

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Preface

The Institute of Physics has seen quite some changes in the year 2009. In February, I started my work as the new Professor and Chair of the Institute. Also, during this year 9 scientific coworkers have newly joined the Institute while only two have left.

More people need new space! Additional office- and laboratory space was provided by the University, and the complete refurbishment of the Institute has started in spring 2009 with the adaptation of the laboratories and the mechanical workshop. In particular, a completely new X-ray laboratory was built and equipped with a small-angle X-ray scattering instrument (NanoStar) which is fully operational since summer 2009.

With the satisfying personnel development, the extreme pressure in terms of teaching duties on the permanent staff could be somewhat released, although the invariably high number of students keeps teaching one of our most intensive responsibilities. The Institute of Physics covers the basic physics courses for all freshman students at the University of Leoben during their first year, as well as lectures and practical training in physics in the second year for about half of them. During the second and third periods the Institute of Physics is involved in the diploma program “Materials Science” where we particularly cover major part of the special program “Materials for Electronics”. During the academic year 2008/2009, lectures with 38 hours per week and lab courses / exercises / seminars with 135 hours per week were delivered by the Institute. Additionally, four diploma theses (one finished) and six doctoral theses were supervised in 2009.

Besides teaching, we see our mission in high-quality scientific research in functional materials physics on an international level. Research topics range from fundamental studies in quantum transport to applied research on the potential of microwave radiation in underground mining, to just name two extremes. The “classical” research fields of the Institute (semiconductor physics, surface physics and low-temperature electronic transport) are meanwhile complemented by new fields such as research on nanomaterials and biological/biomimetic materials, as well as on organic thin films and on photonic crystals. Additionally, the methodic expertise on scanning probe microscopy and low-temperature physics are now complemented by scattering techniques performed in particular also at large scale facilities such as synchrotron radiation X-ray sources or neutron sources.

The scientific output of the Institute in the year 2009 includes 20 SCI publications, almost 50 talks at conferences and foreign scientific institutions, and 30 poster presentations. Some of the papers appeared in high-impact interdisciplinary journals such as Nano Letters, PNAS or Advanced Materials, others in some of the best Physics journals such as Physical Review or Applied Physics Letters. The Institute is embedded in national and international cooperation which is documented by its participation in several concerted scientific actions. The FWF-NFN S97 “Interface Controlled and Functionalized Organic Films”, and the PLATON project “Processing Light: Advanced Technologies for Optical Nanostructures” (Austrian Nano-Initiative) were both extended, and a new project started in the framework of the German DFG priority program 1420: „Biomimetic Materials Research: Functionality by Hierarchical

Structuring of Materials“. Furthermore, the new Light-tower “Nano Growth” in the framework of the Nanonet Styria has been co-initiated by the Institute, and a short-term scientific mission was granted in the framework of an EU-COST action. 15 guest lecturers, mostly from foreign countries, as well as several weeks of granted beamtime of institute members at different European large-scale facilities complete the interdisciplinary and international scientific activities and exchange programs of the Institute.

The present annual report gives an overview on the activities of the Institute in the year 2009 and presents some scientific highlights as well as a summary of the actual scientific research. Due to the strong understaffing no report was compiled in 2008. This does however not mean that the Institute was scientifically inactive. Indeed, one paper in *Science* as well as one paper in the *Physical Review Letters* with the main contributions from the Institute were published in 2008. These are highlighted as well in this report and some of the scientific reports date also back to the year 2008.

More information is available at our homepage http://www.unileoben.ac.at/physics

I hope you will enjoy reading this report and keep in touch with the Institute of Physics.

Univ.-Prof. Dr. Oskar Paris July 2010

1. Personnell

Professors	Univ.-Prof. Dr. Oskar PARIS (head since 02/2009) Ao.Univ.-Prof. Dr. Ronald MEISELS Ao.Univ.-Prof. Dr. Josef OSWALD Ao.Univ.-Prof. Dr. Christian TEICHERT
Assistants	Dr. Zakir SEYIDOV (until 01/2009) Dipl. Phys. Maxim ERKO (since 02/2009) Dr. Markus HARTMANN (since 03/2009) Dr. Markus KRATZER (since 03/2009) Dr. Rainer LECHNER (since 10/2009)
Emeritus	Em. O.Univ.-Prof. Dr. Friedemar KUCHAR
Studienassistent	Christian STECHER
Non-scientific Staff	Heide KIRCHBERGER (Secretary) Peter MOHARITSCH (mechanical workshop) Magdalena OTTRIN (Secretary) Ing. Heinz PIRKER (Electrical Engineer)
Postdocs	Dr. Gregor HLAWACEK (until 06/2009) Dr. Gerhard POPOVSKI (since 12/2009) Dr. Christoph UIBERACKER
Doctoral Students	Mag. Oleksandr GLUSHKO Dipl.Ing. Franz SCHMIED Dipl.Ing. Igor BEINIK Dipl.Ing. Stefan LORBEK (since 01/2009) Dipl.Ing. Quan SHEN (since 06/2009)
Diploma Students	Andreas PAVITSCHITZ (since 06/2009) Lin WANG Nurdogan GÜRKAN Quan SHEN (until 06/2009)

2. Teaching

2.1 Courses in the academic year 2008/2009

Winter Term 2008/2009

Nr.	Name		Type/ hours per week
460.002	Oswald Stecher(STAss)	Physik I	V4
460.003	Oswald	Konversatorium zu Physik I	KV1
460.022	Oswald	Repititorium zu Physik I	RP1
460.001	Teichert (2x), Seyidov(2x), Schmied, Gamsjäger (2x), Grasser, Kaschnitz (2x), Kharicha, Kreith (2x), Milko, Puschnig	Rechenübungen zu Physik I *15 Kurse*	Ü2
460.030	Meisels (2x), Seyidov, Endler (4x), Fallmann(2x) Haas (2x), Hyden (2x), Wurster (2x), Stecher, Leitner, Renk (STAss)	Übungen zu Physik (I) 15 *Kurse*	Ü2
460.067	Oswald	Mechanisch-physikalische Meßtechnik	V1
460.094	Meisels, Teichert	Halbleiterwerkstoffe	V2
460.112	Oswald	Ausgewählte Problemstellungen der Quantenphysik	V2
460.111	Teichert	Einführung in die Oberflächen- u. Dünnschichtprozesse	V2
460.104	Andreev	Herstellung einkristalliner Schichten - Epitaxie	V2
460.072	Meisels	Physik der Mikroelektronik-Bauelemente	V2
460.076	Oswald, Meisels, Teichert,	Übungen zur Charakterisierung von Werkstoffen der Elektronik	Ü2
460.121	Oswald/ Teichert/ Meisels	Seminar aus Halbleiterphysik u. Technologie	S2
460.129	Kuchar/ Oswald / Teichert/ Meisels	Anl.z.selbst.wiss.Arbeiten auf dem Gebiet der Halbleiterphysik	P8

Summer Term 2009

Nr.	**Name**		Type/ hours per week
460.010	Paris	Physik II	V2
460.009	Paris, Erko (2x), Hartmann (2x), Kratzer, Lorbek (2x), Grasser, Gamsjäger (2x), Puschnig, Milko	Rechenübungen zu Physik II *13 Kurse*	Ü1
460.016	Teichert	Physik III	V2
460.022	Oswald	Repititorium zu Physik I	RP1
460.048	Teichert, Kratzer	Rechenübungen zu Physik III 2 *Kurse*	Ü1
460.054	Erko, Hartmann, Hlawacek (2x), Kratzer, Meisels, Wurster (2)	Übungen zu Physik II 8 *Kurse*	Ü2
460.049	Endler (2x), Wurster (2x)	Übungen zu Physik I *4 Kurse*	Ü2
460.068	Oswald, Meisels, Schmied	Übungen zu Mechanisch-physikalische Meßtechnik *5 Kurse*	Ü2
460.000	Uiberacker	Methoden der theoretischen Physik	V2
460.110	Oswald	Grundprinzipien der Quantenphysik	V2
460.112	Oswald	Ausgewählte Problemstellungen der Quantenphysik	V2
460.113	Teichert	Physik der Fullerene u. Carbon Nanotubes	V2
460.103	Teichert	Rastersondentechniken zur Charakterisierung von Festkörperoberflächen	V2
460.122	Oswald/Teichert/Meisels	Seminar aus Halbleiterphysik u. Technologie	S2
460.132	Kuchar/Oswald/Teichert/ Meisels	Anl.z.Selbst.wiss.Arbeiten auf dem Gebiet der Halbleiterphysik	P8

2.2 External help

To cover the exercises and the practical training in physics for the freshmen students it was particularly in the Winter Term 2008/2009 necessary to hire an unusual high number of motivated external people from other institutes/chairs and also some persons from outside the University. We are gratefully for the help from:

- Dr. E. Gamsjäger, Institut für Mechanik
- Dr. M. Grasser and Dr. A. Kharicha, Department Metallurgie, Lehrstuhl für Modellierung und Simulation metallurgischer Prozesse
- Dr. M. Milko and Dr. P.Puschnig, Department für Materialphysik, Lehrstuhl für Atomistic Modelling
- Mag. J. Kreith, Institut für Struktur und Funktionskeramik
- Dr. E. Kaschnitz, Gießerei-Institut
- Mag. S. Endler and Dipl. Ing. S. Wurster, Department für Materialphysik, Lehrstuhl für Materialphysik
- Dipl. Ing. W. Hyden, Department Angewandte Geowissenschaften und Geophysik, Lehrstuhl für Geophysik
- Dr. H. Fallmann, BORG Eisenerz
- Dr. G. Haas, BG und BRG Leoben
- Leitner, Renk: Student Tutors

3. Research

3.1 Scientific Highlights 2008

Characterization of Step-Edge Barriers in Organic Thin-Film Growth

Gregor Hlawacek,[1] Peter Puschnig,[2] Paul Frank,[3] Adolf Winkler,[3] Claudia Ambrosch-Draxl,[2] Christian Teichert[1]
[1] *Institute of Physics, University of Leoben, 8700 Leoben, Austria.*
[2] *Chair of Atomistic Modelling and Design of Materials, University of Leoben, 8700 Leoben, Austria.*
[3] Institute of Solid State Physics, Graz University of Technology, 8010 Graz, Austria.

Detailed understanding of growth mechanisms in organic thin-film deposition is crucial for tailoring growth morphologies, which in turn determine the physical properties of the resulting films. For growth of the rodlike molecule *para*-sexiphenyl, the evolution of terraced mounds is observed by atomic force microscopy. Using methods established in inorganic epitaxy, we demonstrate the existence of an additional barrier (0.67 electron volt) for step-edge crossing—the Ehrlich-Schwoebel barrier. This result was confirmed by transition state theory, which revealed a bending of the molecule at the step edge. A gradual reduction of this barrier in the first layers led to an almost layer-by-layer growth during early deposition stage. The reported phenomena are a direct consequence of the complexity of the molecular building blocks versus atomic systems.

Science 321,108 – 111(2008)

Coupling-Induced Bipartite Pointer States in Arrays of Electron Billiards: Quantum Darwinism in Action?

R. Brunner,[1] R. Akis,[2] D. K. Ferry,[2] F. Kuchar,[1] and R. Meisels[1]
[1] *Institute of Physics, University of Leoben, A-8700 Leoben, Austria*
[2] *Department of Electrical Engineering, Arizona State University, Tempe, Arizona 85287, USA*

We discuss a quantum system coupled to the environment, composed of an open array of billiards (dots) in series. Beside pointer states occurring in individual dots, we observe sets of robust states which arise only in the array. We define these new states as *bipartite pointer* states, since they cannot be described in terms of simple linear combinations of robust single-dot states. The classical existence of bipartite pointer states is confirmed by comparing the quantum-mechanical and classical results. The ability of the robust states to create ‘‘offspring’’ indicates that *quantum Darwinism* is in action.

Phys.Rev.Lett. 101, 024102-1 – 024102-4 (2008)

3.2 Scientific Highlights 2009

Sacrificial Ionic Bonds Need To Be Randomly Distributed To Provide Shear Deformability

Markus A. Hartmann[†,‡] and Peter Fratzl[‡]
[†]*Institute of Physics, University of Leoben, Franz-Josef Strasse 18, A-8700 Leoben,*
[‡]*Austria, and Max-Planck-Institute of Colloids and Interfaces, Department of Biomaterials, Am Mühlenberg 1, D-14476 Potsdam, Germany*
(Received June 8, 2009; Revised Manuscript Received August 17, 2009)
Multivalent ions are known to allow for reversible cross-linking in soft biological materials, providing stiffness and extensibility via sacrificial bonds. We present a simple model where stiff nanoscale elements carrying negative charges are coupled in shear by divalent mobile cations in aqueous media. Such a shear coupling through a soft glue has, indeed, been proposed to operate in biological nanocomposites. While the coupling is elastic and brittle when the negative charges are periodically arranged, sufficient randomness in their distribution allows for large irreversible deformation.

Nanoletters 9, 3603-3607 (2009)

Systematic study of nonideal contacts in integer quantum Hall systems

Christoph Uiberacker, Christian Stecher, and Josef Oswald
Institute of Physics, University of Leoben, Franz-Josef-Strasse 18A, 8700 Leoben, Austria
(Received 20 August 2009; revised manuscript received 9 September 2009; published 29 December 2009.)
In the present paper we investigate the influence of the contact region on the distribution of the chemical potential in integer quantum Hall samples as well as the longitudinal and Hall resistance as a function of the magnetic field. First we use a standard quantum Hall sample geometry and analyze the influence of the length of the leads where current enters/leaves the sample and the ratio of the contact width to the width of these leads. Furthermore we investigate potential barriers in the current-injecting leads and the measurement arms in order to simulate nonideal contacts. Second we simulate nonlocal quantum Hall samples with applied gating voltage at the metallic contacts. For such samples it has been found experimentally that both the longitudinal and Hall resistance as a function of the magnetic field can change significantly. Using the nonequilibrium network model we are able to reproduce most qualitative features of the experiments.

Phys.Rev.B 80, .235331-1 – 235331-11 (2009)

Capillarity-driven deformation of ordered nanoporous silica

Johannes Prass[1] , Dirk Müter[1] , Peter Fratzl[1] and Oskar Paris[1,2]
[1]*Department of Biomaterials, Max-Planck-Institute of Colloids and Interfaces, Research Campus Golm, 14424 Potsdam, Germany*
[2]*Institute of Physics, University of Leoben, Franz-Josef-Strasse 18, 8700 Leoben, Austria*
(Received 6 August 2009; accepted 8 August 2009; published online 27 August 2009)
Ordered nanoporous silica is seen to contract reversibly during the condensation and evaporation of fluids in the pores, forming a capillarity-driven actuation system. *In situ*

x-ray diffraction is used to measure the strain of the ordered pore lattice in dependence on the relative vapor pressure of different fluids. Elastic moduli extracted from these strain isotherms are independent of the fluid used, and do therefore constitute real nanomechanical properties of the solid porous framework. The relationship between this pore-load modulus and the Young's modulus of the silica walls is analyzed with simple analytical considerations and with finite element calculations.

Appl.Phys.Lett. 95, 083121-1 – 083121-3 (2009)

Conductive atomic force microscopy study of InAs growth kinetics on vicinal GaAs (110)

Paloma Tejedor,[1],a_ Laura Díez-Merino,[1] Igor Beinik,[2] and Christian Teichert[2]
[1]*Instituto de Ciencia de Materiales de Madrid, CSIC, Sor Juana Inés de la Cruz 3, 28049 Madrid, Spain*
[2]*Institut für Physik, Montanuniversität Leoben, Franz Josef St., 18A-8700 Leoben, Austria*
(Received 29 May 2009; accepted 13 August 2009; published online 21 September 2009)

Conductive atomic force microscopy has been used to investigate the effect of atomic hydrogen and step orientation on the growth behavior of InAs on GaAs (110) misoriented substrates. Samples grown by conventional molecular beam epitaxy exhibit higher conductivity on [$1\bar{1}0$]-multiatomic step edges, where preferential nucleation of InAs nanowires takes place by step decoration. On H-terminated substrates with triangular terraces bounded by [$1\bar{5}0$]-type steps, three-dimensional InAs clusters grow selectively at the terrace apices as a result of a kinetically driven enhancement in upward mass transport via AsH_x intermediate species and a reduction in the surface free energy.

Appl.Phys.Lett. 95, 123103-1 – 123103-3 (2009)

Hierarchy of adhesion forces in patterns of photoreactive surface layers

Gregor Hlawacek,[1] Quan Shen,[1] Christian Teichert,[1,a] Alexandra Lex,[2,b] Gregor Trimmel,[2] and Wolfgang Kern[3]
[1]*Institute of Physics, University of Leoben, 8700 Leoben, Austria*
[2]*Institute for Chemistry and Technology of Materials, Graz University of Technology, 8010 Graz, Austria*
[3]*Institute of Chemistry of Polymeric Materials, University of Leoben, 8700 Leoben, Austria*
(Received 27 August 2008; accepted 5 December 2008; published online 23 January 2009)

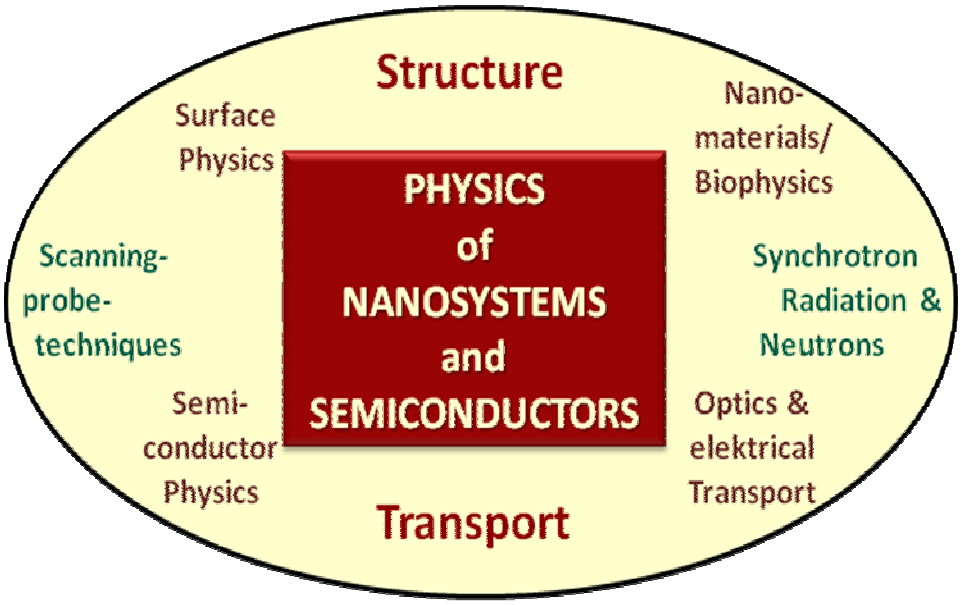
Precise control of surface properties including electrical characteristics, wettability, and friction is aprerequisite for manufacturing modern organic electronic devices. The successful Combination of bottom up approaches for aligning and orienting the molecules and top down techniques to structure the substrate on the nano- and micrometer scale allows the cost efficient fabrication and integration of future organic light emitting diodes and organic thin film transistors. One possibility for the top down patterning of a surface is to utilize different surface free energies or wetting properties of a functional group. Here, we used friction force microscopy (FFM) to reveal chemical patterns inscribed by a photolithographic process into a photosensitive surface layer. FFM allowed the simultaneous visualization of at least three different

chemical surface terminations. The underlying mechanism is related to changes in the chemical interaction between probe and film surface.

Journal of Chem.Physics 130, 044703 (2009)

3.3 Research reports

Research at the Institute of Physics covers four major fields, namely surface physics, semiconductor physics, optics and electric transport, and since the beginning of 2009 also nanomaterials/biomaterials. Both, structural investigations and transport properties are topics of active research, the latter being presently studied theoretically and/or with the help of computer simulations. Two major experimental methods are actively employed within the Institute, i.e., scanning force microscopy and scattering techniques (including synchrotron radiation and neutrons). These are complemented by microwave- and infrared spectroscopic techniques and the possibilities of transport measurements at low-temperature and high magnetic fields.



The following research groups have been established in 2009 at the Institute of Physics. Although there is some overlap between the four groups and the four research fields, they constitute and represent independent groups, each lead by one of the four Professors of the Institute.

Research group **Photonics (Meisels)**
R. Meisels, O. Glushko, F. Kuchar

Research group **Electronic Transport (Oswald)**
J. Oswald, C. Uiberacker, C. Stecher

Research group **Nanomaterials and Scattering Methods (Paris)**
O. Paris, M. Erko, M. Hartmann, R.T. Lechner, G. Popovski

Research group **Surface Physics and Scanning Probe Microscopy (Teichert)**
C. Teichert, I. Beinik, N. Gürkan, M. Kratzer, S. Lorbek, A. Pavitschitz, F. Schmied, Q. Shen, L. Wang

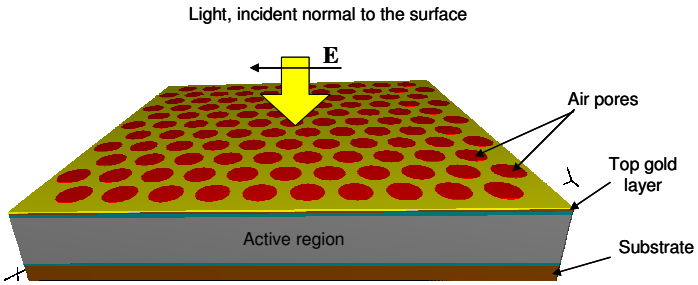
The following reports demonstrate the activities of these groups in the year 2009 (and partly also in 2008).

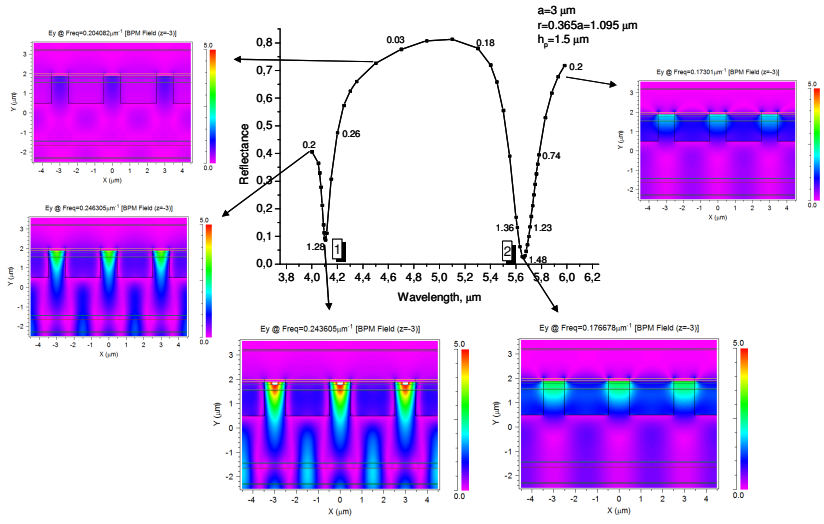
Simulation of the Coupling of Incident IR Radiation to Qwips with Photonic Crystal Structure

O. Glushko, R. Meisels and F. Kuchar

QWIPs (quantum well infrared photodetectors) contain an array of quantum wells in their active region. In these wells, subbands form below the conduction band. Mid infrared radiation excites electrons in these subbands into the conduction band. In this way, QWIPs can be used as photoconductive detectors. However, the electrons are sensitive only to electric fields $E_{||}$ parallel to the growth direction (in terms of quantum mechanics a non-zero matrix element of the electrical dipole moment is required). For normal incidence, the electric field is transverse to the growth direction. Photonic crystals (PhC) are used to modify the electromagnetic field pattern to produce an $E_{||}$ component.

PhCs are structures with a spatially periodic variation of the (not necessarily real) refractive index *n*, e.g., arrays of dielectric or metallic slabs or rods in air. Here the PhC is made by periodically etching holes into the QWIP structure. The active region contains 50 GaAs wells in $Ga_{0.18}Al_{0.82}As$ on top of a GaAs substrate [1]. The structure is covered by a gold layer (except for the holes) as a contact.





Central diagram: reflectance vs. wavelength. The numbers at the curve indicate the integral of $E_{||}^2$ over the active region. Surrounding contour plots: Amplitude of $E_{||}$ (denoted E_y here) for a cross section through the QWIP (the y-direction is parallel to the growth direction, x is transverse)

3D FDTD (finite difference time domain) calculations are used to calculate the field distribution within the QWIP and the reflection by the QWIP. The QWIP will be most sensitive for wavelengths at reflectance minima (high transmission) and for which $E_{||}$ is large in the active layer. The calculations show two minima of the reflection (indicated as 1 and 2). At these wavelengths the field is concentrated near the gold layer between the holes. The gold layer increases the reflection (except for the minima) but strengthens the transverse → parallel conversion of the electric field.

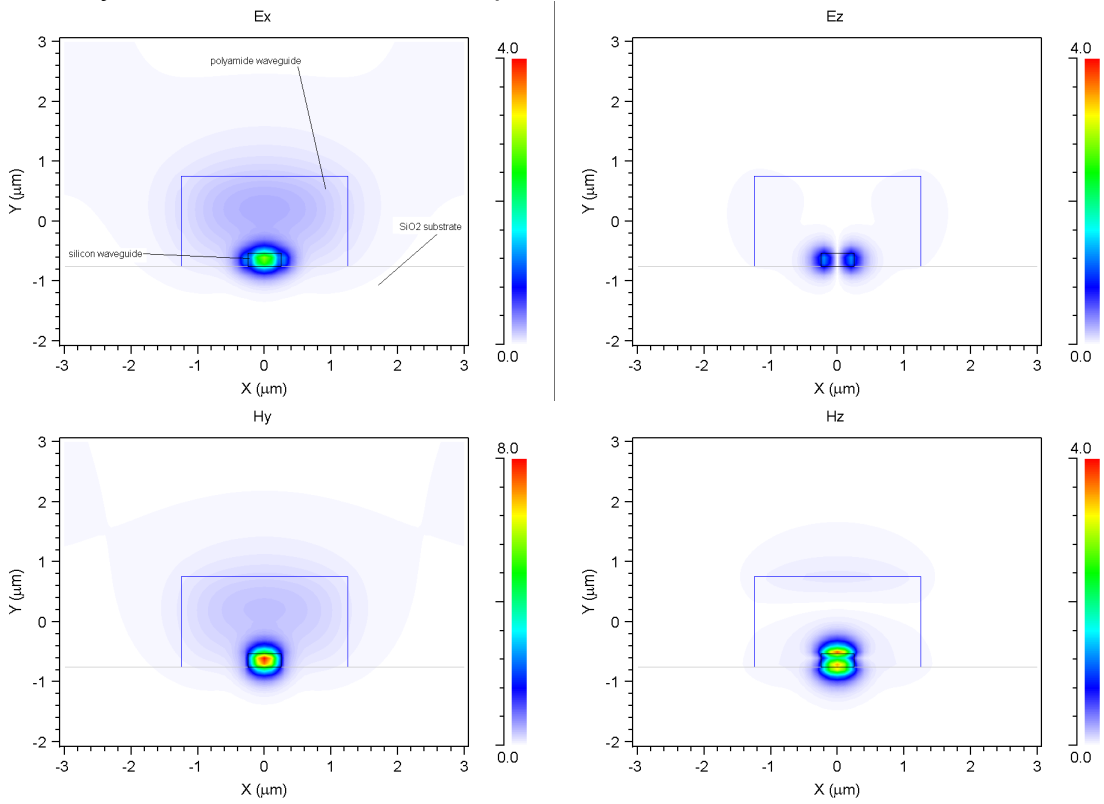
[1] S. Schartner et al., Appl. Phys. Lett. **89** 151107 (2006).

Simulation of the Coupling of Polyamide based Fibers to Silicon Waveguides

O. Glushko and R. Meisels

To optimize the coupling of the IR radiation into the silicon waveguide 3D simulations using FDTD (finite-difference time-domain) and BPM (beam propagation method) were performed. The model developed for the simulations consists of several components including (i) an inverted tapered silicon waveguide which is sitting on the silicon dioxide substrate, (ii) a polyamide waveguide with refractive index n_{poly}= 1.67 placed on top of the silicon waveguide, (iii) a monochromatic plane-wave source which irradiates into the polyamide waveguide, (iv) and a background material which is nominally chosen to have the refractive index of benzocyclobutene-based polymer (1.54). The aim of the investigations is to achieve maximal coupling for the telecom wavelengths in the range 1.4 -1.6 μm. The efforts were concentrated on investigation of the influence of the parameters of the system on the coupling efficiency. In particular, we study the influence of 1) the separation layer between the silicon waveguide and the polyamide waveguide, 2) the shape of the polyamide waveguide, 3) the final width of the inverted taper, 4) the total length of the structure, and 5) the refractive index of the background material.

The coupling efficiency, which is defined as the ratio of the power confined within the silicon waveguide to the power irradiated by the source, exceeds 50%. The coupling efficiency does not change sufficiently with an increase of the separation layer width from 0 to 0.4 μm. For separation layers thicker than 0.45 μm the coupling efficiency reduces. The minimal length of the inverted taper to achieve 50 % coupling efficiency was found to be about 40 μm.

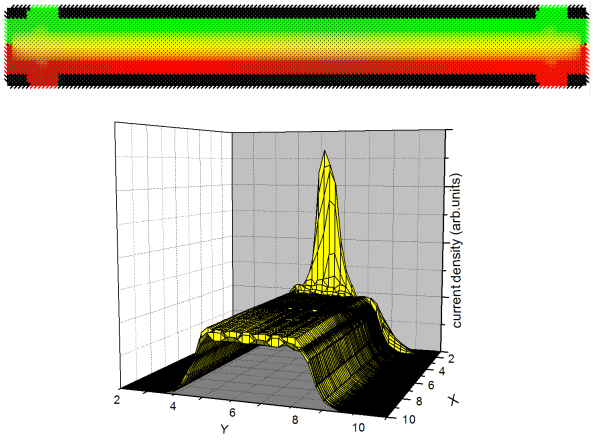


The distribution of the electromagnetic field components in the structure after coupling. The FDTD calculation was done for TE polarization (E_x and H_y components are non-zero in the generated EM wave). The cross sections are taken at Z=54 μm relative to the source position.

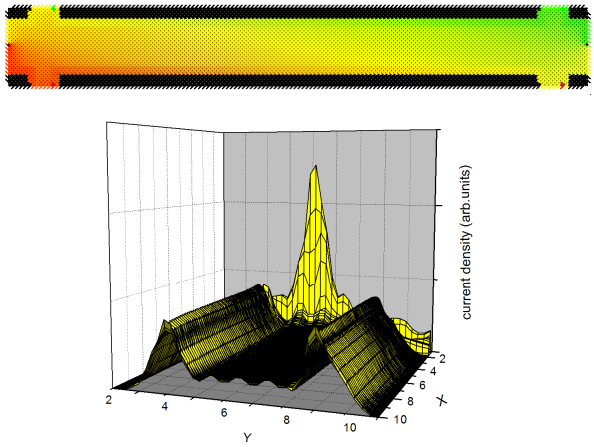
Edge versus Bulk Current in the Quantum Hall Effect Regime

J. Oswald and C. Uiberacker

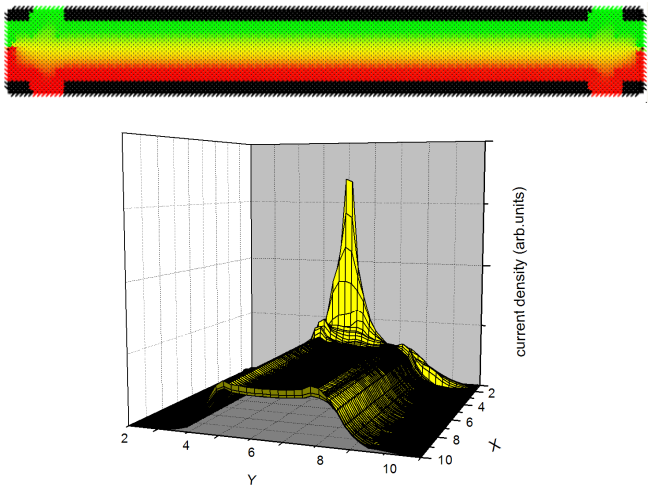
The question about the role of edge and bulk current for the integer quantum Hall effect (IQHE) is still a major topic of the ongoing discussions. The importance of this question is highlighted by experimental results obtained by probing the lateral potential distribution in the QHE-regime[1]. In order to compare this experimental results with theory, a transport model is needed, which is able to capture sample properties close to the real experimental conditions like e.g. sample geometry, carrier inhomogeneities and non-ideal contacts. In recent papers [2,3,4] we have demonstrated, that on the basis of a network model it is possible to account for complex sample geometries and we have further shown, that our network model is able to treat edge and bulk currents on an equal footing. This gives us the ability to address the lateral current distribution in QHE samples [5]. For the pure plateau regime we get a homogeneous distribution of the current in the bulk region, while for the transition regime between plateaus we get an enhancement of the current density near the edges. The figures below show the lateral excitation potential distribution and the lateral distribution of the excitation current at different magnetic fields a) right before the beginning of 3→2 plateau transition, b) in the middle of the 3→2 plateau transition and c) right after the 3→2 plateau transition.



a)



b)



c)

The potential distribution is shown as a 2D colour plot at the top and the current distribution is shown as a 3D plot at the bottom in each of the figures a,b and c.

In the plateau regime right before and after the plateau transition (a and c) one can clearly see, that the lateral potential distribution resembles stripes of constant potential along the edges. Nevertheless the associated current distribution shows a homogeneous lateral current

In contrast, the plateau transition regime leads to an enhancement of the current distribution near the edge region, right opposite to the expectations according to the edge channel picture, but in agreement with the bulk current picture of the QHE. This puzzling behavior, which at the first glance seems to contradict the edge channel picture, can be explained in the following way: Dissipation-less excess current is flowing in the so called incompressible regions between edge stripes, while the edge stripes themselves are current-less. In the plateau regime the entire bulk region represents an incompressible stripe, while in the transition regime the bulk gets compressible. Therefore, in the plateau transition regime the bulk screens out some of the transverse excitation potential gradient and leaves only narrow incompressible stripes between the bulk and the inner most edge stripe, which now takes the screened part of the transverse potential gradient. These results demonstrate that our model captures both, bulk and edge effects and agrees with the bulk- and the edge current picture of the QHE at the same time. In fact, our model does not distinguish between bulk end edge effects in the first place and thus suggests equivalence between the edge and bulk current picture, which usually serve as counterparts for the ongoing discussion since already more than 25 years. On this basis be believe to have made a substantial step forward in explaining the still not completely understood phenomenon of the QHE.

[1] E. Ahlswede, J. Weis, K. von Klitzing and K. Eberl, Physica E **12**, 165 (2002)
[2] J.Oswald, M.Oswald. Phys. Rev. B74(15), 153315 (2006)
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The Role of Dissipation in the Quantum Hall Effect Regime

J. Oswald and C. Uiberacker

The standard explanation for the integer quantum Hall effect (IQHE) is based on the so called localization picture, which maps out the plateau regimes and the transition regimes between plateaus in agreement with the experimentally observed scaling behaviour[1]. Plateaus in the Hall resistance appear, if the Fermi level gets pinned by localized states between Landau levels (LLs), while transitions between plateaus occur, if the Fermi level is pinned within de-localized states near the centre of the LLs. Experimentally the transition regime is accompanied by a non-zero longitudinal resistance R_{xx}, which indicates dissipation in the bulk. For the experimental investigation of the scaling behaviour the width of the R_{xx}-peaks has been therefore mostly used. At this point we want to remind, that dissipation is driven by non-equilibrium, like introduced by the experimentally injected currents, while the scaling theory with all aspects concerning quantum coherence and quantum localization is not aiming at the non-equilibrium situation at all.

Our intention is to bridge the equilibrium and non-equilibrium situations by a proper theoretical approach, which is based on a non-equilibrium network model for magneto transport in the QHE regime [2]. Quantum localization, as the major ingredient for the scaling theory of the QHE, needs quantum coherence of the states on a sufficient length scale. A reduction of the coherence length by e.g. increasing temperature causes a breakdown of localization beyond the reduced coherence length, resulting in an increase of the R_{xx} peak width. As a consequence, the width of the R_{xx} peaks is controlled by quantum coherency. However, considering the non-equilibrium aspect, which is most important from the experimental point of view, the R_{xx}-peaks and their width should be controlled by dissipation. In order to rate both aspects concerning the importance for the QHE, we look for a possibility to control dissipation without affecting phase coherency and studying the possible influence on the experimental data.

Based on simulation results of our non-equilibrium network model we propose an experimental setup, which allows a significant suppression of dissipation in the QHE plateau transition regime. This is achieved by an appropriate biasing of a narrow stripe like gate electrode, which is aligned to the longitudinal direction of a standard QHE sample and which needs to cover only a vanishing small part of the bulk region (for further details see [3,4]). Our calculations demonstrate that the suppression of dissipation is accompanied by a significant narrowing of the plateau transitions (see Figs.1-3), although any manipulation of quantum coherency by this setup can be ruled out. Besides the practical aspect in context with metrology, such an investigation could provide additional insight into the importance of quantum coherency for the QHE, especially for those cases, where a scaling analysis fails.

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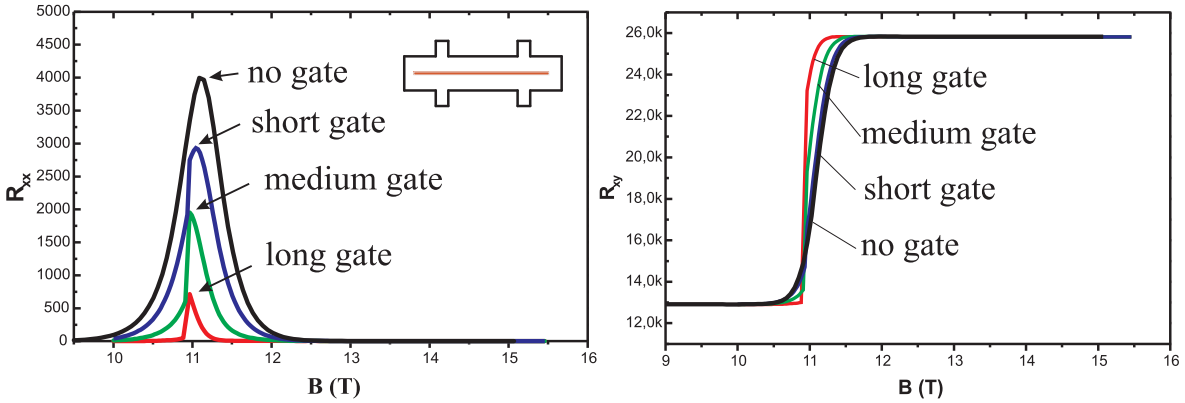

Fig.1 Left: Simulated R_{xx} versus B at different gate stripe lengths. **Right**: Simulated R_{xy} versus B at different gate stripe lengths

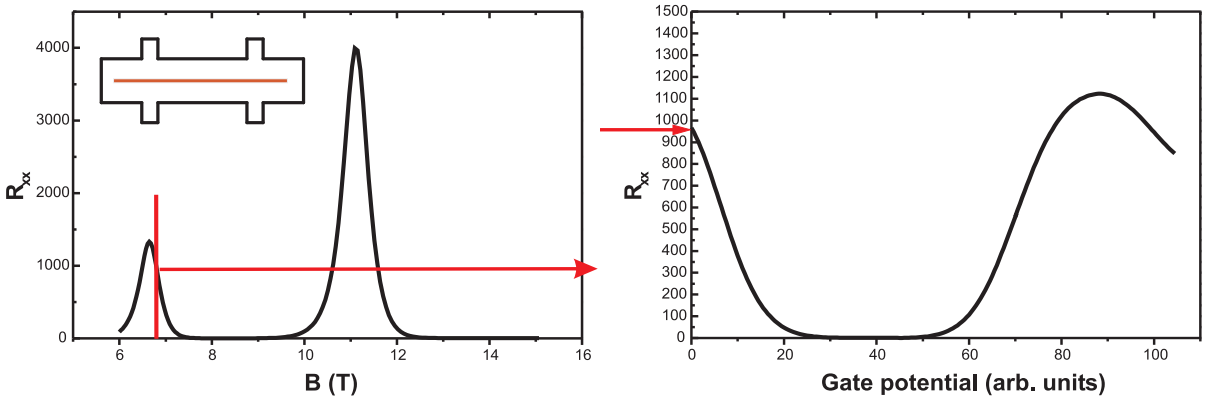

Fig.2 Left: R_{xx} versus magnetic field B with inactive gate. The vertical line marks the fixed magnetic field B at which the gate voltage sweep, which is shown on the right, has been made. The horizontal line marks the initial R_{xx} value for the gate sweep. **Insert:** schematic sample geometry, the bold line in the middle indicates the position of the gate stripe. **Right:** R_{xx} versus gate voltage at fixed magnetic field as marked on the left.

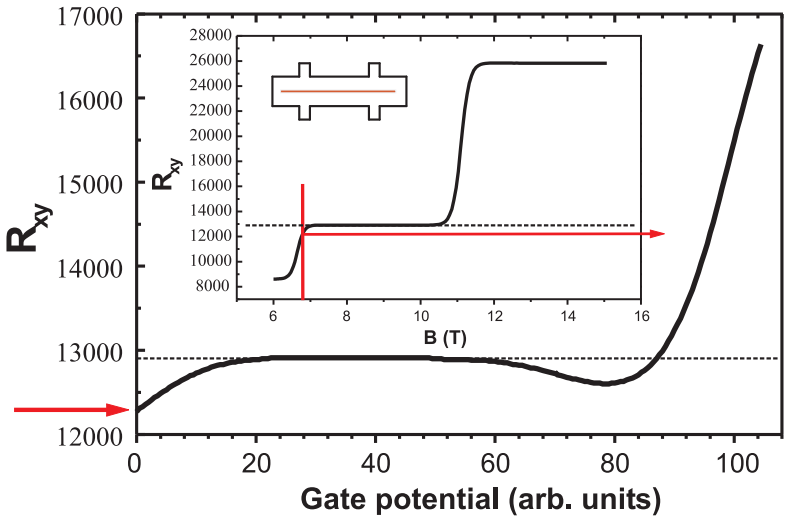

Fig.3 R_{xy} versus gate potential at a fixed magnetic field B. **Insert:** B-sweep of R_{xy} without gate. The vertical line marks the magnetic field for the gate sweep; the horizontal arrow indicates the starting value of R_{xy} for the gate sweep. The broken horizontal line marks the ν=2 plateau value of R_{xy}.

SAXS –WAXS Studies of Magnetic Core-Shell CoFeO Nano-Cubes

R.T. Lechner, G. Popovski and O. Paris

We have studied with small and wide angle x-ray scattering (SAXS-WAXS) techniques magnetic $CoFe_2O_4$ core-shell nanocrystals (NC) in solution. The new type of strongly exchange-coupled iron oxide-based core/shell NC with a cubic shape (see Fig. 1a) are chemically synthesized and consist according to TEM studies of an antiferromagnetic (AFM) core of ferrous oxide (wüstite, Fe_xO), which is surrounded by a ferrimagnetic (FiM) shell of a metal ferrite ($CoFe_2O_4$) [1]. These magnetic nanoparticles show not only a great potential for novel magneto-electronic devices, but also for bio-medical applications. In this work, we have tried to gain structural information of the core and shell structure independently. The SAXS-WAXS experiments have been carried out at the beamline my-spot at the synchrotron HZB-BESSY in Berlin. The scattering spectra

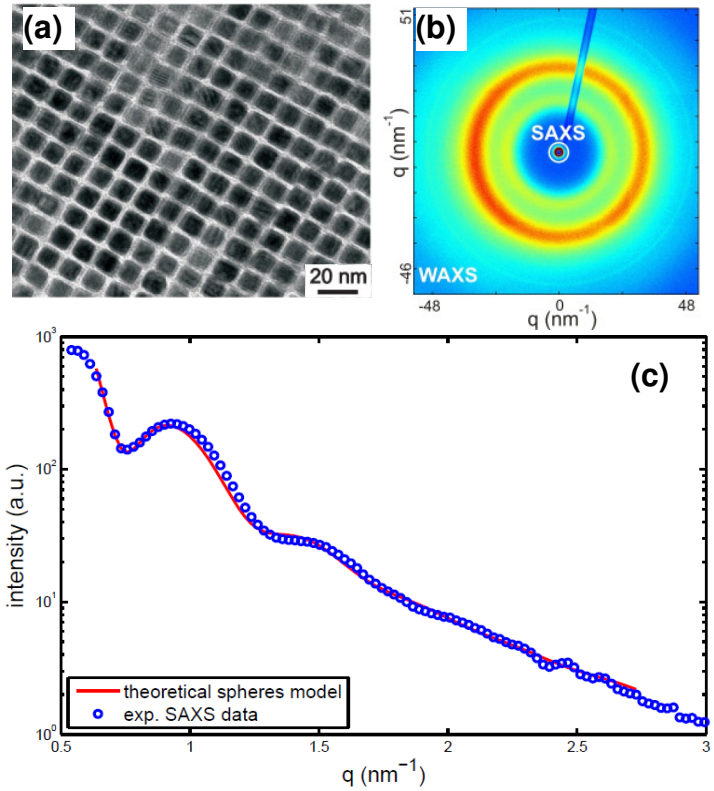

Fig.1: (a) TEM image of a thin film formed by 11-nm cubic $Fe_xO/CoFe_2O_4$ NCs. **(b)** 2D WAXS spectrum of $Fe_xO/CoFe_2O_4$ cubes with nominal 14 nm size measured in a 1wt% solution sealed in quartz-glass-capillaries with 1.5 mm diameter. **(c)** SAXS intensity vs. scattering vector q. From the comparison to the theoretical scattering model we derive a size of ~12 nm for the magnetic nano-cubes. The scattering spectra were recorded using a x-ray energy of 15 keV at the beamline my-spot at HZB-Bessy, Berlin.

were recorded with a 2D CCD-detector in a setup, which enables the detection of the low (SAXS) and the large q-range (WAXS) from 0.5 nm^{-1} to 50 nm^{-1}, within one single measurement (see Fig. 1(b)). From the SAXS modulated intensity distribution over q and the fit with the theoretical scattering curve we can deduce a cube size of ~11.8 ± 1.4 nm (see Fig. 1(c)). From the position and the width FWHM of the structural Bragg peaks at large q-values (WAXS) we derive the size of the wüstite Fe_xO-core of ~9 nm and hence a thickness of the surrounding $CoFe_2O_3$ shell to ~1.5 nm.

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Cooperation partner: Wolfgang Heiss, Institut für Halbleiter- und Festkörperphysik, Johannes Kepler Universität Linz, 8010 Linz, Austria; Barbara Aichmayer, Max-Planck-Institute of Colloids and Interfaces, Potsdam, Germany

EU support: ELISA (European Light Sources Activities, I3 Programme)

The Excess Surface Energy of Carbon Nanostructures

M. A. Hartmann and O. Paris

Carbon nanostructures, such as fullerenes or carbon nanotubes, show extraordinary mechanical and electronic properties. They possess a high stiffness and their electronic properties can be tuned from conducting to semi-conducting and isolating. The ground state of an infinite array of sp^2 bonded carbon atoms is the planar graphene configuration. For finite arrays of carbon atoms the situation changes. The unsaturated bonds at the edges increase significantly the energy of these structures and bending back and closure of these surfaces become energetically favourable. Nevertheless, the energy per atom of such structures is higher as compared to graphene. Thus, closed carbon nanostructures possess an intrinsic excess surface energy. This energy was evaluated using *ab initio* and Monte Carlo (MC) simulation techniques. The combination of these two different techniques allows investigating carbon nanostructures over a wide range of sizes. Density Functional Theory (DFT) was used to calculate fullerenes up to C_{240}. These data were used to determine classical potential functions that were used in subsequent MC simulations that extended the range of accessible fullerenes up to C_{5120}. Furthermore, the results of DFT and MC simulations were compared to investigate the effects of approximations that are inevitable in MC simulations, e.g. the use of classical potential functions and the splitting of the total energy in a sum of different energy contributions (bond stretching, bond bending and bond torsion).

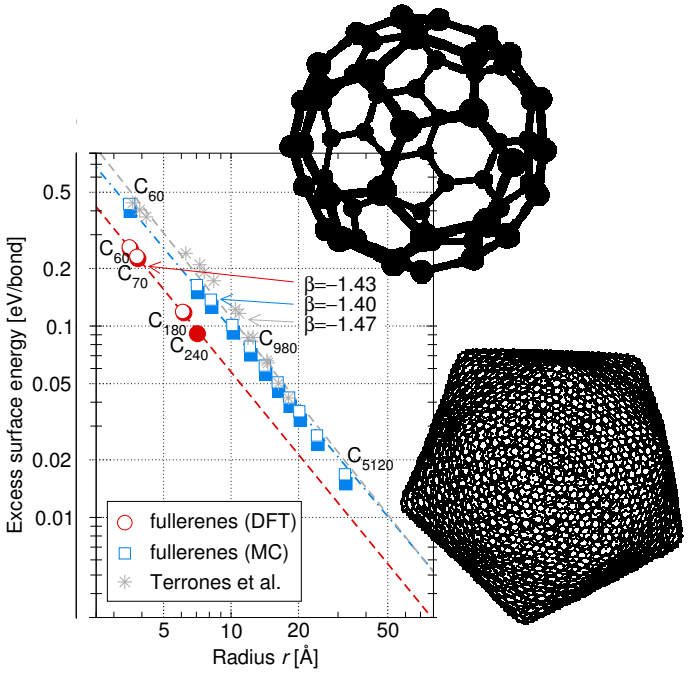


Figure 1: The excess surface energy as a function of size for fullerenes. Literature data from H. Terrones and M. Terrones, J. Phys. Chem. Solids **58**, 1789 (1997) are included for comparison.

In figure 1 the results for the excess surface energy as a function of the fullerene size is shown. Additionally two typical configurations for a small (C_{60}) and a large (C_{5120}) fullerene are shown. For DFT as well as MC the excess surface energy as a function of fullerene size shows a decay following a power law with the same exponent (note the same slope in the semi-logarithmic plot), but the absolute value of the energy is overestimated by MC simulations. Furthermore it was shown that torsion provides the largest contribution to the total energy albeit its small force constant.

Cooperation Partners:

(a) David Holec and Paul Mayrhofer, Department of Physical Metallurgy and Materials Testing, Montanuniversität Leoben
(b) Franz Dieter Fischer, Institute of Mechanics, Montanuniversität Leoben
(c) Franz G. Rammerstorfer, ILSB, Vienna University of Technology

Sacrificial Bonds in Biological Materials

M. A. Hartmann

Biological materials, such as bone, mussel fibres or sea shells, reconcile a high stiffness with an elevated toughness, which are opposing mechanical properties in single component materials. The strategy of nature to achieve its goal is to construct multi-component materials which are hierarchically organized over many lengthscales. A common design principle found in many biological materials is to combine stiff, but brittle, anorganic minerals with a soft, but tough organic matrix (mainly proteins or polysaccharides). The coupling of these two phases has tremendous effects on the mechanical performance of the composite as a whole. So called sacrificial bonds that are weaker than the covalent bonds holding the structure together and that can open and close reversibly are reported to be responsible for the enhanced toughness of many natural materials. Furthermore, there is experimental evidence that these bonds are coulombic in nature. We developed a simple model to describe the effect of coulombic bonds on the mechanical performance of a composite, where stiff entities are arranged in a staggered manner and the interaction between these stiff elements is governed by electrostatic bonds (M. A. Hartmann and P. Fratzl, Nano Lett. **9**, 3603 (2009)). It was found that the sacrificial bonds have to be randomly distributed to provide the material with additional shear deformability. Figure 1 shows load-displacement curves for two extreme scenarios of charge distributions: first, arranged on a lattice and, second, randomly distributed. In the ordered arrangement the material shows a high stiffness, but brittle failure when a given load is exceeded. Due to their ordered distribution all bonds are loaded in exactly the same way and fail collectively when the strength of the system is exceeded. Thus, the toughness of such a material is low. In the case of a random arrangement, the material shows much lower stiffness, but the toughness of the composite is strongly enhanced, because the material can dissipate additional energy by a stick-slip mechanism (see inset in Figure 1). A slipping event occurs when the applied load exceeds the strength of the actual configuration. The material starts slipping and eventually – since the charges are randomly distributed – finds a new, more stable, configuration that prevents further slippage. During the slipping event additional energy is dissipated which reflects the increased toughness of the composite.

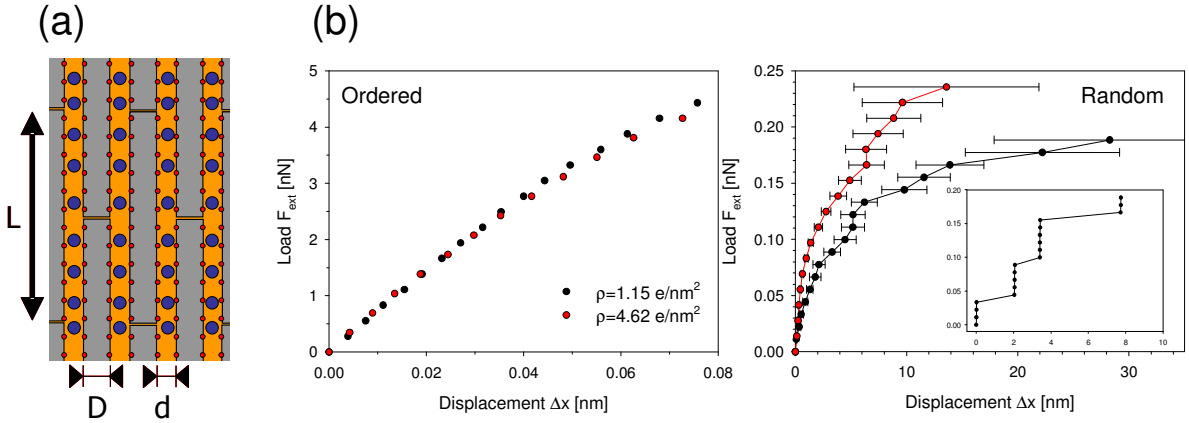


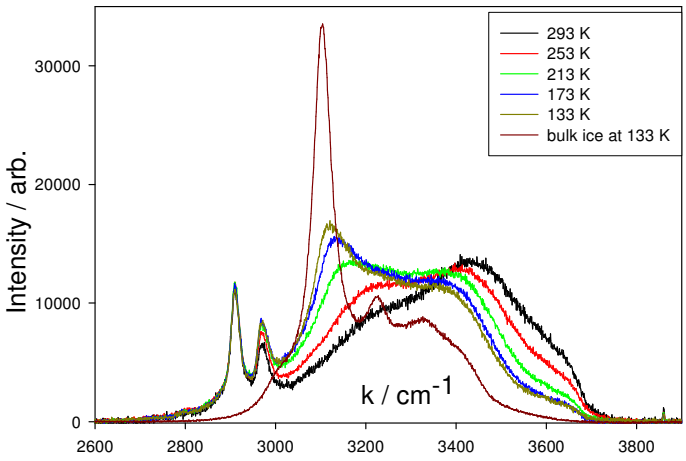
Figure 1: (a) shows the investigated model. Negative charges (shown in red) are placed on stiff entities, representing e.g. mineral particles, while divalent counterions (shown in blue) mediate an effective attraction between these likewise charged plates. (b) Load-Displacement curves for an ordered and a random arrangement of negative charges and for two different charge densities. The inset shows a representative load-displacement curve of a single run, visualizing the stick-slip mechanism, responsible for the toughening effect.

Cooperation Partner: Peter Fratzl, MPI Colloids and Interfaces, Potsdam, Germany.

Raman Scattering of Confined Water

M. Erko and O. Paris

The structure and dynamics of supercooled liquid water and of amorphous ice is a very active area of current research. Confinement induces new phenomena such as melting point suppression, and in some cases, water does even not freeze at all. Micelle-templated porous silica materials, such as SBA-15 and MCM-41 [1] represent an ideal model system for studying water in nano-cofinement. Recent differential calorimetric measurements do not show any freezing peak if water is enclosed in cylindrical nano-pores of MCM-41 with diameter of smaller than 2,5 nm [2]. We performed spectroscopic measurements of confined water in the supercooled region which provide new details about the mobility of water in confinement. Within the European exchange program COST, a Short-Time-Scientific-Mission (STSM), organized between University of Leoben and King's College London we performed Raman scattering experiments in the United Kingdom. Water confined in seven hydrophilic porous samples with pore diameters ranging from 2 nm to 9 nm was investigated in the temperature range between 120 K and 300 K. Significant changes in the Raman signal were observed during the cooling and heating cycles. We observe effects on the OH-stretching vibrations of supercooled water as the confinement dimensions are reduced (Figure).



Raman OH-stretching bond signal of water confined in nanopores with pore width of 2 nm for different temperatures together with signal of bulk ice measured with the same equipment.

For the smallest pore diameter, our Raman peak shifts show a signal-temperature dependence which corresponds to that of amorphous ice [3]. Moreover, the Raman data show good agreement for water melting temperatures described by the Gibbs-Thomson relation as in [3]. In particular, no clear indication of a phase transformation is found for the smallest pores.

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Cooperation partner: Alan G. Michette, Nicholas Cade, King's College London
Gerhard H. Findenegg, Technische Universität Berlin

EU support: COST-Action MP0601

In-situ X-rax Scattering of Confined Water

M. Erko, R.T. Lechner and O. Paris

Water enclosed by nano-confinement is present in practically every biological and in many synthetic materials. Recently reported evidence of a water density minimum at 220 K has shown a new interesting direction of research for several experimental and theoretical fields. Particularly, small-angle x-ray scattering (SAXS) combined with wide-angle x-ray scattering is expected to show new findings concerning temperature-induced structural changes of deeply supercooled confined water.

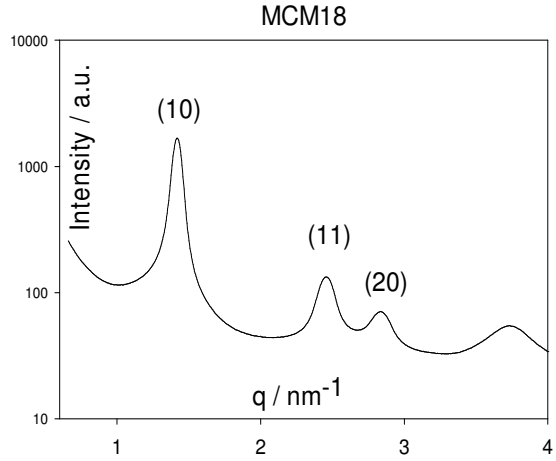


Figure 1: SAXS pattern of MCM18 (pore size 4,4 nm) with Bragg-Peaks resulting from hexagonal mesopore lattice

We have investigated the temperature dependent changes of the scattering signal from water confined in MCM-41 microporous materials using the 7T-MPW-SAXS instrument at the BESSY II synchrotron radiation source in Berlin. Measurements were performed on seven different materials with pore diameters ranging from 2 nm to 9 nm. We used the in-situ DEGAS system developed at the Helmholtz Zentrum Berlin to fill and empty mesoporous materials in a controlled way with water from the gas phase while collecting scattering patterns. The pores were filled with water and for each sample a cooling and heating cycle between 100 K and 300 K was performed, while monitoring the SAXS and the WAXS signal simultaneously. While SAXS delivers information about the density of water and the water/silica nanostructure, WAXS is primarily used to monitor the liquid state of the confined supercooled water. Beside the water filled samples, also empty samples were measured to rule out influences from a possible temperature dependence of the silica matrix structure. An exemplary SAXS pattern of the well defined hexagonal pore structure of MCM-41 porous material is shown in Figure 1. The scattering intensity of the measured Bragg-Peaks gives information on the mean electron density of water inside mesopores. Any phase transition of water is accompanied by a strong density change which can be monitored by a sharp intensity change of the Bragg-Peaks. Moreover, this density change result in a deformation of the pore lattice. Figure 2 shows the change of lattice parameter of the mesoporous pore-matrix due to freezing and melting of water inside pores.

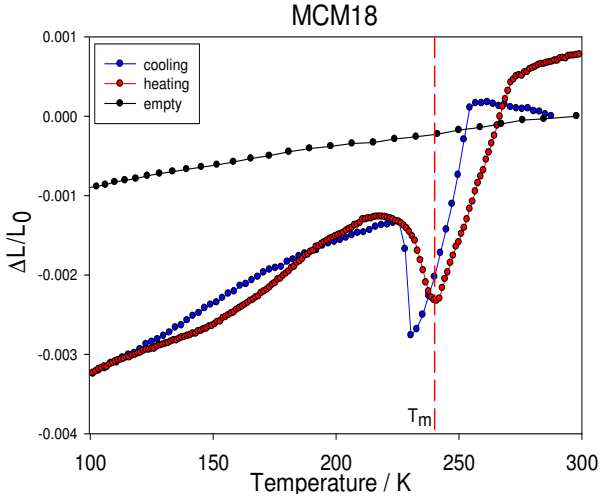


Figure 2: Change of the lattice parameter calculated from the peak-fit position for the (10) Bragg peak for MCM18 material (pore size 4,4 nm). T_m is the water melting temperature measured by differential

Cooperation partner: Dirk Wallacher, Armin Hoell, Helmholtzzentrum Berlin; Gerhard. H. Findenegg, Technische Universität Berlin.

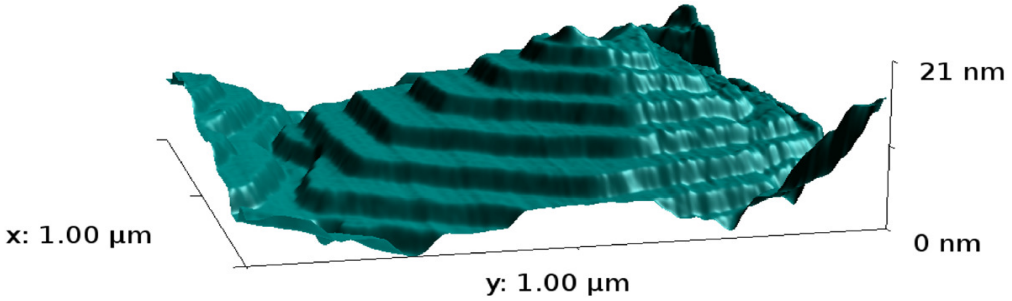
EU support: ELISA (European Light Sources Activities, I3 Programme)

Step edge barriers in organic thin film growth

G. Hlawacek, C. Teichert

In inorganic epitaxy it is well known that kinetically hindered interlayer mass transport due the existence of an additional energy barrier at step edges - the so-called Ehrlich Schwoebel barrier (ESB) [1,2] - results in the formation of terraced mounds [3] instead of layer-by-layer growth. For the growth of rod-like para-sexiphenyl (6P) molecules on mica(001) we found by atomic force microscopy (AFM) that on a pre-ion-bombarded substrate indeed such mounds composed by almost upright standing molecules do form (see 3D AFM image). Analysis of the mound cross sections showed that the layer distribution follows almost ideally a Poisson distribution indicating an absence of mass transport between adjacent layers. The observed deep trenches separating the mounds are in agreement with the predictions of the Zeno effect [4].

From the mound separation and the size of the top terraces, the ESB was estimated following a procedure developed originally for metal homoepitaxy [5]. The obtained value of 0.67 eV has been verified by transition state theory calculations which also revealed that the molecule bends during step edge crossing [6]. A careful analysis of the AFM measurements revealed in the first few monolayers a higher tilt angle of the molecules with respect to the surface normal (up to 43°) as compared to the bulk value observed in thicker films (17°). This leads to a lower value of the ESB of only 0.26 eV for the first layer. The reduction of the ESB could be explained by an interplay between different molecule orientations and necessary molecule bending during terrace edge crossing [6]. The observed level dependence of the ESB is a clear consequence of the anisotropy and complexity of the diffusing species in organic thin film growth.



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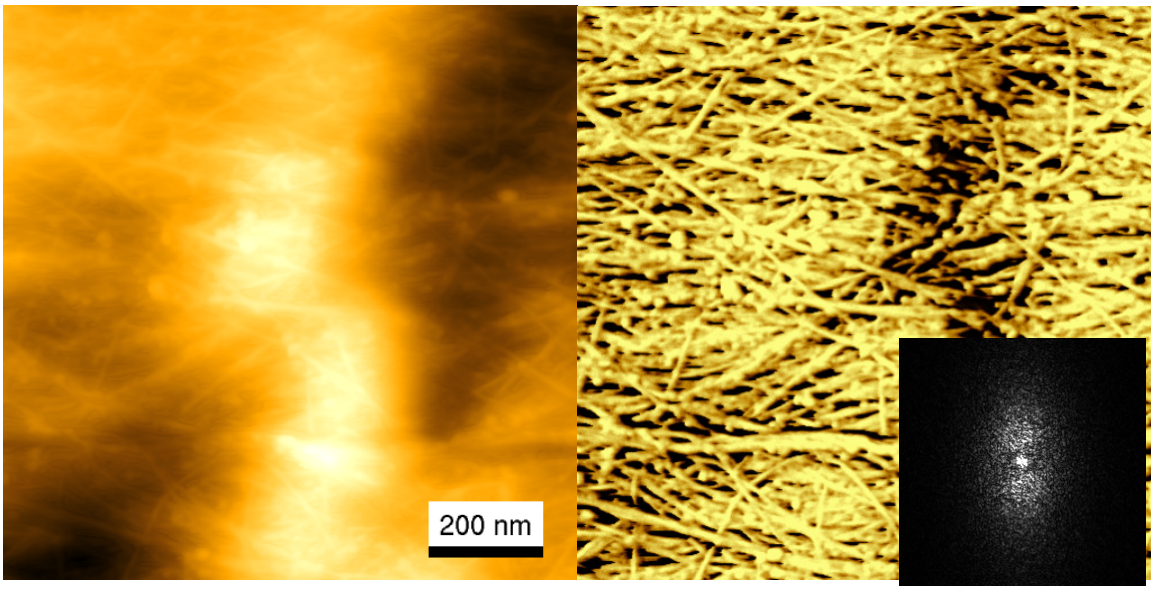
This work has been performed in collaboration with P. Puschnig, C. Ambrosch-Draxl, Chair of Atomistic Modelling and Design of Materials, Montanuniversität Leoben, and P. Frank, and A. Winkler, Institute of Solid State Physics, Graz University of Technology. Support in the framework of the Austrian Science Fund (FWF) within the National Research Network “Interface controlled and functionalized organic films” (S9707+S97014) is greatfully acknowledged.

Characterization of cellulose fiber surfaces using atomic force microscopy

F.J. Schmied, C. Teichert

Paper is made up of wood fibers. These natural fibers consist of cellulose fibrils that are embedded in a matrix of lignin and hemicellulose. The nano- and microstructure of the fibers, as well as the influence of this structure on the inter-fiber bond strength are not yet completely understood. For improvement of paper strength, a deeper insight into this interrelation is desirable because the structure is – besides the chemical composition – the most important influence on the mechanical paper properties.
Here, we applied atomic-force microscopy (AFM) to study the surface of unbleached chemical pulp fibers. It was possible to visualize the single fibrils and their arrangement. Phase imaging with area fraction analysis demonstrated that AFM is an appropriate tool to characterize the surface morphology and the fibrillar structure of chemical pulp fibers on the nanometer scale. From the acquired data it is possible to distinguish the different cell walls of a paper fiber.



AFM height and phase image of an air dried paper fiber. The rms-roughness of the height image is 20 nm. The fibrillar fraction, calculated from the phase image, is 88 ± 1%. The typical fibril diameter is about 30 nm calculated from manually sections and the 2D FFT. The image shows the primary wall with a disordered arrangement of the fibrils.

This work was done in collaboration with L. Kappel and U. Hirn from the Institute for Paper, Pulp and Fiber Technologies and R. Schennach from the Institute of Solid State Physics in Graz and was supported by the Christian Doppler Research Society and Mondi.

Growth of phospholipid membrane systems on self-organized semiconductor templates

G. Trummer, G. Hlawacek, C. Hofer, C. Teichert

Spontaneous pattern formation during epitaxial growth or ion erosion of semiconductor wafers offers an elegant route towards large-area nanostructured surfaces. In the case of semiconductor heteroepitaxy strain relief leads to the formation of nanofaceted three-dimensional crystallites, which may self-organize into quasiperiodic arrays [1]. Since these self-organized nanostructure arrays cover the entire substrate, they can serve as large-area nanopatterned templates for subsequent deposition of all kinds of materials as was recently demonstrated for the deposition of magnetic thin films [2].
Here, we use atomic force microscopy (AFM) to study the formation of solid-supported lipid bilayers on a variety of nanofaceted self-organized SiGe films on Si(001) in comparison to smooth Si(001) wafers. 1-Palmitoyl-2-Oleoyl-*sn*-Glycero-3-Phosphoethanolamine (POPE) and 1,2-Dipalmitoyl-*sn*-Glycero-3-Phosphocholine (DPPC) were used as model systems. The resulting film morphology and the change of surface roughness have been investigated as a function of initial roughness and morphology of the substrate continuing recent work on phospholipid growth on TiAl based implant materials. Phase imaging is used to distinguish between the soft lipid layers and the hard semiconductor substrate. On SiGe templates showing a dislocation network it was found that the ridge trench structures appearing at the surface guide the terrace edges of DPPC layers. As can be seen in Fig. 1b, the substrate steps guide the DPPC lipid layer terrace edges over a distance of up to 5 µm and on top of a 75 nm high lipid island.
This work was conducted in collaboration with R. Willumeit, Department of Structure Research on Macromolecules, GKSS Research Centre, Geesthacht, Germany and H. Clemens, Department of Physical Metallurgy and Materials Testing, University of Leoben, Austria.

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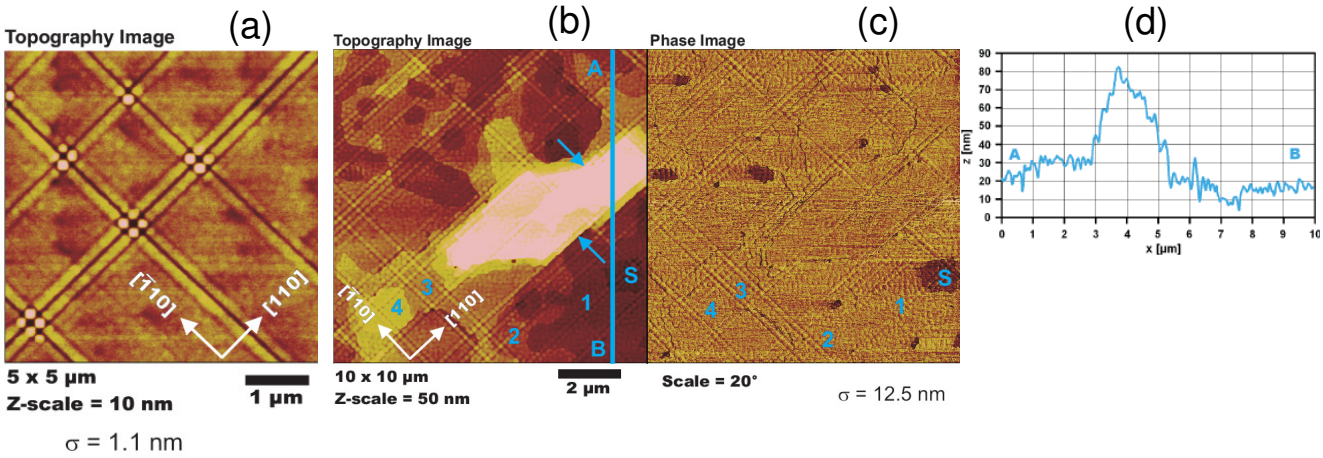

Fig.1: 5 µm x 5 µm AFM image of a SiGe surface with {105} faceted crystallites at the crossing of the cross hatch. (b) 10 µm x 10 µm AFM image of the same surface after spin coating with DPPC and the corresponding phase image (c). The phase imaging allows to distinguish between substrate areas (S, brown) and areas covered with lipid layers (yellow). The lipid layers are numbered with 1 to 4, starting at the substrate. (d) Cross-section along the blue line in c).

Patterned Photosensitive Ultrathin Films: combining Friction Force Microscopy and Contact Angle Measurements

Q. Shen, G. Hlawacek, N. Gürkan, C. Teichert

In this contribution we focus on the investigation of ultrathin layers of the new photosensitive molecule trimethoxy[4-(thiocyanatomethyl)phenyl] silane. The headgroup of this molecule, trimethoxysilyl, can react with surface Si-OH moieties to form a strong covalent bond to the silicon oxide surface. The photosensitive tailgroup, benzyl thiocyante, undergoes a photoisomerization to the corresponding isothiocyanate upon illumination with UV light. In contrast to the non-illuminated areas the illuminated regions can react with amines to give regions with modified surface properties.
By illumination through a contact mask (equidistant lines and spaces) and subsequent modification, photochemically patterned surfaces are achieved [1]. Friction Force Microscopy (FFM) is used to distinguish between the chemically different areas in the pattern. Indeed, a significant friction contrast between up to four different tailgroups is observed simultaneously on the same sample. The hierarchy of the tip-film interactions is also reflected by water contact angle measurements. Currently, efforts are under way to obtain quantitative friction force results.

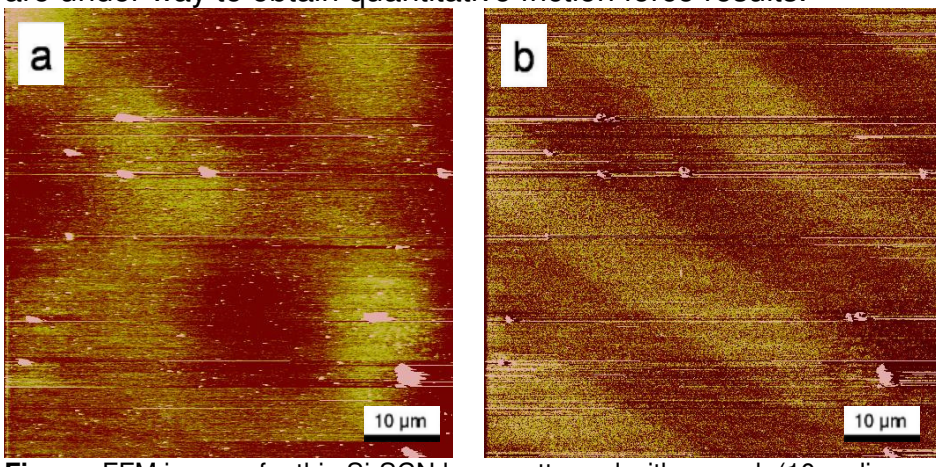

Figure: FFM image of a thin Si-SCN layer patterned with a mask (10μm lines and spaces): (a) morphology (*z* scale of 10 nm) and (b) obtained friction contrast in trace direction [2].

[1] A. Lex, P. Pacher, O. Werzer, A. Track, Q. Shen, R. Schennach, G. Koller, G. Hlawacek, E. Zojer, R. Resel, M. Ramsey, Ch. Teichert, W. Kern, G. Trimmel, „Synthesis of a photosensitive thiocyanate-functionalized trialkoxysilane and its application in patterned surface modifications", Chem. Mater. **20**, 2009-2015 (2008).
[2] G. Hlawacek, Q. Shen, A. Lex, G. Trimmel, W. Kern, C. Teichert, "Hierarchy of adhesion forces in patterns of photoreactive surface layers", J. Chem. Phys. 130 (2009) 044703-1-5.

Supported by Austrian Science Fund FWF National Research Network "Interface controlled and Functionalised Organic Films" (S9702-N08 + S9707-N08) and Joaneum Reasearch

In Collaboration with A. Lex, G. Trimmel: Institute of Chemistry and Technology of Organic Materials, Graz University of Technology, 8010 Graz, Austria; W. Kern: Institute of Synthesis of Polymers, University of Leoben, 8700 Leoben, Austria

Scanning probe microscopy based characterization of reactive sputter deposited coatings

T. Klünsner, G. Hlawacek, C. Teichert

Scanning probe microscopy, in particular atomic-force microscopy (AFM) with its derivatives, is suited for quantitative morphological characterization of thin solid films and the evaluation of their physical properties on the nanometer scale.
Here, we applied atomic force microscopy in tapping mode to study the surface morphology of reactive magnetron sputtered V_2O_5 films on MgO(001) (see figure 1) and TiN/Ag nanocomposite films as a function of substrate temperature or Ag content, respectively. Correlation function analysis was used to determine the rms roughness, the vertical correlation length, and the Hurst parameter. In addition, the AFM images revealed the three-dimensional shape of the plate-like crystallites formed in the polycrystalline phase above 80°C. The results allow - in conjunction with electron microscopy, x-ray diffraction and Raman spectroscopy - to establish synthesis-structure relations of the film.
Finally, friction force microscopy measurements performed in contact mode enable us to determine the friction coefficients of the coatings as a function of deposition conditions.

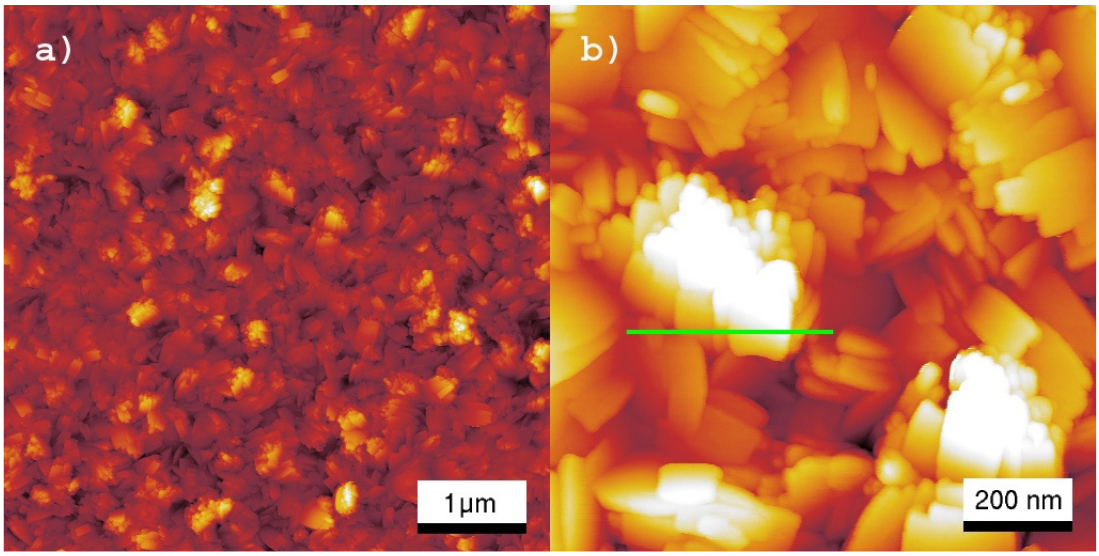

Fig. 1: AFM Tapping Mode topography images of V_2O_5 on MgO (100); deposition temperature 230°C, z-scale: a) 150 nm, b) 75 nm.

This work was done in collaboration with N. Fateh, G. A. Fontalvo and C. Mitterer of the Department of Physical Metallurgy and Materials Testing, University of Leoben. It was supported by the Austrian NANO Initiative via a grant from the Austrian Science Fund FWF within the project "LowFrictionCoatings".

Electrical characterization of electroceramic varistor components on the nanometer scale by conductive atomic force microscopy

M. Schloffer, Y. Hou, A. Andreev, C. Teichert

Electroceramic semiconductors are widely applied to electronic devices such as thermistors (i.e. PTC-Rs), varistors and sensors. Key functions of the underlying materials of these devices are originated from unique properties of the grain boundaries. To analyse current paths in the material, techniques with a high spatial resolution are required. Conducting Atomic-Force Microscopy (C-AFM) is well known as a valuable tool for nanometer scale electric characterization of thin oxide layers [1,2]. C-AFM is a conventional AFM working in contact mode, using a conductive cantilever and tip. Between the tip and the sample a voltage is applied and the resulting current is measured using a special amplification circuit. The technique operating at the sample surface can also be applied to cross-sectional samples in order to study bulk materials.

Here, we demonstrate the analytical capabilities of C-AFM for nanoscale resolved electrical and topographical investigations of ZnO varistor ceramics within a multilayer varistor component. Two-dimensional lateral current mapping allows to locate conducting paths and to identify the individual grains responsible for conduction. Local I-V curves, on the other hand, reveal the electrical nature of the grains. The results are discussed in terms of grain orientation, twin formation, and electrical active grain boundaries. The demonstrated ability of C-AFM to locate and characterize current paths will help to understand the underlying mechanisms in detail and will finally result in increased life-time and reliability of the electroceramic components [3].

This work was performed in collaboration with P. Supancic, Z. Wang, and R. Danzer, Institut für Struktur- und Funktionskeramik, University of Leoben.

[1] S. Kremmer, S. Peissl, C. Teichert, F. Kuchar, H. Hofer, Mat. Sci. Eng. B102 (2003), 88.
[2] S. Kremmer, H. Wurmbauer, C. Teichert, G. Tallarida, S. Spiga, C. Wiemer, M. Fanciulli, J. Appl. Phys. 97/7 (2005), 74315-1-7.
[3] M. Schloffer, C. Teichert, P. Supancic, A. Andreev, Y. Hou, Z. Wang, J. Eur. Ceram. Soc. **30** (2010) 1761-1764.

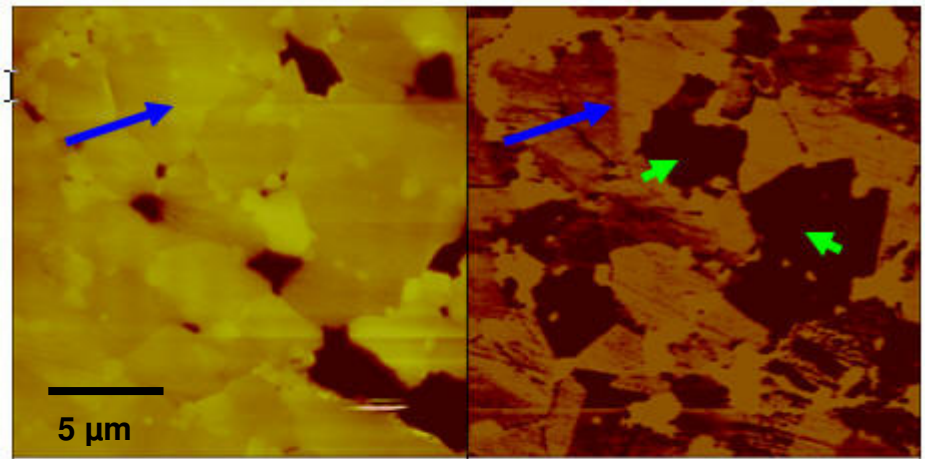

Fig.1: 20 µm x 5 µm AFM image of of a ZnO varistor ceramic sample. a) Topography image showing individual grains. Height scale is 200 nm. The blue arrow denotes a twin boundary. b) Two-dimensional C-AFM image recorded at + 10 V. Current scale ranges from 0 (bright) to 100 pA (dark). Differently oriented grains exhibit different conductivity.

Conductive AFM investigations of InAs nanowires and nanodots on GaAs(110)

I. Beinik, C. Teichert

Self-organized growth on vicinal semiconductor substrates offers an attractive alternative to complex high-resolution lithography nanofabrication as a method to create nanostructured templates for subsequent nucleation of two- and three-dimensional arrays of dots and wires having nanoscale dimensions. During homoepitaxial growth on GaAs(110) substrates misoriented towards (111)A various surface patterns occur such as step bunches, meanders and mounds [1]. By utilizing atomic hydrogen irradiation prior or during GaAs homoepitaxy on the vicinal surface we demonstrated that both the group III adatom (Ga) migration and the group III element (As) incorporation kinetics (and hence the growth mode) are modified. This leads to nanostructured templates having periods in the range of 10-100 nm along different crystallographic directions and narrower terrace width distributions than those grown by conventional MBE [2]. Here, we use conductive atomic force microscopy (C-AFM) to study the growth of InAs on vicinal GaAs(110) surfaces. Comparing topography and 2D current images we found that the non H-treated substrate exhibits a higher conductivity on the step bunches relative to the step free terraces separating them (Fig. 1). Thus, InAs preferentially decorates the step bunches in full agreement with a previous transmission electron microscopy study [3]. On the H treated GaAs template, however, we observed that InAs grows on the triangular terraces of the substrate but avoids nucleation on the surface steps [4].

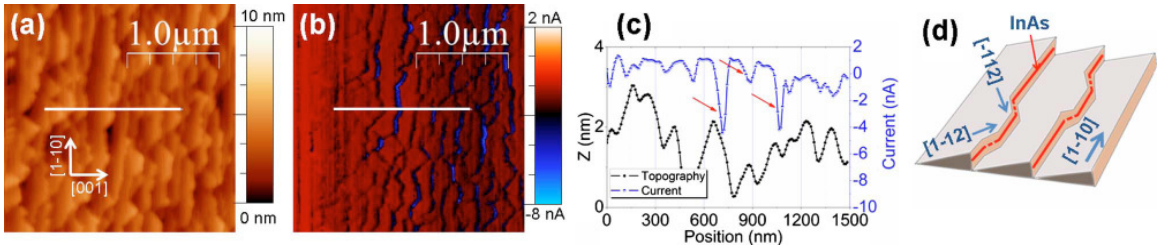

Fig. 1: C-AFM (a) topography image in UHV, (b) 2D current map recorded at -9.1 V sample bias, (c) corresponding cross-section profiles, and (d) schematic of the ideal terrace topology after deposition of 5 ML InAs on the non-treated substrate [4].

[1] P.Tejedor, F.E. Allegretti, P. Šmilauer, and B.A. Joyce, Surf. Sci. 407 (1998) 82.
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[4] P. Tejedor, L. Díez-Merino, I. Beinik, C. Teichert, "Conductive atomic force microscopy study of InAs growth kinetics on vicinal GaAs (110)", Appl. Phys. Lett. **95** (2009) 123103.

This work was supported in the framework of the Austrian Science Fund (FWF) Project # P19636, by the Acciones Integradas project ES 17/2007 (ÖAD) and by the MEC (Spain) under grants MAT2004-05348-C04-02, TEC2007-66955 and HU2006-0022 and was performed in collaboration with Laura Díez-Merino and Paloma Tejedor, Instituto de Ciencia de Materiales de Madrid, CSIC, Sor Juana Inés de la Cruz 3, 28049-Madrid, Spain.

4. Publication List

SCI Journals

1. Al-Sawalmih, A.; Li, C.; Fratzl, P.; Paris, O.
On the Stability of Amorphous Minerals in Lobster Cuticle.
Advanced Materials 21 (2009) , S. 4011 - 4015

2. Brauer, G.; Anwand, W.; Grambole, D.; Beinik, I.; Wang, L.; Teichert, C.; Kuriplach, J.; Djurisic, A.; Skorupa, W.
Characterization of ZnO nanostructures: A challenge to positron annihilation spectroscopy and other methods. - in: Physica Status Solidi / C 6 (2009) 11 , S. 2556 – 2560

3. Dunlop, J. W.; Hartmann, M.; Bréchet, Y. J.; Fratzl, P.; Weinkamer, R.
New Suggestions for the Mechanical Control of Bone Remodeling.
Calcified Tissue International 85 (2009) , S. 45 - 54

4. Hartmann, M.; Fratzl, P.
Sacrificial Ionic Bonds Need To Be Randomly Distributed To Provide Shear Deformability.
Nano Letters 9 (2009) , S. 3603 - 3607

5. Hejazi, M.; Fettke, J.; Paris, O.; Steup, M.
The two plastidial starch-related dikinases sequentially phosphorylate glucosyl residues at the surface of both the A- and B-allomorph of crystallized maltodextrins but the mode of action differs.
Plant Physiology 150 (2009) , S. 962 – 976

6. Hlawacek, G.; Shen, Q.; Teichert, C.; Lex, A.; Trimmel, G.; Kern, W.
Hierarchy of adhesion forces in patterns of photoreactive surface layers. - in: Journal of Chemical Physics (The journal of chemical physics) 130 (2009) 4 , S. 44703-1 - 44703-5

7. Hlawacek, G.; Baqi, S. A.; Sitter, H.; Teichert, C.
Rubrene on mica: from the early growth stage to late crystallization.
Springer Proc. Phys. 129 (2009) , S. 55 - 60

8. Hofer, C.; Teichert, C.; Werner, J.; Lyutovich, K.; Kasper, E.
Ion-bombardment induced morphology change of device related SiGe multilayer heterostructures.
Applied Surface Science 256 (2009) , S. 267 - 273

9. Jähnert, S.; Müter, D.; Prass, J.; Zickler, G. A.; Paris, O.; Findenegg, G. H.
Pore Structure and Fluid Sorption in Ordered Mesoporous Silica. I. Experimental Study by in situ Small-Angle X-ray Scattering.
Journal of Physical Chemistry C (C, Nanomaterials and Interfaces) 113 (2009) Part I , S. 15201 - 15210

10. Kadashchuk, A.; Schols, S.; Heremans, P.; Skryshevski, Y.; Piryantinski, Y.; Beinik, I.; Teichert, C.; Hernandez-Sosa, G.; Sitter, H.; Andreev, A.; Frank, P.; Winkler, A.
Origin of the low-energy emission band in epitaxially grown para-sexiphenyl nanocrystallites.
Journal of Chemical Physics (The journal of chemical physics) 130 (2009) , S. 084901-1 - 084901-9

11. Kadashchuk, A.; Schols, S.; Skryshevski, Y.; Beinik, I.; Teichert, C.; Hernandez-Sosa, G.; Sitter, H.; Andreev, A.; Frank, P.; Winkler, A.
Spectroscopy of defects in epitaxially grown para-sexiphenyl nanostructures.
Springer Proc. Phys. 129 (2009) , S. 121 - 125

12. Köstenbauer, H.; Fontalvo, G.; Mitterer, C.; Hlawacek, G.; Teichert, C.; Keckes, J.
Structure, stresses and stress relaxation of TiN/Ag nanocomposite films.
Journal of Nanoscience and Nanotechnology 9 (2009) , S. 3606 - 3610

13. Ma, Y.; Aichmayer, B.; Paris, O.; Fratzl, P.; Meibom, A.; Metzler, R. A.; Politi, Y.; Addadi, L.; Gilbert, P.; Weiner, S.
The grinding tip of the sea urchin tooth exhibits exquisite control over calcite crystal orientation and Mg distribution.
Proceedings of the National Academy of Sciences of the United States of America (PNAS) 106 (2009) , S. 6048 - 6053

14. Müter, D.; Jähnert, S.; Dunlop, J. W.; Findenegg, G. H.; Paris, O.
Pore Structure and Fluid Sorption in Ordered Mesoporous Silica. II. Modeling.
Journal of Physical Chemistry C (C, Nanomaterials and Interfaces) 113 (2009) Part II , S. 15211 - 15217

15. Prass, J.; Müter, D.; Fratzl, P.; Paris, O.
Capillarity-driven deformation of ordered nanoporous silica.
Applied Physics Letters (2009) 95, S. 083121-1 - 083121-3

16. Shkilnyy, A.; Brandt, J.; Mantion, A.; Paris, O.; Schlaad, H.; Taubert, A.
Calcium Phosphate with a Channel-like Morphology by Polymer Templating.
Chemistry of Materials 21 (2009) , S. 1572 – 1578

17. Tejedor, P.; Díez-Merino, L.; Beinik, I.; Teichert, C.
Conductive atomic force microscopy study of InAs growth kinetics on vicinal GaAs (110). - in: Applied Physics Letters 95 (2009) , S. 123103-1 - 123103-3

18. Teichert, C.; de Miguel, J. J.; Bobek, T.
Ion beam sputtered nanostructured semiconductor surfaces as templates for nanomagnet arrays.
Journal of Physics (Condensed Matter) 21 (2009) , S. 224025 - 224033

19. Uiberacker, C.; Jakubetz, W.
Strong-field dipole resonance: Limiting analytical cases.
Physical Review A (Atomic, Molecular, and Optical Physics) 80 (2009) , S. 063406-1 - 063406-15

20. Uiberacker, C.; Stecher, C.; Oswald, J.
Systematic study of nonideal contacts in integer quantum Hall systems.
Physical Review B (Condensed Matter and Materials Physics) 80 (2009) , S. 235331-1 - 235331-11

Conference Proceedings

21. Pondicherry, K.; Beinik, I.; Grün, F.; Godor, I.; Teichert, C.
Application of conductive AFM technique to measure electrical conductance of tribofilms.
Proceedings of 26th Danubia-Adria Symposium on Advances in Experimental Mechanics. (2009), S. 205 - 206

22. Teichert, C.; Hlawacek, G.; Puschnig, P.; Draxl, C.; Frank, P.; Winkler, A.
The Ehrlich Schwoebel barrier in organic thin film growth.
JSPS 141 Committee Activity Report (2009), S. 583 - 585

Book contributions

23. Paris, O.; Peterlik, H.
The structure of carbon fibres
Woodhead Publishing in Textiles: Number 88, Handbook of Textile Fibre Structure. (2009) Oxford, S. 353 - 377

24. Sohrmann, C.; Oswald, J.; Römer, R.
Quantum Percolation in the Quantum Hall Regime
Quantum and Semi-Classical Percolation and Breakdown in Disordered Solids. (2009) Springer, S. 163 - 193

5. Presentations

Talks at conferences

1. Paris, O.
Interaction of photons and neutrons with matter: an introductory lecture.
6th European Winterschool, NESY 2009. Planneralm, 09.03.2009

2. Teichert, C.
Step edge barriers in organic thin film growth.
March Meeting APS Center for Nanoscale Science, Pennsylvania State University. Pittsburgh, 17.03.2009

3. Teichert, C.
Step edge barriers in organic thin film growth.
Surface kinetics International Conference . **(invited talk)** Salt Lake City, Utah, 20.03.2009

4. Beinik, I.
Electrical characterization of InAs/GaAs (110) nanostructures by Conductive Atomic Force Microscopy.
DPG Spring Meeting 2009 of the Condensed Matter Section. Dresden, 22.03.2009

5. Schmied, F.
Investigation of pulp fiber surfaces and cross-sections using atomic force microscopy.
DPG Spring Meeting 2009 of the Condensed Matter Section. Dresden, 22.03.2009

6. Shen, Q.
Hierarchy of adhesion forces in patterns of photoreactive surface layers.
Frühjahrstagung der Deutschen Physikalischen Gesellschaft in Dresden 2009. Dresden, 22.03.2009

7. Teichert, C.
   Experimental investigation of the spin reorientation in self-organized magentic nano-dot arrays.
   European Workshop on "Selforganized Nanomagnets" 2009. Aussois, 29.03.2009

8. Hartmann, M.; Fratzl, P.
   Modeling the mechanical properties of a soft matrix in biological composites.
   MRS Spring Meeting. San Francisco, 13.04.2009

9. Teichert, C.
   The Ehrlich Schwoebel barrier in organic thin film growth.
   IUVSTA Highlight Seminar. Champaign-Urbana, Illinois, 20.04.2009

10. Schmied, F.
    AFM an präzipitiertem Lignin auf Kraftzellstoff.
    Zukunft.Forum Papier. Graz, 27.05.2009

11. Teichert, C.
    AFM based characterization of inorganic and organic nanostructures: From nanomagnets to paper fibres. (**invited talk**)
    EuroAFM Forum 2009. München, 01.07.2009

12. Paris, O.
    Fluids in Nanocontainers: what can we learn from in-situ X-ray and neutron scattering.
    Symposium "Kinetik und Dynamik im Laufe der Zeit". (**invited talk**) Wien, 02.07.2009

13. Teichert, C.
    Ehrlich Schwoebel barriers in organic thin film growth.
    Gordon Research Conference. (**highlight talk**) New London NH, 12.07.2009

14. Oswald, J.
    Gate controlled separation of edge and bulk current transport in the quantum Hall effect regime.
    9th International Conference on Research in High Magnetic Fields (RHMF 2009). Dresden, 22.07.2009

15. Teichert, C.
    On the spin reorientation of ordered magnetic nano-dot arrays: Pt/Co/Pt versus Au/Co/Au.
    14th Int. Conf. on x-ray Absorption Fiwe structure. Camerino, 26.07.2009

16. Meisels, R.
    Photonic Crystals: Properties and Applications Part I: Basic Principles.
    Photonica09. Belgrad, 24.08.2009

17. Meisels, R.
    Photonic Crystals: Properties and Applications Part II: Applications.
    Photonica09. Belgrad, 24.08.2009

18. Oswald, J.
    A non-equilibrium network model for magneto transport in the quantum Hall effect regime (**invited talk).**
    EPSRC Symposium Workshop on Quantum Simulations (QUANTSIM09). Centre for Scientific Computing and Department of Mathematics, University of Warwick, 24.08.2009

19. Teichert, C.
    Molecular diffussion processes in organic thin film growth. (**invited talk**)
    THERMEC 2009. Berlin, 25.08.2009

20. Teichert, C.
    The effect of initially amorphous SiOx (x<2) layer on epitaxial formation and optical properties of three-dimensional Ge nanoclusters.
    ECOSS-26. Parma, 30.08.2009

21. Teichert, C.
    Nanostructures at surfaces and their scanning probe microscopy based characterization. (**invited talk**)
    ÖPG Jahrestagung. Innsbruck, 02.09.2009

22. Teichert, C.
    Nanoscale Modifications of Surfaces and thin films.
    ÖPG Jahrestagung . Innsbruck, 02.09.2009

23. Uiberacker, C.
    Statistics properties of nonequilibrium transport quantities in integer quantum Hall systems.
    Joint Annual Meeting of the Austrian Physical Society, Swiss Physical Society, and Austrian Society of Astronomy and Astrophysics. Innsbruck, 02.09.2009

24. Paris, O.
    Nanomaterials in the new light: position-resolved and in-situ experiments with synchrotron radiation.
    Joint ÖPG / SPS / ÖGAA Meeting, Solid State Physics & NESY Session, (**invited**

talk) Innsbruck 2.-4. September 2009.

25. Paris, O.
    Adsorption and self-assembly phenomena in ordered mesoporous silica: Scattering experiments and modelling.
    Sfb 448, Final International Symposium, Berlin, 3.-4. September 2009

26. Meisels, R.; Glushko, O.; Kalchmair, S.; Strasser, G.
    3D FDTD simulations of photonic devices.
    Gemeinsame Jahrestagung ÖPG und SPS . Innsbruck, 04.09.2009

27. Shen, Q.; Hlawacek, G.; Flesch, H.-G.; Potocar, T.; Resel, R.; Winkler, A.; Teichert, C.
    Crystallographic Orientation Maps by Transverse Shear Microscopy (TSM).
    NFN Meeting Admont 2009. Admont, 16.09.2009

28. Teichert, C.
    The Ehrlich Schwoebel barrier in organic thin film growth.
    ASCIN-10. Granada, 21.09.2009

29. Hartmann, M.
    Investigations on Glue, (nano)-Footballs, Lobster (and of course on “Hartz 4”).
    Klausurmeeting der Abteilung Biomaterialien des Max-Planck-Instituts für Kolloid- und Grenzflächenforschung. Schloss Ringberg, 28.09.2009

30. Paris, O.
    Watching nanomaterials at work: Scattering experiments with X-rays and neutrons.
    BESSY User Meeting, Berlin (**invited plenary lecture**). Berlin, 12.11.2009

31. Oswald, J.
    The role of dissipation in the quantum Hall effect.
    International Symposium on Advanced Nanodevices and Nanotechnology (ISANN2009). Kaanapali, Maui, Hawaii, 29.11.2009

Invited talks in external institutions

32. Teichert, C.
    Mound formation in organic-semiconductor thin films.
    Halbleiterphysikseminar, Institut für Halbleiterphysik, Universität Linz. Linz, 12.01.2009

33. Teichert, C.
    Atomic-force microscopy investigations of organic thin films.
    Seminar, Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Golm. Golm, 13.01.2009

34. Paris, O.
    Fluids in ordered mesoporous materials: What can we learn from in-situ small-angle scattering.
    Sfb 448 Kolloquium. TU-Berlin, 03.02.2009

35. Teichert, C.
    The Ehrlich Schwoebel barrier in organic thin film growth.
    Seminar, IMDEA & Department of Physics, Universidad Autonoma de Madrid. Madrid, 04.02.2009

36. Teichert, C.
    Hierarchy of adhesion forces in patterned photoreactive polymers determined by friction force microscopy.
    Seminar, Instituto Sciencia de Materiales de Madrid. Madrid, 05.02.2009

37. Teichert, C.
    Mound formation in organic-semiconductor thin films.
    Seminar, Center for Nanoscale Science, Pennsylvania State University,. State College, PA, 16.03.2009

38. Teichert, C.
    Scanning Probe Microscopy based characterization of semiconductor nanostructures.
    Seminar, Dept. of Electrical and Computer Engineering, University of Illinois, Chicago, . Chicago, 22.04.2009

39. Teichert, C.
    Secrets of Ehrlich Schwoebel barriers in organic thin film growth.
    Seminar, Dept. of Materials Science, University of Madison Wisconsin. Madison, Wisconsin, 23.04.2009

40. Teichert, C.
    Characterization of semiconductor nanostructures by Scanning Probe Microscopy.
    Seminar, Institue of Physics, Academy of Sciences of the Czech Republic, Prag, 26.05.2009

41. Paris, O.
    X-ray and neutron scattering studies of fluids in silica nanocontainers.

Seminar Institut für Chemie, KFU Graz, 09.10.2009

42. Glushko, O.
    Simulation of quantum well infrared photodetectors with coupling of light by embedded 2D photonic crystal.
    FKE-Seminar. TU Wien, Institut für Festkörperelektronik, 27.10.2009

43. Teichert, C.
    Scanning probe microscopy of organic semiconductor films.
    Seminar on Advanced Materials, LIOS, JKU Linz. Linz, 11.11.2009

44. Paris, O.
    Nanomaterials in the new light: Scattering experiments with synchrotron radiation and neutrons.
    Neutronen in Forschung und Industrie: Seminar der Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM-II). Leibnitz, 16.11.2009

45. Paris, O.
    Nanomaterials in the new light: Scattering experiments with synchrotron radiation and neutrons.
    Kolloquium der Chemisch Physikalischen Gesellschaft., Wien, 17.11.2009

Poster

1. Kuchar, F.; Meisels, R.; Glushko, O.
   Control of Semiconductor-Based Photonic Crystals by Magnetic Fields
   Nanometa 2009. Seefeld, Österreich, 06.01.2009

2. G.Brauer, W.Anwand, D.Grambole, W.Egger, P.Sperr, I.Beynik, C.Hofer, Teichert, C. J.Kuriplach, J.Lang, S.Zviagin, C.C.Ling, Y.F.Hsu, Y.Y.Xi, A.B.Djurisic, W.Skorupa
   Characterization of ZnO nanostructures: A challenge to positron annihilation spectroscopy and other methods
   XVth Int. Conf. on Positron Annihilation. Kolkata, India, 18.01.2009

3. Shen, Q.; Hlawacek, G.; Gürkan, N.; Teichert, C.; Lex, A.; Trimmel, G.; Kern, W.
   Patterned Photosensitive Ultrathin Films: combining Friction Force Microscopy and Contact Angle Measurements
   9. Workshop Rastersondermikroskopie in der Werkstoffwissenschaft. Aachen, Germany, 26.02.2009

4. Teichert, C.
   High Resolution RBS on High-k Dielectrics
   DPG Dresden, 22.03.2009

5. Glushko, O.; Meisels, R.; Kuchar, F.; Takiguchi, Y.; Toyotama, A.; Yamanaka, J.
   Model calculations for low-contrast 3D photonic crystals with BCC lattice
   Nano and Photonics Mauterndorf 2009. Mauterndorf, 11.03.2009

6. Seyidov Z., Rubezhanska M., Hofer C., Kozyrev Y., Teichert, C., Naumovets A.
   Morphological properties of three dimensional Ge nanoclusters grown on SiOx (x<2) films
   DPG Dresden. Dresden, 22.03.2009

7. Gürkan N., Hlawacek G., Teichert, C., Sonnleitner R., Mori G.
   Statistical slip step evaluation in CrMn and CrNi cold worked steels by atomic force microscopy
   DPG Dresden. Dresden, 22.03.2009

8. Teichert, C. Hofer C., Seyidov Z., Nino M.A., Mikuszeit N., Jimenez E., Camarero J., De Miguel J.J., Miranda R., Bobek T., Kurz H.
   Nanomagnet arrays fabricated on ion bombardment induced semiconductor nanostructures
   European Workshop on "Selforganized Nanomagnets" 2009. Aussois, 29.03.2009

9. Hartmann, M.; Fratzl, P.
   Modeling the mechanical properties of a soft matrix in biological composites
   Bioamorphys. Neuhardenberg, Deutschland, 01.06.2009

10. Schmied, F.; Teichert, C.; Kappel, L.; Hirn, U.; Schennach, R.
    Charcterization of kraft pulp fiber surfaces using atomic force microscopy
    XI International Scanning Probe Microscopy Conference. Madrid, Spanien, 17.06.2009

11. Beinik I., Kratzer M., Wang L., Brauer G., Anwand W., Teichert, C.
    Characterization of single ZnO nanorods by conductive atomic microscopy
    International Symposium Piezoresponse Microscopy and Nanoscale Phenomena in Polar Materials. Aeiro, Portugal, 23.06.2009

12. Schmied, F.; Teichert, C.; Kappel, L.; Hirn, U.; Schennach, R.; Schröttner, H.
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27. Pondicherry, K.; Beinik, I.; Grün, F.; Godor, I.; Teichert, C.
    Application of conductive AFM technique to measure electrical conductance of tribofilms
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    Post-Fabrication Precision Tuning of Photonic Crystal Microstructures
    Micro & Nano Engineering. Ghent, Belgium, 28.09.2009

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    The Ehrlich Schwoebel Barrier in Organic Thin Film Growth
    7th Int. Symposium on Atomic Level Characterizations for New Materials and Devices 09ALC ’09 . Maui, Hawaii, USA, 06.12.2009

6. Research Projects

§ 26 – Projects

Project:	**"Exploring fundamental growth morphologies in organic thin film systems"** Framework National Research Network "Interface controlled and functionalized organic films"
Funded by:	FWF (S9707-N08)
Start:	1 Feb 2006
Duration:	until 31 Jan 2009
Applicant:	C. Teichert
Agent:	G. Hlawacek, A. Andreev, Q. Shen

Project:	**"Exploring fundamental growth morphologies in organic thin film systems"** Framework National Research Network "Interface controlled and functionalized organic films"
Funded by:	FWF (S9707-N20)
Start:	1 Feb 2009
Duration:	until 31 Jan 2012
Applicant:	C. Teichert
Agent:	G. Hlawacek, St. Lorbek, Q. Shen, A. Pavitschitz

Project:	**"Circuit type simulations of the quantum electron transport"**
Funded by:	FWF (P18942-N20)
Start	6 Nov 2006
Duration:	until 6 Nov 2010
Applicant:	J. Oswald
Agent:	Ch. Uiberacker

Project:	"**Electrical properties of thin films on the nanometer scale**"
Funded by:	FWF (P19636-N20)
Start:	1 June 2007
Duration:	until 31 March 2011
Applicant:	C. Teichert / A. Andreev
Agent:	I. Beinik, M. Kratzer

Project:	**"Hierarchically structured porous ceramics and composites from nanocasting of Plant cell walls"** DFG Framework: Biomimetic Materials Research: Functionality by Hierarchical Structuring of Materials (SPP 1420)
Funded by:	DFG (Project Number 566678)
Start:	1 Dec 2009
Duration:	until 30 Nov 2011
Applicant:	O. Paris, C. Zollfrank (Erlangen)

Agent: G. Popovski

Project: **"Ferromagnetic Semiconductor Hetero- and Nanostructures based on GeMnTe grown by Molecular Beam Epitaxy"**
Funded by: FWF (P18942-N20)
Start: 1 Dez 2009
Duration: 31 Jan 2011
Applicant: R.T. Lechner
Agent: R.T. Lechner

Project: **PLATON**
"Simulation of Photonic crystal structures with disorder" SIM-PHC
Funded by: FFG/FWF (N1104-NAN) accepted Dec 2005
Start: March 2007
Duration: until Feb 2009
Coordinator: F. Kuchar

§ 27 - Projects

Project: **PLATON II**
PLATON - SiN - Silicon nanostructures for photonics
PLATON-35N - III-V Nanophotonics
Funded by: FFG Österreichische NANO Initiative (1100)
Start: 1 March 2009
Duration: until 28 Feb 2011
Coordinator: R. Meisels
Agent: O. Glushko

Other Projects

Project: **"Hydrogen-assisted fabrication of semiconductor nanostructures on patterned substrates and their scanning probe microscopy based characterization"**
Funded by: ÖAD/ Acciones Integradas Austria-Spain (ES17/2007)
Start: 1 Jan 2007
Duration: until 31 March 2009
Applicant: C. Teichert
Co-Applicant: P. Tejedor, Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigaciones Cientificas, Spain
Agent: I. Beinik, St. Lorbek

Project:	**"Growth of magnetic nano-objects by self-organization on varios templates"**
Funded by:	ÖAD/ Wissenschaftlich-Technisches Abkommen mit Frankreich, Amadee 2009-10 (FR 13/2009)
Start:	1 Jan 2009
Duration:	until 31 Dezember 2010
Applicant:	C. Teichert
Co-Applicant:	L. Masson, Institut CINAM.CNRS, Marseille France
Agent:	I. Beinik, M. Kratzer, Q. Shen, Ch. Hofer

Project:	**"Formation mechanisms and quantum effects in Ge quantum dots on Si(001) and Si(111)"**
Funded by:	ÖAD/ Wissenschaftlich-Technisches Abkommen mit der Ukraine (UA 11/2009
Start:	1 Jan 2009
Duration:	until 31 Dec 2010
Applicant:	C. Teichert
Co-Applicant:	A. Naumovets, Institute of Physics of National Academy of Sciences of Ukraine, Kiev, Ukraine
Agent:	I. Beinik, St. Lorbek, M. Kratzer, Q. Shen.

Project:	**COST Action MP0601** Short wavelength laboratory sources
Funded by:	EU
Start:	19. Mai 2009
Duration:	1. October 2011
Project leader:	O. Paris (Management Committee Member)
Agent:	M. Erko
Scope:	Development of an in-situ Gas-sorption apparatus in connection with a laboratory based Small-angle X-ray scattering system

Project:	**CD Labor Papierfestigkeit**
Funded by:	Christian Doppler Gesellschaft
Start:	1. Jänner 2007
Duration:	29. Februar 2012
Project leader:	R. Schennach, TU Graz
Co-Project leader	C. Teichert

7. Cooperation

International and national cooperation exists with the following institutions:

- Centre for Scientific Computing and Department of Mathematics, University of Warwick, UK.
- Christian Doppler Laboratory for surface chemical and physical fundamentals of paper strength, Graz; Institut für Festkörperphysik, TU Graz;
- Department of Basic Science, Institute for Solid State Physics, University of Tokyo, Japan; Department of Electronics and Mechanical Engineering, Faculty of Engineering, Chiba University, Japan;
- Department of Electrical Engineering, Arizona State University, Tempe, USA;
- Department of Materials Science, University of Erlangen/Nürnberg, Germany
- Department of Physics, Universidad Autonoma de Madrid, Spain;
- Department of Physics, University of Hongkong, China;
- Department of Physics & Astronomy, Georgia State University, USA;
- Faculty of Physics, University of Vienna, Austria
- Helmholtz Zentrum für Materialien und Energie, Berlin, Germany
- High magnetic field laboratory, Grenoble, France;
- ICMM, Madrid, Spain;
- ILSB, Vienna University of Technology, Austria
- IMS Microfabrication Systems GmbH, Vienna; Lenzing AG, Lenzing;
- Institute of Chemistry, Technical University of Berlin, Germany
- Institut für Experimentalphysik, Universität Graz;
- Institut für Halbleiter- und Festkörperphysik, Universität Linz / Christian Doppler Laboratory for Surface Optical Methods;
- Institut für Halbleitertechnik, Universität Stuttgart;
- Institut für Ionenstrahlphysik und Materialforschung, Forschungszentrum Rossendorf;
- Institute of Physics, Belgrade, Serbia and Montenegro;
- Institute of Physics, National Academy of Science of Ukraine, Kiev
- Institut für Werkstoffforschung, GKSS Forschungszentrum Geesthacht;
- Max-Planck Institute of Colloids and Interfaces, Potsdam, Germany
- Max Planck Institut für Festkörperforschung, Stuttgart;
- Weizmann Institute of Science, Rehovot, Israel
- Zentrum für Mikro- und Nanostrukturen, Vienna University of Technology, Austria

The supply of samples from the following institutions is acknowledged: Institut für Halbleitertechnik, Universität Stuttgart; EPCOS OHG, Deutschlandsberg, Austria.

8. Diploma and Doctoral Theses

8.1 Diploma Theses

Shen Quan
"Friction Force Microscopy characterization of organic thin films"
Supervisor: C. Teichert
Finished: Juni 2009

Nurdogan Gürkan
"Gleitstufenuntersuchungen an austenitischen Stahlproben"
Supervisor: C. Teichert
Begin: Juli 2008

Lin Wang
"Conductive atomic-force microscopy investigations of semiconductor nanostructures"
Supervisor: C. Teichert
Begin: September 2008

Andreas Pavitschitz
"Leitfähigkeitsrasterkraftmikroskopie an organischen dielektrischen Schichten"
Supervisor: C. Teichert
Begin: Juni 2009

8.2 Doctoral Theses

Dipl.Ing. Igor Beinik
Nanoscale electrical properties of phase-seperated low-conductive thin films
Supervisor: C. Teichert
Begin: Jänner 2008

Mag. Oleksandr. Glushko
Investigations of disorder in photonic structures
Supervisor: R. Meisels
Begin: Februar 2008

Dipl.Ing. Franz Schmied
Einsatz der Rasterkraftmikroskopie zur Untersuchung der Faser-Faserbindung in Papier
Supervisor: C. Teichert
Begin: März 2008

Dipl.Ing. Stefan Lorbek
Molecular processes in organic thin film growth
Supervisor: C.Teichert
Begin: Jänner 2009

Dipl.Phys. Maxim Erko	Phasenverhalten von Wasser in der begrenzten Geometrie von nanoporösen Materialien *Supervisor:* O. Paris *Begin:* Februar 2009
Dipl.Ing. Shen Quan	Atomic-force microscopy based characterization on functional organic thin films *Supervisor:* C. Teichert *Begin:* Juni 2009

9. Invited Guests (Seminar)

20.1.2009 Gerhard Ecker (Nobelpreiskolloquium)
Fakultät der Physik, Universität Wien
“Symmetrieverletzung in der subatomaren Physik“

20.1.2009 Gottfried Köhler (Nobelpreiskolloqium)
Max F. Perutz Labor, Universität Wien
“Vorgänge in lebenden Zellen sichtbar machen“

28.01.2009 Markus Kratzer
Institut für Festkörperphysik, TU Graz
"Reaction kinetics & dynamics of simple molecules on modified Pd(111) surfaces"

30.04.2009 S. Schartner
Zentrum für Mikro- u. Nanostructuren Inst. F. Festkörperelektronie, TU Wien
"Photonic Crystal Photodetectors"

06.05.2009 Adolf Winkler
Institut für Festkörperphysik, TU Graz
"Ultra-thin organic films investigated by thermal desorption spectroscopy"

19.05.2009 Rainer T. Lechner
Institut für Halbleiter- und Festkörperphysik, Johannes Kepler Universität Linz
"Magnetic Semiconductors: Influence of Structure on Magnetism”

14.07.2009 Barbara Aichmayer
Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Potsdam
"Organic inclusions in biogenic and biomimetic calcite crystals”

12.08.2009 Dirk Müter
Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Potsdam
"Small-angle neutron scattering study of surfactant self assembly in nanoporous silica”

08.09.2009 Laurence Masson
Centre Interdisciplinarie de Nanscience de Marseille CINaM UPR 3118 CNRS, Aix-Marseille Universite, France
“Formation of self-assembled nanostructure array on Si(111) and AG (110) surfaces”

19.10.2009 Tatiana Perova
Department of Electronic and Electrical Engineering, University of Dublin, Trinity College, Ireland
"Application of Micro-Raman Spectroscopy to Surface Modification Technologies"

20.10.2009 Martin Schoen
Institut für Chemie, TU Berlin
„Fluids confined by nanopatterned solid substrates“

27.10.2009 Cordt Zollfrank
University of Erlangen-Nürnberg, Departmant of Materials Science and Engineering Institute of Glass and Ceramics (WW3)
"Polysaccarides as templates for bioinspired materials engineering"

03.11.2009 Wilfried Schranz
Institut für Physik, Universität Wien
"The sound of materials – Akustische Spektroskopie"

16.12.2009 Christoph Kratky (Nobelpreiskolloquium)
Zentrum für Molekulare Biowissenschaften, Universität Graz
"Translation in atomarer Auflösung": die Kristallstruktur des Ribosoms

16.12.2009 Gottfried Strasser (Nobelpreiskolloquium)
Institut für Festkörperelektronik, TU Wien
"The masters of light" – Die Gründerväter der optischen Technologien

10. Foreign stays

M. Erko:	1.7.-31.8.2009	STSM London Kings College London
	7.12.-16.12.2009	Berliner Elektronenspeicherring-Gesellschaft für Synchotronstrahlungm.b.H.
R.T. Lechner:	7.12.-16.12.2009	Berliner Elektronenspeicherring-Gesellschaft für Synchotronstrahlungm.b.H.
M. Kratzer	20-9.-25.9.2009	CINaM-CNRS-Marseille, France,
I.Beinik	22.2.-1.3.2009	INSTITUTO DE CIENCIA DE MATERIALES DE MADRID (ICMM) (Spanien)
	12.9.-1.10.2009	Institute of Physics, NAS Ukraine (Ukraine)
	19.12.2009-6.1.2010	Institute of Physics, NAS Ukraine (Ukraine)
St. Lorbek	21.3.-28.3.2009	Instituto de Ciencia de Materiales de Madrid, Consejo, Superior de Investigaciones Centificas (Spanien)
	1.11.-7.11.2009	O.O. Chuiko Institute of Surface Chemistry of the National Academy of Sciences of Ukraine, Kiev (Ukraine)

11. Memberships

R. Meisels
- Curriculum commission Dotoratsstudium
- Associate Member IEEE (Institute of Electrical and Electronic Engineers)

J. Oswald
- Senate of the University of Leoben (Vize Chair)
- Betriebsratsvorsitz (Vize Chair)
- Berufungskommission Mechanik
- CK Dotoratsstudium
- Mitglied des Satzungsarbeitskreises des Rektors
- Mitglied der Wahlkommission für die Senatswahl

O. Paris
- Senate of the University of Leoben
- HASYLAB (DESY, Hamburg): Project Review Panel
- Helmholtz Center Berlin (HZB): Scientific Selection Panel
- COST Action MP0601: Management Committee Member

C. Teichert
- Mitglied Organisationskomitee Rathen (Deutschland)
- Vorsitzender Organisationskomitee, Leuchtturm „Nanogrowth“ im NANONET Styria,
- Gutachtertätigkeit ÖAD, Czech Science Foundation, Promotionskommission TU Graz
- Mitglied Int. Steering Committee Int. Vacuum Conf. 18 & ICN+T 2010, Beijing
- National representative in der Nanometer Structures Devision, IUVSTA