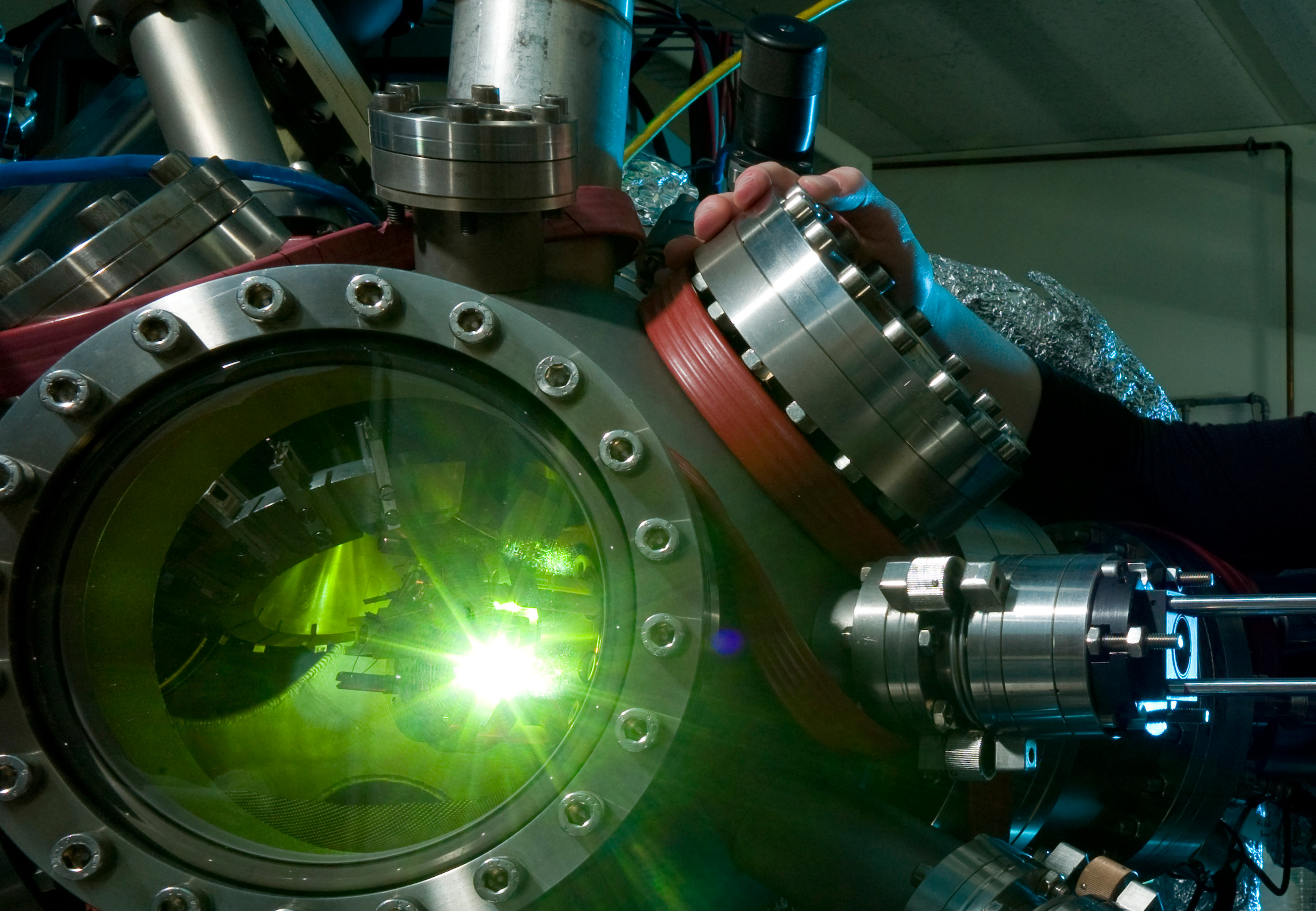


MATERIALS SCIENCE IN MAINZ
The Graduate School of EXCELLENCE
SUMMARY > 2008 > 2009 > 2010 >

TITLE:

A doctoral student of the Graduate School MAINZ demonstrates how to measure magnetic circular dichroism, a specific property of layers of magnetized metals, using a femtosecond laser. Exposure to the laser beam in a vacuum chamber (see reverse of this brochure) causes a magnetic layer of metal to emit electrons that are captured by a positively-charged metal plate for the purpose of detection. A better understanding of the circular dichroism properties of layered magnetic metals will aid in the development of improved materials for constructing smaller and more rapidly reacting storage media, such as hard disks.

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

Max-Planck-Institut für Polymerforschung
Max Planck Institute for Polymer Research

Prof. Claudia Felser, Director of MAINZ

"THE **GRADUATE SCHOOL MAINZ** WILL BECOME PART OF AN INTERNATIONAL EXCELLENCE NETWORK"

Following the success in the first phase of the Excellence Initiative, Johannes Gutenberg University Mainz (JGU), Max Planck Institute for Polymer Research and University of Kaiserslautern together founded the Graduate School Materials Science in Mainz (MAINZ). The school is now competing for further support in the second phase of the Excellence Initiative. We interviewed Prof. Claudia Felser, MAINZ's director, about the school's innovative educational approach, its success to date and its future prospects to 2017 and beyond.

Ms Felser, it was in autumn of 2007 that you founded the Graduate School MAINZ. What has happened at the school since then?

We have improved the quality of the education – more than 50% of our doctoral students graduate with distinction. This is five times the average compared to the natural sciences at JGU. And we have extended and strengthened international collaboration of the school. For example, we have managed to establish close ties with Stanford University, Princeton University, IBM's Almaden Research Center, and MIT. We have partnership agreements with Peking University, the Université de Bourgogne, and also a joint postgraduate program with Seoul National University. These partnerships allow us to offer joint educational events, such as summer schools and workshops, from which our postgraduates can directly benefit.

The school now offers a new approach to postgraduate education in materials sciences. What are its special features?

One of the main characteristics of our program is that students are supervised by a team of up to three experienced researchers. A major role is played here by an external mentor working in an academic research field or in the industry, as they can add completely new perspectives to a project. With the help of their mentors and supervisors, doctoral students set up an individual "Career Development and Training Plan" that is reviewed at regular intervals and updated as necessary. In addition, doctoral candidates are encouraged to regularly present their research project and progress to their colleagues at the school. Another innovation is that we offer our students the option of spending a research period of up to one year in an academic institute or corporate facility abroad, and many doctoral candidates take advantage of this opportunity. Through subsidized attendance at conferences, participation in our summer schools and our mentoring program we enable our students to form their own network.

And has your new approach been successful?

It has been very successful! The 80 doctoral candidates currently studying with us have their own, individual international networks. It is largely by virtue of our approach that our candidates only need less than three years on average before they are awarded their doctorates by the graduate school. We already have our first spin-off: the Journal of Unsolved Questions, in which details of unsuccessful research projects are published. Additionally, this journal represents a contribution to the debate on current publishing practices and the question of honesty in science.

What are your plans for future years?

We are seeking to bring about a brain gain from international elite universities. MAINZ is to become one element of an international excellence network and for this reason, we are planning to introduce a Master's degree program in Materials Science at JGU that will be taught in English and will complement the curriculum at the graduate school. We also hope to be able to extend our ties with industry and commerce which will be reflected in our training by introduction of modules relevant to applied research and development..

Assuming your proposal is also successful in the second phase of the Excellence Initiative, what will happen when the financial support provided by the Excellence Initiative ends in 2017?

Our school is a role model for the training of doctoral students throughout JGU. The plan is to integrate the school in the Center for Young Researchers, which will be established as part of JGU's Institutional Strategy. Beyond the second funding period, MAINZ will receive an additional fixed annual budget by JGU and the State Rhineland-Palatinate. This enables us to pursue graduate education at this high level beyond the second phase of the Excellence Initiative. Furthermore because around 60% of all students of the school are financed from resources other than the German Research Foundation, it seems unlikely that we will encounter funding problems after 2017.

Interview: Jonas Siehoff

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The Graduate School of Excellence Materials Science in Mainz (MAINZ) is an international doctoral program currently composed of roughly 80 doctoral students. The program is conducted by excellent scientists from Johannes Gutenberg University Mainz (JGU), Max Planck Institute for Polymer Research (MPI-P) and University of Kaiserslautern (TUKL).

As part of the Excellence Initiative, MAINZ has been awarded a federal grant (2007-2012) as one of the few doctoral programs in the interdisciplinary area of Chemistry, Physics, and Biology.

Our three-year training program focuses on laboratory-based research training supported by summer schools, seminars, secondments abroad, conferences, complementary skills workshops, and colloquia that supply the intellectual framework necessary to become an independent scientist. Networking is one of the key aspects of the program reflected in all training offered. This aspect is embodied in our mentoring program, which provides our doctoral students early contact with the international scientific community and the industry.

FACTS & FIGURES

INCREASING NUMBER OF FEMALE MAINZ PhD STUDENTS (IN %)

	Male	Female
2010	64	36
2009	67	33
2008	72	28

DOCTORAL DEGREES CONFERRED

GRADING OF DOCTORAL DEGREES 2008-2010 (IN %)

	summa cum laude	magna cum laude	cum laude
MAINZ	49	51	-
Department of Chemistry, JGU	17	75	8
Department of Physics, JGU	13	78	9
Department of Physics, TUKL	23	66	11

DURATION OF PhD

AVERAGE DURATION OF PhD THESES COMPLETED BETWEEN 2008 AND 2010 (IN YRS):

	Ø
MAINZ	3,24
Department of Chemistry, JGU	3,70
Department of Physics, JGU	4,34
Department of Physics, TUKL	4,30

PUBLICATIONS

TOTAL PUBLICATIONS OF MAINZ PhD STUDENTS BETWEEN 2008 AND 2010:

ALL	FIRST AUTHOR	CO-AUTHOR
226	149	77

JOURNAL IMPACT FACTOR

AVERAGE JOURNAL IMPACT FACTOR OF ALL JOURNALS COMBINED WHERE PAPERS OF OUR PhD STUDENTS WERE PUBLISHED (INCLUDING FIRST AND CO-AUTHORSHIPS)

2010	6,20
2009	4,66
2008	5,22

NUMBER OF SUMMER AND WINTER SCHOOLS ORGANIZED BY MAINZ

2010	2009	2008
6	4	6

A substantial number of our summer and winter schools is organized in cooperation with our international partners showing the increasing internationality of our program.

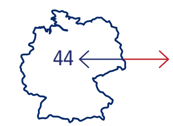
CONFERENCE PARTICIPATION 2008-2010

TOTAL NUMBER: 138

PRESENTATIONS AT CONFERENCES (IN %)

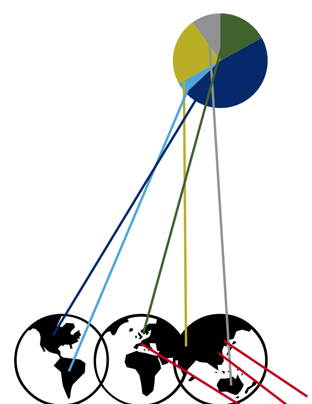
	POSTERS	TALKS
2010	58	42
2009	72	28
2008	76	24

LOCATION OF CONFERENCES VISITED (IN %)



Germany	Abroad
44	56

ON AVERAGE EVERY 4TH PhD STUDENT SPENDS A SECONDMENT ABROAD
THE AVERAGE DURATION OF A SECONDMENT IS 13 WEEKS



SECONDMENTS BY CONTINENTS:

17%	EUROPE
46%	NORTH AMERICA
3%	SOUTH AMERICA
26%	ASIA
8%	AUSTRALIA

COOPERATION AGREEMENTS:

- Seoul National University, Korea
- Peking University, China
- Université de Bourgogne, Dijon, France

TIMELINE

Granting of the
Graduate School MAINZ
Excellence Initiative, Oct. 2007

Official Opening Ceremony of the
Graduate School MAINZ, Apr. 2008

Gutenberg Research Award 2008:
Stuart Parkin, Nov. 2008

MAINZ PhD Student Workshop, Lyviv, Ukraine, Aug. 2009

Summer School "Novel Superconductors" in Cooperation with UCSB/Materials Research Lab, Santa Barbara, Aug. 2009

Gutenberg Lecture Award 2009:
Alex Zunger, Nov. 2009

2008

2009

2010

Gutenberg Lecture Award 2008:
Michele Parrinello, Aug. 2008

Start of the Lecture Series
"Materials and Energy", Apr. 2009

Gutenberg Research Award 2009:
Christopher K. Ober, Aug. 2009

Winter School "Photoemission",
in Cooperation with Université de Bourgogne,
Dijon, Feb. 2010

Retreat of the Graduate School MAINZ,
Schmitten, Germany, April 2010

Photos: MAINZ, Lena Giovanazzi, Thomas Hartmann, Roland Ruffing, Daniela Schmitter

2010

Gutenberg Lecture Award 2010:
Krzysztof Matyjaszewski, June 2010

Gutenberg Research Award 2010:
Shoucheng Zhang, July 2010

First MAINZ PhD Student Workshop,
Geseke, Germany, July 2010

Summer School "Spintronics",
in Cooperation with Stanford University
and IBM Research, Almaden,
Watsonville, Aug. 2010

Start of the Lecture Series
"Materials and Industry", Aug. 2010

2011

Gutenberg Lecture Award 2011:
Robert J. Cava, Apr. 2011

Start of the Lecture Series
"Publish or Perish", Apr. 2011

Podium Discussion, "How Do Current Publication Practices Influence Science?", May 2011

Summer School "Quantum
Properties" in Cooperation with
the University of Trieste, Venice,
May 2011

Gutenberg Research Award 2011:
Michael Grätzel, July 2011

NETWORK OF MAINZ

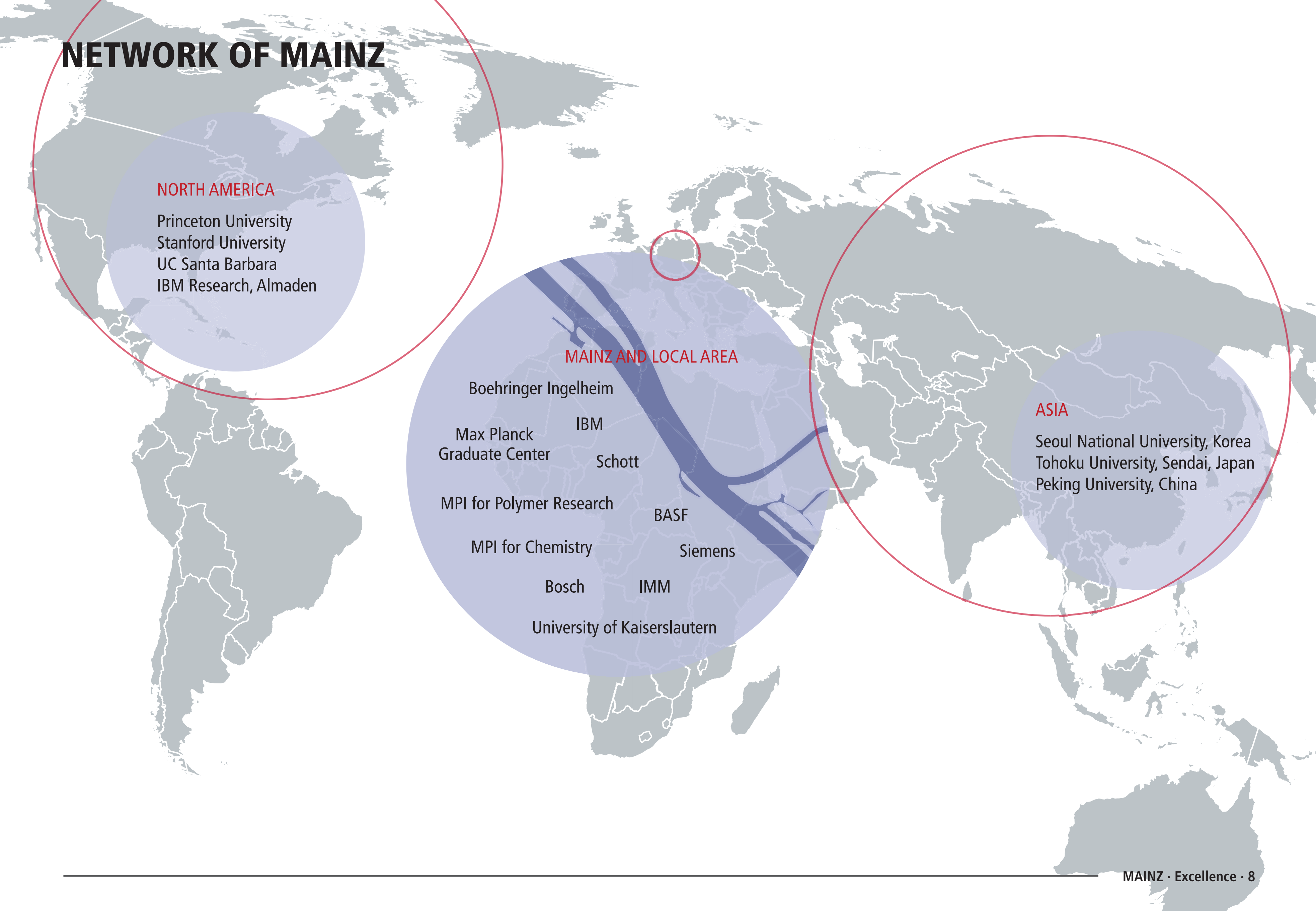


Photo: Thomas Hartmann

EXPANDING OPPORTUNITIES FOR EXCELLENCE – YOUNG ACADEMICS ON THE WAY TO THE TOP

For more than ten years, Johannes Gutenberg University Mainz (JGU) has been investing heavily in the development and design of its programs aimed at cultivating the talents of young researchers. Recognition of the program's success in promoting new academic talent in selected fields has been acknowledged by, for example, the Center for Higher Education Development (CHE) and the German Science Council among other organizations – which consistently place our development programs in the top group of various ranking and rating systems. By virtue of its central areas of research, JGU is now rapidly becoming an internationally recognized and highly competitive research venue for young academics not only from Germany but also from abroad. Here, doctoral degree candidates will find the freedom and the supportive infrastructure they need to conduct their research and to develop their long-term career prospects. One of the most outstanding examples in this context is our Graduate School of Excellence Materials Science in Mainz (MAINZ), the flagship institution of our system for structured and targeted advancement of young academics. JGU is fully committed to the successful model embodied in MAINZ, which is based on three fundamental cornerstones:

- *Maintenance of the very highest academic quality with seminal research concepts for the development of materials with new functional properties.*
- *Extensive cooperation with partner universities, such as Princeton, Stanford and Seoul National University.*
- *Close collaboration with partners from the business community and the conversion of academic theory into future technology.*

MAINZ also benefits significantly from our university's governance structures. One example: The appointment of Stuart Parkin as a fellow of the Gutenberg Research College (GRC) involves not only an intensification of our collaboration in the field of spintronics with this eminent experimental physicist from IBM Almaden and associate professor at Stanford. The GRC fellowship also provides two doctoral candidates from the Graduate School MAINZ with the opportunity of having Professor Parkin serve as their mentor. This includes periodic research stays abroad, principally with IBM in California, where Parkin serves as an IBM Fellow and manager of the Magnetoelectronics Group at IBM Almaden. I consider a prime example of the application of best practices the way in which the Graduate School MAINZ is able to combine training in a superior academic environment with high quality international networking and exclusive mentoring, enabling students to plot out the course of their future careers at an early stage.
At the same time, the standards of quality employed by MAINZ provide impetus to the development of young academic talent at JGU – impetus that has also found expression in the Center for Young Researchers – through its mentoring programs, in particular for foreign (post-)doctoral candidates, through its career support for doctoral students, and through the allocation of tenured posts to distinguished academic talent.

The Graduate School Materials Science in Mainz is an example of an institution with a highly competitive future in the international sector that can serve as a role model far beyond the confines of Johannes Gutenberg University Mainz.

Prof. Georg Krausch
President of Johannes Gutenberg University Mainz

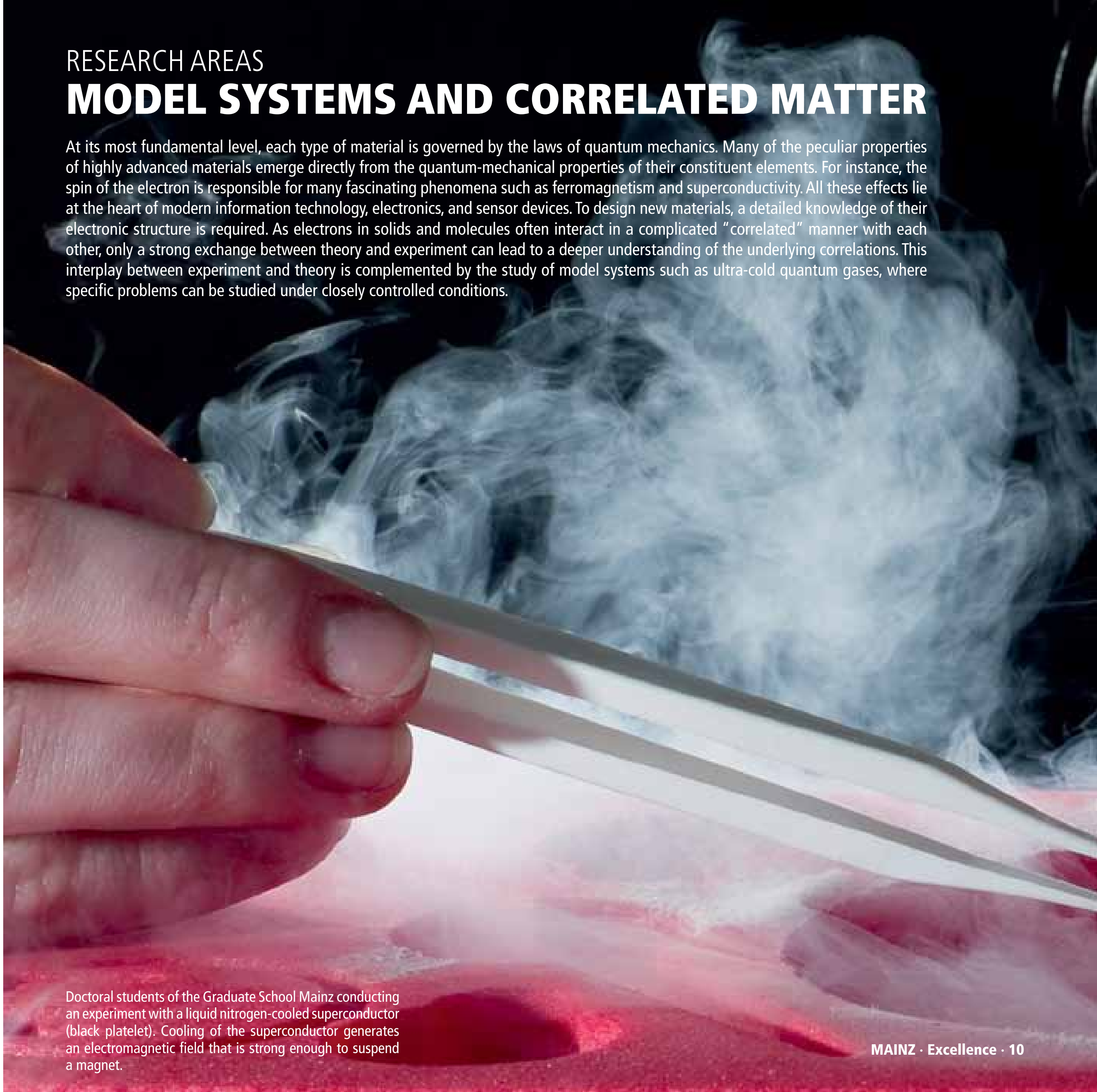
RESEARCH AREAS AND RED THREADS

As the world moves towards a society in which “information and communication are everywhere”, nanoscale devices for information technology, healthcare, energy, and communication become ubiquitous and are key enablers of the fast pace at which technological development improves our lives. To address this phenomenon, the Graduate School of Excellence Materials Science in Mainz focuses on four different research areas. These are: Model Systems and Correlated Matter, Bio-Related Materials, Functional Polymers, and Hybrid Stuctures. These different research areas are linked with one another by means of red threads – represented in this report by Theory, Nanoscience, and Energy.

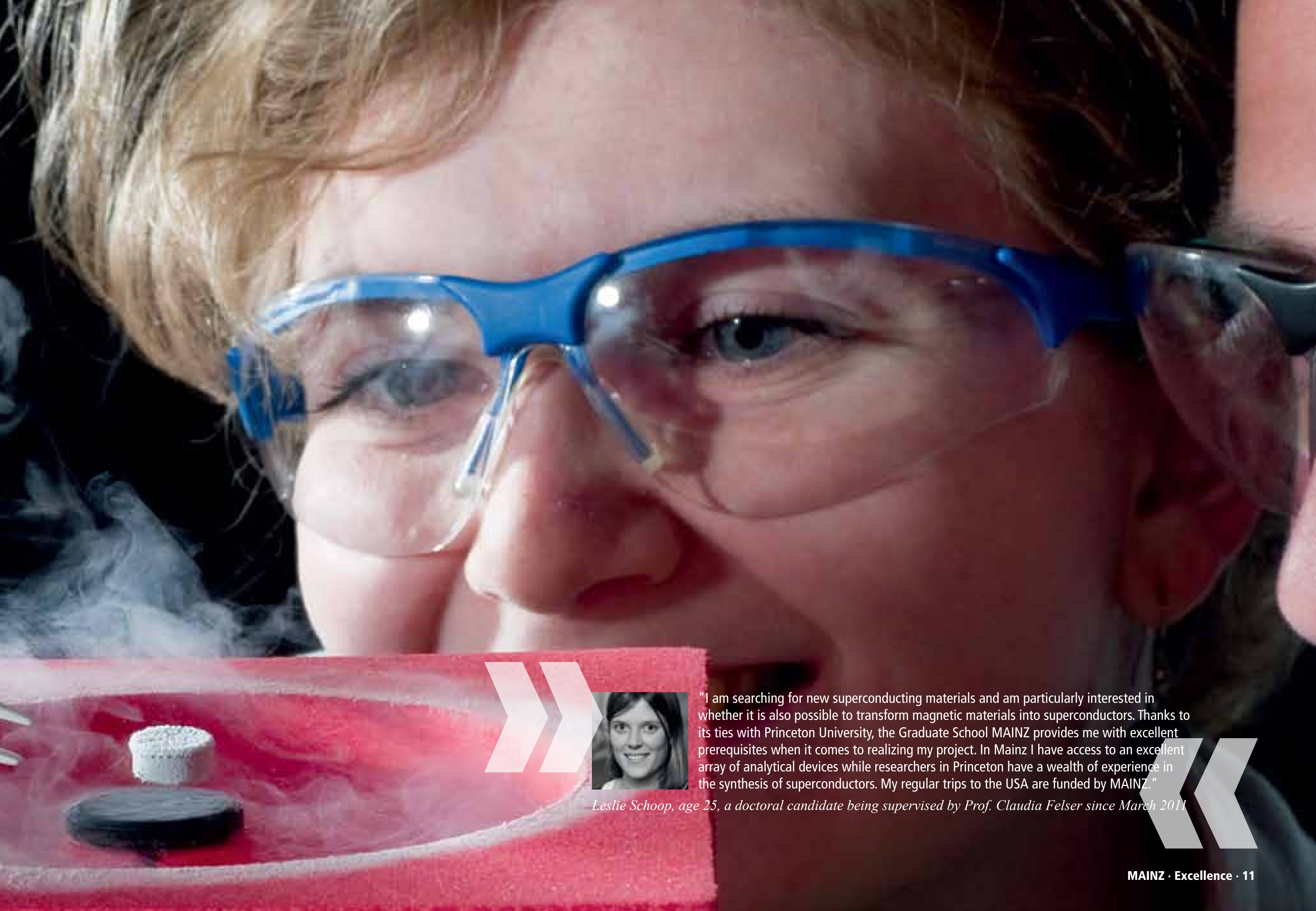
RESEARCH AREAS

MODEL SYSTEMS AND CORRELATED MATTER

At its most fundamental level, each type of material is governed by the laws of quantum mechanics. Many of the peculiar properties of highly advanced materials emerge directly from the quantum-mechanical properties of their constituent elements. For instance, the spin of the electron is responsible for many fascinating phenomena such as ferromagnetism and superconductivity. All these effects lie at the heart of modern information technology, electronics, and sensor devices. To design new materials, a detailed knowledge of their electronic structure is required. As electrons in solids and molecules often interact in a complicated “correlated” manner with each other, only a strong exchange between theory and experiment can lead to a deeper understanding of the underlying correlations. This interplay between experiment and theory is complemented by the study of model systems such as ultra-cold quantum gases, where specific problems can be studied under closely controlled conditions.



Doctoral students of the Graduate School Mainz conducting an experiment with a liquid nitrogen-cooled superconductor (black platelet). Cooling of the superconductor generates an electromagnetic field that is strong enough to suspend a magnet.



"I am searching for new superconducting materials and am particularly interested in whether it is also possible to transform magnetic materials into superconductors. Thanks to its ties with Princeton University, the Graduate School MAINZ provides me with excellent prerequisites when it comes to realizing my project. In Mainz I have access to an excellent array of analytical devices while researchers in Princeton have a wealth of experience in the synthesis of superconductors. My regular trips to the USA are funded by MAINZ."

Leslie Schoop, age 25, a doctoral candidate being supervised by Prof. Claudia Felser since March 2011

RESEARCH AREAS

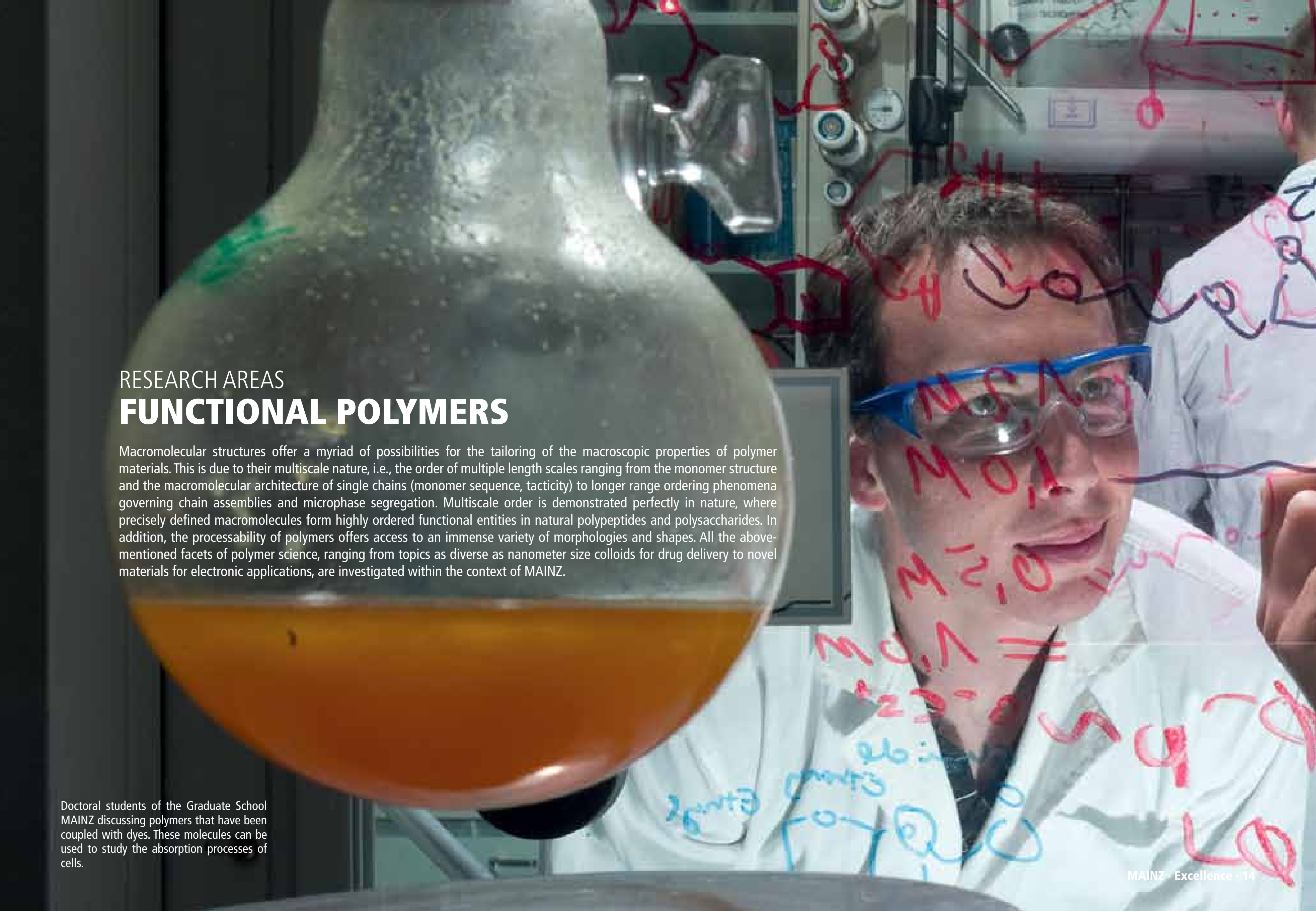
BIO-RELATED MATERIALS

In recent years, MAINZ research directed at bio-related materials has increased significantly. It is therefore anticipated that ties to medical research will be strengthened in the future. Accordingly, one major challenge for the future development of MAINZ is to continuously integrate biomedical research into its research portfolio. Bio-related materials research in MAINZ addresses a wide range of topics. The specific recognition capabilities of biological constituents (proteins, DNA) are utilized in order to create new bio-hybrid materials. Materials for biomedical applications comprise biocompatible and biodegradable polymers, polymer-protein/antibody, polymer-drug conjugates, and polyelectrolyte complexes for DNA transfection. Imitating biological matter may lead to the design of new materials through "learning from nature". This includes super-hydrophobic surfaces mimicking the lotus effect or biomimetic active surfaces with smart adhesive properties.

The van der Waals force exerted by the tiny hair on the feet of geckos allow that these lizards can even cling to polished glass sheets. Materials scientists are trying to mimic these hair in an attempt to develop new forms of adhesive strips.

"I'm analyzing the properties of molecular complexes that can be used to insert healthy DNA in cells with genetic defects. We have not yet identified any complexes that are capable of achieving this perfectly. The interdisciplinary and international approach at the Graduate School MAINZ provides me with ideal conditions for my research. For example, it allows me to exchange information with other doctoral students during summer schools and to learn a vast amount from others."

Angel Medina, age 28, a doctoral candidate being supervised by Prof. Manfred Schmidt since October 2008

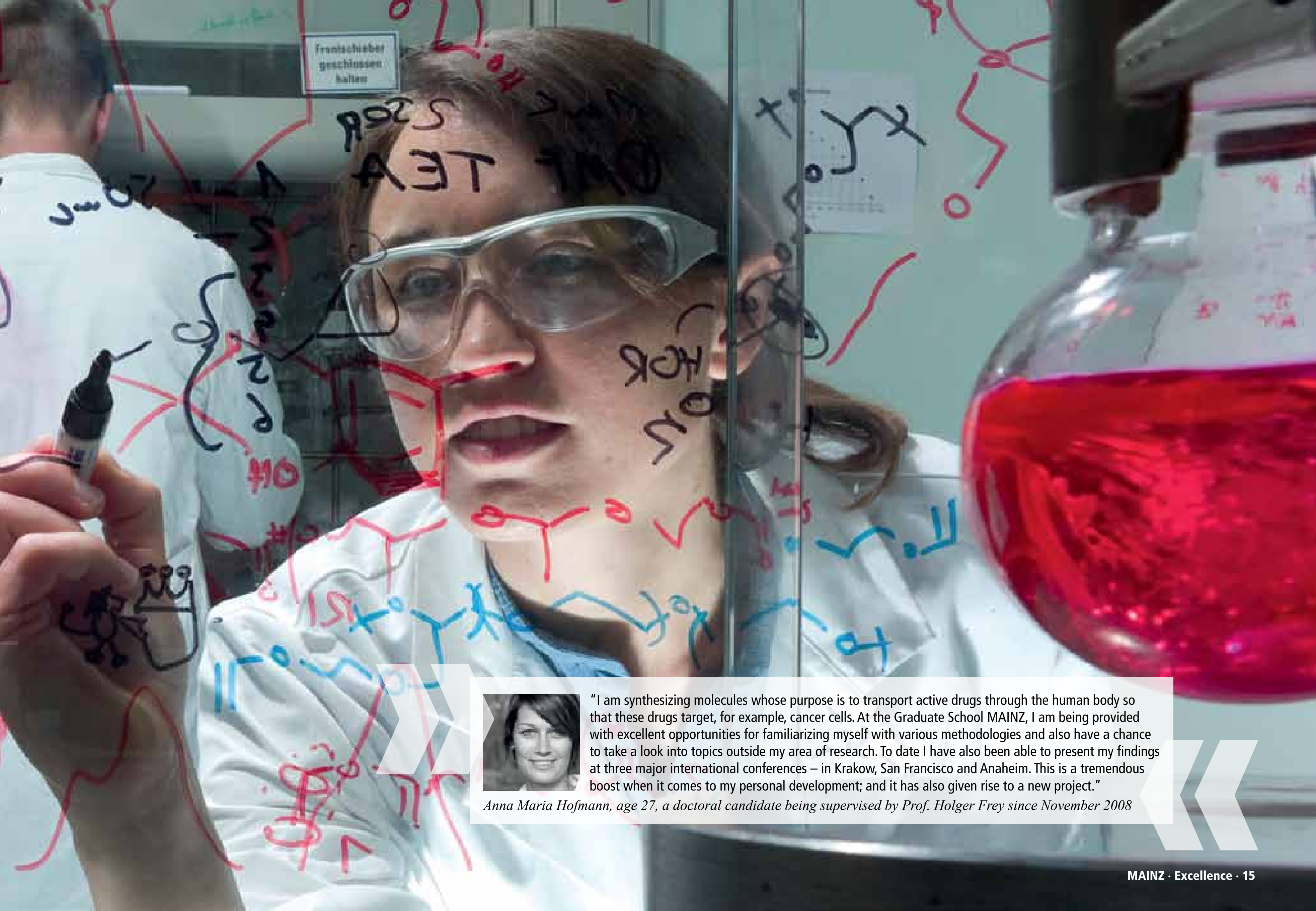


RESEARCH AREAS

FUNCTIONAL POLYMERS

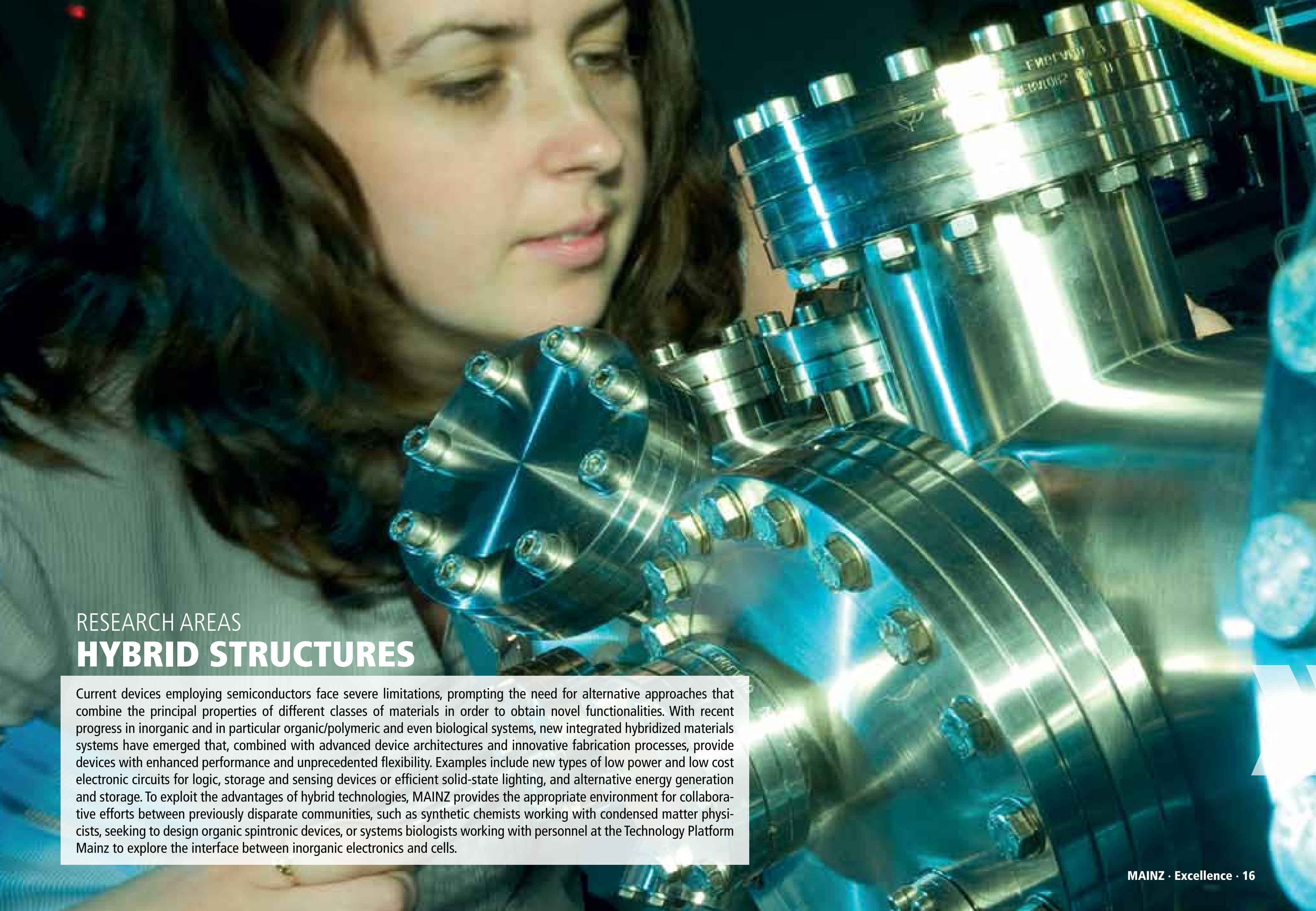
Macromolecular structures offer a myriad of possibilities for the tailoring of the macroscopic properties of polymer materials. This is due to their multiscale nature, i.e., the order of multiple length scales ranging from the monomer structure and the macromolecular architecture of single chains (monomer sequence, tacticity) to longer range ordering phenomena governing chain assemblies and microphase segregation. Multiscale order is demonstrated perfectly in nature, where precisely defined macromolecules form highly ordered functional entities in natural polypeptides and polysaccharides. In addition, the processability of polymers offers access to an immense variety of morphologies and shapes. All the above-mentioned facets of polymer science, ranging from topics as diverse as nanometer size colloids for drug delivery to novel materials for electronic applications, are investigated within the context of MAINZ.

Doctoral students of the Graduate School MAINZ discussing polymers that have been coupled with dyes. These molecules can be used to study the absorption processes of cells.



"I am synthesizing molecules whose purpose is to transport active drugs through the human body so that these drugs target, for example, cancer cells. At the Graduate School MAINZ, I am being provided with excellent opportunities for familiarizing myself with various methodologies and also have a chance to take a look into topics outside my area of research. To date I have also been able to present my findings at three major international conferences – in Krakow, San Francisco and Anaheim. This is a tremendous boost when it comes to my personal development; and it has also given rise to a new project."

Anna Maria Hofmann, age 27, a doctoral candidate being supervised by Prof. Holger Frey since November 2008



RESEARCH AREAS

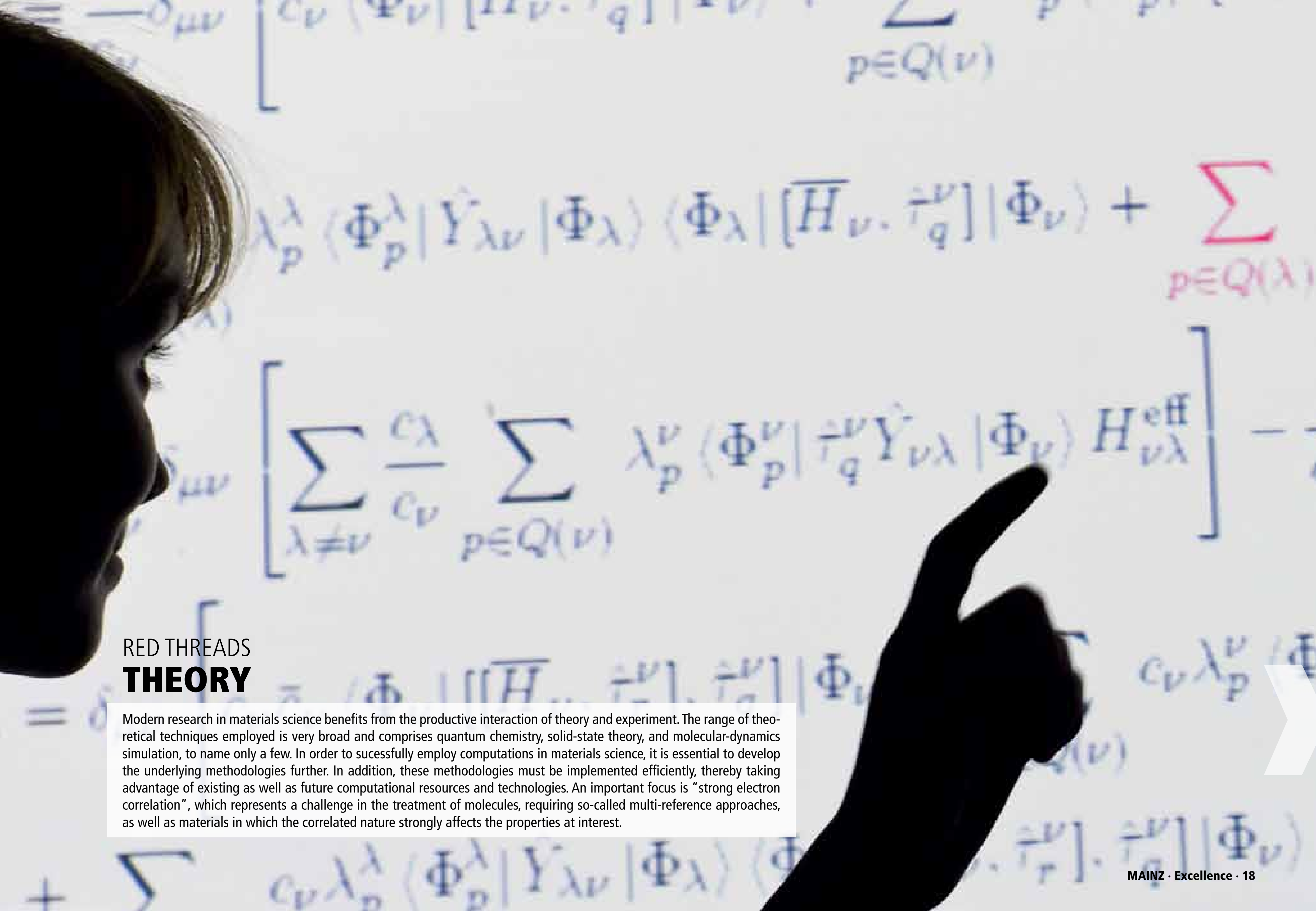
HYBRID STRUCTURES

Current devices employing semiconductors face severe limitations, prompting the need for alternative approaches that combine the principal properties of different classes of materials in order to obtain novel functionalities. With recent progress in inorganic and in particular organic/polymeric and even biological systems, new integrated hybridized materials systems have emerged that, combined with advanced device architectures and innovative fabrication processes, provide devices with enhanced performance and unprecedented flexibility. Examples include new types of low power and low cost electronic circuits for logic, storage and sensing devices or efficient solid-state lighting, and alternative energy generation and storage. To exploit the advantages of hybrid technologies, MAINZ provides the appropriate environment for collaborative efforts between previously disparate communities, such as synthetic chemists working with condensed matter physicists, seeking to design organic spintronic devices, or systems biologists working with personnel at the Technology Platform Mainz to explore the interface between inorganic electronics and cells.

A doctoral student of the Graduate School Mainz using a photoelectron spectrometer to investigate the electronic properties of a sample of a new type of organic conductor. These organic conductors are being synthesized in an interdisciplinary program in which the graduate school is collaborating with the Max Planck Institute for Polymer Research.

“In my project, I am looking at the structures formed on non-conducting surfaces by electrically conducting molecules by means of the effect known as molecular self-assembly. I hope that the results of my work will one day contribute towards the creation of even more powerful computer chips. It is extremely important for me that I have contacts with other research groups so that I can gain new insight into my own findings – and it is here that MAINZ really delivers. What appealed to me most about completing my doctorate here, and one aspect I also consider to be beneficial for my future career, are the contacts that the school has with industry.”

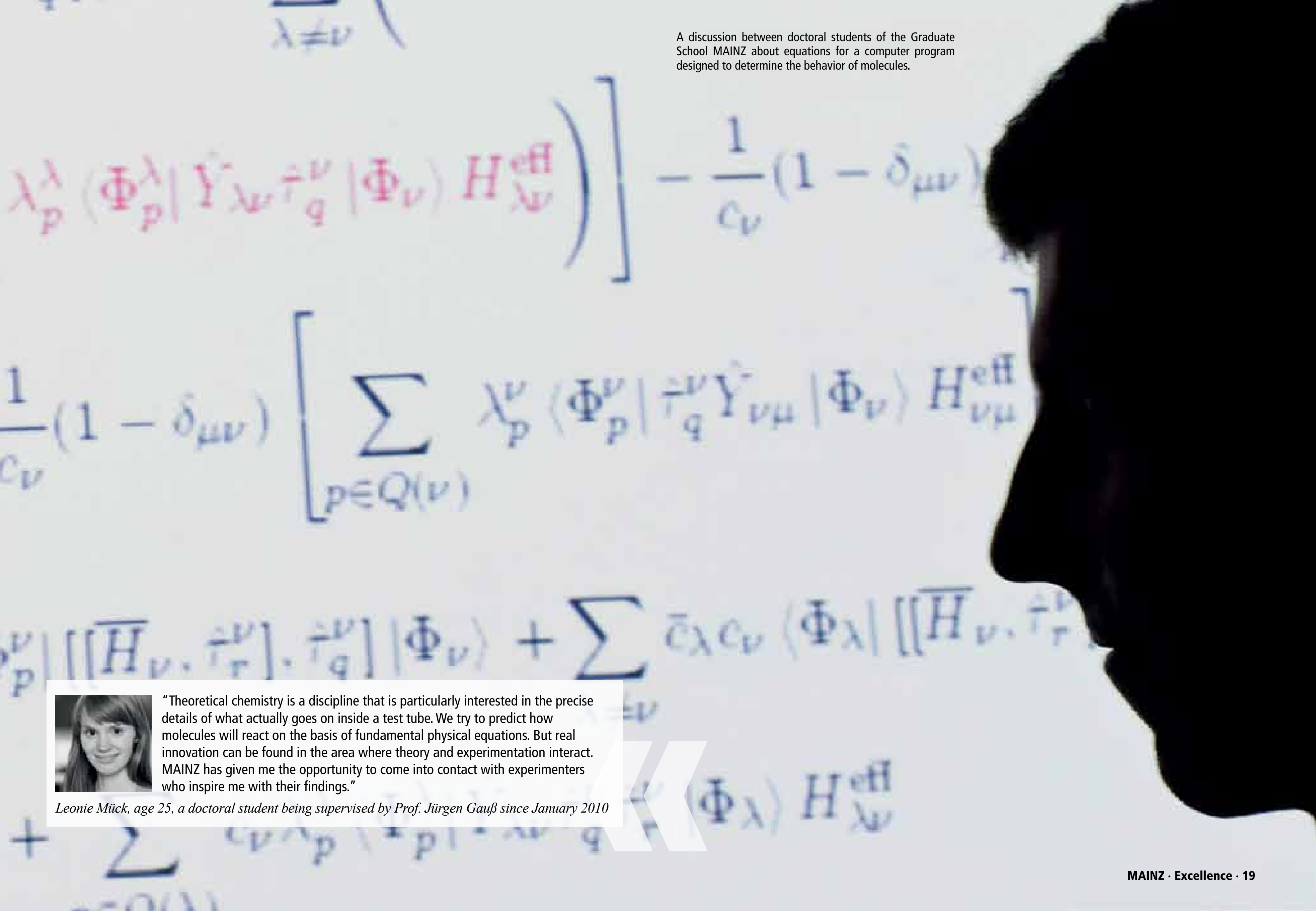
Christopher Hauke, age 27, a doctoral student being supervised by Prof. Angelika Kühnle since April 2010



RED THREADS

THEORY

Modern research in materials science benefits from the productive interaction of theory and experiment. The range of theoretical techniques employed is very broad and comprises quantum chemistry, solid-state theory, and molecular-dynamics simulation, to name only a few. In order to sucessfully employ computations in materials science, it is essential to develop the underlying methodologies further. In addition, these methodologies must be implemented efficiently, thereby taking advantage of existing as well as future computational resources and technologies. An important focus is "strong electron correlation", which represents a challenge in the treatment of molecules, requiring so-called multi-reference approaches, as well as materials in which the correlated nature strongly affects the properties at interest.



A discussion between doctoral students of the Graduate School MAINZ about equations for a computer program designed to determine the behavior of molecules.

"Theoretical chemistry is a discipline that is particularly interested in the precise details of what actually goes on inside a test tube. We try to predict how molecules will react on the basis of fundamental physical equations. But real innovation can be found in the area where theory and experimentation interact. MAINZ has given me the opportunity to come into contact with experimenters who inspire me with their findings."

Leonie Mück, age 25, a doctoral student being supervised by Prof. Jürgen Gauß since January 2010

RED THREADS
NANOSCIENCE

Many properties of materials change profoundly when confined to spaces measured in nanometers. Nanometer sized objects are large enough to contain as many atoms that one can disregard the individual atomic structure. And yet, electronic, magnetic, mechanical, and optical properties can differ fundamentally from those of extended or bulk materials of the same composition. An example can be found in the vivid colors produced by gold nanoparticles suspended in water – which differ remarkably from the yellow color of bulk gold. The physical effects causing such unusual behavior are still puzzling to researchers and are the subject of intense research. Many classic materials like cement, steel, or ceramics are structured on the nanometer scale as well and their continued development is of great importance. However, the most exciting aspect of nanoscience is the effort to create entirely new structures with very unusual properties, like those of varicolored gold. For the researcher this means exploring uncharted territory and involves a stimulating exchange between the development of new approaches to create nanostructures, the observation of physical effects of nanostructures, and formulating ideas about the effects that could be created thereby.

While working on my doctorate, I synthesized gold nanoparticles and studied their optical properties. In the future, it might be possible to analyze blood samples for specific proteins and antibodies using such particles. While at MAINZ, it was particularly important for me that there was the opportunity to meet many researchers from other work groups and to interact with other doctoral students. Therefore, if you want to try out an analytical method developed by another institute participating in MAINZ, one should already having the necessary personal network."

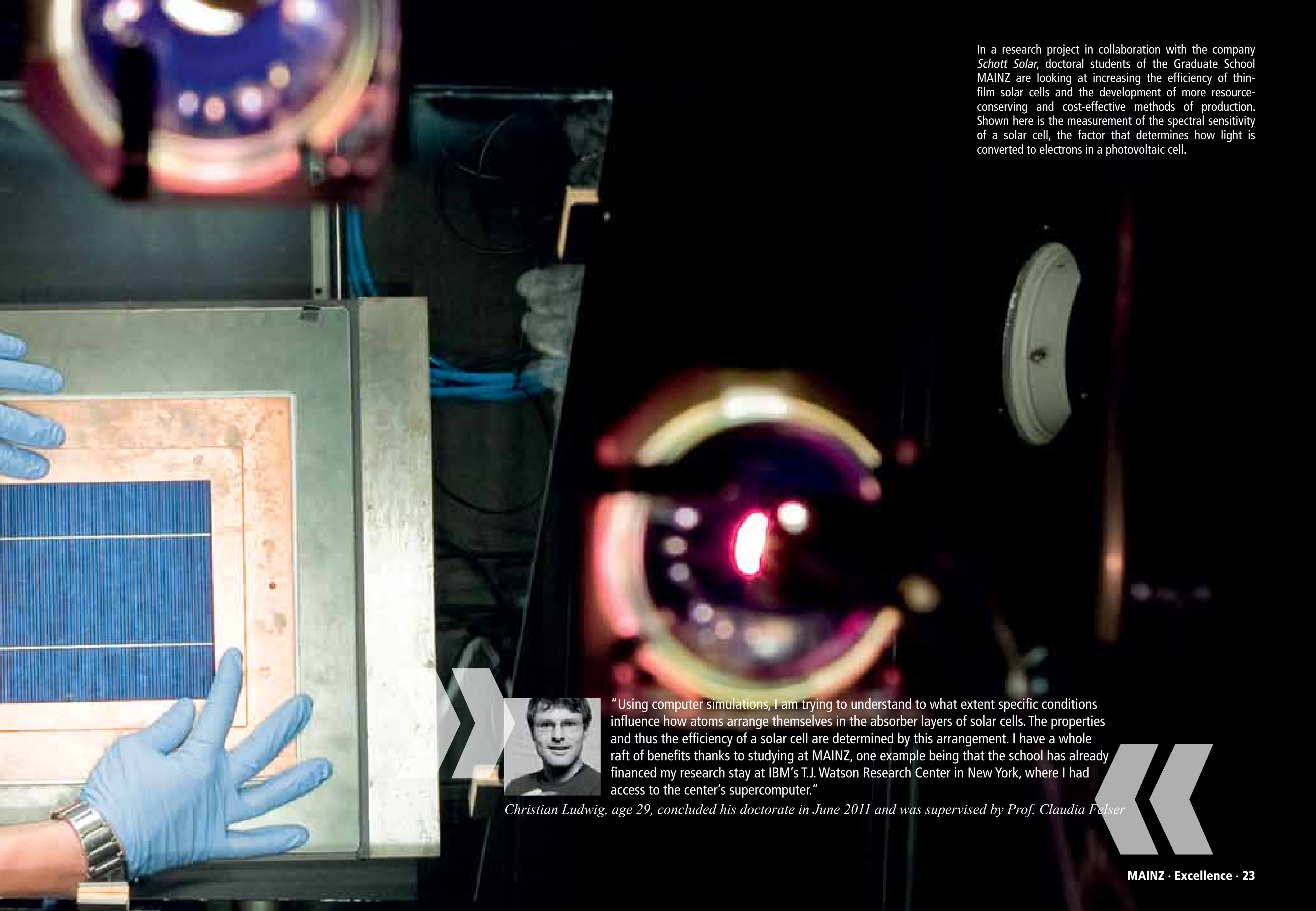
Inga Zins, age 27, concluded her doctorate in March 2011 and was supervised by Prof. Carsten Sönnichsen

Because of their color effects, nanoparticles of some metals can be used as indicator substances. To the right two suspensions of silver particles can be seen, that assume a green or purple coloration depending on the incidence of the light passing through them. On the left is a suspension of gold particles that has changed the color following the addition of a saline solution.

RED THREADS

ENERGY

There is no doubt that the design of new materials for applications in the field of renewable energy is one of the most important challenges in materials science. MAINZ tackles this challenge on all levels. In our virtual, we design new materials and interfaces with appropriate electronic properties. Inorganic materials are required, for example, in high temperature thermoelectric applications (where wasted heat can be converted into electrical power) and for easily processable, highly efficient solar cells. Solar cells based on organic materials are sustainable, cheap, and flexible. Composites of organic and inorganic materials combine the best of both worlds: flexibility and stability. Nano-engineering (designing particles on the scale of billionths of a meter) can produce substances with unique properties that will boost the production of renewable energy. On the other hand, the best solar cells are produced in nature and therefore the design of bio-inspired materials for energy applications is an important research area of MAINZ.



In a research project in collaboration with the company *Schott Solar*, doctoral students of the Graduate School MAINZ are looking at increasing the efficiency of thin-film solar cells and the development of more resource-conserving and cost-effective methods of production. Shown here is the measurement of the spectral sensitivity of a solar cell, the factor that determines how light is converted to electrons in a photovoltaic cell.

"Using computer simulations, I am trying to understand to what extent specific conditions influence how atoms arrange themselves in the absorber layers of solar cells. The properties and thus the efficiency of a solar cell are determined by this arrangement. I have a whole raft of benefits thanks to studying at MAINZ, one example being that the school has already financed my research stay at IBM's T.J. Watson Research Center in New York, where I had access to the center's supercomputer."

Christian Ludwig, age 29, concluded his doctorate in June 2011 and was supervised by Prof. Claudia Felser

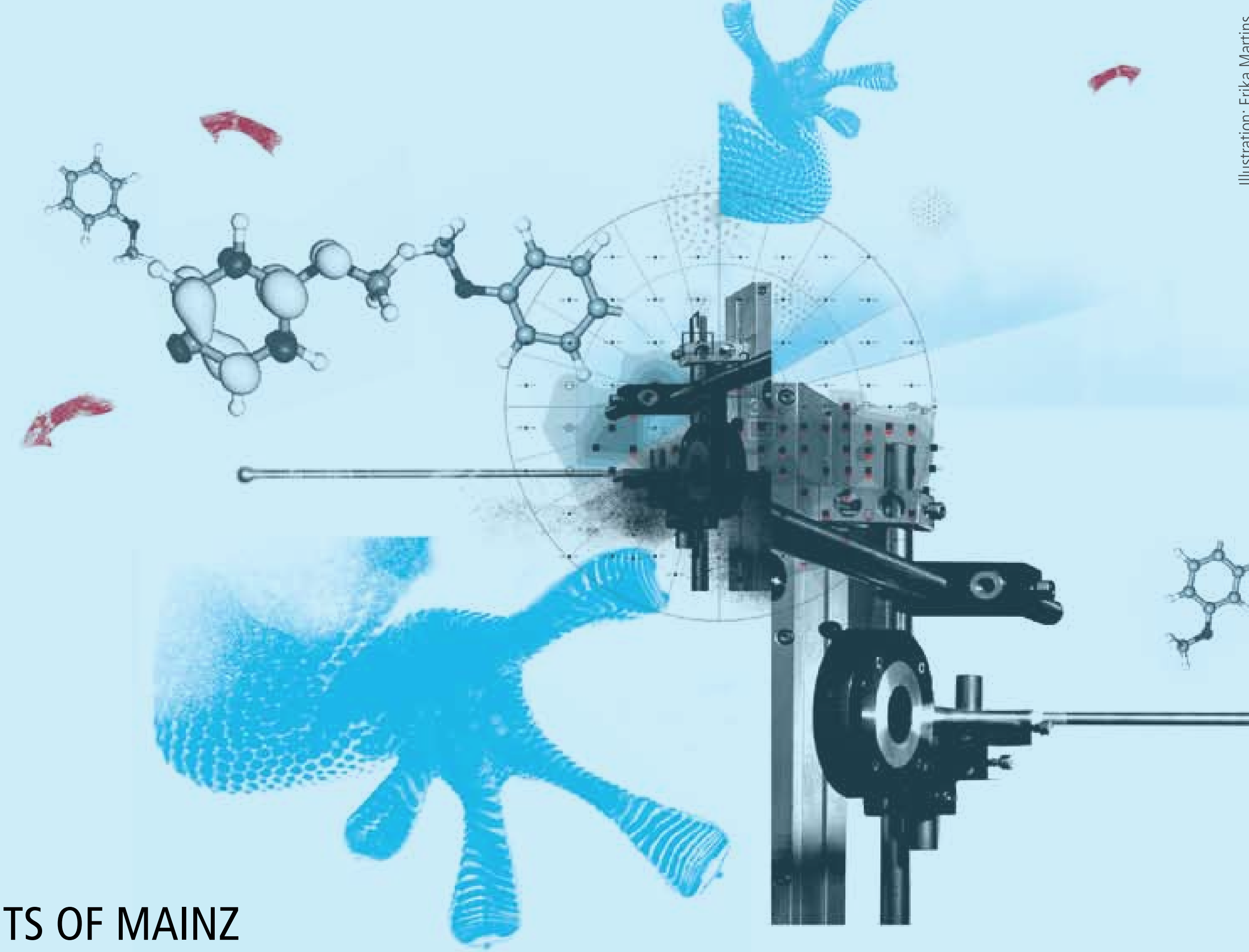


Illustration: Erika Martins

RESEARCH HIGHLIGHTS OF MAINZ

While excellent research is the heart of our graduate school, training is the focus of MAINZ. Since it would be beyond the scope of this summary to illustrate the research programs being conducted through MAINZ in their entirety, we have instead selected a few research highlights, a digest of important publications by our young researchers and a selection of high impact papers from our principle investigators, which will hopefully give you a taste of the work going on at MAINZ.

Organic Spintronics

Organic semiconductors are a family of materials characterized by extreme flexibility, tunability, easy manipulation and low-cost production. Research on those materials developed strongly in the last decades, especially in the field of optoelectronics. Devices based on organic semiconductors, like OLED display or organic photovoltaic cells are already available on the market. Recently, significant efforts have been made to integrate organic semiconductors in the field of spintronics, where information is stored and transported by an intrinsic property of the electrons: the spin. The first step to build an "organic spintronics" device is to "inject spins" from a source (in general a ferromagnetic metal) into the organic material itself, i.e. to bring the spin from the ferromagnet - where spins are naturally "available" – into the organic molecules. Since standard spectroscopic methods conventionally used to characterize inorganic semiconductors fail when applied to their organic counterpart, the question whether or not spin polarized electrons can be injected in the organic could not be answered until now. In their article, Cinchetti el al. demonstrated the feasibility of extremely high spin injection efficiency into an organic semiconductor by using a purpose made spectroscopic technique. They provide a quantitative basis for studying the mostly unknown mechanisms responsible for spin-relaxation in organic molecules and for the optimization of organic spintronics devices.

Schematic picture showing spin polarized electrons (green) injected from a cobalt substrate (gray) through different layers of the organic semiconductor copper phthalocyanine.

REFERENCES

[1] Cinchetti M, Heimer K, Wüstenberg JP, Andreyev O, Bauer M, Lach S, Ziegler C, Gao Y and Aeschlimann M (2009). Determination of Spin Injection and Transport in a Ferromagnet/Organic Semiconductor Heterojunction by Two-photon Photoemission. Nature Materials 8(2): 115-119.

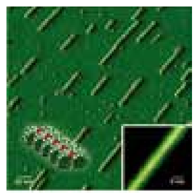
[2] Cinchetti M, Neuschwander S, Fischer A, Ruffing A, Mathias S, Wüstenberg JP and Aeschlimann M (2010). Tailoring the Spin Functionality of a Hybrid Metal-Organic Interface by Means of Alkali-Metal Doping. Physical Review Letters 104(21).

Molecular Self-Assembly on Insulators: Supramolecular Architectures for Molecular Electronics

Electronic circuits are constantly shrinking at high pace and traditional silicon-based technology is approaching its theoretical limits. A very promising strategy to overcome these limitations is exploiting the exceptional flexibility of organic molecules as building blocks for future electronic devices.

The Kühnle group explores the potential of molecular self-assembly as versatile tool for building tailor-made molecular structures on surfaces [1]. Future application in electronic devices requires electronic decoupling from the supporting substrate surface, thus, metallic surfaces are of limited use in molecular electronics. So far, the self-assembly of functional molecular structures such as, e.g., molecular wires on electrically insulating surfaces has been hindered by comparatively weak molecule-substrate interactions.

Recently, the Kühnle group has successfully demonstrated the self-assembled growth of uni-directional molecular structures on a bulk insulator surface at room temperature [2]. The key aspect is a rational design of functionalized molecules for tailoring both, the molecule-substrate as well as the molecule-molecule interaction. Thereby, the subtle balance between the decisive interactions can be tuned even on insulating surfaces, where high molecular mobility has so far hampered self-assembly of tailor-made molecular structures.



Non-contact atomic force microscopy image showing uni-directional wires self-assembled from heptahelicene-2-carboxylic acid molecules on the cleavage plane of calcite.

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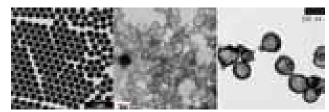
From Stable Miniemulsions to Stimuli-Responsive Nanocapsules

The mini emulsions process represents a versatile tool for the formation of polymeric nanoparticles and nanocapsules consisting of different kinds of polymers as obtained by a variety of polymerization types ranging from radical, anionic, cationic, enzymatic polymerization to polyaddition and polycondensation. The process perfectly allows the encapsulation of hydrophilic and hydrophobic liquids and solids in polymeric shells. In combination with a specific functionalization of the nanoparticles' or nanocapsules' surfaces and the possibility to release substances in a defined way from the interior, complex nanoparticles or nanocapsules are obtained which are ideally suited in materials as anticorrosive systems and in biomedical applications as marker and targeted drug delivery systems. The formation of nanocapsules in miniemulsion with a hydrophilic or hydrophobic content can be obtained by a phase separation throughout a polymerization process, a nanoprecipitation onto nanodroplets or a interfacial polymerization at the nanodroplet's interface. The release of the components can be triggered in different ways, e.g. by nanoexplosions induced by azo-components which are embedded in the core or by labile groups in the shell which can be cleaved by an external trigger. The nanodroplets or nanoparticles can also be used as templates for producing inorganic shells as it offers the feasibility of synthesizing hybrid organic/inorganic functional materials for a broad spectrum of applications ranging from optoelectronics to biomedicine. The high surface area of nanoparticles can be used to grow inorganic material on the surface of the particles in order to produce composite nanoparticles comprising of bone mineral hydroxyapatite.



Different nanoparticles and nanocapsules consisting of magnetite or liquid cores with various components as obtained by miniemulsion polymerization.

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[1] Landfester K (2009). Miniemulsion Polymerization and the Structure of Polymer and Hybrid Nanoparticles. Angew. Chem.-Int. Edit. 48(25): 4488-4507.

[2] Landfester K, Musyanovych A, Mailander V (2010). From Polymeric Particles to Multifunctional Nanocapsules for Biomedical Applications Using the Miniemulsion Process. J. Polym. Sci. Pol. Chem. 48(3): 493-515.

Nano Graphene

Graphenes, single-layered subunits of graphite, exhibit unique electrical, optical and mechanical properties. The high charge carrier mobilities of graphenes qualify them as semiconductor components for field effect transistors. A problem for such electronic applications is their unsatisfyingly low on-off ratio. This drawback can be overcome by opening a band gap which is possible by the bottom-up fabrication of graphene nanoribbons (GNR's) which feature much higher aspect ratios.

Figure 1: Bottom-up organic synthesis of defect-free graphene nanoribbons in solution.

In an astonishingly straightforward process we can subject nonplanar polyphenylene precursors to a cyclodehydrogention reaction and thus flatten them (Figure 1) [1]. Despite the great success of this process the flat disc molecules exhibit a high propensity for aggregation thus hindering solution processability. To circumvent this dilemma we have developed a new chemistry by adsorbing precursor molecules on metal surfaces and monitoring the progress of the cyclodehydrogenation via scanning tunneling microscopy. The atomically precise synthesis of GNRs and the possibility of tuning their band gap highlight their possible role as semiconductors instead of silicon and conjugated polymers (Figure 2) [2,3].

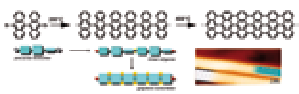

Figure 2: Bottom-up fabrication of atomicallyprecise graphene nanoribbons.

This process holds promise for a novel "programmed" polymer synthesis after deposition and pre-organisation of different monomer components on template surfaces.

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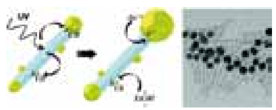
[3] Treier M, Pignedoli CA, Laino T, Rieger R, Müllen K, Passerone D, et al. (2011). Surface-assisted Cyclodehydrogenation Provides a Synthetic Route towards Easily Processable and Chemically Tailored Nanographenes. Nature Chemistry 3(1): 61-67.

Plasmonic Nanosensors: from Labeling Structures towards Truly Molecular Sensors

Optical spectroscopy of single plasmonic nanoparticles has evolved into a recognized tool for nanoscopic sensing applications, using the sensitivity to the nanoparticles environment,charge, size, shape, and proximity to other particles. Prof. Sönnichsen has been a pioneer of this technique for more than a decade and his group in Mainz is one of leading pleaces using this concept to study molecular processes and chemical reactions on individual particles. The group continues to optimize and automatize the technique. An example is the innovative use of a liquid crystal device as an electronically adressable spacial shutter replacing the entrance slit of an imaging spectrometer [1]. This simple modification allowed to carry out 30 experiments within one sample, effectively putting one month of work into a single day. The Sönnichsen group also tries to expand the use of the technique into new fields. From now well established investigations of biomolecular binding events, the group recently monitored the photo-induced growth of gold domains on semiconductor quantum rods on a single particle level [2]. Those hybrid metal-semiconductor particles are very promising candidates for photocatalytic conversion of solar light energy into artifical fuel. This study was the one of the first ever where a chemical reaction of single nanoparticles was monitored in real time. Since crystalline nanoparticles vary strongly from particle to particle in size, shape and crystal structure, such single particle investigations provide valuable insight into reaction mechanism and kinetic parameters.



UV light shining on a CdS nanorod (blue) leads to the excitation of electrons into the conduction band (left). These electrons transfer to the largest gold domain (yellow) where they reduce more gold from solution (center). This process results in 'matchstick'-like particles with large gold domains (TEM image on the right).

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[1] J. Becker, O. Schubert, C. Sönnichsen (2007). Gold Nanoparticle Growth Monitored in situ Using a Novel Fast Optical Single-Particle Spectroscopy Method. Nano Lett. 7: 1664-1669.

[2] L. Carbone, A. Jakab, Y. Khalavka, C. Sönnichsen (2009). Light-Controlled One-Sided Growth of Large Plasmonic Gold Domains on Quantum Rods Observed on the Single Particle Level. Nano Lett. 9: 3710-3714.

Optoelectronics

We succeeded recently in the preparation of monodisperse particles from a liquid crystalline elastomer in a microfluidic setup [1, 2]. For this, we prepare droplets from a liquid crystalline monomer in a microfluidic device and polymerize them, while they are flowing inside a microtube (see title page added). The particles obtained by this method possess an internal orientation of their polymer backbones, which gives them actuating properties. When they are heated into the isotropic phase of the liquid crystalline material they show a reversible change in shape whereby they change their length in one direction by almost 100%. We show, how the variation of experimental parameters during their synthesis impacts their primal shape, the strength of their shape changing properties, their size and their mechanical properties. Especially the possibility of producing actuators with an anisotropic primal shape is very exciting [2]. These have considerable advantages over spherical particles as the direction of actuation can be predicted beforehand (figure 1). Additionally a positioning of the actuators by self-organization becomes possible, because the "pumpkins" described in this article tend to lie on their flat side on a smooth substrate. This allows their use in large number, all actuating into a uniform direction.

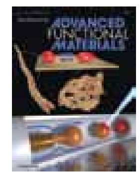

Figure 1: Title page: The artwork shows three aspects of our research: the microfluidic preparation of microparticles, their internal orientation and their ability to reversibly change their shape.

Figure 2: Heating experiment on an anisotropically shaped actuator looked at from the top and from the side. During heating to 130°C to shows a strong actuation perpendicular to its flat side. The scalebar is 100 µm.

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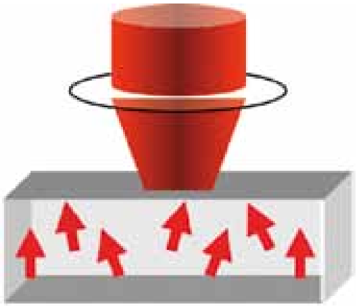
PUBLICATIONS OF PRINCIPAL INVESTIGATORS OF MAINZ

Explaining the Paradoxical Diversity of Ultrafast Laser-Induced Demagnetization

It is well known that heating a magnet leads to a reduction of its magnetization. In other words, the originally uniform orientation of the magnetization carrying spins is destroyed and they are driven into disorder.
But what happens when we use as heating source the shortest man-made process – a femtosecond laser pulse? In the field called Ultrafast Demagnetization researchers intensively discuss how fast a spin can change its orientation, and which are the predominant microscopic interactions behind such a spin-flip mechanism. This fundamental challenge was approached in a joint project, combining experimental and theoretical studies. The result was the development of the so-called "Microscopic Three Temperature Model (M3TM)", that is able to describe the rich variety of experimental findings on equal footing. Besides revealing the microscopic origin of the ultrafast demagnetization it was also possible to extract the spin-flip probability, the essential quantity behind the process. In particular, the M3TM offers a surprising simple explanation why in ferromagnetic cobalt, nickel and iron the time for the laser-induced loss of magnetization is three orders of magnitude faster than in gadolinium.
Regarding the tremendous velocity of this optical strategy it outclasses the contemporary data storage technology. A forceful application of this novel concept promises to pave the way for a revolutionary read-write concept in the computer of tomorrow.



Schematic picture showing a laser beam illuminating a ferromagnetic sample. The randomly oriented red arrows (spins) in the sample represent the laser-induced reduction of ferromagnetic order.

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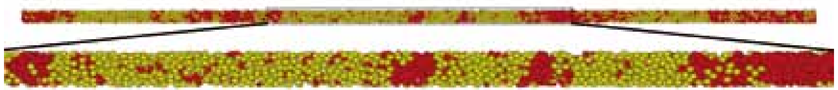
Koopmans B, Malinowski G, Longa FD, Steiauf D, Faehnle M, Roth T, Cinchetti M, Aeschlimann M (2010). Explaining the Paradoxical Diversity of Ultrafast Laser-Induced Demagnetization. Nature Materials 9(3): 259-265.

Rounding of Phase Transitions in Cylindrical Pores

Porous media find applications in the chemical and pharmaceutical industry for the separation of fluid mixtures; related problems occur also in the oil industry (oil recovery from porous sands and rocks, etc.). Understanding the phase behavior of fluids and fluid mixtures (vapor-liquid transitions as well as liquid-liquid unmixing) confined in long cylindrical pores is a central aspect to control such processes.
Using large-scale computer simulations for idealized model systems (Ising/lattice gas system, Asakura-Oosawa model of a colloid-polymer mixture) a substantial clarification could be achieved. It was shown that in the general case for a long straight pore (L much larger than D) two transitions occur: at a higher temperature, where the correlation length of order parameter fluctuations becomes comparable to D, the state of the fluid inside the pore changes from a state which is homogeneous in axial direction to an inhomogeneous state, characterized by a sequence of domains of length Ld, much larger than D but much smaller than L. When the temperature decreases further, Ld increases rapidly, and when Ld is of the order of L, the state of the pore changes from a multidomain configuration to a (bistable) monodomain configuration. This transition is accompanied by the occurrence of hysteresis (since domain walls running across the pore need to be nucleated, while in the multidomain state these domain walls are already present, and can easily be moved).



The snapshots show a typical multi domain configuration. Colloids are drawn in yellow, while polymers are drawn in red. The figure was generated with the QMGA-Sofware.

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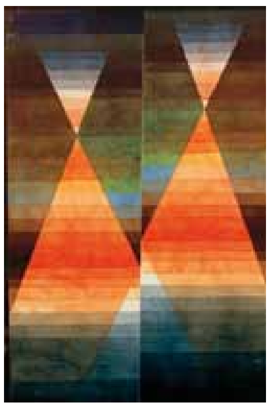
Wilms D, Winkler A, Virnau P, Binder K (2010). Rounding of Phase Transitions in Cylindrical Pores. Phys. Rev. Lett. 105(4).

Tunable Multifunctional Topological Insulators in Ternary Heusler Compounds

The novel Quantum Spin Hall state of matter realized in topological insulators (TIs) is an intensively emerging condensed matter field. It was predicted and than observed in HgTe/CdTe quantum well. The TI is connected with the quantized Hall effect (K. von Klitzing, Nobel prize 1985) and the superconductivity. TI insulates only in bulk, but exhibits conductive surface states formed pairwise by electrons of opposite spins moving antiparallel. Such current transfers only spin, but no charge. If the time is reversed, the spin current will not change since both electron spin and velocity are reversed. Being robust against any time-reversal symmetric perturbation this state leads to an outstanding property of TIs – the dissipationless spin current. Its linear dispersion in a form of the Dirac cone was also observed in graphene (A. Geim and K. Novoselov, Nobel Prize 2010). However the spin Hall effect in graphene is weak due to a weak spin-orbit coupling. Energy bands can be monitored by the angle-resolved photoemission. The Heusler compounds studied in Mainz are relatives of HgTe binary, thus it was not surprising to find more than 20 topologically non-trivial Heuslers. In contrast to binaries, Heuslers contain 3 elements by providing a coupling of several properties within one material, e. g. as superconductivity and topologically non-trivial band structure in LaPtBi. Some of them exist at the boundary between trivial and non-trivial states, i.e. at the quantum critical point.



The Dirac cone which appears in a band structure has also rather aesthetic view. Indeed, the similar shapes can be found in the pictures of Paul Klee, the famous German artist.

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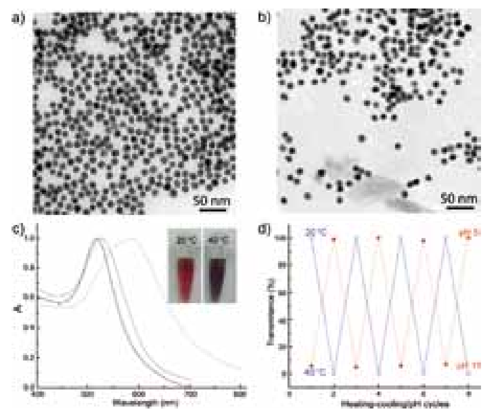
Chadov S, Qi XL, Kübler J, Fecher GH, Felser C, Zhang SC (2010). Tunable Multifunctional Topological Insulators in Ternary Heusler Compounds. Nat. Mater. 9(7): 541-545.

Thermosensitive Hyperbranched Polyelectrolyte-Coated Gold Nanoparticles: Towards Smart Temperature- and pH-Nanosensors

Metal and semiconductor nanoparticles are emerging as a new class of functional building blocks for sensing and biodetecting devices due to the easily detectable shifts of their unique optical and electronic properties upon alteration of the local environment or aggregation states. Although gold nanoparticles have been known for centuries, they currently find renewed interest in this context. In the paper by Frey et al. a simple, yet highly efficient strategy to switch aggregation states of gold nanoparticles has been developed. Using convenient chemistry, thermosensitive macromolecules with tree-like structure and a large number of end groups have been generated. These molecularly "sticky" polymers have been utilized to coat water-soluble gold nanoparticles. This gives rise to reversible thermal switching of the particle order, that is from ordered aggregates to single nanoparticles in the temperature range of 25-55°C. The paper clearly demonstrates the synergies that can be achieved by the combination of "hard" (i.e., inorganic metal) nanoparticles with a "soft" organic shell, reflecting the two large research areas present in the Graduate School MAINZ. The principles developed in this seminal paper have meanwhile been transferred to other nanoparticle systems in numerous other laboratories.



Microscopy images of gold nanoparticles a) before and b) after coating with the branched polymer shell; C) UV-vis absorption spectra of the original gold nanoparticles (solid line), gold nanoparticles coated with polymer shell at 20.0oC (dash line), coated gold nanoparticles at 40.0 °C (dotted line). Inset: photographs of aqueous solutions (pH= 9.0) of the coated gold nanoparticles at 20 oC and after heating up to 40.0oC; d) Changes of transmittance during both pH variation cycles between pH=5 and 11 and heating-cooling cycles between 20.0 °C and 40.0 °C.

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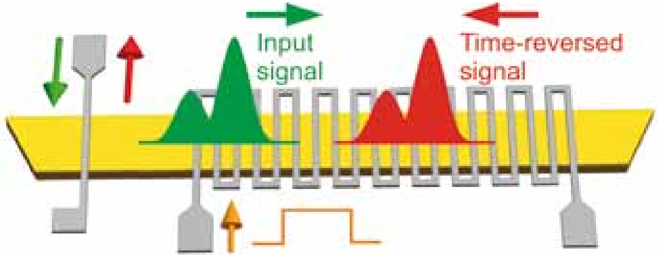
Shen Y, Kuang M, Shen Z, Nieberle J, Duan HW, Frey H (2008). Gold Nanoparticles Coated with a Thermosensitive Hyperbranched Polyelectrolyte: Towards Smart Temperature and pH Nanosensors. Angew. Chem.-Int. Edit. 47(12): 2227-2230.

All-Linear Time Reversal by a Dynamic Artificial Crystal

The paper describes an entirely new mechanism for the time reversal of pulsed signals that uses a particular type of dynamic artificial crystal with a lattice that can be rapidly made to appear and disappear. By briefly making the crystal lattice appear while a signal – in the form of a travelling wave – propagates through it, it is possible to generate a time-reversed version of it. The time-reversal effect was experimentally demonstrated using magnetic waves – known as spin waves – propagating in a dynamic artificial magnetic crystal but the phenomenon is entirely general, and can be applied to waves and signals of any type. The results not only have exciting implications for future information and data processing systems, but offer fascinating new insight into the fundamental physics of signals and waves.



Turning back time. A signal wave (green) is launched from an antenna (left) and allowed to propagate into a structure known as a dynamic artificial crystal. By rapidly altering the properties of the crystal structure using a control pulse (orange), a time-reversed version of the signal (red) is created.

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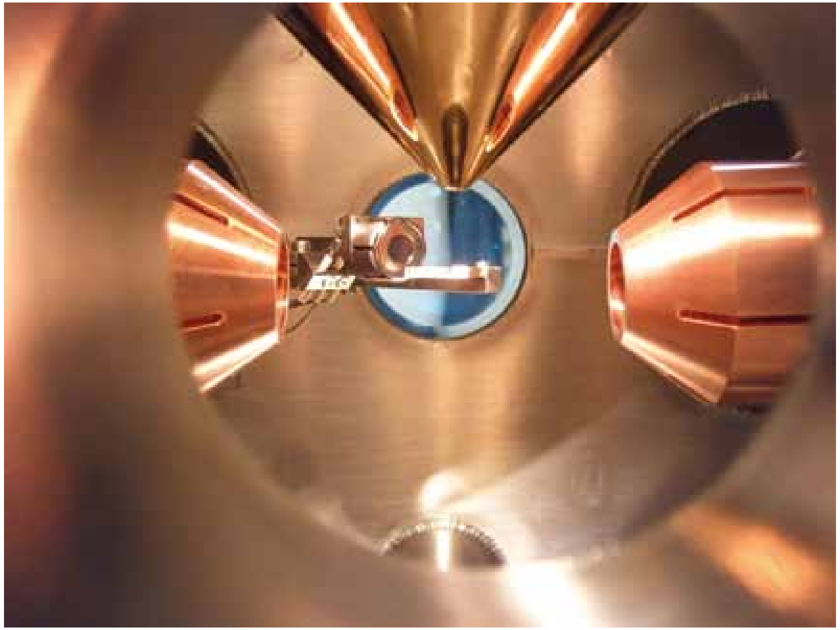
Chumak AV, Tiberkevich VS, Karenowska AD, Serga AA, Gregg JF, Slavin AN, Hillebrands B (2010). All-Linear Time Reversal by a Dynamic Artificial Crystal. Nature Communications 1(141).

High-Resolution Scanning Electron Microscopy of an Ultracold Quantum Gas

The physics of ultracold quantum gases bears many fascinating phenomena, ranging from fundamental quantum-mechanical questions up to technological applications such as high precision sensors. With help of scanning electron microscopy it is now possible to retrieve high resolution images of the atomic distribution in an ultracold quantum gas. This opens up new possibilities for the investigation of strongly correlated quantum gases, with special emphasis on their local static and dynamical properties. Such studies help to get more insight into quantum-mechanical many-body systems – a class of systems that often resists to an exact theoretical description.



Inside view of the scanning electron microscope for ultracold atoms.

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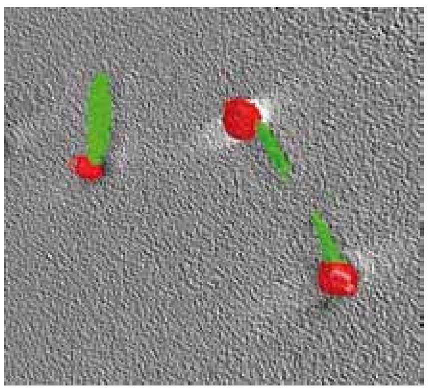
Gericke T, Würtz P, Reitz D, Langen T, Ott H (2008). High-Resolution Scanning Electron Microscopy of an Ultracold Quantum Gas. Nat. Phys. 4(12): 949-953.

One-Sided Growth of Large Plasmonic Gold Domains on CdS Quantum Rods Observed on the Single Particle Level

The synthesis of "hybrid" nanocrystals composed of domains from different material classes (e.g. magnetic, semiconducting, metal) represents a challenging field in material science. The multiple components of such nano-sized hybrid crystals provide several physical-chemical functionalities within one structure and novel properties are expected via the electronic and electromagnetic coupling between the components. Only a few years ago, the controlled crystallographic growth of small gold crystals selectively on the tips of rod-shaped semiconducting nanocrystals emerged, where the metal is in direct crystallographic contact with the semiconductor. Those structures showed a switch from two-sided to one-sided growth attributed to intraparticle electrochemical Oswald ripening. Those "dumbbell" or "matchstick" particles were used for directed self-assembly and it was shown that electrons created in the semiconductor by optical excitation transfer and accumulate on the gold tip where they are able to reduce organic molecules. So far, it has not been possible to control the size of the gold domain in those metal-sc hybrids. We developed a new strategy to create large gold domains (up to 15 nm) on CdS or CdSe/CdS quantum rods using a photochemical process. The gold domain is large enough to visualize single hybrid particles in a dark-field microscope during the particle growth in real time, which gives new insight into the electrochemical processes involved after photo-excitation of metal-semiconductor hybrid particles.



Projection of a reconstructed 3D TEM tomography representation of three CdS quantum rods (green) with a large gold domain (red). 3D tomography reveals the non-centric attachment of the gold domain on the semiconductor rod (best seen in this projection on the hybrid particle on the upper right).

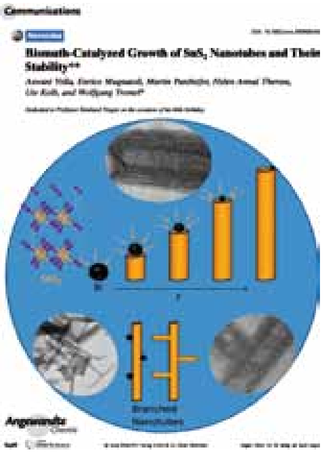
REFERENCES

Carbone L, Jakab A, Khalavka Y, Sönnichsen C (2009). Light-Controlled One-Sided Growth of Large Plasmonic Gold Domains on Quantum Rods Observed on the Single Particle Level. Nano Lett. 9(11): 3710-3714.

PUBLICATIONS OF DOCTORAL STUDENTS OF MAINZ

Bismuth-Catalyzed Growth of SnS2 Nanotubes and Their Stability

The vapor-liquid-solid approach (VLS) is used for the growth of 1D structures, such as nanowires by chemical vapor deposition. The VLS mechanism circumvents the slow crystal growth of a solid from the gas phase by a catalytic liquid metal phase which can rapidly adsorb vapor to the supersaturation level. Crystal growth can occur from nucleated seeds at the liquid-solid interface. We have applied this approach to the synthesis of these chalcogenide nanotubes by using a bismuth/tin catalytic alloy and SnS2 by heating this mixture under a stream of argon. The physical characteristics of the nanotube grown in this manner depend, in a controllable way, upon the size and physical properties of the liquid alloy.



Scheme illustrating the VLS approach for the growth of SnS2 nanotubes. Top row: (left) SnS2 crystal structure. (right) Bi metal droplet catalyzing the growth of a SnS2 nanotube. The growth of the nanotube grown depend upon the size of the liquid droplet. Nanotube growth stops when the Bi droplet is evaporated. Bottom row: Branched SnS2 nanotubes grown from Bi droplets on the sidewalls of a parent tube.

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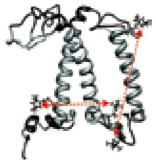
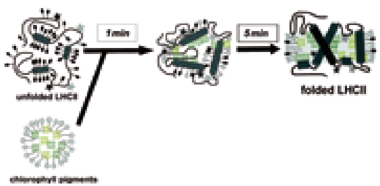
Yella A, Mugnaioli E, Panthöfer M, Therese HA, Kolb U, Tremel W (2009). Bismuth-Catalyzed Growth of SnS2 Nanotubes and Their Stability. Angewandte Chemie-International Edition 48(35): 6426-6430.

Refolding of the Integral Membrane Protein Light-Harvesting Complex II Monitored by Pulse EPR

The article focuses on the molecular folding process of a membrane protein with a key function in photosynthesis, known as the major light-harvesting chlorophyll a/b complex or LHCII. Electron paramagnetic resonance (EPR) techniques were used to measure distances between individual LHCII domains as a function of folding time. The study revealed two distinctive folding steps which are triggered by the binding of chlorophyll molecules into LHCII.
The two-step kinetics observed gives direct experimental proof to the hypothesized pigment-induced folding of the LHCII apoprotein and will help to understand membrane protein folding in general. This in turn will facilitate the insertion of recombinant LHCII in artificial membranes and its potential use as a light-harvester in photovoltaic applications.



Dotted traces show distances measured between PROXYL spin labels attached to the backbone of LHCII.



Two step folding model for LHCII in vitro. Mixing of denatured LHCII with chlorophylls induces the formation of secondary (less then one min) and tertiary structure (several minutes).

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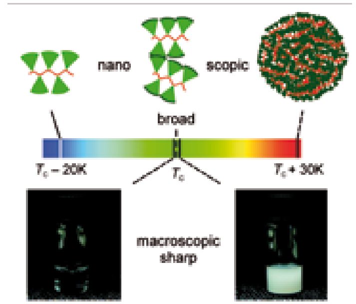
Dockter C, Volkov A, Bauer C, Polyhach Y, Joly-Lopez Z, Jeschke G, et al. (2009). Refolding of the Integral Membrane Protein Light-Harvesting Complex II Monitored by Pulse EPR. Proceedings of the National Academy of Sciences of the United States of America 106(44): 18485-18490.

EPR Spectroscopic Characterization of Local Nanoscopic Heterogeneities during the Thermal Collapse of Thermoresponsive Dendronized Polymers

Thermoresponsive polymers are promising materials for a wide range of applications since their state of hydration in aqueous solution can easily be controlled via a change in temperature. In this article, the authors employed a simple and cost-efficient electron paramagnetic resonance (EPR) spectroscopic technique to gain insight into the nanoscopic processes associated with the thermal collapse of dendronized polymers into monodisperse mesoglobular aggregates. It is shown that the aggregation of the polymer is triggered by dynamic structural heterogeneities of a few nanometers. Although macroscopically a sharp phase transition, the dehydration of the polymer chains involves several distinct processes and proceeds over a temperature interval of at least 30 K. These fundamental insights on the nanoscopic scale are essential for a rational materials design.



As evidenced by EPR spectroscopy, the thermal transition of water-swollen dendronized polymers to fully dehydrated mesoglobules proceeds over a much larger temperature range than their macroscopically observable aggregation.

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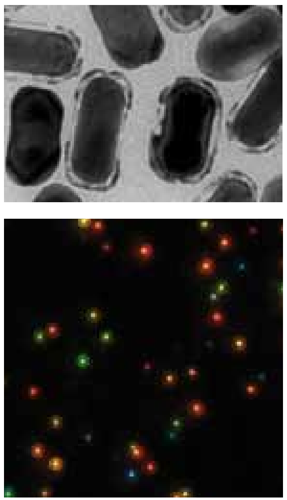
Junk MJN, Li W, Schlüter AD, Wegner G, Spiess HW, Zhang A, et al. (2010). EPR Spectroscopic Characterization of Local Nanoscopic Heterogeneities during the Thermal Collapse of Thermoresponsive Dendronized Polymers. Angewandte Chemie-International Edition 49(33): 5683-5692.

Synthesis of Rod-Shaped Gold Nanorattles with Improved Plasmon Sensitivity and Catalytic Activity

In our paper, we report a strategy for the preparation of rod-shaped gold nanorattles – hollow nanostructures with a solid nanorod inside. These particles combine two interesting features – strong scattering of the visible light and the high surface area.
Nanorattles can be used as very small biosensors because their color is influenced by the refractive index of surrounding medium. Furthermore, we have demonstrated that the rattles exhibited high catalytic activity for the conversion of 4-nitrophenol into widely used in chemical industry 4-aminophenol, for example in paracetamol production.



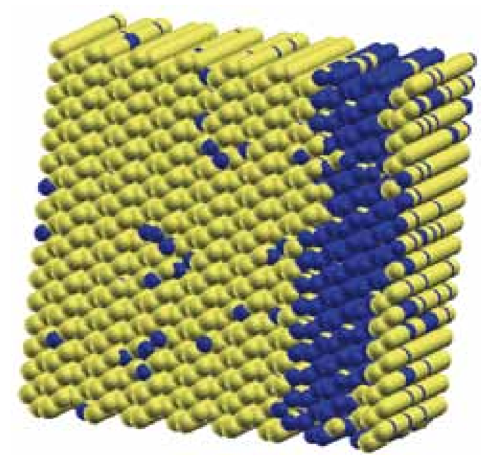
TEM image of the gold nanorattles (above) and their darkfield image (left).

REFERENCES

Khalavka Y, Becker J, Sönnichsen C (2009). Synthesis of Rod-Shaped Gold Nanorattles with Improved Plasmon Sensitivity and Catalytic Activity. Journal of the American Chemical Society 131(5): 1871-1875.

Indium-Gallium Segregation in CuInxGa1-xSe2: An Ab Initio-Based Monte Carlo Study

Solar power plays an increasingly important role in the generation of electrical energy, but it is still more expensive than fossile fuels. Therefore, research on solar cells is essential to provide us with cheap electricity in the future.
In a publication in Phys. Rev. Lett., the authors present results of computer simulations that explain why a higher production temperature leads to better CuInxGa1-xSe2 thin-film solar cells. The increased temperature improves the homogeneity and reduces band gap fluctuations. The conclusions can help to improve efficiencies and optimise industrial processes.



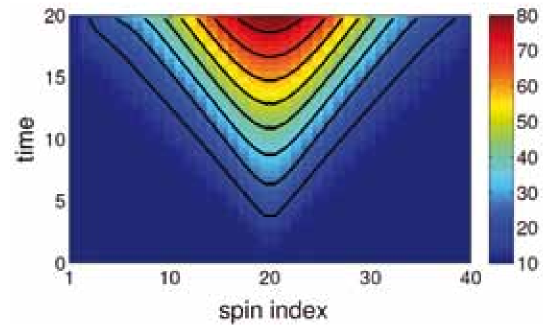
Distribution of In and Ga atoms in a Monte Carlo simulation. The snapshot shows phase separation into CuInSe2 and CuGaSe2 at low temperatures.

REFERENCES

Ludwig CDR, Gruhn T, Felser C, Schilling T, Windeln J, Kratzer P (2010). Indium-Gallium Segregation in CuInxGa1-xSe2: An Ab Initio-Based Monte Carlo Study. Physical Review Letters 105(2), 025702.

Dynamical Simulation of Integrable and Nonintegrable Models in the Heisenberg Picture

Understanding the quantum dynamics of condensed matter systems is crucial for new technological applications. However few models are simple enough to allow analytical treatment and numerical studies are limited by the growth of entanglement with time. Our paper explains why for integrable models certain quantities can be calculated requiring only a small amount of entanglement, which is what ordinary computers can handle. Furthermore we show that certain quantities can also efficiently be simulated in the case of non-integrable systems, thus potentially opening a new approach to dynamical many-body calculations.



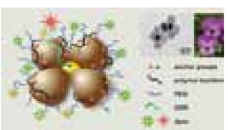
Effective Hilbert space dimension for any Pauli operator as a function of position and time in an isotropic spin 1/2 Heisenberg chain.

REFERENCES

Muth D, Unanyan RG, Fleischhauer M (2011). Dynamical Simulation of Integrable and Nonintegrable Models in the Heisenberg Picture. Physical Review Letters 106(7), 077202.

Au@MnO Nanoflowers: Hybrid Nanocomposites for Selective Dual Functionalization and Imaging

Located at the interface between nanotechnology, medicine and biotechnology, nano-biotechnology offers tremendous advantages for the development of future therapeutic and diagnostic techniques. Magnetic nanoparticles (MNPs) are especially interesting in this respect because they show an enormous potential as contrast agents for magnetic resonance imaging (MRI). Furthermore, MNPs offer the possibility to decorate their surface with special molecules to allow, for example, the detection of cancer or the controlled release of drugs. Yet, this surface modification is usually achieved by equipping the desired molecules with certain "anchors" that strongly attach on top of the NPs. However, most of these anchors are restricted to one kind of material which limits the number of functionalities on the MNPs. As a solution to this problem, we created composite NPs consisting of two materials, gold (Au) and manganese oxide (MnO), in a flowerlike arrangement. Herein, the MnO "petals" represent a powerful contrast agent for MRI, while Au NPs are effective probes for cancer treatment. Now, with the presence of two different materials, there are also two individual surfaces that each can be selectively addressed by suitable anchors, thus doubling the functionality of the NPs. For instance, dopamine binds on MnO, whereas thiols bind to Au. Hence, we developed two ligands to selectively attach on either surface: one containing dopamine and one carrying a thiol group. As a proof of principle, we tagged each ligand with a different dye after the attachment was complete (red for Au, green for MnO). And indeed, the red and green signals were clearly visible under the microscope and originated from the same spot. Therefore, the assumption that it is possible to selectively modify both entities of the Au@MnO nanoflowers to increase the overall functionality was hereby confirmed. As a result, Au@MnO nanoflowers are promising as multifunctional devices for biomedical applications, including MRI and cancer treatment.



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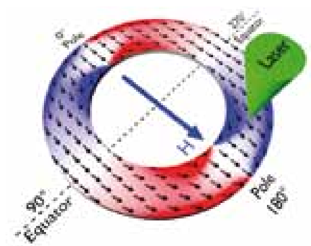
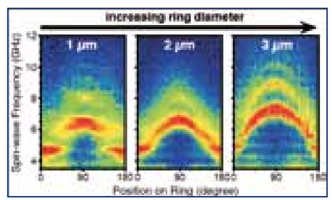
Schladt TD, Shukoor MI, Schneider K, Tahir MN, Natalio F, Ament I, et al. (2010). Au@MnO Nanoflowers: Hybrid Nanocomposites for Selective Dual Functionalization and Imaging. Angewandte Chemie-International Edition 49(23): 3976-3980.

Observation of Coherence and Partial Decoherence of Quantized Spin Waves in Nanoscaled Magnetic Ring Structures

A challenging task in the field of spintronics is the realization of purely spin-based data processing. For this purpose an efficient mechanism for the transportation of spin-encoded information is needed. The straight forward solution, diffusive transport of spin information, has the disadvantage of very small operating distances due to high spin relaxation rates in metallic materials. Another promising approach is the conversion of spin information into spin waves, the fundamental excitation quanta of ferromagnetic materials with operating distances two orders of magnitude larger than the spin diffusion lengths in metals. Here we address the coherence of spin waves in micron sized rings and demonstrate the transition from a fully coherent to a partially decoherent eigenmode system.



The black arrows indicate the direction of the magnetization in a micro-ring with a diameter of 2µm. The spin-wave intensity is locally probed by means of Brillouin light scattering (BLS) microscopy with a focused laser spot.



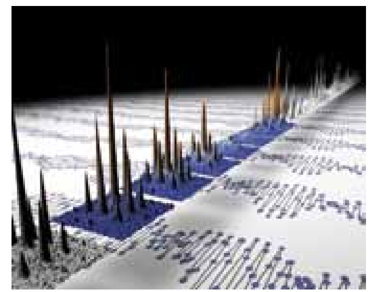
BLS spectra as a function of position on the ring structures. Red (blue) indicates high (low) spin-wave intensities.

REFERENCES

Schultheiss H, Schäfer S, Candeloro P, Leven B, Hillebrands B, Slavin AN (2008). Observation of Coherence and Partial Decoherence of Quantized Spin Waves in Nanoscaled Magnetic Ring Structures. Physical Review Letters 100(4), 047204.

Time-resolved Observation of Coherent Multi-Body Interactions in Quantum Phase Revivals

At extremely low temperatures atoms can aggregate into so-called Bose Einstein condensates (BEC) forming coherent laser-like matter waves. Due to interactions between the atoms fundamental quantum dynamics emerge and give rise to periodic collapses and revivals of the matter wave field. This work takes a glance "behind the scenes" of atomic interactions by revealing the complex structure of these quantum dynamics. By generating thousands of miniature BECs ordered in an optical lattice it was possible to observe a large number of collapse and revival cycles. The experimental results imply that the atoms do not only interact pairwise – as typically assumed – but also perform exotic collisions involving three, four or more atoms at the same time. On the one hand, these results have fundamental importance for the understanding of quantum many-body systems. On the other hand, they pave the way for the generation of new exotic states of matter, based on such multi-body interactions.



The collapse and revival dynamics of Bose-Einstein condensates trapped in an optical lattice reveal exotic multi-body interactions. The image shows a sequence of interference patterns containing the dynamics.

REFERENCES

Will S, Best T, Schneider U, Hackermüller L, Lühmann DS, Bloch I (2010). Time-resolved Observation of Coherent Multi-body Interactions in Quantum Phase Revivals. Nature 465(7295): 197-201.

KEY ELEMENTS OF OUR PROGRAM

In the following section you will find the key elements of the structured doctoral program of the Graduate School Materials Science in Mainz (MAINZ). Every aspect of our program places special emphasis on networking. Networking opportunities for our doctoral students are provided through a variety of avenues, e.g., external mentoring, secondments at our partner institutions worldwide, contact with industrial partners, and conference participation. Our graduate school training program primarily focuses on scientific and technological training through research on individual and personalized projects. This is complemented by substantial training for researchers addressing relevant complementary skills and competencies. The research training opportunities provided by the Graduate School MAINZ go far beyond the scope of a single research training group. They include interdisciplinary training and an exchange of knowledge in different fields of materials science.

TEAM SUPERVISION

Each student has an individual thesis committee of at least two experienced scientists comprising the thesis advisor and one additional advisor who will meet with the doctoral student on a regular basis to discuss the student's progress. The committee is responsible for the student's personalized development and training, ensures the quality of the training, and supports the student's career development. Students analyze their skills and abilities together with their thesis committee shortly after starting the doctoral thesis and agree on training to develop individual skills further. This is documented in each student's Career Development and Training Plan to allow tracking of progress throughout the doctoral thesis. In this way, the structured training program of MAINZ ensures that students receive the most individualized, flexible and effective means of meeting their needs in preparing and writing a doctoral thesis. This way their pathway towards becoming an excellent scientist is paved. Additionally, the thesis committee ensures individual interaction of the doctoral student with other permanent or visiting scientists to assist them in building his or her own scientific network.

CAREER SUPPORT AND MENTORING

Our program provides career support for doctoral students in a variety of ways. Firstly, doctoral students have the opportunity to acquire complementary skills through our Training for Researchers Program which offers a variety of courses from time management and additional language training to intercultural communication. Secondly, we support and encourage networking activities in many ways, including via the mentoring program. In this program, each student can choose an external mentor from an industrial partner, or a high-profile, internationally renowned scientist from academia. The external mentor provides advice on more general aspects of training and research and also assists in establishing an individual scientific network to support the student's career development.

INTERNATIONAL CHARACTER

The graduate school provides doctoral students an outstanding opportunity to gain valuable international experience. International students constitute approximately 30% of all doctoral student members of MAINZ, hailing from over 20 different countries. MAINZ partners with research institutions, universities and industrial partners from around the globe. During their thesis preparation, doctoral students of MAINZ are given the opportunity to spend up to 12 months at a foreign academic institution or industrial partner of the graduate school. Additionally, doctoral students attend international summer schools – MAINZ organizes up to six schools per year together with international partners – and present their research work at international conferences. Furthermore, MAINZ provides undergraduate and graduate students from foreign institutions the opportunity to join the school for an internship of up to 12 months. English is the working language within the graduate school.


ROMANIA
PASAPORT
पासपोर्ट
PASSPORT
भारत गणराज्य
REPUBLIC OF INDIA

COMMUNICATION OF SCIENCE

Doctoral students in our program are encouraged to actively participate in domestic and international scientific conferences or workshops, allowing them to present the results of their research even at a very early stage of their careers. These events often serve as a forum for young scientists, where they can not only present their own research to a wider audience, thereby obtaining greater confidence and improved communication skills, but also make themselves known to the professional community in their respective fields. We encourage our students not only to present posters at conferences but also to deliver oral presentations about their work in sessions or symposia during those conferences. Additionally, the graduate school awards the Gutenberg Research and Gutenberg Lecture Award annually to outstanding international renowned scientists who in turn give lectures at the graduate school.

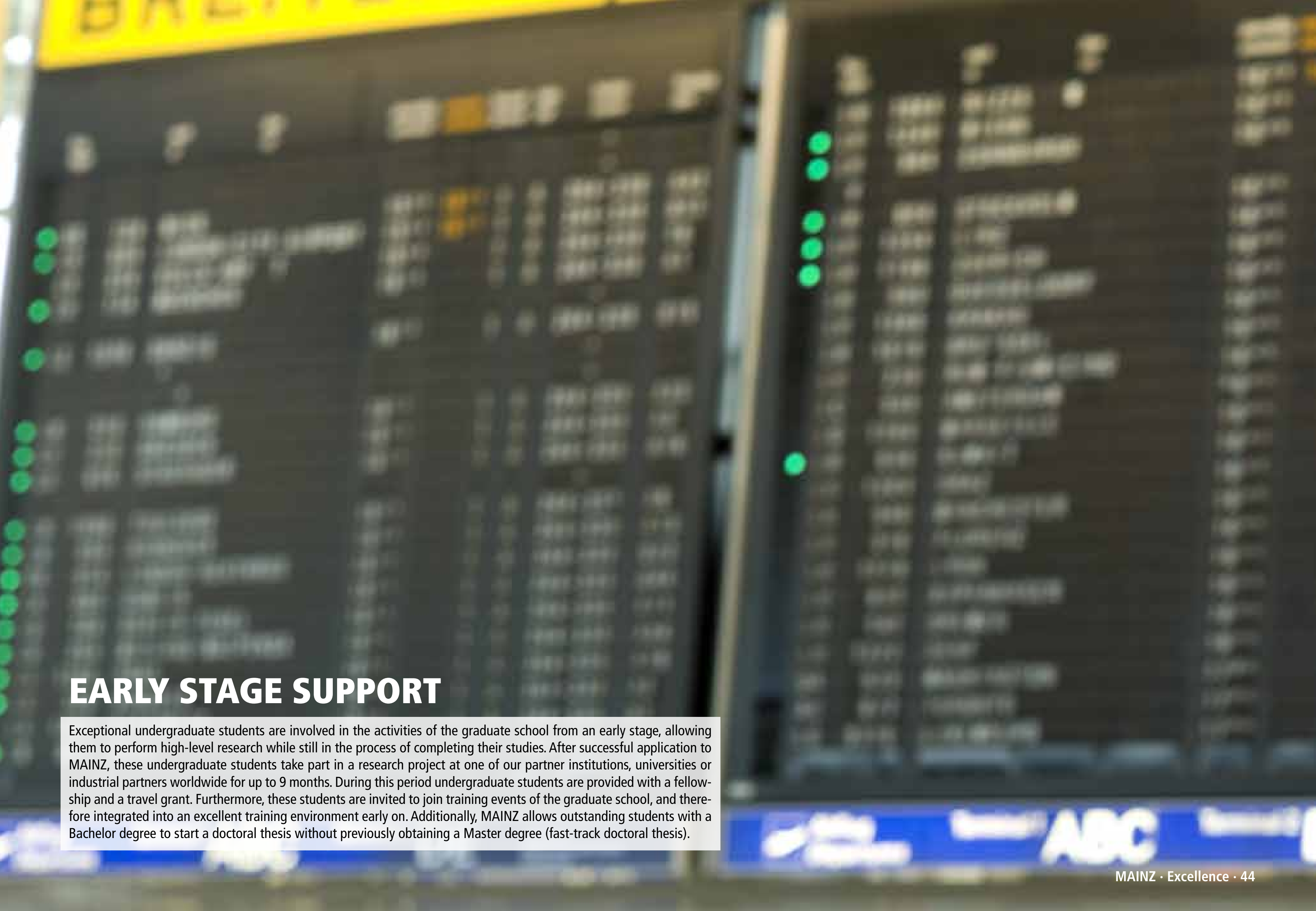
COOPERATION WITH INDUSTRY AND TECHNOLOGY TRANSFER

MAINZ offers its students contact with world leading industrial partners in the field of materials science. Personnel from our industrial partners are involved in many graduate school activities, such as lectures, summer schools, as mentors and in joint research projects. In cooperative research projects, students have the opportunity to complete all or part of their thesis at one of our industrial partners. These projects are performed in close collaboration with and under supervision of an experienced academic scientist of the graduate school, which serves to facilitate technology transfer.

AGFA
BASF
BAYER
BOSCH
DUPONT
EVONIK
Henkel
Heraeus
IBM
IMM Institut für Mikrotechnik Mainz GmbH
ISABELLENHÜTTE
SCHOTT
SIEMENS
SURFACE CONCEPT

NEW APPROACHES TO TRAINING

To foster the establishment of innovative training for doctoral students, the graduate school supports new approaches to training – approaches that are developed by the students themselves. The school provides a stimulating environment for creativity and invites experts to support our students in their efforts. This approach has, for example, led our doctoral students to establish the Journal of Unsolved Questions (abbreviated JUnQ), an idea born during a think tank session with experts from the MIT and UC Berkeley. The first issue of JUnQ was published in January 2011. The Donor's Association for the Promotion of Science and Humanities in Germany honored our students' efforts by bestowing JUnQ with the "Hochschulperle" award in April 2011. The editors of JUnQ also helped to establish our lecture series, "Publish or Perish?", which not only stimulated discussion about honesty in science both within and outside the graduate school but also contributed to greater public and media interest in this issue and the journal itself.



EARLY STAGE SUPPORT

Exceptional undergraduate students are involved in the activities of the graduate school from an early stage, allowing them to perform high-level research while still in the process of completing their studies. After successful application to MAINZ, these undergraduate students take part in a research project at one of our partner institutions, universities or industrial partners worldwide for up to 9 months. During this period undergraduate students are provided with a fellowship and a travel grant. Furthermore, these students are invited to join training events of the graduate school, and therefore integrated into an excellent training environment early on. Additionally, MAINZ allows outstanding students with a Bachelor degree to start a doctoral thesis without previously obtaining a Master degree (fast-track doctoral thesis).

CAREERS OF OUR ALUMNI

Doctoral students who have completed their thesis at our graduate school successfully continue their career in another academic institution or in commercial industry. The graduate school follows its alumnae's careers and stays in close contact with them by including them in training activities at the school and by having them as advisors or mentors for the next generation of doctoral students. Our aim is to create the conditions for a better postgraduate education by bringing together former and current students through alumni events and activities, thereby promoting career-long cross-disciplinary thought in science and industry. In the following, we profile four selected MAINZ alumni, focusing on their subsequent careers and hopes for the future.

Foto: BASF

Kerstin Wiss

Kerstin Wiss
Head of a Laboratory Team at BASF

"I WOULD LIKE to continue working in polymer research over the next few years. I'm not yet sure what I want to do after that; after all, I'm still only really getting started," explains Kerstin Wiss. Since December 2010, the 28-year-old has been working as the head of a polymer research laboratory team at the chemicals company BASF, based in Ludwigshafen. Kerstin and her three colleagues direct their efforts toward the synthesis of polyols required to produce polyurethanes. These plastics are used to make products as diverse as insulating foams, mattresses, athletic tracks for sports stadiums and much more. Kerstin is following up on the doctoral project she undertook at the Graduate School of Excellence Materials Science in Mainz (MAINZ), which was concerned with the synthesis of polymers. These are long chains or extensively branched molecules made up of several homogeneous building blocks, called monomers. In August 2010, she finalized her doctoral degree under the supervision of Patrick Théato and Prof. Rudolf Zentel of the Institute of Organic Chemistry of Johannes Gutenberg University Mainz (JGU), after which she accepted a position at BASF. "I found the atmosphere there and the projects proposed to me during the interview very attractive. And there are plenty of opportunities to progress in a global company like BASF," Kerstin adds. In her current job, she finds that she is not only profiting from the academic training she received in MAINZ but also from the soft skill courses provided by the school. "Presentation techniques, self-management skills, intercultural communication – all these I find really useful both personally and career wise," she claims. "Also of importance for me were my stays in the USA that were financed by MAINZ." During her doctoral studies, Kerstin attended, among others, two conferences of the American Chemical Society – one in Philadelphia, the other in San Francisco – and also spent three months doing research in Delaware. "These were really valuable experiences for me." Her improved language skills are of great value to her now that she communicates with colleagues around the world.

Christina Birkel
Postdoctoral Student at UC Santa Barbara

Foto: Thomas Hartmann

Christina Birkel

"COMPLETING A POST-DOCTORAL lecturer qualification at a university or Fraunhofer institute and overseeing my own study group" is how Christina Birkel sees her ideal professional future in about two years' time. The 27-year-old is currently working towards this goal by producing top quality publications. Since March 2011, Christina has been working as a postdoctoral student under Prof. Galen Stucky at University of California in Santa Barbara (UCSB). She qualified for this post thanks to the doctoral degree awarded in November 2010 by the Graduate School MAINZ under the supervision of Prof. Wolfgang Tremel of the Institute for Inorganic and Analytical Chemistry at JGU. MAINZ allowed her to nominate her own mentor and to maintain close contacts with him. Christina chose Ram Seshadri, for whom she had already written her senior-year thesis. Seshadri is a former postdoctoral student of Wolfgang Tremel and now Professor at UCSB. Thanks to financial support provided by MAINZ, Christina was able to meet with him last summer at a conference in New London, New Hampshire, where she asked him for his advice on how she should shape her future career. Seshadri advised her to get in touch with his colleague Galen Stucky. Once it became clear that Christina's husband (like her an alumnus of MAINZ) would also get a post at UCSB, she took Seshadri's advice and turned down the job offer she had received from the University of Oregon. In Santa Barbara on the Pacific coast, she is also intending to continue with the subject she dealt with in her doctoral thesis – the thermo electrical applications of nanoparticles; in other words, how electrical energy can be generated from special chemical compounds, such as antimonides, by means of temperature variation.

Daniel Keßler

Department Head at Steuler-KCH Materials

Daniel Kessler defines his short term professional goal as "organizing and expanding my department." For Daniel, "my department" means the R&D "Rubber Linings" department at Steuler-KCH Materials in Siershahn in Germany's Westerwald region. As a subsidiary of the Steuler Corporation, with its 2000 employees worldwide, Steuler-KCH Materials produces anticorrosion systems for industrial plants and other major construction projects. Daniel has been working for Steuler-KCH Materials since January 2010. He was appointed head of department in February 2011 and supervises a staff of five. The 30-year-old laid the cornerstone for his career by completing a doctoral degree at the Graduate School MAINZ under the supervision of Prof. Rudolf Zentel of JGU's Institute of Organic Chemistry. Awarded his doctorate in August 2009, Daniel had been conducting research into how surfaces could be coated to provide them with specific characteristics, such as making them particularly water-resistant or ensuring that certain substances adhere well to them. "Exploring surface effects represents a common theme of my course of studies," explains Daniel. "A position in a company that produces coatings was a perfect fit for me." Among other things, he is now working on the development of linings for flue gas desulfurization scrubbers, which need to be highly resistant to sulfuric and phosphoric acid. What he finds particularly interesting in his work is his contact with the clients – "they give you direct feedback on your products" – and the vastly different range of requirements that he needs to meet. "We not only work with customers from the fertilizer, gold and solar industries, but have also been commissioned to develop a special lining for a swimming pool installed on the 30th floor of a hotel." He also finds that he still profits from the interdisciplinary approach at MAINZ: "There were plenty of workshops and seminars on various subjects that even today are of use to me. It provided me with insights across a wide range of topics."

Foto: Eric Lichtenscheid

Daniel Keßler

Frederik Wurm

Postdoctoral Student at EPFL

Asked about his future career aims, Frederik Wurm replies: "A professorship in Germany." Since the autumn of 2009, the 30-year-old has been working as a postdoctoral student in Prof. Harm-Anton Klok's research group at École polytechnique fédérale de Lausanne (EPFL), one of Switzerland's leading scientific institutions. From the fall of 2006 to the summer of 2009, Wurm studied to acquire his doctoral degree under Holger Frey, Professor at the Institute of Organic Chemistry of JGU. In the fall of 2007, following its success in the Excellence Initiative, he switched to the then recently founded Graduate School MAINZ. The subject of his doctoral dissertation was the synthesis of special, multi-branched macromolecules derived, for example, from polyglycerins. These molecules have a range of uses, including medical applications. When combined with active drug substances, they can protect these as they pass through the body on the way to their target site, which could be cancer cells. "The polymer acts as a protective coating that shields the active substance," he explains. He is also working on bio applications of these substances, including polyglycerins, at EPFL. But his training at the Graduate School MAINZ proved to be of benefit in other ways as well: "It was great that the school provided the financial support to enable me to spend three months with a work group in Bristol," he points out. This not only allowed him to improve his language skills and gain insight into other cultures, but also introduced him to new ways of doing things. Frederik will probably remain at EPFL on Switzerland's Lake Geneva until the end of the year. Then he hopes to obtain an appointment in Germany that eventually will lead to the aspired professorship.

Foto: privat

Frederik Wurm

Portrayals: Jonas Siehoff

Illustration: Erika Martins

MEMBERS OF THE GRADUATE SCHOOL MAINZ

Prof. Martin Aeschlimann

DEPARTMENT OF PHYSICS AND RESEARCH CENTER OPTIMAS, UNIVERSITY OF KAISERSLAUTERN

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

Our research program is devoted to the investigation of ultrafast phenomena in solids, thin films and nanoparticles. This includes the combination of short pulsed laser systems with surface science technology in order to develop novel methods for measuring ultrafast relaxation processes in real time with high temporal and spatial resolution.

SELECTED PUBLICATIONS

- Koopmans B, Malinowski G, Longa FD, Steiauf D, Faehnle M, Roth T, Cinchetti M, Aeschlimann M(2010). Explaining the Paradoxical Diversity of Ultrafast Laser-Induced Demagnetization. Nature Materials 9(3): 259-265.
- Aeschlimann M, Bauer M, Bayer D, Brixner T, de Abajo FJ, Pfeiffer W, et al. (2007). Adaptive Subwavelength Control of Nano-Optical Fields. Nature 446(7133): 301-304.

Prof. James R. Anglin

DEPARTMENT OF PHYSICS, UNIVERSITY OF KAISERSLAUTERN

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

Theory of ultra-cold quantum gases as a probe of fundamental physics at the interface between quantum mechanics and thermodynamics. In particular: transport and collective dynamics in non-equilibrium many-body quantum systems; localized collective excitations, such as solitons, vortices, topological defects and textures; post-adiabatic effects under time-dependent Hamiltonians leading to quantum entropy production; quantum decoherence in open systems.

SELECTED PUBLICATIONS

- Strzys MP, Anglin JR (2010). Four-Mode Bose-Hubbard Model With Two Greatly Different Tunneling Rates As a Model for The Josephson Oscillation of Heat. Phys. Rev. A 81 043616.
- Thouless DJ, Anglin JR (2007). Vortex Mass in a Superfluid at Low Frequencies. Phys. Rev. Lett. 99(10), 105301.

Prof. Thomas Basché

INSTITUTE OF PHYSICAL CHEMISTRY,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

Optical single molecule techniques are employed to study a variety of phenomena including molecular photophysics and photochemistry, energy and charge transport between molecules and dynamics of glasses and polymers. Core-shell semiconductor nanocrystals with different shapes and composition are synthesized and characterized by electron microscopy and optical spectroscopy. In addition, nanocrystals are assembled into supramolecular aggregates to achieve novel optical properties.

SELECTED PUBLICATIONS

- Fückel B, Hinze G, Nolde F, Müllen K, Basché T (2009). Control of the Electronic Energy Transfer Pathway between Two Single Fluorophores by Dual Pulse Excitation. Phys. Rev. Lett. 103(10), 103003.
- Feist FA, Tommaseo G, Basché T (2007). Observation of Very Narrow Linewidths in the Fluorescence Excitation Spectra of Single Conjugated Polymer Chains at 1.2 K. Phys. Rev. Lett. 98(20), 208301

Prof. Kurt Binder

INSTITUTE OF PHYSICS,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The research field of Kurt Binder and collaborators has its focus on the statistical mechanics of condensed matter, with a strong emphasis on both the development and the application of computer simulation methods, such as Monte Carlo techniques and molecular dynamics simulation. The systems that are studied range from generic model systems (e.g. the random field Ising model as a description of antiferromagnets with nonmagnetic impurities in a magnetic field, and at the same time of colloid-polymer mixtures in a frozen gel-like structure) to chemically realistic models of real materials which can be directly compared to corresponding experimental data. The latter include both "hard matter" (e.g. glassy germaniumdioxide) and "soft matter" (e.g. alkane chains dissolved in carbon dioxide) and even hybrid hard/soft systems (polybutadiene near graphite or alumina solids). Central themes of research are colloids (participation in the TR6) and functional polymers such as bottle-brush polymers (participation in the CRC625).

SELECTED PUBLICATIONS

- Wilms D, Winkler A, Virnau P, Binder K (2010). Rounding of Phase Transitions in Cylindrical Pores. Phys. Rev. Lett. 105(4), 045701.
- Winter D, Virnau P, Binder K (2009). Monte Carlo Test of the Classical Theory for Heterogeneous Nucleation Barriers. Phys. Rev. Lett.103(22), 225703.

Prof. Hans-Jürgen Butt

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

We study the structure and properties of interfaces and the interaction between them. Our aim is to better understand the relationship between structural changes, dynamics, and driving forces. Major topics are interfacial forces and the dynamics of wetting. For example, we investigate liquids that are internally structured at different length scales, such as polymer melts, solutions, dispersions, or emulsions. The methods we use include scanning probe techniques, confocal microscopy, focused ion beam, microrheology, light and X-ray scattering. To expand the range of length and time scales accessible, new methods are continuously developed. Our goal is to solve fundamental questions, with the perspective of future applications.

SELECTED PUBLICATIONS

- Sokuler M, Auernhammer GK, Roth M, Liu CJ, Bonaccurso E, Butt HJ (2010). The Softer the Better: Fast Condensation on Soft Surfaces. Langmuir 26(3): 1544-1547.
- Gomopoulos N, Maschke D, Koh CY, Thomas EL, Tremel W, Butt HJ, Fytas G (2010). One-Dimensional Hypersonic Phononic Crystals. Nano Lett. 10(3): 980-984.

Aránzazu del Campo, PhD

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 11/09

AREA OF RESEARCH

The interaction between two bodies in close proximity is strongly influenced by the chemical nature of their outmost molecular layer and their surface topography. The external control of these factors enables fine tuning of the resulting adhesion forces. Of particular interest are surface designs which enable strong but reversible attachment, or even selective adhesion. Biology provides spectacular examples which inspire our developments, e.g., the hierarchical assembly of nano-sized setae found in gecko's feet, which enable their effective locomotion, or the selective attachment of cells to surfaces with particular topographies and compositions. Artificial realization of such properties requires the combination of responsive chemistries and surface engineering with micro- and nanofabrication techniques to obtain complex and active surface designs. This combination allows us to control adhesion phenomena at different levels in multiple fields of modern technologies.

SELECTED PUBLICATIONS

- Boesel LF, Greiner C, Arzt E, del Campo A (2010). Gecko-Inspired Surfaces: A Path to Strong and Reversible Dry Adhesives. Advanced Materials 22(19): 2125-2137.
- Petersen S, Alonso JM, Specht A, Duodu P, Goeldner M, del Campo A (2008). Phototriggering of Cell Adhesion by Caged Cyclic RGD Peptides. Angewandte Chemie-International Edition 47(17): 3192-3195.

Prof. Sebastian Eggert

DEPARTMENT OF PHYSICS,
UNIVERSITY OF KAISERSLAUTERN

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The research is focused on interacting quantum many-body systems in which the correlation effects are so strong that their properties cannot be described by perturbation theory from an independent particle picture. This is frequently the case in low dimensional electron systems, such as nanostructured quantum wires (Luttinger liquids), low dimensional antiferromagnets, carbon nanotubes, quasi-one-dimensional metals, and fractional quantum Hall edge states. The interest in these systems seems to be ever increasing due to the rapid experimental progress in nanoscale physics, ultra-cold quantum gases, and the availability of materials with intrinsically low-dimensional behavior, such as high-temperature superconductors.
In order to study these systems it is useful to combine field theoretical methods with advanced numerical techniques. The numerical techniques yield nearly exact results, but are limited by finite temperatures and/or system sizes. On the other hand, field theory techniques give asymptotically exact analytical results in the thermodynamic limit and at low temperatures. The two methods therefore complement each other to give a complete understanding which often allows detailed comparisons with experiments. Most recently we have focused on supersolid phases, the density of states in tunneling experiments, dynamic decoherence properties, and scattering from impurities and boundaries.

SELECTED PUBLICATIONS

- Schneider I, Eggert S (2010). Recursive Method for the Density of States in One Dimension. Phys. Rev. Lett. 104(3), 036402.
- Schneider I, Struck A, Bortz M, Eggert S (2008). Local Density of States for Individual Energy Levels in Finite Quantum Wires. Phys. Rev. Lett. 101(20), 206401.

Prof. Hans-Joachim Elmers

INSTITUTE OF PHYSICS,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The research area focuses on ferromagnetic epitaxial films and nanostructures, new materials with high spin polarization and dynamic magnetic properties. Using spin-polarized low-temperature scanning tunneling spectroscopy, magnetization structures, and their interaction with electronic states are investigated with atomic resolution. The width of magnetic domain walls in two-dimensional ferromagnets consisting of a single atomic layer shrinks below one nanometer, thus pushing the physical limits of magnetic storage density to the atomic scale. Recent activities include spatially resolved spin transport through molecules deposited on ferromagnetic surfaces. Material design has been sustained by compositional tailoring of high spin polarization and shape memory properties of ferromagnets. As a recent highlight we determined the spin-resolved density-of-states function in Heusler alloys from polarization-dependent X-ray absorption. An experimental progress has been achieved by a method allowing an X-ray absorption measurement on epitaxial films in transmission. A newly detected circular dichroism effect in threshold two-photon photoemission using femtosecond laser pulses enables future investigations of magnetization dynamics on a femtosecond time scale. The large value of the dichroism effect that is comparable to X-ray magnetic circular dichroism challenges the understanding of classical photoemission theories.

SELECTED PUBLICATIONS

- Hild K, Maul J, Schönhense G, Elmers HJ, Amft M, Oppeneer PM (2009). Magnetic Circular Dichroism in Two-Photon Photoemission. Phys. Rev. Lett.102(5), 057207.
- Jakob G, Eichhorn T, Kallmayer M, Elmers HJ (2007). Correlation of Electronic Structure and Martensitic Transition in Epitaxial Ni2MnGa Films. Phys. Rev. B 76, 174407.

Prof. Claudia Felser

INSTITUTE OF CHEMISTRY AND ANALYTICAL CHEMISTRY, JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The scientific concept behind MOMENT (Materials for Optical, Magnetic, and Energy Technologies) is the synthesis of new multifunctional materials on the basis of a rational inverse design for future electronics and energy technologies. The short-term goal is the design, synthesis, and investigation of building blocks (new compounds) based on a filled tetrahedral structure (Heusler compounds and related structure type) with combined functionalities manipulated on an atomic scale. In an inverse approach the materials will be designed with a desired property. The long-term goal is the development of artificial materials based on the building blocks made by chemistry on the atomic scale (thin film technique) with contactless switchable functionalities via external control (fields, current, electrolyte gating (electron doping), temperature, or other physical quantities).

SELECTED PUBLICATIONS

- Chadov S, Qi XL, Kübler J, Fecher GH, Felser C, Zhang SC (2010). Tunable Multifunctional Topological Insulators in Ternary Heusler Compounds. Nat. Mater. 9(7): 541-545.
- Felser C, Fecher GH, Balke B (2007). Spintronics: A Challenge for Materials Science and Solid-State Chemistry. Angew. Chem.-Int. Edit. 46(5): 668-699.

Prof. Michael Fleischhauer

DEPARTMENT OF PHYSICS AND RESEARCH CENTER OPTIMAS, UNIVERSITY OF KAISERSLAUTERN

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The main research field is theoretical quantum optics with applications to many-body physics and quantum information. In particular, we study the interaction of quantized light with coherently prepared media, quantum information processing with photons and atomic ensembles, coherence and interference effects in optical meta-materials, as well as ground-state and non-equilibrium properties of strongly interacting ultra-cold quantum gases.

SELECTED PUBLICATIONS

- Otterbach J, Ruseckas J, Unanyan RG, Juzeliunas G, Fleischhauer M (2010). Effective Magnetic Fields for Stationary Light. Physical Review Letters 104(3), 033903.
- Liu N, Langguth L, Weiss T, Kastel J, Fleischhauer M, Pfau T (2009). Plasmonic Analogue of Electromagnetically Induced Transparency at the Drude Damping Limit. Nat. Mater. 8(9): 758-762.

Prof. Holger Frey

DEPARTMENT OF CHEMISTRY,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

Synthetic polymer chemistry: design and synthesis of novel functional polymer materials; branched and dendritic polymers; block copolymers and nanostructures; novel surfactants and biomedical application. Central research areas: polyether chemistry, polyesters, Si-based polymer structures (polycarbosilanes, polysiloxanes). Central objectives are the design of novel macromolecular architectures, investigation of their structure-property relationships, and potential application in areas like nanotechnology, surface modification, medicine, and sensor technology. Novel Li-ion conductors and hybrid structures with high ion mobility (in the context of the ITRG).

SELECTED PUBLICATIONS

- Hofmann AM, Wurm F, Hühn E, Nawroth T, Langguth P, Frey H (2010). Hyperbranched Polyglycerol-Based Lipids via Oxyanionic Polymerization: Toward Multifunctional Stealth Liposomes. Biomacromolecules 11(3): 568-574.
- Mangold C, Wurm F, Obermeier B, Frey H (2010). „Functional Poly(ethylene glycol": PEG-Based Random Copolymers with 1,2-Diol Side Chains and Terminal Amino Functionality. Macromolecules 43(20): 8511-8518.

Prof. Jürgen Gauß

INSTITUTE OF PHYSICAL CHEMISTRY,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The research comprises the development and application of quantum-chemical methods for the investigation of the electronic structure of atoms and molecules. The emphasis is on high-accuracy calculations with the inclusion of electron-correlation effects (via many-body methods, such as perturbation or coupled-cluster theory) and on the efficient calculation of molecular properties (molecular geometries, NMR parameters, excitation energies, etc.) using analytic-derivative and response-theory techniques. The application of quantum-chemical methods to chemical problems involves issues from all areas of chemistry ranging from the highly accurate prediction of rotational spectra up to the determination of the structure of supramolecular systems via NMR chemical-shift calculations.

SELECTED PUBLICATIONS

- Lattanzi V, Thorwirth S, Halfen DT, Mück LA, Ziurys LM, Thaddeus P, Gauss J, McCarthy MC (2010). Bonding in the Heavy Analogue of Hydrogen Cyanide: The Curious Case of Bridged HPSi. Angew. Chem. Int. Ed. Engl. 49: 5661-5664.
- Janke M, Rudzevich Y, Molokanova O, Metzroth T, Mey I, Diezemann G, Marszalek PE, Gauss J, Böhmer V, Janshoff A (2009). Mechanically Interlocked Calix[4]arene Dimers Display Reversible Bond Breakage under Force. Nat. Nanotechnol. 4: 225-229.

Prof. Burkard Hillebrands

**DEPARTMENT OF PHYSICS,
UNIVERSITY OF KAISERSLAUTERN**

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The “Magnetism” research group of Burkard Hillebrands is active in the field of spin dynamics and spintronics, focusing on high frequency phenomena, such as spin waves and their quanta, the magnons, and ultrafast magnetic switching processes. As main experimental techniques Brillouin light scattering (BLS) spectroscopy and microscopy, as well as magneto-optic Kerr effect (MOKE) techniques are used. The research field currently comprises magnon-based spintronic phenomena, magnon gases, magnonic spin-caloric transport phenomena, and novel spintronic materials.

SELECTED PUBLICATIONS

- Schneider T, Serga AA, Chumak AV, Sandweg CW, Trudel S, Wolff S, Kostylev MP, Tiberkevich VS, Slavin AN, Hillebrands B (2010). Nondiffractive Subwavelength Wave Beams in a Medium with Externally Controlled Anisotropy. Phys. Rev. Lett. 104(19), 197203.
- Chumak AV, Tiberkevich VS, Karenowska AD, Serga AA, Gregg JF, Slavin AN, Hillebrands B (2010). All-Linear Time Reversal by a Dynamic Artificial Crystal. Nature Communications 1(141).

Prof. Kurt Kremer

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The work of Kurt Kremer focuses on numerical investigations of polymer systems and soft matter in general, based on intensive efforts in methodological development. These include multi-scale simulation techniques as well as novel adaptive resolution procedures. Systems covered range from highly idealized polymer models, which are used to investigate basic conformational and rheological properties, to highly specialized models for macromolecular organic electronics or biological problems.

SELECTED PUBLICATIONS

- Harmandaris VA, Kremer K (2009). Predicting Polymer Dynamics at Multiple Length and Time Scales. Soft Matter 5(20): 3920-3926.
- Feng XL, Marcon V, Pisula W, Hansen MR, Kirkpatrick J, Grozema F, Andrienko D, Kremer K, Müllen K (2009). Towards High Charge-Carrier Mobilities by Rational Design of the Shape and Periphery of Discotics. Nat. Mater. 8(5): 421-426.

Prof. Angelika Kühnle

INSTITUTE OF PHYSICAL CHEMISTRY, JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 10/09

AREA OF RESEARCH

Molecular self-assembly represents a very promising strategy for the fabrication of tailor-made functional structures, e.g., for future molecular electronic devices. Consequently, molecular self-assembly has been studied extensively on metallic surfaces, gaining deep insight into the mechanisms governing molecular self-assembly. For many applications, however, these studies need to be extended to insulating substrates, e.g., in order to reduce electronic coupling to the substrate surface. Other areas of interest include bio-mineralization, incrustation inhibition, and on-surface synthesis. Our research is dedicated to understanding molecular binding and structure formation on dielectric surfaces, both under the precise control of ultra-high vacuum as well as in biological relevant environments such as aqueous solutions. Our main experimental technique is atomic force microscopy operated in the non-contact mode, allowing for true atomic resolution imaging. We collaborate closely with organic chemists to explore the structural variety of tailor-made organic molecules providing dedicated functionalities. For detailed data interpretation, we work in close cooperation with theoreticians, revealing insights into molecule-surface interactions, and contrast formation in atomic force microscopy. Besides projects dedicated to a fundamental understanding of molecular structure formation, we also perform application-oriented projects in cooperation with industrial partners.

SELECTED PUBLICATIONS

- Loske F, Lübbe J, Schütte J, Reichling M, Kühnle A (2010). Quantitative Description of C60 Diffusion on an Insulating Surface. Phys. Rev. B 82 155428.
- Nimmrich M, Kittelmann M, Rahe P, Mayne AJ, Dujardin G, von Schmidsfeld A, Reichling M, Harneit W, Kühnle A (2010). Atomic-Resolution Imaging of Clean and Hydrogen-Terminated C(100)-(2x1) Diamond Surfaces Using Noncontact AFM. Phys. Rev. B 81, 201403(R).

Prof. Katharina Landfester

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 05/09

AREA OF RESEARCH

The mini-emulsions process represents a versatile tool for the formation of polymeric nanoparticles and nanocapsules consisting of different kinds of polymers as obtained by a variety of polymerization types, ranging from radical, anionic, cationic, enzymatic polymerization to polyaddition and polycondensation. In combination with a specific functionalization of the nanoparticles' or nanocapsules' surfaces and the possibility to release substances in a defined way from the interior, complex nanoparticles or nanocapsules are obtained, which are ideally suited in materials and in biomedical applications as marker and targeted delivery systems.

SELECTED PUBLICATIONS

- Landfester K, Musyanovych A, Mailander V (2010). From Polymeric Particles to Multi-functional Nanocapsules for Biomedical Applications Using the Miniemulsion Process. J. Polym. Sci. Pol. Chem. 48(3): 493-515.
- Landfester K (2009). Miniemulsion Polymerization and the Structure of Polymer and Hybrid Nanoparticles. Angew. Chem.-Int. Edit. 48(25): 4488-4507.

Prof. Klaus Müllen

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The Müllen group focuses on the development of synthetic concepts for low molecular compounds and polymers applicable in electronics, biomedical transport, modern energy technologies and in materials sciences. In particular, a polymer synthesis-driven approach toward graphenes using twisted dendritic polyphenylenes as precursor has been developed to obtain monodispersed nanographenes can be used as perfect materials for modern polymer electronics, e.g., in field effect transistors, for energy storage in batteries or as electrode materials.

SELECTED PUBLICATIONS

- Feng XL, Marcon V, Pisula W, Hansen MR, Kirkpatrick J, Grozema F, Andrienko D, Kremer K, Müllen K (2009). Towards High Charge-Carrier Mobilities by Rational Design of the Shape and Periphery of Discotics. Nat. Mater. 8(5): 421-426.
- Rader HJ, Rouhanipour A, Talarico AM, Palermo V, Samori P, Müllen K (2006). Processing of Giant Graphene Molecules by Soft-Landing Mass Spectrometry. Nat. Mater. 5(4): 276-280.

Prof. Herwig Ott

DEPARTMENT OF PHYSICS, UNIVERSITY OF KAISERSLAUTERN

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

Ultra-cold quantum gases are an ideal instrument to study many-body physics under controlled and clean experimental conditions. The research group led by Herwig Ott specializes in high resolution imaging and manipulation of ultra-cold quantum gases employing scanning electron microscopy. Using this technique, the local static and dynamic properties can be investigated with high precision. The research topics that are studied within the group include low-dimensional quantum gases, static and dynamic correlation functions, tunneling dynamics in optical lattices, non-equilibrium dynamics, the implementation of long-range interactions via Rydberg states, the simulation of quantum spin systems, dissipative processes in ultra-cold quantum gases, as well as technical applications such as high brightness ultra-cold ion sources.

SELECTED PUBLICATIONS

- Würtz P, Langen T, Gericke T, Koglbauer A, Ott H (2009). Experimental Demonstration of Single-Site Addressability in a Two-Dimensional Optical Lattice. Phys. Rev. Lett.103(8), 080404.
- Gericke T, Würtz P, Reitz D, Langen T, Ott H (2008). High-Resolution Scanning Electron Microscopy of an Ultra-cold Quantum Gas. Nat. Phys. 4(12): 949-953.

Prof. Thomas Palberg

**INSTITUTE OF PHYSICS,
JOHANNES GUTENBERG UNIVERSITY MAINZ**

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The group focuses on experimental soft matter physics, in particular, strongly interacting colloidal systems investigated by optical microscopy and light scattering. Equilibrium properties of colloidal fluids, crystals glasses and clusters (phase behavior, elasticity, diffusion, conductivity), non-equilibrium properties (behavior in confinement and under shear), and phase transition kinetics are topics of particular interest and pursued in close collaboration with theory and simulation. Recent developments also include low-dimensional systems and surface physics of colloidal solids.

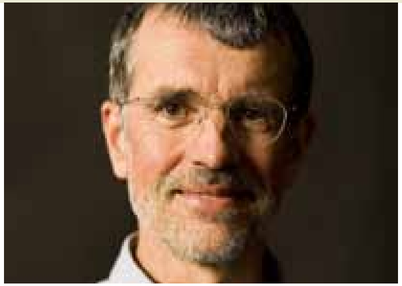
SELECTED PUBLICATIONS

- Reinmüller A, Schöpe HJ, Palberg T (2010). Transient Moire Rotation Patterns in Thin Colloidal Crystals. Soft Matter 6(21): 5312-5315.
- Palberg T, Stipp A, Bartsch E (2009). Unusual Crystallization Kinetics in a Hard Sphere Colloid-Polymer Mixture. Phys. Rev. Lett. 102(3), 038302.

Prof. Harald Paulsen

**INSTITUTE OF GENERAL BOTANY,
JOHANNES GUTENBERG UNIVERSITY MAINZ**

MEMBER OF GSC SINCE 11/07



AREA OF RESEARCH

The group uses recombinant plant proteins for tailor-made biological-chemical hybrid constructs with potentially useful functions. Our main object is the major light-harvesting chlorophyll protein of the photo-synthetic apparatus, a spontaneously folding, and assembling pigment-protein complex. The mechanism of its self-organization is unraveled by spectroscopic means, and the complex is decorated with organic dyes and/or bound to semiconductor nanocrystals or other solid surfaces for potential photovoltaic or biosensor functions. Another approach uses recombinant derivatives of silica-biomineralizing protein from diatoms, aiming to use these to control low-pressure, low-temperature silica formation on various surfaces. Finally, we work with a water-soluble chlorophyll-binding protein, another spontaneously assembling pigment-protein complex that is attractive because of its unusual thermal and biochemical stability. Our expertise includes the generation, mutagenesis, and modification of recombinant proteins, including membrane proteins in artificial liposomes. Structures are analyzed by biochemical and spectroscopic techniques, including fluorescence and CD spectroscopy, stationary or time-resolved. In collaboration with other groups we use EM, EPR, NMR, AFM, and MS.

SELECTED PUBLICATIONS

- Lauterbach R, Liu J, Knoll W, Paulsen H (2010). Energy Transfer Between Surface-Immobilized Light-Harvesting Chlorophyll a/b Complex (LHCII) Studied by Surface Plasmon Field-Enhanced Fluorescence Spectroscopy (SPFS). Langmuir 26(22): 17315-17321.
- Dockter C, Volkov A, Bauer C, Polyhach Y, Joly-Lopez Z, Jeschke G, Paulsen H (2009). Refolding of the Integral Membrane Protein Light-Harvesting Complex II Monitored by Pulse EPR. Proc. Natl. Acad. Sci. U. S. A. 106(44): 18485-18490.

Prof. Eva Rentschler

INSTITUTE OF INORGANIC CHEMISTRY AND ANALYTICAL CHEMISTRY,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

A particularly active area of nanoscience deals with the design, synthesis, investigation, and modeling of magnetic particles of nanometer scale. Molecular magnetism is one of the most challenging research areas in the development of new technologies in electronics. We synthesize molecular clusters and extended low dimensional systems of exchange-coupled transition metal ions. In particular clusters with isolated spin ground states and molecular size big enough to make addressing possible are essential objectives. Within this research, the assembly of pre-formed polymetallic clusters by covalent bonds in a step-by-step strategy has become a quite desirable goal. We use trinuclear carboxylate-bridged metal complexes as they display a wide variety of interesting properties associated with spin frustration, mixed-valency in homometallic compounds, or high spin state in heterometallic compounds. In addition to high level magnetic susceptibility measurements, XPS and XMCD investigations on distinct clusters are performed in collaboration with the groups led by Hans-Joachim Elmers and Gerhard Schönhense. The search for new compounds with interesting magnetic properties has prompted us also to combine different spin carriers within the same molecular entity. Thus, stable organic radicals attached to spin carrying transition metal ions were investigated. Sophisticate EPR spectroscopic investigations were done in collaboration with Dr. Hinderberger from the MPIP.

SELECTED PUBLICATIONS

- Alborés P, Rentschler E (2010). Rational Design of Covalently Bridged (Fe2MO)-M-III-O-II Clusters. Dalton Trans. 39(20): 5005-5019.
- Alborés P, Rentschler E (2009). A Co-36 Cluster Assembled from the Reaction of Cobalt Pivalate with 2,3-Dicarboxypyrazine. Angew. Chem.-Int. Edit. 48(49): 9366-9370.

Prof. Friederike Schmid

INSTITUTE OF PHYSICS,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 02/10

AREA OF RESEARCH

The research of the Condensed Matter Theory group is devoted to the statistical thermodynamics of solids and liquids, with special focus on soft condensed matter and complex fluids (membranes, polymers, colloids), and on biologically motivated problems. Since our research heavily relies on computer simulations, much effort is also spent on the development of new efficient simulation techniques. Among other topics, we are currently interested in the transport and electrohydrodynamic phenomena in electrolyte solutions (electrophoresis and dielectrophoresis), in self-organizing macromolecular systems, and in membrane phase transitions. We perform our simulations on local clusters (including GPUs) and on parallel supercomputers.

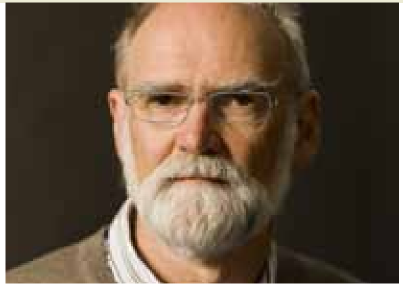
SELECTED PUBLICATIONS

- West B, Brown FLH, Schmid F (2009). Membrane-Protein Interactions in a Generic Coarse-Grained Model for Lipid Bilayers. Biophys. J. 96: 101-15.
- He XH, Schmid F (2008). Spontaneous Formation of Complex Micelles from a Homogeneous Solution. Phys. Rev. Lett. 100(13), 137802.

Prof. Manfred Schmidt

INSTITUTE OF PHYSICAL CHEMISTRY,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07



AREA OF RESEARCH

Synthesis of perfectly defined polymers with chemical recognition sites for directed self-assembly, biological synthetic hybrid polymers for biomedical applications, polyelectrolytes and polyelectrolyte complexes including DNA and RNA, polymer characterization, in particular light scattering techniques including stopped flow light scattering for monitorization of aggregation processes.

SELECTED PUBLICATIONS

- Cong Y, Gunari N, Zhang B, Janshoff A, Schmidt M (2009). Hierarchical Structure Formation of Cylindrical Brush Polymer-Surfactant Complexes. Langmuir 25(11): 6392-6397.
- Kuehn F, Fischer K, Schmidt M (2009). Kinetics of Complex Formation between DNA and Cationically Charged Cylindrical Brush Polymers Observed by Stopped Flow Light Scattering. Macromol. Rapid Commun. 30(17): 1470-1476.

Prof. Gerhard Schönhense

INSTITUTE OF PHYSICS,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The Schönhense group works in the research areas of electron-spectroscopy (UPS, XPS) and -microscopy (PEEM). Special aspects are Synchrotron-radiation based techniques (XMCD-PEEM, NEXAFS, HAXPES), non-magnetic and magnetic dichroism effects in photoemission and detection of electron spin-polarization. Current research is focused on novel charge-transfer complexes, pre-solar and early solar stardust samples (cooperation with MPI for Chemistry), ferromagnetic films and adsorbates. Imaging techniques with ultrahigh time resolution and plasmon-mediated optical near fields are studied using fs-laser PEEM. One recent issue is the transfer of angular momentum by circularly polarised near fields. Various technological goals concern the combination of microscopy and spectroscopy. The group developed extensions of the photoemission electron microscope (PEEM), in particular, time-of-flight techniques and time-resolved image detection. This development led to the foundation of a spin-off company (Surface Concept GmbH). Several types of spin-polarization detectors (including a novel multichannel version) have been developed, the latter in cooperation with the MPI of Microstructure Physics, Halle. In cooperation with the MPI for Polymer Research, we study donor-acceptor combinations based on novel functionalized polycyclic aromatic hydrocarbons and charge-transfer salts using UPS, NEXAFS, and HAXPES. A project of current interest is the application of spin-resolved detection in HAXPES.

SELECTED PUBLICATIONS

- Hild K, Maul J, Schönhense G, Elmers HJ, Amft M, Oppeneer PM (2009). Magnetic Circular Dichroism in Two-Photon Photoemission. Phys. Rev. Lett. 102(5), 057207.
- Kandpal HC, Fecher GH, Felser C, Schönhense G (2006). Correlation in the Transition-metal-Based Heusler Compounds Co2MnSi and Co2FeSi. Phys. Rev. B 73, 094422.

Prof. Carsten Sönnichsen

INSTITUTE OF PHYSICAL CHEMISTRY, JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The Nanobiotechnology Group (AG Sönnichsen) at the Institute of Physical Chemistry of the Mainz University studies the physical chemistry of nanoparticles. Our focus is on metal particles with plasmon excitations and their use as molecular sensors for single molecule investigations, the use of plasmonic particles for biomedical diagnostics, and the use of metal-semiconductor hybrid nanoparticles for photo-catalysis. Furthermore, we are interested in the physical and chemical mechanisms of wet-chemical nanoparticle formation itself and the basic physical and chemical properties of the resulting particles. Besides optical microscopy, a main characterization technique is electron microscopy. The group runs currently five electron microscopes, offering an electron microscopy characterization service for the whole university and industry.

SELECTED PUBLICATIONS

- Carbone L, Jakab A, Khalavka Y, Sönnichsen C (2009). Light-Controlled One-Sided Growth of Large Plasmonic Gold Domains on Quantum Rods Observed on the Single Particle Level. Nano Lett. 9(11): 3710-3714.
- Khalavka Y, Sönnichsen C (2008). Growth of Gold Tips onto Hyperbranched CdTe Nanostructures. Adv. Mater. 20(3): 588.

Prof. Hans Wolfgang Spiess

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The unique versatility of magnetic resonance techniques is exploited to study various aspects of soft matter science. As far as the structure of supramolecular functional materials is concerned, specific detail such as weak hydrogen bonds can determine the pitch angle in columnar photoconductors. Collective dynamics can be identified, which is crucial for the processing of such materials. Similar statements hold for hydrogen bonded supramolecular aggregates. Electron Paramagnetic Resonance (EPR) yields unique information about the phase transitions of thermoresponsive polymers, which is much more involved than suggested from scattering experiments. Such knowledge can directly be used in Dynamic Nuclear Polarization for future applications in medical Magnetic Resonance Imaging. Advanced pulsed EPR techniques also provide important insights in the relation between structure and function of proteins. For instance, in Human Serum Albumin, the structure in solution differs significantly from that in the crystal, in particular at the periphery. This flexibility as determined by EPR spectroscopy is the key for understanding the function of this important transport protein.

SELECTED PUBLICATIONS

- Junk MJN, Li W, Schlüter AD, Wegner G, Spiess HW, Zhang A, et al. (2010). EPR Spectroscopic Characterization of Local Nanoscopic Heterogeneities during the Thermal Collapse of Thermoresponsive Dendronized Polymers. Angew. Chem.-Int. Edit. 49(33): 5683-5692.
- Elmahdy MM, Floudas G, Mondeshki M, Spiess HW, Dou X, Müllen K (2008). Origin of the Complex Molecular Dynamics in Functionalized Discotic Liquid Crystals. Phys. Rev. Lett. 100(10), 107801.

Prof. Wolfgang Tremel

INSTITUTE OF INORGANIC CHEMISTRY AND ANALYTICAL CHEMISTRY, JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The Inorganic Materials Chemistry group is interested in the synthesis, the in-depth structural and physical characterization, and the design and potential applications of new materials with a variety of chemical, physical, or electronic properties. Areas of interest include electronic and magnetic materials, tribology, and surface properties. A second and larger field of activity is the chemistry of organized matter. Our interdisciplinary research combines elements of chemistry, physics, engineering, and biology for an understanding of self-assembly and self-organization in both equilibrium and non-equilibrium ensembles at various length-scales. We apply these ideas in practical applications ranging from micro and nanotechnology to biology and biomedicine. In particular, we are interested in bio-inspired, chemically-derived routes to complex inorganic materials. We are attempting in a bottom-up approach to integrate concepts and knowledge of how organisms fabricate biominerals, such as bones, shells, and teeth within a biomimetic approach to the synthesis of organized materials with structural hierarchy and morphological complexity across a range of length scales. Top-down and bottom-up approaches converge in our biology-oriented work on the self-assembly of cell components responsible for metastasis. The knowledge of how these components assemble and interact with one another is important for the part of our research devoted to the discovery of new antimetastatic drugs.

SELECTED PUBLICATIONS

- Sahoo JK, Tahir MN, Yella A, Schladt TD, Mugnaoli E, Kolb U, Tremel W (2010). Reversible Self-Assembly of Metal Chalcogenide/Metal Oxide Nanostructures Based on Pearson Hardness. Angew. Chem. Int. Edit. 49(41): 7578-7582.
- Birkel CS, Mugnaioli E, Gorelik T, Kolb U, Panthöfer M, Tremel W (2010). Solution Synthesis of a New Thermoelectric Zn1+xSb Nanophase and its Structure Determination Using Automated Electron Diffraction Tomography. J. Am. Chem. Soc. 132(28): 9881-9889.

Prof. Gerhard Wegner

MAX PLANCK INSTITUTE FOR POLYMER RESEARCH, MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

Design and study of properties of novel polymeric solids based on the self-organizing features of macromolecules; methods for organizing macromolecules in two or three dimensions; analytical techniques characterizing the relation of molecular features to the packing and interaction of molecules on various length scales; materials science of polymers.

SELECTED PUBLICATIONS

- Junk MJN, Li W, Schlüter AD, Wegner G, Spiess HW, Zhang A, et al. (2010). EPR Spectroscopic Characterization of Local Nanoscopic Heterogeneities during the Thermal Collapse of Thermoresponsive Dendronized Polymers. Angewandte Chemie-International Edition 49(33): 5683-5692.
- Baluschev S, Yakutkin V, Miteva T, Avlasevich Y, Chernov S, Aleshchenkov S, Nelles G, Cheprakov A, Yasuda A, Müllen K, Wegner G (2007). Blue-Green Up-Conversion: Noncoherent Excitation by NIR Light. Angewandte Chemie-International Edition 46: 7693-7696.

Prof. Rudolf Zentel

INSTITUTE OF ORGANIC CHEMISTRY,
JOHANNES GUTENBERG UNIVERSITY MAINZ

MEMBER OF GSC SINCE 11/07

AREA OF RESEARCH

The group's expertise lies in synthetic polymer chemistry and is directed toward the design of new polymeric materials with properties like: response to electric fields, interaction with light, semiconducting properties. The molecular structure is thereby chosen as basis for the materials properties. The research interests center around 3 topics: 1. liquid crystalline materials and mesophases in general; 2. synthesis of self-organizing semiconducting polymeric materials; 3. the crystallization of monodisperse colloids into photonic crystals including replica formation.

SELECTED PUBLICATIONS

- Zorn M, Weber SAL, Tahir MN, Tremel W, Butt HJ, Berger R, Zentel R (2010). Light-Induced Charging of Polymer Functionalized Nanorods. Nano Lett. 10(8): 2812-2816.
- Zorn M, Bae WK, Kwak J, Lee H, Lee C, Zentel R, et al.(2009). Quantum Dot – Block Copolymer Hybrids with Improved Properties and their Application to Quantum Dot Light-Emitting Devices. ACS Nano 3(5): 1063-1068.

FORMER PRINCIPAL INVESTIGATORS

No.	Last Name, First Name	Current Institution	Member of GSC from – until
1.	Prof. Bach, Volker	Institute for Analysis and Algebra, Braunschweig Institute of Technology	11/07 – 09/10
2.	Prof. Banhart, Florian	IPCMS, University of Strasbourg	11/07 – 12/07
3.	Prof. Bloch, Immanuel	Max-Planck Institute for Quantum Optics, Munich	11/07 – 03/09
4.	Prof. Janshoff, Andreas	Institute for Physical Chemistry, University of Göttingen	11/07 – 12/08
5.	Prof. Knoll, Wolfgang	Austrian Institute of Technology, Vienna	11/07 – 07/08

ASSOCIATED MEMBERS

No.	Last Name, First Name	Current Institution	Member of GSC since
1.	Baumgarten, Martin, PhD	Max Planck Institute of Polymer Research	11/07
2.	Jun.-Prof. Blümer, Nils	Institute of Physics, JGU	11/07
3.	Prof. Decker, Heinz	Institute of Molecular Biophysics, JGU	11/07
4.	Fecher, Gerhard, PhD	Institute of Inorganic and Analytical Chemistry, JGU	11/07
5.	Jun.-Prof. Hoffmann-Röder, Anja	Institute of Organic Chemistry, JGU	05/09
6.	Jakob, Gerhard, PhD	Institute of Physics, JGU	11/07
7.	Jourdan, Martin, PhD	Institute of Physics, JGU	11/07
8.	Jun.-Prof. Kühne, Thomas	Institute of Physical Chemistry, JGU	11/10
9.	Prof. Kläui, Mathias	Institute of Physics, JGU	05/11
10.	Prof. Markl, Jürgen	Institute of Zoology, JGU	11/07
11.	Oettel, Martin, PhD	Institute of Physics, JGU	11/07
12.	Schärtl, Wolfgang, PhD	Institute of Physical Chemistry, JGU	11/07
13.	Prof. Schilling, Rolf	Institute of Physics, JGU	11/07
14.	Jun.-Prof. Schneider, Hans Christian	Department of Physics, TUKL	11/07
15.	Jun.-Prof. Sirker, Jesko	Department of Physics, TUKL	11/09
16.	Jun.-Prof. Sulpizi, Marialore	Institute of Physics, JGU	11/10
17.	Weigel, Martin, PhD	Institute of Physics, JGU	11/10
18.	Prof. Widera, Artur	Department of Physics, TUKL	11/10
19.	Prof. van Dongen, Peter GJ	Institut of Physics, JGU	11/07

FORMER ASSOCIATED MEMBERS

No.	Last Name, First Name	Current Institution	Member of GSC from – until
1.	Prof. Dr. Blaum, Klaus	Max Planck Institute for Nuclear Physics, Heidelberg	11/07 – 07/08
2.	Prof. Deserno, Markus	IPCMS, University of Strasbourg	11/07 – 12/07
3.	Prof. Kuhr, Stefan	Max-Planck Institute for Quantum Optics, Munich	11/07 – 08/09
4.	Maskos, Michael, PhD	Institut für Mikrotechnik Mainz	11/07 – 05/09
5.	Prof. Knoll, Wolfgang	Austrian Institute of Technology, Vienna	11/07 – 06/09
6.	Prof. Rauschenbeutel, Arno	Institute of Atomic and Subatomic Physics, Vienna University of Technology	11/07 – 06/10
7.	Prof. Renz, Franz	Institute of Anorganic Chemistry, University of Hanover	11/07 – 12/07
8.	Prof. Schilling, Tanja	Theory of Soft Condensed Matter, University of Luxembourg	11/07 – 12/09

DOCTORAL STUDENTS
CURRENT DOCTORAL STUDENTS

No.	Last Name, First Name	Title of Thesis	Host Supervisors	Member of GSC since
1.	Afshar, Yasar	Polymer Induced Pores in Lipid-Membranes	Prof. Schmid	04/11
2.	Agrawal, Milan	Spin Dynamics in Non-Magnetic Metals	Prof. Hillebrands	09/10
3.	Bannwarth, Markus	Magnetic Switchable Nanocapsules	Prof. Landfester	02/11
4.	Böhm, Paul	Functional Silicones and Silicone-Containing Block Copolymers	Prof. Frey	01/09
5.	Bühler, Jasmin	Poly(2-oxazoline) brushes as Nanocarriers for biomedical applications	Prof. Schmidt	08/11
6.	Calcavecchia, Francesco	The Quantum Fluid of Metallic Hydrogen	Prof. Kühne	11/10
7.	Crisenza, Tommaso	Characterization of Thermoplastic Elastomers from Rubber-Plastic Blends	Prof. Butt	02/11
8.	Custodio, Catarina	Development of New Smart Surfaces Able to Control Specific Cell Interactions onto Biodegradable Substrates	del Campo, PhD	10/10
9.	Dadfar, Mohammad	Investigation of Mechanical and Rheological Properties of Polymer Material	Prof. Butt	10/10
10.	Dietzsch, Michael	Precipitation of Calcium Carbonate during the Early Stages in the Presence of Polyionic Additives	Prof. Tremel	01/11
11.	Doroshenko, Misha	Fluorescence Correlation Spectroscopy Studies of Diffusion and Flow Near Solid/Liquid Interface	Prof. Butt	10/10
12.	Duro Castano, Aroa	Define Polyglutamates as Drug Carriers	Prof. Zentel	04/11
13.	Ebert, Marlon	De-Mixing and Test Particle Dynamics in Complex Fluids	Prof. Oettl	03/09
14.	Fernandez, Almudena	Molecular Dynamics of Poly Electrolyte Brushes	Prof. Spiess	05/11
15.	Etzold, Fabian	Photophysics of Bulk Heterojunction Solar Cells	Laquai, PhD	08/10
16.	Fischer, Anna	Synthetic Strategies towards Different Polyester Architectures	Prof. Frey	09/10
17.	Fuentes, Clara	Cell Culture and Cell Analysis as Cell Adhesion with Calcein Staining and Cell Proliferation with Alamar Blue Assays	del Campo, PhD	11/10
18.	Gilz, Lukas	Non-equilibrium Quantum Thermodynamics	Prof. Anglin	04/10
19.	Golling, Florian	Olefin Polymerisations in Fluorous Emulsions	Prof. Müllen	08/11
20.	Graf, Tanja	TMR Devices Based on Heusler Compounds	Prof. Felser	11/08
21.	Happ, Peter	Heterometallacrowns as High-Spin Molecules	Prof. Rentschler	02/11
22.	Hauke, Christopher	Investigating Codeposition and Molecular Self-Assembly of Thermically Stable Molecules on Insulating Surfaces Using Noncontact Atomic Force Microscopy	Prof. Kühnle	03/11
23.	Heinrich, Christophe	Control over the Thermal Conductivity in Metallpnictides and Chalcogenides Through Creation of Nanodomains	Prof. Tremel	04/11
24.	Hofmann, Anna Maria	Stealth Liposomases Based on Polyether Modified Phospholipids	Prof. Frey	11/08
25.	Horzum Polat, Nesrin	Functionalization of Electrospun Nanofibers with Metal Oxide Nanoparticles	Prof. Landfester	08/11
26.	Inci, Bora	TEM Characterization of Crystallization of Polyolefines	Prof. Landfester	04/11
27.	Jagau, Thomas	Treatment of Excited States in Multireference Coupled-Cluster Theory	Prof. Gauß	02/11
28.	Jakobs, Sebastian	Investigation of Quantum-Well Systems with a Giant Spin-Orbit-Coupling by Means of Spin-, Time- and Angle-Resolved Two-Photon-Photoemission (STAR-2PPE)	Prof. Aeschlimann	12/10
29.	Jung, Björn	Switchable Polymeric Hybrid Materials for Lab on a Chip Devices	Prof. Zentel	03/11
30.	Kaveh, Faraneh	Bioadhesion	Prof. Butt	03/11
31.	Kieslich, Gregor	Synthesis and Characterization of Nanostructured Thermoelectrics	Prof. Tremel	10/10
32.	Kins, Christoph	NMR Structure and Dynamics of Functional Materials	Prof. Spiess	01/11
33.	Koll, Dominik	Three Approaches Towards One Aim: Nanostructured Photovoltaic Devices	Prof. Tremel	11/08
34.	Koll, Kerstin	Selective Biofunctionalization of Magnetic Nanoparticles for Drug Delivery in Cells	Prof. Tremel	11/08
35.	Kolman, Krzysztof	Mechanism of Ultra-Fast Delamination of Montmorillonite in Protein Solutions	Prof. Butt	03/11
36.	Kozina, Xeniya	Hard X-Ray Photoemission of Bulk and Thin Films of Heusler's Compounds	Prof. Felser	11/08

37.	Krez, Julia	Nanostructuring of Half-Heusler Compounds and Related Structures for Thermoelectric Applications	Prof. Felser	08/11
38.	Labouvie, Ralf	Ultracold Bosons in Optical Lattices	Prof. Ott	01/11
39.	Li, Changhua	Kinetic Studies on Uptake and Release of DNA into and from Cylindrical Brush Polymers	Prof. Schmidt	10/10
40.	Malzahn, Kerstin	Drug Release Systems Based on Plasma-polymerization Modified Surfaces	Prof. Landfester	07/11
41.	Mangold, Christine	Functional Poly(ethylene oxide)-based Copolymers	Prof. Frey	12/09
42.	Mangold, Hanah	Morphological Characterisation of the Absorber Blend	Laquai, PhD	10/10
43.	Medina, Angel	DNA-Polycation Complexation in Organic Solvents	Prof. Schmidt	10/08
44.	Medina Hernando, Stefan	Simulation Methods for Electrolytes at High Salt Concentrations	Prof. Schmid	07/10
45.	Meshcheriakova, Olga	Magnetism and Superconductivity under Pressure	Prof. Felser	11/10
46.	Mix, Christian	Laserablation of Interface Dominated Oxide Heterostructures	Jakob, PhD	02/11
47.	Moderegger, Dorothea	Radioactive Labeling and In vivo Evaluation of Nanoparticular Systems Using Positron Emission Tomography	Prof. Zentel	01/10
48.	Moers, Christian	Amphiphic Branched Polymers	Prof. Frey	11/10
49.	Mück, Leonie	Multireference Coupled-Cluster Methods for Open-Shell Systems	Prof. Gauß	01/10
50.	Müller, Sophie	Polyether-based lipids for biomedical applications	Prof. Frey	08/11
51.	Muth, Dominik	Dynamics of Ultra Cold Quantum Gases in Low Dimensions	Prof. Fleischhauer	09/09
52.	Perkert, Sandra	Investigation of Electronic Correlation Effects in Organic Charge-Transfer Salts Using Scanning Tunneling Spectroscopy	Prof. Elmers	04/11
53.	Plenk, Christian	Building Units of High-Spin Molecules	Prof. Rentschler	06/11
54.	Prasad, Janak	Plasmonic Nanoparticles as Multiplexed Sensors	Prof. Sönnichsen	10/10
55.	Rahe, Philipp	Molecular Self-Assembly on the Cacite (104) Surface	Prof. Kühnle	08/10
56.	Reichert, Peter	Molecular Structure of Liquid Interfaces Studied by X-Ray Reflectivity	Prof. Butt	01/11
57.	Reuß, Valerie	Responsive Macrocyclic Polymers	Prof. Frey	10/09
58.	Schattling, Philipp	Utilization of Organic and Inorganic Membranes for Templating Organic Semiconductors to be Used in Organic Photovoltaic Applications	Prof. Zentel	05/11
59.	Schömer, Martina	Synthesis and Application of Noncrystalline, Multifunctional Polyethers Based on Polyethylene Glycol PEG	Prof. Frey	10/09
60.	Schoop, Leslie Mareike	Investigation of Superconducting Properties in AlB2 Structure Type and Related Compounds	Prof. Felser	04/11
61.	Schüll, Christoph	Hyperbranched Polymer Brushes	Prof. Frey	07/10
62.	Schwall, Michael	Heusler Compounds for Thermoelectric Applications	Prof. Felser	08/11
63.	Sebastian, Thomas	Magnetization dynamics in micro structural Heusler films	Prof. Hillebrands	03/10
64.	Slaughter, Liane	In Vitro Development of a Lipid Sensing System for Small Volumes	Prof. Sönnichsen	08/11
65.	Söffing, Stefan	Spin and Charge Correlations of Interacting Fermions on Finite Lattices	Prof. Eggert	06/09
66.	Sun, Yi	Preparation of Porous Anodic Alumina Template with Different Pore Size	Prof. Landfester	02/11
67.	Tonhauser, Christoph	Synthesis of Functional Polymers in a Microstructured Reactor	Prof. Frey	09/09
68.	Vogel, Nicolas	Approaches to Lithography Using Colloidal Monolayer Architectures	Prof. Landfester	09/08
69.	Wei, Wei	Controlled Synthesis of Graphene Materials for Energy Storage	Prof. Müllen	06/11
70.	Vogt, Katrin	Spin-Wave Transport in Two-Dimensional Microstructures	Prof. Hillebrands	06/10
71.	Weller, Désirée	Synthesis and Characterization of Thermoresponsive Polymer Brushes with Peptidic Side Chains	Prof. Schmidt	04/11
72.	Wenzlik, Daniel	Fluorescent Nanorod - Cholesteric Liquid Crystal Composites as Mirrorless Lasing Devices	Prof. Zentel	04/10
73.	Werre, Mathias	New Sythetic Strategies to Mictoarmstarpolymers and AnBAn-Triblockcopolymers	Prof. Frey	07/10
74.	Wilms, Dorothea	Colloidal Systems in Confinement	Prof. Binder	10/10
75.	Yoojin, Kim	Organic Solar Cells	Laquai, PhD	08/11
76.	Zeier, Wolfgang	Thermoelectric Transport Properties of Chalcogenides	Prof. Tremel	10/10
77.	Zickler, Martin	Investigation of the Electronic Coupling by Applying Single Molecule Spectroscopy	Prof. Basché	08/11
78.	Zöphel, Lukas	Design and Synthesis of Extended Polycyclic Aromatic Hydrocarbons for Electronic Applications	Prof. Müllen	06/10
79.	Zur Borg, Lisa	Semiconducting Block Copolymers for Optoelectronic Devices	Prof. Zentel	06/11

DOCTORAL STUDENTS
ALUMNI

No.	Last Name, First Name	Title of Thesis	Host Supervisor	Member of GSC from – since
1.	Andres, Markus	Correlations in Low Dimensional Spin and Fermion Lattice Models	Prof. Eggert	05/07–04/08
2.	Anyfantakis, Manos	Writing of Mesoscopic Structures in Polymer Solutions Using Laser Beams	Prof. Butt	02/09–01/10
3.	Bantz, Christoph	Polymeric Nanoparticles and Nanocontainers: From Materials Science to Biotechnology	Prof. Schmidt	01/08–12/09
4.	Barz, Matthias	Functional Polymer Based Nanoparticles: Development of Defined Complex Structures as Basis for in vitro and in vivo Applications	Prof. Zentel	04/07–12/09
5.	Battagliarin, Glaucho	Synthesis of Zwitterionic Acridinic Derivatives with High Torsional Angle Along the Conjugation Axys Direction	Prof. Müllen	02/09–01/10
6.	Beckmann, Dirk	Benzo-bis-benzothiophene Based Organic Field-Effect Transistors	Prof. Müllen	01/08–07/09
7.	Beyer, Patrick	Photocrosslinkable Liquid Crystalline Polymers with Different Chain Topologies	Prof. Zentel	01/07–07/07
8.	Birkel, Alexander	Tin (IV) Oxide Nanostructures: Controlled Synthesis, Properties and Applications in Dye-Sensitized Solar Cells	Prof. Tremel	06/08–10/10
9.	Birkel, Christina	Wet Chemistry Synthesis Towards Nanostructures of Thermoelectric Antimonides	Prof. Tremel	06/08–10/10
10.	Bohle, Anne	NMR on Supramolecular Assemblies	Prof. Spiess	02/08–02/10
11.	Busko, Dmitry	Conversion of the Multimode Conical LaserBbeams by Simulated Raman Scattering	Prof. Landfester	05/09–07/10
12.	Cho, Don Mark	Synthesis and Characterization of Polymers for Use in Organic Electronic Devices	Prof. Müllen	08/08–06/10
13.	Coustet, Marcos	Photoactive Macromolecular Materials	del Campo, PhD	08/10–11/10
14.	Dallos, Timea	Study of the Synthesis and Intramolecular Interactions in the Case of Phenothiazine Derivates and Other Heterocyclic Rings	Prof. Müllen	04/08–03/09
15.	Dockter, Christoph	The Analysis of Structure and Assembly of Light-Harvesting Complex II by Electron Paramagnetic Resonance (EPR)	Prof. Paulsen	12/07–08/09
16.	Eichhorn, Tobias	Microstructure of Epitaxial Ni2MnGa Films	Jakob, PhD	10/08–09/10
17.	Fassbender, Birgit	Synthesis of Polyphosphacenephosphonicacid as Electrolyte Membrane in Fuel Cells	Prof. Spiess	01/08–12/09
18.	Feist, Florian	Investigations on the Photophysics of Single Conjugated Polymer Chains at Low Temperatures	Prof. Basché	06/06–05/09
19.	Filevich, Oscar	Biocompatible Caged-Compounds to Control Gene Expression by Light	del Campo, PhD	09/09–02/10
20.	Fine, Tamir	Mechanical Properties of Pore Spanning MDCK II Apical and Basolateralplasma Membranes Probed by AFM	Prof. Janshoff	01/08–01/09
21.	Fischer, Janina	Near-Field Mediated Enhancement of Two-Photon-Induced Fluorescence on Plasmonic Nanostructure	Kreiter, PhD	06/09–05/10
22.	Fleischhaker, Friederike	Designed Functional Defects in Colloidal Photonic Crystals: Switching, Biomonitoring and Modified Photoluminescence	Prof. Zentel	08/06–05/07
23.	Flügel, Sabine	Oligodeoxynucleotide-Polypeptide Block Copolymers	Prof. M. Schmidt	01/07–01/10
24.	Fritz, Dominik	Coarse Graining Methods and Polymer Dynamics	Prof. Kremer	11/08–03/10
25.	Gan, Yanjie	Point Defects in Carbon Nanostructures Studied by in situ Electron Microscopy	Prof. Schmidt	05/08–10/08
26.	Geidel, Christian	Hydrophobic Modified Anorganic Nanoparticles for Nano-Composite Materials	Prof. Müllen	01/09–07/10
27.	Gojzewski, Hubert	Visco-Elastic Properties of Thin Nylon Films Using Multi-Cycling Nanoindentation	Prof. Butt	10/08–07/09
28.	Gundlach, Kristina	Plant Light-Harvester (LHCII) in Hybrid Complexes with Organic Dyes and Inorganic Semiconductor Nanocrystals (Quantum Dots)	Prof. Paulsen	03/08–06/10
29.	Gupta, Jyotsana	Nonlinear Optical Studies of Nano-Hybrids and Polymers	Prof. Bubeck	05/09–08/10
30.	Haberkorn, Niko	Template-Assisted Patterning of Functional Polymers	Prof. Zentel	06/08–04/10
31.	Hadji, Rashid	X-ray and Neutron Reflectometry to Determine Thin Film Structures	Prof. Butt	01/08–02/08
32.	Haschick, Robert	Synthesis of Polymer Nanoparticles in Non-Aqueous Emulsions	Prof. Müllen	02/08–07/09
33.	Herbort, Christian	Tunnel Junctions with Heusler Electrodes: Spin Polarization of Co2CrO, 6FeO, 4Al and the Influence of the Barrier	Prof. Adrian	10/07–06/08
34.	Herrera, Isaac	Sequential Functionalization of Copolymers Containing Different Active-Esters	Prof. Zentel	09/08–02/09
35.	Hild, Kerstin	Photoemission Magnetic Circular Dichroism Using Ultrashort Pulse Laser	Prof. Elmers	01/09–04/11
36.	Hilf, Stefan	New Methods for the Functionalization of Metathesis Polymers	Prof. Frey	07/07–05/09
37.	Hoshyargar, Faegheh	Formation Mechanisms of Chalcogenic Nanoparticles	Prof. Tremel	05/09–05/10

38.	Jakab, Arpad	Optical Spectroscopy of Mettalic Nanoparticles	Prof. Sönnichsen	03/08–02/09
39.	Jakobi, Eberhard	Numerical and Analytical Investigations of Strongly Correlated Termionic Multiband Systems	Prof. Blümer	11/07–01/09
40.	Jaskiewicz, Karmena	Crystallization of Polymers	Prof. Butt	05/09–12/09
41.	Jenkins, Catherine	Magnetic Spectroscopy and Microscopy of Functional Materials	Prof. Felser	11/07–10/09
42.	Jimenez Garcia, Lucia	Improvement of the Proton Conducting Properties of Anhydrous Fuel Cell Membranes	Prof. Müllen	01/08–01/10
43.	Jung, Martin	Magnetic Interaction of Spin Exchange-Coupled Systems with Nitroxide and Nitronyl-Nitroxide Radicals	Prof. Rentschler	06/07–01/09
44.	Jung, Verena	An Investigation into Complex Inorganic Materials with Mössbauer Spectroscopy	Prof. Felser	03/07–02/09
45.	Junk, Matthias	Assessing the Functional Structure of Molecular Transporters by EPR Spectroscopy	Prof. Spiess	11/07–05/10
46.	Kamm, Valentin	Electronic and Optical Properties of Organic Semiconductors	Laquai, PhD	08/09–07/10
47.	Kessler, Daniel	Inorganic-Organic Hybrid Polymers: Solution-Processible Coating Materials for Defined Surface Functionalization	Prof. Zentel	06/08–08/09
48.	Khalavka, Yuriy	Metal-Semiconductor Hybrid Particles	Prof. Binder	09/07–08/10
49.	Klinger, Daniel	Switchable Core-Shell-Particles with an Hydrogelic Core	Prof. Landfester	01/10–12/10
50.	Klos, Johannes	Synthesis and Characterization of Oligo(thiophene Carboxamide)s	Prof. Zentel	11/08–10/10
51.	Kocun, Marta	Force Spectroscopy of Biomolecules	Prof. Janshoff	01/08–01/09
52.	Köller, Tetyana	Transport Behavior of Aqueous Colloidal Polymer Dispersions	Prof. Palberg	05/07–04/10
53.	Krohne, Korinna	Polyelectrolyte-Surfactant-Complexes and Interpolyelectrolyte-Complexes	Maskos, PhD	03/08–09/09
54.	Kühn, Frauke	Polycation-DNA-Complexes: Characterization and Application in Gene Transfection	Prof. Schmidt	01/08–11/10
55.	Kulaga, Emilia	Structure of Nanocomposites	Prof. Butt	05/09–11/09
56.	Kutnyakhov, Dmytro	Spin Analysis of Photoelectrons from Tunneling Devices	Prof. Elmers	09/07–09/10
57.	Lange, Birger	Chemistry on Functional Polymer Opals	Prof. Zentel	01/07–06/07
58.	Lazarra, Thomas	Optical Waveguide Spectroscopy and Laser-by-Laser Dendrimer Self Assembly in Porous Aluminia Templates	Prof. Knoll	01/08–12/08
59.	Lechmann, Maria	Chemistry on Functional Polymer Opals	Prof. Butt	08/07–07/09
60.	Li, Yi	Electrostatically Self-Assembled	Prof. Schmidt	09/07–08/09
61.	Liaqat, Faroha	Nanostructured Hybrid Materials	Prof. Tremel	06/10–06/11
62.	Loges, Niklas	Controllling the Morphology and Polymorphy of Calcium Carbonate by Monomeric and Polymeric Ionic Additives	Prof. Tremel	05/07–06/09
63.	Ludwig, Christian	Optimizing Thin-Film Solar Cells by Computer Simulations	Gruhn, PhD	07/08–06/11
64.	Lotz, Alex	Multi Cantilever Arrays for Antibacterial Coating	Förch, PhD	10/09–09/10
65.	Luis, Duque	Development and Analysis of Polymer Based Multifunctional Bactericidal Materials	Förch, PhD	10/09–09/10
66.	Luty-Blocho, Magdalena	Syntheses of Polymer-Stabilized AU and Pt(C) Nanoparticles Using Micro-Mixers	Prof. Schmidt	01/09–03/09, 07/09–09/09, 01/10–03/10
67.	Luz, Gisela	Biomimetic Composites Obtained by Layer-by-Layer Assembly of Bioglass and Natural Polyelectrolytes	del Campo, PhD	09/10–12/10
68.	Makowski, Marcin	Adhesion of Biopolymers Particularly Highly Adhesive Proteins Like the Catecholic Amino Acid 3 4-Dihydroxyphenylalanine (DOPA)	Prof. Butt	10/09–10/10
69.	Mauer, Ralf	Hydrogen Barrier Properties of Reactive Sputtered Alumiumoxide	Laquai, PhD	01/09–07/10
70.	Medina, Angel	Light Scattering Studies on Supramolecular Polymer Structures	Prof. Schmidt	10/08–09/09
71.	Medyanyk, Kateryna	Angular Resolved Spectroscopy of Charge Transfer Salts	Prof. Schönhense	10/08–01/11
72.	Meister, Michael	Quasi steady-state photoinduced absorption on ID176	Laquai, PhD	03/09–07/10
73.	Meuer, Stefan	Liquid Crystalline Phases of Anisotropic, Polymer Functionalized Nanoparticles	Prof. Zentel	05/06–10/08
74.	Minoia, Andrea	Force Field-Based Modelling on Self-Assembly of Tetrathiafulvalene (TTF) Derivatives	Prof. Kremer	12/07–11/08
75.	Müller, Waltraut	Hydrophobic and Hydrophilic Loading of Polymeric Vesicles	Maskos, PhD	09/06–11/09
76.	Naing, Tun	Systematic Wetting Studies of Au Nanowires on Different Surfaces	Köper, PhD	08/08–11/09
77.	Naghavi, Shahab	Ab Initio Calculations on Charge Transfer Salts	Prof. Felser	11/07–12/10
78.	Nguyen, Thi Huong	Rupture Force of Aptamer Binding Small Molecules	Prof. Butt	10/09–09/10
79.	Neumann, Timo	Dynamic Control of Spin Waves through Localized, Magnetic Inhomogeneities	Prof. Hillebrands	04/06–11/09

80.	Nicolescu, Alina	Solid State NMR Spectroscopy	Prof. Spiess	02/11–04/11
81.	Noskov, Sergey	Determination of Hamaker Constants of Polymeric Nanoparticles in Organic Solvents and Aqueous Electrolyte Solutions by Asymmetrical Flow Field-Flow Fractionation	Maskos, PhD	02/07–01/10
82.	Obermeier, Boris	Linear-Hyper Branched Block Copolymers as Soluble High-Loading Supports for Catalysts	Prof. Frey	12/07–11/10
83.	Ohm, Christian	Preparation of Defined Micro- and Nanometer-Sized Structures from Liquid Crystalline Elastomers	Prof. Zentel	05/08–12/10
84.	Opper, Kathleen	Acid Containing Precise Polyolefins	Prof. Müllen	11/08–03/09
85.	Pang, Shuping	Nanostructured Functional Carbon Materials for Energy Storage	Prof. Müllen	01/08–12/08
86.	Paroor, Harsha Mohan	Network Formation in Mixtures of Colloids	Prof. Butt	11/08–11/09
87.	Poma, Adolfo	Theoretical Foundation of the Coarse-Grained Approaches in Multiscale Simulations	DelleSite, PhD	12/07–11/08
88.	Preis, Jasmin	Synthesis of Hyperbranched Polymers on Surfaces	Prof. Frey	05/09–01/10
89.	Pütz, Anna-Maria	Investigation of Higher Dimensional Structures like 2D Sheets or 3D Net-Work Composed of Transition Metal Carboxylate Complexes	Prof. Rentschler	09/07–09/10
90.	Raccis, Riccardo	Interaction of Molecular Diffusants and Hydrogel Components: PNIPAAm-Rhodamine Interaction in Solution	Prof. Butt	10/08–12/09
91.	Reuter, Frank	Dinuclear 3d-Transition Metal Complexes with Derivatives of the Para-Phenylenediamine as Redoxavtive Bridging Ligands	Prof. Rentschler	08/08–10/10
92.	Rix, Stephan	Point Defects in Calciumfluoride and their Effect on Material Properties under 193nm Laser Irridation	Prof. Felser	10/08–01/11
93.	Roth, Marcel	Dynamics of Colloidal Suspensions: Growth, Aggregation, Reorganisation and Dryin	Prof. Butt	05/08–01/11
94.	Roth, Meike	Synthesis and Hydrogenation of Unsaturated Substrates with Parahydrogen, PHIP	Prof. Spiess	08/08–07/10
95.	Roth, Peter	α,ω End Group Functionalization of RAFT Polymers Based on Pentafluorophenyl Esters and Methane Thiosulfonates	Theato, PhD	11/08–08/09
96.	Rühle, Victor	Morphologies and Charge Transport in Conjugated Polymers	Prof. Kremer	10/08–04/10
97.	Ruthard, Christian	Structure and Properties of Nanostructures from Polyelectrolytes and Porphyrins: Self-Assembly in Aqueous Solution	Gröhn, PhD	01/08–12/09
98.	Saha, Sanjib	Polyelectrolytes in Poor Solvents	Prof. Schmidt	09/08–08/09
99.	Sahl, Mike	Synthesis and Characterisation of Polypeptide Brushes	Prof. Schmidt	04/08–01/11
100.	Scheibe, Patrick	Polymer Stabilized Lipid Membranes	Prof. Zentel	08/08–12/09
101.	Scherer, Christian	Synthesis and Characterization of Polyorganosiloxane Particles	Maskos, PhD	12/06–09/09, 10/09–09/10 (IMPRS)
102.	Schladt, Thomas	Design of Multifunctional Magnetic Nanomaterials for Biomedical Applications	Prof. Tremel	07/08–11/10
103.	Schneider, Imke	Spin and Electronic Densities in Low-Dimensional Strongly Correlated Systems	Prof. Eggert	04/06–04/09
104.	Schultheiss, Helmut	Coherence and Damping of Spin Waves in Magnetic Micro Structures	Prof. Hillebrands	07/07–06/10
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