MATERIALS IN MAINZ SCIENCE

Graduate School of Excellence

MAterials Science IN MainZ (MAINZ)

www.mainz.uni-mainz.de

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Graduate School of Excellence

MAterials Science IN MainZ (MAINZ)

Dear reader,

It is an honour to welcome you to the Graduate School of Excellence "MAterials Science IN MainZ" (MAINZ). Our Graduate School, founded in 2007, aims to provide you with meaningful, rigorous, and high-quality graduate experiences and an individualised training programme in a personalised environment. We are offering a structured doctoral studies programme with extracurricular support for all of our graduate students.

As director, I work closely with excellent principal investigators (PIs) and staff to provide an open and challenging intellectual environment where inter-disciplinary exchange and outstanding research can take place. We aim to make education a stimulating and rewarding experience so that the Graduate School of Excellence MAINZ and its sixty graduate students develop their full potential and make a substantial impact at an international level of research. We are well aware that there has never before been a greater need for highly qualified scientists in the field of materials science.

The programme focuses on laboratory-based research training ("training at the bench") supported by summer schools as well as seminars, international internships and colloquia that supply the intellectual framework necessary to become an independent scientist.

The MAINZ graduate school also offers a supportive infrastructure. It is small enough to guarantee that students achieve good personal development and close working relationships with faculty, yet large enough to offer curricula with flexibility, depth and international relevance. The early contact with the international scientific community and companies via our mentoring programme further serves the needs of our graduate students.

I invite you now to explore what MAINZ has to offer and to learn more about the programmes at our website http://www.mainz.uni-mainz.de. I strongly encourage you to call or email our faculty with any questions you might have. Better yet, come share these opportunities by joining the Graduate School of Excellence "MAterials Science IN MainZ".

On behalf of everyone dedicated to MAINZ, we are looking forward getting to know more about you, and we promise to make your education a stimulating and rewarding experience that will allow you to manage the challenges of the 21st century. Materials science research needs an excellent team.

Professor Claudia Felser
Director of MAINZ

CONTENTS

About MAINZ

Since 1946, polymer science has been one of the central research areas at the University of Mainz.

The university was selected in October 2007 in the second round of the excellence initiative supported by the Federal Ministry of Education and Research and the German Research Foundation. Thus, the Graduate School of Excellence "MAterials Science IN MainZ" (MAINZ) was launched.

MAINZ currently consists of 27 principal investigators (PIs) supported by a smaller group of young researchers and associated members. They are recognised in their respective research communities and many scientists who once studied here hold leading positions around the world in academia and industry. The graduate school promotes training through excellence in research combined with complementary skills. In the graduate school, we pursue research in the fields of polymer science, colloids, supramolecular structures, magnetoelectronics, and strongly correlated quantum systems including ultracold quantum gases.

A FRAMEWORK THAT SUPPORTS YOU

MAINZ integrates excellence programmes of the Johannes Gutenberg University of Mainz (JGUM), the Technical University of Kaiserslautern (TUKL), and the Max Planck Institute for Polymer Research (MPI-P) in Mainz. The school is also part of the Gutenberg Research College (GRC), which serves as the umbrella organisation for the whole network.

The training area is located in and operated by the JGUM, comprising the Departments of Chemistry, Physics, Mathematics and Biology as well as the nearby MPI-P and TUKL. Together they constitute one of the major centres of academic research in polymer science and correlated systems. Here, students can work in a stimulating atmosphere on highly interdisciplinary topics together with leading scientists from all over the world.

The school consists of three programmes that build on existing research and training structures. Each programme provides a specific research and training agenda for the scholars of MAINZ, while the graduate school itself links them and provides additional educational modules of general interest. The overarching scientific concept is to acquire an understanding of related phenomena in systems traditionally seen as separate, and to encourage synergistic transfer of knowledge between these disciplines.

HOSTING THE WORLD

Founded in 1477, the University of Mainz is one of the oldest universities in Germany. More than 35,000 students from over 130 countries are registered, making it among the largest and most dynamic. With about 200,000 residents, 2000-year-old Mainz is the largest city in Rhineland-Palatinate, located in the Rhine-Main Area close to Frankfurt and Wiesbaden. Various theatres and a number of museums offer a range of cultural events to suit any taste. The beautiful surroundings along the river Rhine provide excellent opportunities for excursions to vineyards and hikes through the nearby forests.

The Technical University of Kaiserslautern was founded in 1970 to bridge the gap between natural and engineering science. It is located on the outskirts of Kaiserslautern next to the Palatinate Forest (Pfälzer Wald), the largest contiguous forested area in Europe.

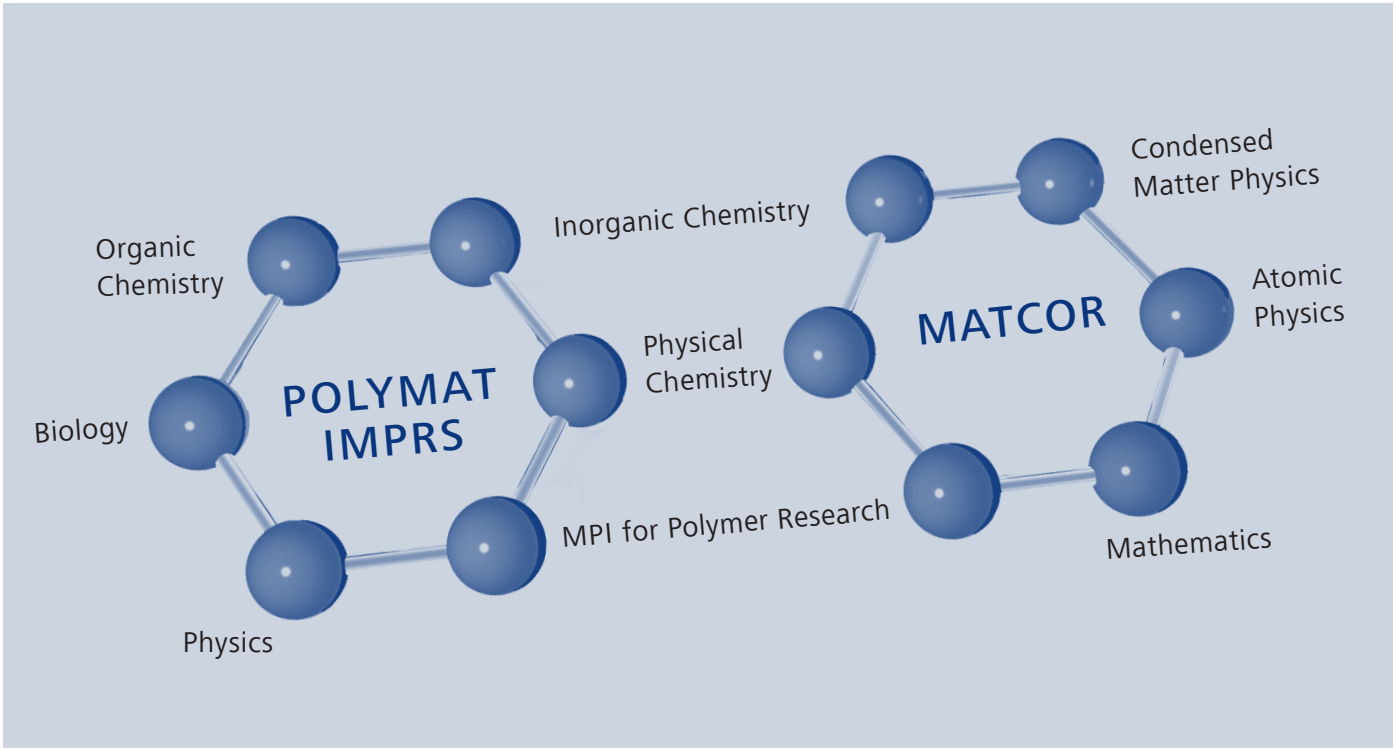
MATCOR, POLYMAT and IMPRS are three classes with a specific research and training programme. A strong link between the scientific goals is the shared scientific objective of contributing to multidisciplinary research.

GRC
(Gutenberg Research College)

University of Mainz
Max Planck Institute for Polymer Research Mainz

MAINZ
MAterials Science IN MainZ

MATCOR	POLYMAT	IMPRS-PMS
3 years	3 years	1 year



Education

What we offer

MAINZ provides an advanced education in the interdisciplinary fields of materials science. For students working towards a doctoral degree, we offer continuing education opportunities through seminars and lecture courses, supervision by our PIs, and contact with academia. Based on a spirit of community among the MAINZ participants, the school serves as a platform for interdisciplinary collaboration and the exchange of ideas. Participation in international seminars, symposia, and conferences helps to augment your international scientific network. The complementary training, for example written and oral presentations, is also an important part of the education. The school comprises three programmes, lasting either one or three years.

Three Year Programmes (complete doctoral degree)
- POLYMAT – POLYmers in advanced MATerials
- MATCOR – MATerials with CORrelations

The programmes of excellence MATCOR and POLYMAT were initially founded in 2005 and aim to educate the top five percent of doctoral students. The training programme and curriculum are designed to train very talented, highly motivated, and dedicated doctoral students.

One Year Programme (registered students worldwide)
- IMPRS-PMS – The International Max Planck Research School for Polymer Materials Science

Founded in 2000, the IMPRS-PMS is one of 49 International Max Planck Research Schools supported by the Max Planck Society. The school is a joint project of the Max Planck Institute for Polymer Research and the Department of Chemistry at the Johannes Gutenberg University.

As a doctoral student of MAINZ, you are member of one of the above programmes. The three programmes are linked through the shared scientific objective of multidisciplinary research. Our approach combines the best specialised research with a broad perspective. We aim to produce well-trained scientists who will be involved with magneto-electronics as well as materials science and the information industry in general. Special partnerships with industry will encourage entrepreneurship.

Detailed policies and procedures are indicated in the Training and Policy Manual, which is provided to all POLYMAT and MATCOR students and their supervisors. It specifies the standard requirements for employment, training projects, and follow-up procedures, as well as covering frequently asked questions, and group and university-wide training measures. The manual is designed to assist students during their doctoral programme and will always be available for download at the MAINZ website (http://www.mainz.uni-mainz.de/) after the applicant is accepted.

Excellent principal investigators and staff provide an open and challenging intellectual environment where interdisciplinary exchange and outstanding research can take place.

POLYMAT

The scientific goal of this interdisciplinary programme is to provide students with comprehensive training in advanced methods of synthesis and characterisation of polymer materials. With this in mind, students are given the task of designing novel methods in analysis and characterisation including computer-assisted modelling, visualisation, and predictive data evaluation. Particular emphasis is placed on creative approaches to the synthesis and analysis of polymers for biomedical applications. Further, characterisation of the surface and bulk properties of polymer systems designed for electro-optical and electronic applications is undertaken. We foresee intensive investigation in hybrid polymer systems containing synthetic and biological components including pigments and release agents at the nanoscale.

Current PIs include Prof. Dr. Kurt Binder, Prof. Dr. Hans-Jürgen Butt, Prof. Dr. Andreas Janshoff, Prof. Dr. Klaus Müllen, Prof. Dr. Manfred Schmidt, Prof. Dr. Hans Wolfgang Spiess, Prof. Dr. Wolfgang Tremel, and Prof. Dr. Rudolf Zentel.

MATCOR

MATCOR is an interdisciplinary programme for the rational design of new functional materials. Therefore, it is necessary to have a solid grounding in theoretical and experimental knowledge. A first-rate scientific education enables students to develop a profound knowledge of the research field in an international environment, and in particular it allows them to develop knowledge of the connections between the various research topics. The guiding principle for all courses offered in the curriculum is a problem-oriented approach with an emphasis on project work. Courses mainly focus on the synthesis, structure, analysis, and functionality of new materials, e.g., optical and magnetic materials, superconductors, nano-structured solids and surfaces, and Bose Einstein Condensates. Low temperature physics and a theory of correlated systems are also in the focus of our research.

Currently, the PIs for this area include Prof. Dr. Kurt Binder, Prof. Dr. Immanuel Bloch, Prof. Dr. Hans-Joachim Elmers, Prof. Dr. Claudia Felser, Prof. Dr. Jürgen Gauß, and Prof. Dr. Burkhard Hillebrands.

IMPRS-PMS

The aim of the IMPRS-PMS is to provide training for doctoral students in the field of polymer science, specifically in the areas of organic synthesis, soft matter theory, solid state and organometallic chemistry. This is done by giving doctoral students the opportunity to complete a research project for one year either at the Max Planck Institute for Polymer Research Mainz or the Johannes Gutenberg University in Mainz. German students are required to spend up to six months carrying out a research project at a foreign university. The training is supplemented by a series of seminars and summer/winter schools that the students are required to attend. Please check the current programme on the website http://www.mpip-mainz.mpg.de/phd/imprs/. The Max Planck Institute for Polymer Research and the Johannes Gutenberg University both have excellent laboratory and computational facilities, and both have outstanding international reputations for research.

Some current PIs are Prof. Dr. Thomas Basché, Prof. Dr. Hans-Jürgen Butt, Prof. Dr. Holger Frey, Prof. Dr. Wolfgang Knoll, Prof. Dr. Klaus Müllen, Prof. Dr. Manfred Schmidt, and Prof. Dr. Hans Wolfgang Spiess.

Who we are looking for

REGULAR STUDENTS

We encourage students from all over the world to apply to MAINZ. Applicants should hold a first-rate Master's, Diplom, or equivalent degree in physics, biology, chemistry, mathematics, materials science, biotechnology, biomaterials, electrical engineering, materials engineering, or another related field. Students should demonstrate proficiency in English, for example with a TOEFL certificate. Knowledge of German is welcome but not essential. Furthermore, applicants for POLYMAT and MATCOR should not be older than 28 years (exemptions will be granted for periods of childcare as well as for military and social service). Successful admission to the POLYMAT or MATCOR programme enables a student to apply for grants to fund research-related travel, conference participation, summer schools, and international internships lasting between three and six months.

Competition for the available positions is strong. To be considered for the programme, a student must have achieved excellent grades (final grade better than 1.3 to 1.5 in the German educational system). Please find further details for application and guidelines for selected countries on our website http://www.mainz.uni-mainz.de/.

ASSOCIATE STUDENTS

Students enrolled in other doctoral programmes at the University of Mainz under the supervision of official MAINZ PIs and fulfilling all the criteria of excellence stated above can join us as associate students (see section "How to apply"). They can attend all courses offered by MAINZ and get financial support for participation in conferences, workshops, summer/winter schools, and research-related travel. A certificate is provided at the end of the tenure.

How to apply

In general, application is possible throughout the year and there is no application fee. In order to apply to one of the three programmes, please visit our website http://www.mainz.uni-mainz.de and follow the appropriate link.

POLYMAT AND MATCOR

You will find all necessary information on our website (http://www.polymat.uni-mainz.de or http://www.matcor.de) under the section "Admission and Application" where the relevant application form for students from abroad is available for download. To initiate the process, please send the completed and signed application form together with the necessary documentation to the International Office by e-mail (fsa@verwaltung.uni-mainz.de) or by regular mail (Johannes Gutenberg University of Mainz, International Office, Incoming, D-55099 Mainz, Germany). Students coming from Germany can send their certified documents directly to our office. Subsequently, you will be informed of our decision and requested to send supplementary material via e-mail. In some cases, applicants will be invited for an on-site interview before a final decision is made concerning their admission to one of our programmes (see application checklist below).

Candidates are selected by a competitive selection procedure. For POLYMAT and MATCOR recruitment, selection, appointment, and training are carried out in accordance with university regulations.

Application checklist for POLYMAT and MATCOR

Step A: Formal eligibility
(to be sent by e-mail or regular mail)

- ¬ Completed and signed form "Application for the recognition/validation of foreign certificates".
- ¬ Copies of your Bachelor's and Master's degrees in the original language as well as translations into German or English.
- ¬ Copies of transcripts indicating your academic standing (lists of courses and grades) in the original language as well as in German or English.
- ¬ The name of your intended supervisor (see section "Principal investigators"). Please contact her/him before applying.

Step B: Personal eligibility
(to be sent by e-mail ONLY after acknowledgment of formal eligibility)

- ¬ A detailed CV (applicants should not be older than 28).
- ¬ A 1-2 page statement of purpose outlining your research interests and how you intend to pursue those interests within the Graduate School of Excellence.
- ¬ Two references, including websites and e-mail addresses, for persons from whom letters of recommendation and/or professional references can be obtained.
- ¬ All documents and translations must now be officially certified or notarised.
- ¬ Proof of English language proficiency; TOEFL preferred.

IMPRS-PMS

The IMPRS-PMS is a one-year programme and exchange opportunity for international research. Those students should be registered for doctoral studies at their home universities. Therefore, its application procedures differ from those of POLYMAT and MATCOR. For example, there is no particular age limit. Please send all necessary documentation by e-mail (imprs@mpip-mainz.mpg.de) according to the checklist below. For further information, please refer directly to the website of the IMPRS-PMS http://www.mpip-mainz.mpg.de/phd/imprs.

Application checklist IMPRS-PMS

- ¬ Your CV.
- ¬ A copy of your degree / Masters certificate.
- ¬ A copy of your PhD registration.
- ¬ The title of your thesis.
- ¬ The name of your intended supervisor.
- ¬ A short research proposal for your stay with us.
- ¬ Proof of English language proficiency.
- ¬ Two letters of reference.

Personal support

A change in job or place of residence always entails coping with various challenges, not only before moving but also upon arrival. In order to ease your first steps in Mainz, especially if you come from abroad, the school and the university's International Office can offer significant assistance. We have ongoing coordination with the Student Service Centre, the Registrar's Office, and the Language Centre, and we can help you find suitable accommodation. Recently, the university has also expanded these informational and support services in order to enable international doctoral students to concentrate more fully on their research and studies. Students and visitors with young children should also note that several places have been reserved in the campus kindergarten (see section "Women in science"). The following practical services are organised for all students of MAINZ:

PRE-DEPARTURE

- ¬ Information on available doctoral courses.
- ¬ Information on admission requirements and procedures.
- ¬ Application and admission.
- ¬ Support with financial issues, insurance policies, visa requirements.

UPON ARRIVAL

- ¬ "First steps"/orientation in Mainz.
- ¬ Enrolment and other administrative matters, e.g., accompanied visits to local authorities.
- ¬ Support finding an apartment.
- ¬ Help in organising childcare, e.g., finding childcare providers or places in the campus kindergarten, childcare upon request in cases of emergency in cooperation with the existing young mothers' network.

DURING YOUR STAY

- ¬ Individual counselling/advising and tutoring.
- ¬ International networking.
- ¬ Language courses: the university's language centre provides an extensive range of courses in German, English, Spanish, and French.
- ¬ Health services and insurance.
- ¬ Sports and recreation, culture and social activities, e.g., sightseeing walks and guided tours around Mainz and neighbouring cities (Wiesbaden, Frankfurt, Koblenz) as well as other excursions in the vicinity.
- ¬ Alumni activities.

Financial support

POLYMAT AND MATCOR

These programmes fully fund our thirty students for a total of three years. Therefore, accepted students have all their research and living expenses paid by the school. An additional thirty students can receive third party funding through Collaborative Research Centres (SFB) or other funding institutions. Associate students can expect partial funding for conference participation, summer schools, workshops, or research abroad.

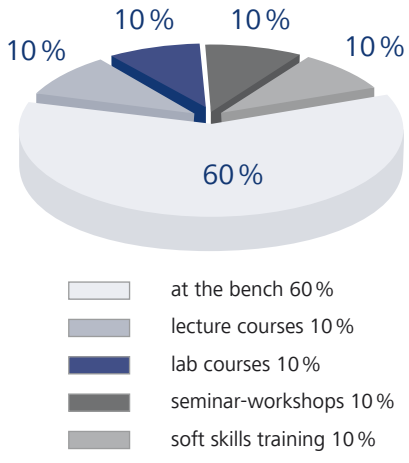
IMPRS-PMS

This one-year programme provides funding for all of its international students registered for a doctoral degree at any accredited university worldwide.

Training programme

POLYMAT AND MATCOR

Regular training in the core specialities emphasises "training at the bench", as well as lab courses and lecture courses. Coursework is partly offered in the form of summer and winter schools given by leading experts in the respective fields. Additionally, soft skills training is provided in areas such as teamwork, project management, and presentation techniques. Educational modules also comprise seminars on career planning, intellectual property protection, networking, and the rights and responsibilities of scientists.



The Graduate School of Excellence "Materials Science in Mainz" aims to provide students with meaningful, rigorous, and high-quality graduate experiences and an individualised training programme in a personalised environment.

The content of the MAINZ curriculum is designed to provide high-quality education for outstanding graduate students, adapted to the students' personal needs and career plans. Particular emphasis is placed on fields of knowledge outside the student's primary research disciplines. An individual career plan is developed with each scholar through the mentoring relationship.

As a student of MAINZ, you are supported by a committee of three experienced scientists: one professor or senior scientist from among the PIs as the principal advisor, one co-advisor (MAINZ member), and one mentor, determined by the student's particular research field. The committee helps you to develop a personalised research plan, ensures the quality of your training, and assists in your career development. Each advisor is involved in one or more research teams (comprising typically five to six scientists) with which you will have strong links and interaction throughout your stay.

Depending on your particular research goals, you will work with your committee to develop a programme of seminars and lecture courses that you will attend. You will also determine a target work schedule with defined milestones and scientific accomplishments. Furthermore, participation is mandatory in dedicated training exercises in the research field. These are organised by senior scientists of JGUM, MPI-P, or TUKL on a regular basis, and include topics such as techniques of instrumental analysis, preparation techniques in microscopy, or introduction to relevant software packages. The committee can assist in recommending a course of study with the understanding that a special seminar programme will also be organised by and for our students. Here, once a month a highly recognised international scientist is invited to present his or her commentary on current research.

You are expected to demonstrate regular progress in your research by contributing to one of the ongoing seminar programmes of MAINZ. As you advance in your studies, you should submit articles for publication in international scientific journals. By the time you graduate, you can expect to have appeared as co-author on at least two publications. Your participation in international conferences is also encouraged.

As many as six undergraduate students at a time have the opportunity to complete up to nine months of study abroad. Most of these students attend the University of Massachusetts, Amherst, the University of Toronto, Cornell University, the University of New York in Long Island, or Seoul National University. MAINZ is offering additional grants to ensure that students can spend time at our international partner universities.

The programme focuses on laboratory-based research training supported by summer schools as well as seminars, international internships and colloquia that supply the intellectual framework necessary to become an independent scientist.

We allow a few top students who have completed their Bachelor's degree among the top one percent of their class to complete their studies more quickly by becoming "early" doctoral students, i.e., without having obtained a Master's degree. You will participate in extra coursework and be required to fulfil additional requirements during your doctoral studies in order to receive a Master's degree at the same time you receive your PhD.

Due to our focus on learning by teaching, you will be required to give the equivalent of tutorials for undergraduate courses. Because most undergraduate courses are taught in German and German language proficiency is not a requirement for admission, those of you wishing to teach in English have an alternative opportunity to tutor students preparing for their Master or Diploma thesis.

IMPRS-PMS

The school consists of a twelve-month research project carried out in one of the eleven research groups. German students are expected to spend up to six months at a foreign university to be chosen by the student and his/her supervisor. The training is supplemented by a series of seminars, the teaching of soft skills, and the participation in four summer/winter schools. Please check the current programme on our website (http://www.mpip-mainz.mpg.de/phd/imprs/).

SOFT SKILLS

As previously mentioned, MAINZ focuses on an individualised education including soft skills training. Participation in these regularly offered courses is mandatory. Within the scope of the existing General Post-Graduate Programme, short courses are organised by JGUM and MPI-P to serve all students. The following soft skills courses are offered:

- ¬ Oral presentation and rhetoric
- ¬ Poster preparation
- ¬ Conflict management and communication
- ¬ Scientific writing and publishing
- ¬ Intercultural communication and relations
- ¬ Project-, time-, and self-management
- ¬ Team organisation, teamwork
- ¬ Information and knowledge management
- ¬ Intellectual property protection and patent law

As a matter of course, you will have the opportunity to improve your language skills. Correspondence courses are offered in English and German. Information is available at the website of the Foreign Language Centre http://www.fsz.uni-mainz.de/. For further information about our soft skills programme, check the university's website http://zope.verwaltung.uni-mainz.de/eng/promo/allgemeines.

With its general plan for the promotion of women and a system of incentives for the advancement of women, the University of Mainz has developed two important instruments for realising equality between men and women in higher education.

Women in science

Sponsoring women and creating equal opportunities for women is of central concern for the Graduate School of Excellence MAINZ. A differentiated incentive system is in effect at the JGUM, with the intention of promoting the inclusion and participation of women in the scientific workforce. In June 2005, the JGUM received the "Total E-Quality Award" for its consistent implementation of institutional policies designed to promote equal opportunities for women and men. This incentive system improved for example,

- ¬ the promotion of women in the departments.
- ¬ the financing of additional university teaching positions dedicated to Gender Studies.
- ¬ awards for particularly talented young female students.

The minimum participation by women has been set at forty percent, and we strongly encourage female researchers to apply to our graduate school. As a female student at MAINZ, you can expect not only equal opportunities but also numerous forms of support, for example in matters of childcare (see section "Personal support"). Furthermore, you will have the opportunity to participate in programmes of the "Coaching Centre for Young Women Researchers". These programmes include special training seminars, as well as courses held by women who are experts in various industries, the social sector, or tutoring.

Student perspectives

Currently there are 50 students enrolled in POLYMAT and MATCOR. They join us from all over the world: India, Iran, Russia, Ukraine, the US, and the European Union. At present, the one-year programme IMPRS-PMS includes 25 students from Africa, Australia, Brazil, China, India, Russia, Turkey, the US, and the European Union. We invite you to read some testimonials from current and former students.

American student

Being associated with MATCOR has given me the opportunity to perform high-level research on an international stage. I really appreciate the dedication of the other students to developing not just a CV with a strong publication record but also to being involved with teaching and soft skills such as giving high-quality presentations.

German student

MATCOR provides a stimulating environment for graduate students of chemistry and physics in Mainz. We aim at notable contributions to materials science in a joint effort. At first sight, it was not obvious to me how chemistry and physics students could inspire each other. However, through MATCOR talks, seminars, and workshops I realised that chemists and physicists are often talking about the same things – just in a different kind of language. MATCOR is the chance to unify that language and pull the rope together. This is truly exciting!

MAINZ graduate school provides a stimulating environment for graduate students: Based on a spirit of community among its participants, the school serves as a platform for interdisciplinary collaboration and exchange of ideas.

Ukrainian student

MATCOR – well-balanced programme, which gives me an opportunity to get in touch with advanced international science in a very efficient way.

German student

MATCOR provides an excellent framework for continuous advancement in a young career. It strongly supports personal development by offering intense soft-skills training (presentation techniques, project management etc.). The MATCOR framework also brings together young scientists and researchers from different realms in exciting workshops and common activities. Therefore, it massively increases the permeability in the community of correlated matter.

Brazilian student

The IMPRS provides a great infrastructure to improve skills in state-of-the-art research techniques. It is also a brilliant opportunity to meet new people and participate in cultural as well as scientific exchange.

German student

The IMPRS is an important part of my PhD studies. The many-facetted schools deepen my understanding in topics that are not directly related to my PhD thesis. At the same time, they offer an excellent way to get in touch with motivated students from institutions and universities all over the world.

Israeli student

I think the IMPRS is an attractive training programme. Researchers are financially supported and encouraged to participate in international conferences and workshops. The schools combine an interesting atmosphere of study, fascinating excursions, and intercultural exchange.

Chinese student

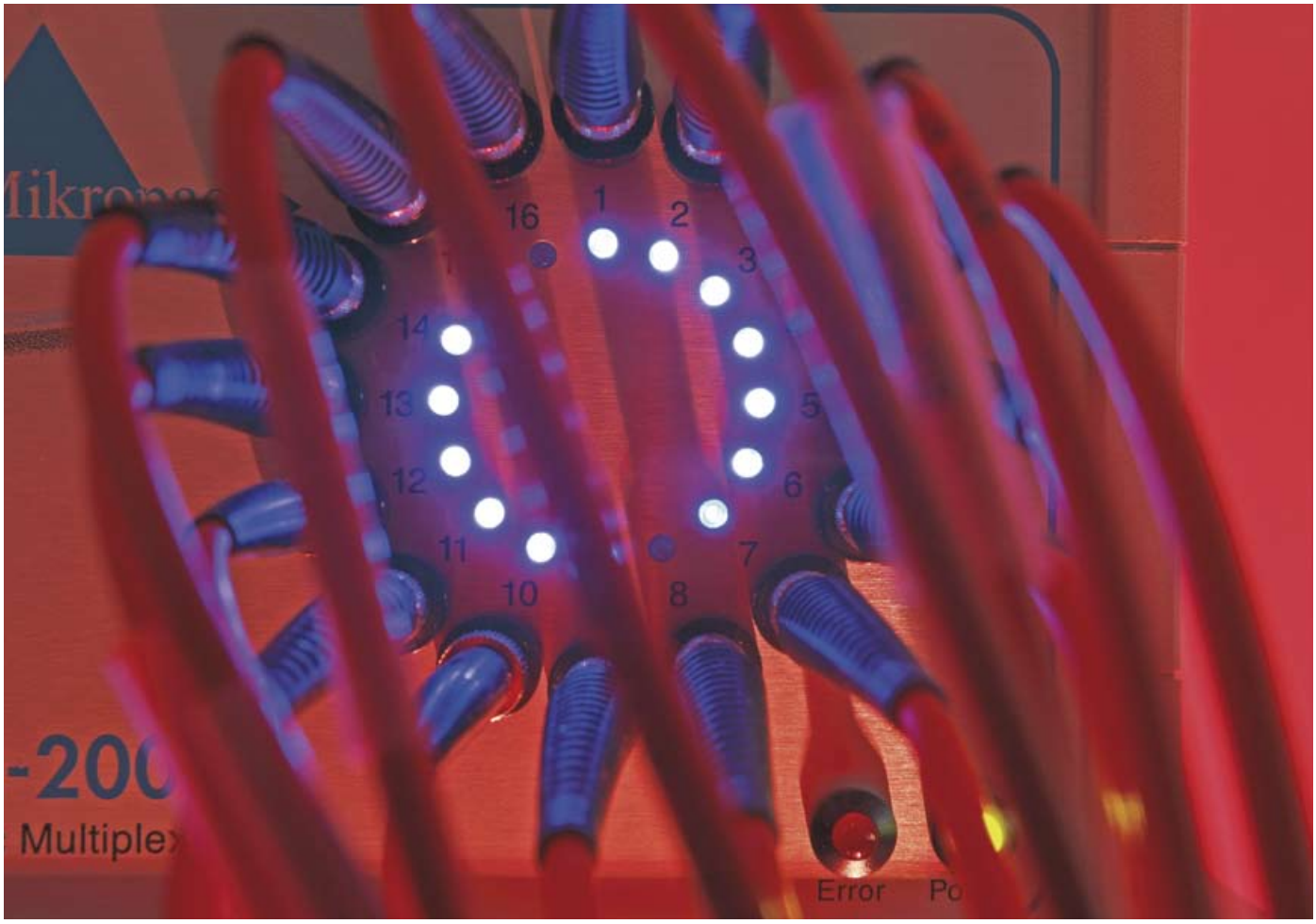
IMPRS offers me a great opportunity to come to Mainz during my PhD studies and get in touch with the best research facility in polymer science.

German student

POLYMAT offers me an interesting programme complementary to my research. Especially the soft skill seminars and summer schools are very helpful occasions to improve my personal abilities and to discuss science with other PhD students. It is great as well that POLYMAT encourages us to go on (inter)national conferences and to spend a research stay abroad.

German student

As POLYMAT member, I am part of a research network that offers me straightforward contact to current research in a way my small working group could never manage.



Grants and awards

How about winning an award during your stay in Mainz? Not only outstanding scientists but also extraordinary students can win university-wide and national awards.

For example, MAINZ and Siemens offer all MAINZ post-graduate students training in entrepreneurship the opportunity to enter an annual competition to prepare a business plan. The final winner of a multi-stage competition will be honoured with a € 2,000 prize sponsored by Siemens. The scholar will give a final presentation to an audience of venture capitalists, entrepreneurs, and interested business people.

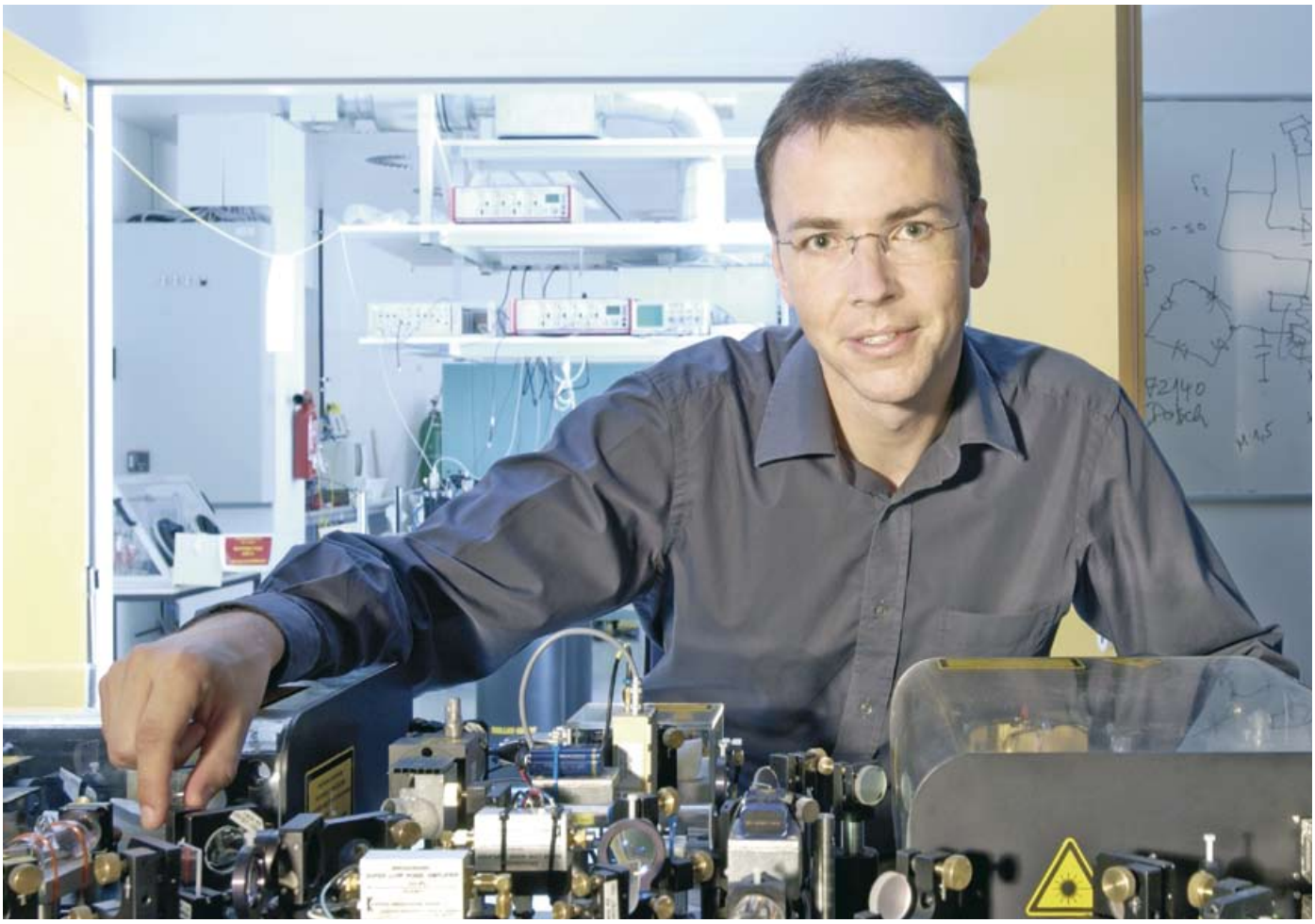
Furthermore, the school will grant three awards of € 1,000 each for outstanding PhD theses each year. These awards are financed through various industrial collaborations.

Once you have completed your doctoral studies programme at MAINZ, you may apply to carry out a research project at JGUM or MPI-P as part of the Ringsdorf Fellowship Programme, offered to outstanding graduates of MAINZ. The specific purpose of this fellowship is to give young researchers an opportunity to pursue their studies in any science-related department of the University, free from formal requirements and at an early stage of their career. The number of Ringsdorf Fellows at any time is normally limited to two.

MAINZ and the Gutenberg Research College confer the Gutenberg Lecture Award and the Gutenberg Research Award to outstanding scientists once a year. The Johannes Gutenberg Lecture Award (€ 10,000) will be granted to top international leaders in the field of polymer research or correlated materials and is presented annually at the MAINZ summer school.

The first Johannes Gutenberg Lecturer was Nobel Laureate Jean-Marie Lehn (Isis-CNRS, Strasbourg) in 2005. Professor Lehn was awarded the 1987 Nobel Prize in Chemistry for his development and use of molecules with structure-specific interactions of high selectivity.

In 2006, the award was jointly granted to Eugene A. Demler (Harvard University) and Albert Fert (Université Paris Sud,



Orsay). Demler's work is focused on the development of general theoretical tools for understanding the effects of interactions in condensed matter systems. The aim of this work is to establish a common framework for understanding the physics of strongly correlated systems. Albert Fert is one of the co-winners of the 2007 Nobel Prize in Physics together with Peter Grünberg from the Jülich Research Centre for their independent discoveries of the giant magnetoresistance effect (GMR) in multilayers of iron and chromium. This is recognised as the birth of spintronics.

In spring 2007, Benjamin Chu (State University of New York at Stony Brook) was honoured for his fundamental work on polymer analytics. Also in 2007, Murugappan Muthukumar (University of Massachusetts at Amherst) received the Gutenberg Lecture Award. Professor Muthukumar investigates how macromolecules assume their sizes and shapes, organise into assemblies, and move around in densely packed environments.

The Johannes Gutenberg Research Award (€ 10,000 – € 20,000) supports guest scientists. Distinguished scientists collaborating with researchers in Mainz can be nominated for this award, which includes travel costs and a fellowship for up to four months. This award requires that the research be conducted in Mainz.

The Gutenberg Research Award was conferred in July 2006 to Kookheon Char (Seoul National University, Korea). Professor Char works with extremely thin polymer films that can be used in organic light-emitting diodes for screens or displays or in organic solar cells. The award is a tribute to Professor Char's research achievements in the field of polymer physics and polymer chemistry.

Excellent principal investigator: In 2005, the German Research Foundation (DFG) awarded its annual Gottfried Wilhelm Leibniz Prize to Prof. Dr. Immanuel Bloch.

Scientific Vision

Major needs of modern civilisation such as food, clothing, health care, transportation, energy, and communication cannot be met without continual progress in materials science. As we face an increase in the world's population and a decrease in the availability of natural resources, sustaining the growth of the economy while protecting the environment is only possible with the advent of new technologies. A condition for the technological revolution is innovation in new materials.

Polymers for MAINZ

Innovation and invention are particularly rich in the polymeric materials domain. Due to their low weight, flexible processibility, mechanical and chemical stability, they are not only replacing conventional materials but also opening up qualitatively new applications. For example, it is possible to print transistors, solar cells, or OLEDs (organic light emitting diodes) onto flexible substrates using conducting polymers. Key components in fuel cells or batteries, polymers also act as membranes in biomedical applications such as implants and drug carriers. In general terms, polymeric materials play a central role in technology as well as fulfilling an essential role in biology.

Within MAINZ, we develop new methods to synthesise, characterise, and better understand macromolecular materials. A clear distinction between fundamental and applied science is usually not helpful or even possible. Many fundamental projects lead to applications. Conversely, technological developments lead to new scientific questions and fundamental insights. Therefore, we interact closely with our industrial partners. The traditional separation of natural and synthetic polymers seems rather artificial because they share the same scientific questions. Biopolymers as functional units in proteins or as a raw material for "green chemistry" become more and more relevant. Despite their interdisciplinary significance, high industrial relevance, and abundant natural occurrence a systematic, fundamental understanding of macromolecules is still missing.

Prof. Dr. Carsten Sönnichsen, Young Researcher

The research in Prof. Dr. Carsten Sönnichsen's group focuses on nano-bio-technology – the synthesis and functionalisation of nanoparticles, especially metal nanocrystals, and their use as markers for single biomolecules in light microscopy. The basis is a special optical effect in the visible spectral region called "plasmon". Plasmonic particles act as tiny nano antennas for light. This leads to very bright colours that have been used for centuries to make coloured glass, for example in church windows. We use this effect in a new way to investigate single biomolecules, for example by using plasmonic particles as nano-ruler or nanoscale orientation sensor. The research programme is highly interdisciplinary and involves inorganic chemistry to make nanoparticles, organic chemistry to functionalise and organise them, material science, physical chemistry, and physics to understand and predict the resulting properties. The graduate school offers an excellent framework for such work by providing training for graduate students, a platform for exchanging ideas, and by enhancing collaborations with other groups at the university and the Max Planck Institutes.

Materials science research needs an excellent team. Therefore, the Mainz graduate school is designed to attract excellent students from all over the world to work in an interdisciplinary research environment.

Recently, the focus in macromolecular science has shifted:

- ¬ In contrast to linear polymers of simple monomers, we focus on more complex macromolecules (e.g. block copolymers, dendrimers, graft polymers) and their assembly into larger functional units.
- ¬ To understand structure formation in such complex macromolecular materials different length and time scales have to be explicitly considered. This can lead to a hierarchy of supramolecular structures.
- ¬ Structures are often not in thermodynamic equilibrium but are significantly influenced by the experimental procedure. To a large extent, structure formation far from thermodynamic equilibrium is not understood theoretically and the experimental techniques for its characterisation still have to be developed.
- ¬ Instead of monofunctional materials, multifunctional materials with a combination of properties and tasks or stimuli responsive materials move into the centre of research.
- ¬ Material properties are more and more influenced by structures on the nanometer scale. As a result, interfaces become important. In fact, interfaces often dominate the material properties, and a clear distinction between bulk and interfacial phases is no longer possible, marking a clear shift towards nanotechnology.
- ¬ Characteristic length scales are often so small that a description in terms of the current asymptotic theoretical models is not possible. Qualitatively new concepts are required for a theoretical description.
- ¬ Polymers play an essential role as additives in soft matter. In multicomponent systems such as dispersions, emulsions, gels, or in mineralisation, small amounts of macromolecules can dominate the structures. Central issues are not yet understood and need to be clarified.

The scope of MAINZ extends beyond just polymers, although we see polymers as the most important representatives of soft matter. Soft matter such as liquids, gels, or dispersions is easily deformable. Practically all biological materials are also soft. For example, in food science, pharmaceuticals, mineral processing, and chemical engineering, soft matter plays a central role. Soft matter science is a rapidly growing field because the state and properties of soft matter are rather unique. Teasing out the structure, dynamics, functions, and thus the role of (bio-)polymers in complex processes remains a challenge for the future.

Inorganic-organic hybrid materials

Polymers are in the focus of MAINZ. However, inorganic-organic hybrid materials have great potential impact on numerous future developments because they combine functionalities with complementary properties in a synergistic manner.

The key concept is to combine soft matter with inorganic semiconductors, metals, ferromagnets, and biopolymers to form hybrid functional systems. Joint expertise and efforts in soft condensed matter (polymers, macromolecular chemistry, and supramolecular chemistry) and hard matter are a central research objective of MAINZ. The crystallisation of inorganic nanocrystals from solutions can be strongly influenced by polymers, in a manner similar to the formation of pearls in nature. Another example of a hybrid system is the Grätzel type solar cell. Severe compatibility problems are often encountered when using TiO2 as a basic material with other components, such as sensitising dyes or hole transporting systems. In this context, the far-reaching research outline will also strengthen the bottom-up approach to miniaturisation.

At MAINZ, we concentrate on both the fundamental understanding of complex structure formation and new functional assemblies, with emphasis on shared phenomena, such as control of conformation, tunable interactions, mobility and transport, and shape and size as variables in structure formation. The interactions between building blocks will be tuned either through chemical design or through the application of external driving forces. Such a general approach requires sophisticated theoretical and experimental methods to meet the challenges of creating and characterising new advanced functional materials.

By using rational design and instrumental control over structures, MAINZ will pave the way for building new hybrid architectures that will meet the demand for sophisticated applications such as drug delivery vehicles, stochastic sensors, photovoltaic cells, and devices based on spintronics that require new controllable functionalities.

The study of such complex systems as multifunctional hybrid materials from the point of view of correlation and

Dr. Tanja Schilling, Young Researcher

My research interest is the application of methods from statistical mechanics to "soft condensed matter". Soft condensed matter means everything which is dense on the one hand, but which can easily be deformed on the other hand. Most biological materials and many everyday substances such as paint, shampoo, or yoghurt are soft condensed matter. In my group, we are mainly doing computer simulations and sometimes theory. One topic that we are particularly interested in is the simulation of rare events. Many processes in nature exhibit free energy barriers, as for example nucleation barriers at first order phase transitions or barriers between different conformations of a molecule. The states on top of the barrier (the transition states) are crucial for the evolution of the system, but they are difficult to find with conventional simulation methods. We are looking for new algorithms in order to identify such states in nucleation problems. The MAINZ graduate school of excellence offers me opportunities to discuss research with scientists from related fields and to exchange knowledge. I enjoy very much taking part in this project.

The research of Prof. Dr. Kurt Binder and his co-workers overwhelmingly relies on various techniques of computer simulation. The further development of these techniques is in the centre of interest.

interaction is only possible by first breaking down the problem, then by investigating model systems, and by transferring the concepts to single component materials with an increasing degree of complexity.

Correlations in materials

The "structure-to-function" relation links aspects of the structure of matter with its functional properties. However, simple inorganic materials such as transition metal oxides often belong to the class of correlated materials and cannot be described with simple theories. Many, if not most transition metal oxides belong to this class, which may be subdivided according to their behaviour, e.g., high Tc superconductors, spintronic materials, Mott insulators, spin-Peierls materials, heavy fermion materials, quasi low-dimensional materials. Spin electronics, or spintronics, make use not only of the charge of electrons but also their spin. The independent discovery of giant magnetoresistance in 1988 by Albert Fert et al. and Peter Grünberg et al. is considered to be the birth of spintronics. Both Grünberg and Fert received the 2007 Nobel Prize in Physics for their discovery. Magnetoelectronics is a subdiscipline dealing with devices that make use of ferromagnetic materials, for example the read-write heads of computer hard drives.

To exploit the full potential of spintronics, the development of new magnetic materials, magnetic semiconductors, and half-metallic ferromagnets is necessary. Half-metallic ferromagnets such as Heusler compounds meet all the requirements of spintronics because of their exceptional electronic structure.

The combination of such simple systems with single component complex materials, such as organic charge-transfer salts, organic semiconductors and metals, correlated oxides, chalcogenides and half-metallic or semiconducting ferromagnets, is of particular interest to the MATCOR programme. Superconductivity, materials with a Mott transition, and magnetism are topics in solid state physics where many-body interactions and correlation effects are the most obvious. Recently and for the first time, the Mott transition was also found in ultracold quantum gases.

Dr. Herwig Ott, Young Researcher

Our understanding of the microscopic structure of materials strongly depends on our ability to see objects on smallest length scales. With ever-increasing resolution and sensitivity, microscopy ultimately enters the quantum world in which the image formation has to be interpreted in terms of quantum mechanics. One of the most striking consequences is that the detection of a particle is now understood as a projection of its quantum mechanical wave function. This makes any image of a quantum object intrinsically probabilistic. – Ultracold quantum gases are particularly well suited to study these effects due to their purity, diluteness, and macroscopic extension. We have developed a new microscope technique that allows us to image the distribution of individual atoms in a quantum gas with unprecedented spatial resolution. This unique combination makes it possible to zoom deeply into these quantum objects and visualise the granular structure of the many-body wave function. From such images, we can learn about the correlations, the dynamics, and the spatial structure of these systems. In combination with optical lattices, we can even mimic solid state systems – as if one could image the spatial distribution of the individual electrons in a solid.

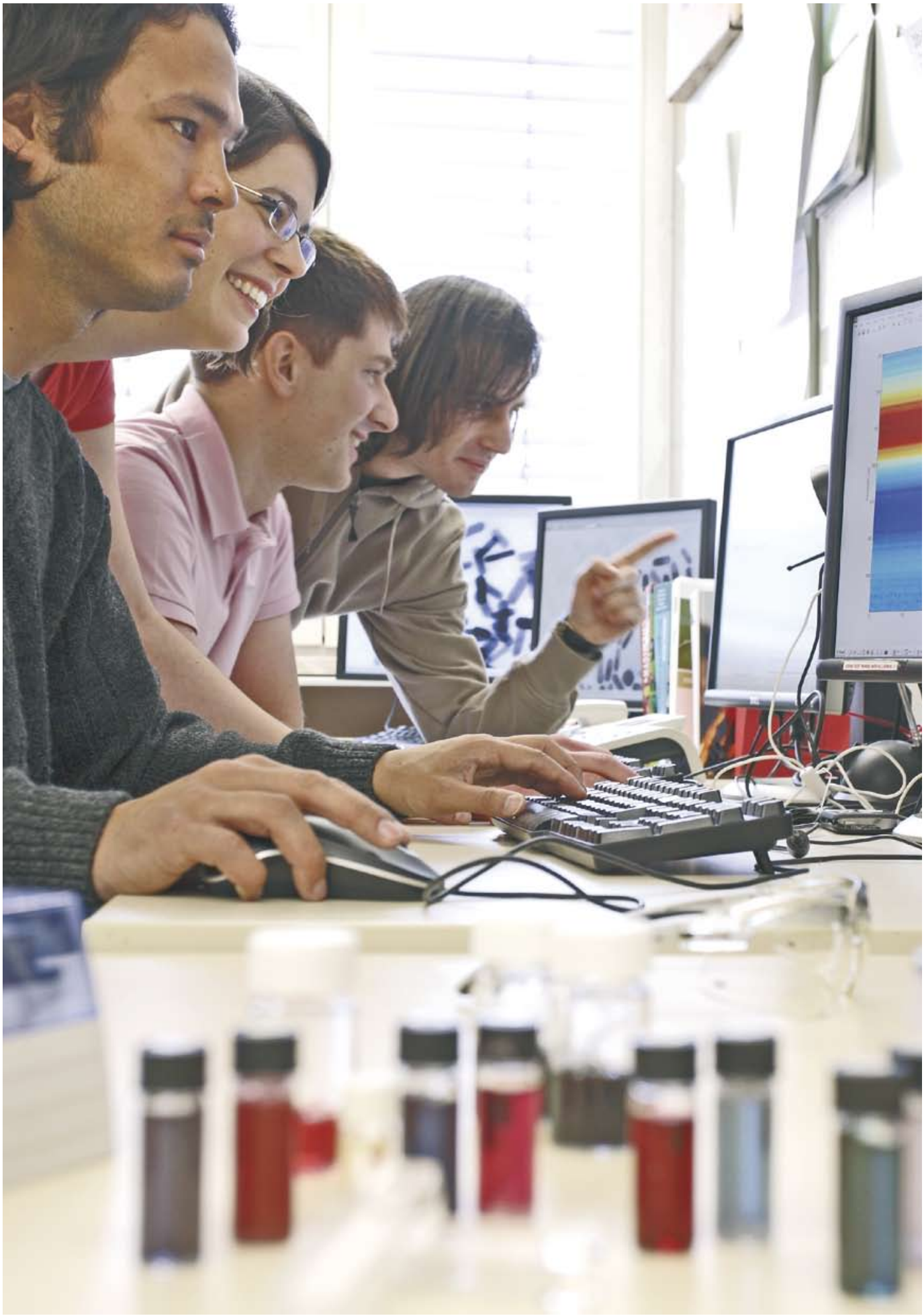
MAINZ offers an excellent scientific environment for Dr. Herwig Ott's group. Its students have the opportunity to perform a research project at the leading front of current research in an exciting and stimulating scientific atmosphere.

Model systems for materials design

Ultracold quantum gases can serve as model systems for quantum magnets, such as frustrated antiferromagnets, and as model systems for the influence of disorder on quantum phases and transport properties in conducting polymers. The ultracold atoms are strongly diluted atoms such as lithium trapped by electromagnetic fields at ultralow temperatures, and they behave like matter waves. Artificial crystals of light, consisting of hundreds of thousands of optical microtraps, are created by interfering optical laser beams. These so-called optical lattices act as versatile potential landscapes to trap ultracold quantum gases of bosons and fermions. They form powerful model systems of quantum many-body systems in periodic potentials for probing nonlinear wave dynamics and strongly correlated quantum phases, building fundamental quantum gates, or observing Fermi surfaces in periodic potentials. Optical lattices represent a fast-paced modern and interdisciplinary field of research.

Due to their exceptional degree of controllability, ultracold quantum gases – as initially conceived by Richard P. Feynman – can form "quantum simulators" for strongly correlated quantum systems.

The main focus of research in Prof. Felser's working group is on inorganic functional and multifunctional materials. For many years she has followed one primary philosophy, i.e., the rational design of novel materials based on electronic structure calculations.



Network and Communication

All MAINZ scientists and their institutes, including the Max Planck Institute for Polymer Research, will be based in close proximity to one another on campuses in Mainz and Kaiserslautern. In compliance with the interdisciplinary approach of MAINZ, a lot of other institutions and research projects as well as industrial partners are associated with the school. All initiatives are regularly evaluated by external scientists according to international standards. A brief summary of existing cooperative arrangements is listed below.

Alumni

In order to keep in touch with former students, the departments and faculties of the university have a long-standing tradition of creating alumni networks. Created in 2004, the university-wide alumni association "Alumneum" reinforced the building of such networks. All alumni of MAINZ are represented in a special section of "Alumneum". This network will enable the graduate school to invite alumni for evening talks with topics on such far-ranging issues as job opportunities and mentoring relationships for current students.

In order to assess alumni satisfaction with their programme of study and their passage from university to professional life, the university's Centre for Quality Assurance and Development (ZQ) conducts several surveys concerning questions of specific relevance for the graduate school. In particular, these surveys are designed to monitor the connection between skill sets fostered during the time at MAINZ with competence requirements later in life.

The MAINZ graduate school guarantees its students the achievement of good personal development and close working relationships with faculty. The early contact with the international scientific community and companies via mentoring programmes further serves the needs of the graduate students' needs.

Academic network

¬ DFG Collaborative Research Centre SFB 625 "From Single Molecules to Nanoscopically Structured Materials" (Coordinator M. Schmidt, http://www.uni-mainz.de/Organisationen/sfb/625/).

¬ International Research Training Group (GRK1404) "Self-organised Materials for Optoelectronics" established between groups from Mainz and Seoul (www.optoelectronics.chemie.uni-mainz.de).

¬ Several groups participate in TRR 6 "Colloidal Dispersions in External Fields" (Spokesman H. Löwen, http://www.sfb-tr6.de/public/home/public.php).

¬ DFG funded Research Unit 559 "New Materials with High Spin Polarisation" (Coordinator C. Felser, http://www.magnetoresistance.de) with Sendai.

¬ The Marie Curie Host Fellowship for Early Stage Research Training "Analytical Methods in the Development of Science and Technology of Polymers" (Coordinator G. Wegner, www.mpip-mainz.mpg.de/phd/est/).

¬ Transregional Collaborative Research Centre SFB/TRR 49 "Condensed matter systems with variable many-body interactions".

¬ The Mainz Electron Microscopy Centre also contributes to the excellent environment (http://www.emzm.uni-mainz.de). It is run jointly by the University of Mainz and MPI-P.

¬ The academic institutions are complemented by the associated Institute of Microtechnology Mainz (IMM, http://www.IMM-mainz.de).

Industrial partners

Our principal investigators maintain different research collaborations with industrial partners. Such relationships are very important not only for additional fundraising but also for students to improve their chances on the job market. Here are some of our partners who are of importance within the framework of the graduate school.

¬ BASF AG
Carl-Bosch-Straße 38, 67056 Ludwigshafen

¬ Bayer AG
Werk Leverkusen, 51368 Leverkusen

¬ DuPont Performance Coating GmbH & Co. KG
Werk 7 Köln, Fritz-Hecker-Str. 47-107, 50968 Köln

¬ IBM Deutschland GmbH
Pascalstraße 100, 70569 Stuttgart

¬ Schott AG
Hattenbergstr. 10, 55122 Mainz

¬ Agfa-Gevaert N.V
Septestraat 27, B-2640 Mortsel (Belgium)

¬ Siemens Corporate Technology
Günther Scharowsky-Str. 2, 91058 Erlangen

Awards for principal investigators

Many of our PIs have been decorated with national and international awards. Because a complete list would go beyond the scope of this publication, we introduce five of our senior fellows with a selection of their most important awards.

Prof. Dr. Kurt Binder, member of the Institute of Physics at Mainz University and a participant in MATCOR and POLYMAT, leads the Condensed Matter Theory Group, which focuses on the statistical thermodynamics of solids

and liquids. He has received the following awards: Boltzmann Medal (2006), Staudinger Durrer Medal (2003), Max Planck Medal (1993).

Prof. Dr. Immanuel Bloch, member of the Institute of Physics at Mainz University and a participant in MATCOR, is the scientific leader of the QUANTUM group, which researches in the field of quantum, atomic, and neutron physics. He has received the following awards: Philip Morris Research Prize (2007), Gottfried Wilhelm Leibniz Prize of the DFG and National Medal of Great Merit (2005), Marie Curie Prize (2004), Philip Morris Research Prize (2000).

Prof. Dr. Jürgen Gauß, member of the Institute of Physical Chemistry at Mainz University and a participant in MATCOR and POLYMAT, researches theoretical chemistry and quantum chemistry. He has received: Gottfried Wilhelm Leibniz Prize of the DFG (2005), Academy Award of the Berlin-Brandenburger Academy of Sciences (2003), Carl Duisberg Memorial Prize of the German Chemical Society (GDCh) (1996).

Prof. Dr. Klaus Müllen, Director at the Max Planck Institute for Polymer Research and a participant in IMPRS-PMS and POLYMAT, is currently pursuing research on shape-persistent polyphenylene dendrimers as programmable nanometer-scale building blocks. He will be President of the German Chemical Society until 2010 and has received the following prizes: Science Prize of the "Stifterverband für die Deutsche Wissenschaft" (2003), Philip Morris Research Prize (1997).

Prof. Dr. Hans Wolfgang Spiess, Director at the Max Planck Institute for Polymer Research and a participant in IMPRS-PMS and POLYMAT, currently focuses on shape, dynamics, and proximities in supramolecular assemblies from magnetic resonance spectroscopy. He has received the following medals: Walter Nernst Medal of the "Deutsche Bunsen Gesellschaft für Physikalische Chemie" (2005), Liebig Medal of the German Chemical Society (2002).

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Publications

The principal investigators and young researchers of MAINZ are very active; a selection of publications is given below.

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