CINSaT Center for Interdisciplinary Nanostructure Science and Technology

Newsletter 2/2017

UNIKASSEL
VERSITÄT

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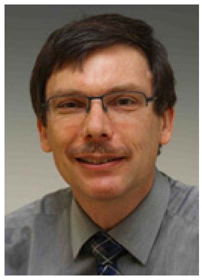
photo: Press and Public Relations Office University of Kassel, Studio Blåfield

Preface

Welcome to the second CINSaT newsletter in 2017



In the meantime, some routine is established in generating the newsletter, although it is still challenging to bring all the information together from many authors and data sources before the publishing date. Therefore, we are proud to have the current newsletter in hand with a similar size and quality as the previous one. Thanks again to all the article writers contributing to this issue with their stories about amazing new research results and presentations of new exciting projects. I would like to take the opportunity to encourage all the CINSaT members to utilize this platform for the visualization of their research for students, colleagues and the interested public.

This issue starts with the education section, reporting about a seminar for senior class pupils, the introduction of the Kassel group of „Junge Deutsche Physikalische Gesellschaft" and of the „JungChemikerForum Kassel". These articles are reflecting the multi-disciplinary interest of young people in CINSaT topics, from the school age, up to the PhD student age. We would like to intensify in the future contacts to schools and young scientists initiatives. New exciting research highlights in physics are reported by Thomas Baumert, André Knie, Arno Ehresmann and Dennis Holzinger. New projects will be presented by Christiane Koch (Physics), who is coordinating an European innovative training network, and Raffael Schaffrath (Biology), who works on a new DFG-project in the frame of the „DFG Schwerpunktprogramm Iron Sulfur for Life". Further coordinated projects, where several CINSaT members are participating, will be subsequently presented. SMART.Con is dealing with the use of shape memory alloys in constructions and is coordinated by Bernhard Middendorf (civil engineering) with participation from mechanical engineering. An already externally funded project by the Volkswagen foundation is the „Quantum Coin" project, coordinated by Kilian Singer (Physics), which has started about 1 year ago.

Related to the above mentioned successful acquisition of coordinated projects, I also want to highlight an important date, Nov. 27, 2017, when the first „DFG Sonderforschungsbereich" initiated by CINSaT members was approved. Congratulations to Thomas Baumert and his team from the „Chiral Systems" priority group. About this new project will be reported in more details in one of the coming newsletters. In the last newsletter, it was reported that CINSaT gained three new members, i.e. Christiane Koch (Physics), Arno Müller (Biology) and Peter Lehmann (electrical engineering). In this issue, they introduce themselves and their research fields. As a general section, we have the presentation of CINSaT members. This time, Ulrich Siemeling (Chemistry), Bernhard Middendorf (Civil Engineering) and Alexander Wetzel (Civil Engineering, associate member) will tell you about their history and current research interests.

Members of CINSaT groups were awarded at international conferences and summer schools with poster prices as reported in the award section. Congratulations to these achievements. In October, we had our autumn colloquium with four distinguished guest lecturers covering a broad field from optical measurement, quantum optics, colloidal quantum dots and electro switchable biomolecules. Finally, brief reports are given about CINSaT external presentations, at the „Hessentag" in Rüsselsheim and at the University Campus Festival.

You should also have a look on the announcements, in particular for the spring colloquium and not miss the nano art page. If you look carefully on the last image, you may identify some nice star-like features, which clearly give a hint to the quickly coming Christmas time.

Enjoy the reading of this issue.

Johann Peter Reithmaier

General

Latest information from the CINSaT management

Here, we report briefly about major issues from the CINSaT committees and major discussion results in their meetings.

Since the appearance of our last newsletter we had two steering committees, one priority speaker and one member meeting.

(a) Duties of priority speakers

An important issue, in particular in the priority speaker meeting, was the more detailed definition of the duties of the priority speakers. We agreed on the following major tasks, which are more detailed in the related document, available on the WEB-site.

1. Organization of periodic internal priority meetings (once per semester)
2. Initiative support of interdisciplinary cooperation within a priority topic
3. Brief report and evaluation of current projects within a priority topic (twice a year)
4. Long term agenda and further development of the priority topic (once a year)

(b) Priority topics

It was agreed that the priority topic „Biosensing“ has to be renamed because of the change of the research topics under this umbrella. Discussion mainly within the biology members should go on (guided by Friedrich Herberg) to come to a conclusion until the next member meeting. All other priority topics remain the same.

(c) Scientific advisory board

The steering committee has decided to search for only one additional new board member. However, the search and approval is still delayed. We hope an appropriate board member can be found and approved by the president beginning of next year. The following board members were already approved by the president.

- Prof. Markus-Christian Amann (electrical engineering, TU München)
- Prof. Hans-Joachim Freund (chemical physics, MPI Berlin, Fritz-Haber-Institute)
- Prof. Andreas Offenhäuser (bioelectronics, Research Center Jülich)

(d) CINSaT assistant position

The search for a management assistant position was still not successful, mainly due to the administrative restrictions we have to take into account. The steering committee is working on this issue but apologizes again that the management work force is still very limited.

(e) Application of ongoing financial support

The application of institutional support for the next two years (2018 and 2019) was submitted recently but is still waiting for approval.

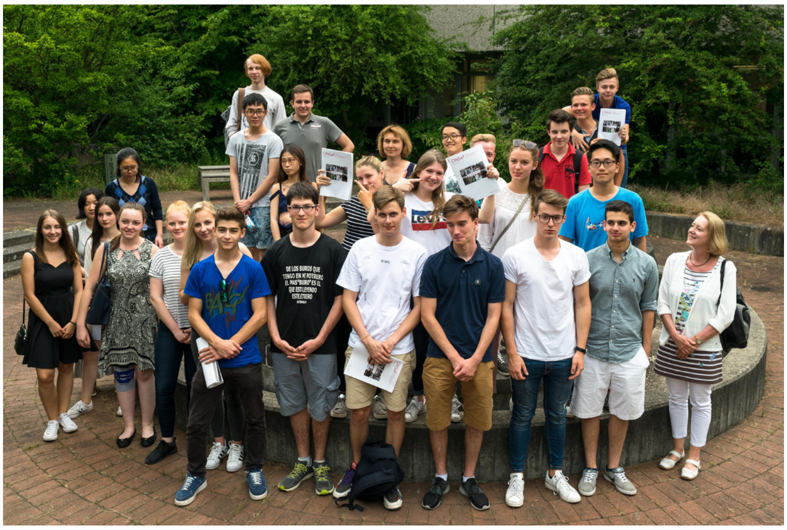
Education

CINSaT hosts seminar event for pupils

For the first time, a seminar event for pupils – as requested by the former CINSaT member Dr. Frank Hubenthal – from the private boarding school Solling was organized on June 22nd, 2017 by CINSaT members from the physics and chemistry departments in order to give an insight into the world of nanostructures from different points of views. To this end, a series of three lectures was given, i.e., presentations by Prof. Singer on the quantum mechanical phenomena related to nanostructures, by Prof. Fuhrmann-Lieker on their appearance in everyday life and finally by Prof. Garcia on ultrafast phenomena in materials processing via specially tailored laser pulses, were given.

To give a little relief in between the half-hour-long sessions, lab tours were offered by the research groups for Light-Matter-Interaction, Macromolecular Chemistry and Molecular Materials, and Functional Thin Films and Physics with Synchrotron Radiation. The students' feedback turned out to be very positive, not least because of the kindness and commitment of the groups' employees (staff). In future, it is planned to proceed with seminar events for pupils and also to intensify the contact to local schools.

Audience listening to the exciting talk given by Prof. Dr. Martin Garcia.



Group photo of the school class.

Junge Deutsche Physikalische Gesellschaft
Regional Group Kassel

As a subgroup of the DPG, the jDPG is an association of young people interested in physics. The jDPG is committed to the interests of postgraduate students, undergraduates, and school students in the field of physics.

We, as the regional group Kassel, have focused our attention on networking with students, school students and Ph.D. students at the University of Kassel. We also cooperate with the student council of the FB10 and the Jungchemiker Forum. Together with the help of the IAPS, we also forge Germany-wide and international relationships with young physicists.

For this purpose, we organize various events throughout the year that are open to all interested parties. Last year, these included an excursion to the nuclear power plant in Biblis, the physics breakfast, the quiz night as well as networking meetings in Hamburg, Heidelberg, Bayreuth, and Cologne. We suggest you watch out for our posters and join the next event.

If you have questions or ideas for new events, just write to us. We also look forward to you participating in our open regulars‘ table, which takes place every first Saturday of the month at 7pm in Bitburger Bier Haus (Friedrich-Ebert-Straße).

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Group photo of the jDPG Regional Group Kassel.

JungChemikerForum Kassel

The JungChemikerForum Kassel is the youth and student organisation of the GDCh (Gesellschaft Deutscher Chemiker) and it offers a platform for students and doctorands of the faculty.

During the academic year, the members of the JCF organize special events for everyone at the University who is interested in chemistry: There is a guest lecture in summer and one before Christmas, which attract a wide audience, and bring them in touch with chemistry, especially its fun and beautiful sides. After the speakers from "Cradle to Cradle e.V." (registered association) informed us about their sustainable concepts of up- and recycling for a responsible handling of our resources and our environment in June, the winter lecture held by Prof. Dr. Matthias Ducci mesmerized the audience with fluorescence experiments created from products of our daily life. Afterwards, the participants usually get together to share some time and discussions - depending on the time of the year either with beer and barbeque or some 'glühwein' and waffles. During the last couple of years, the JCF has also made it to its business to arrange expeditions to companies or institutes of interest for the active members, such as visiting CERN in Geneva, Airbus in Hamburg and the Max Planck Institute for Polymer Research in Mainz. These mutual adventures create not only a good network for every participating student, but also offers new perspectives on science, academics and industrial research.

Another fun event was set up in this year's November: the 4th Science QuizNight brought students and PhD candidates from different natural sciences together. Prompted by some nice prizes for the three best teams, the groups puzzled over more or less serious chemical, physical and biological questions and riddles. The JCF Kassel welcomes all chemistry and nanoscience students or doctorands who would like to be part of the team! Contact us via koerner@student.uni-kassel.de or on our Facebook page "JungChemikerForum Kassel"!

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Andreas Körner (spokesman of the JCF) showing nanomaterials, here ferrofluid, to guests of the Campusfest at HoPla this summer.

The winning team (Gero Grunewald, Denise Täubert and Sebastian Greve) of the 4th Science QuizNight in November 2017.

Research Highlights

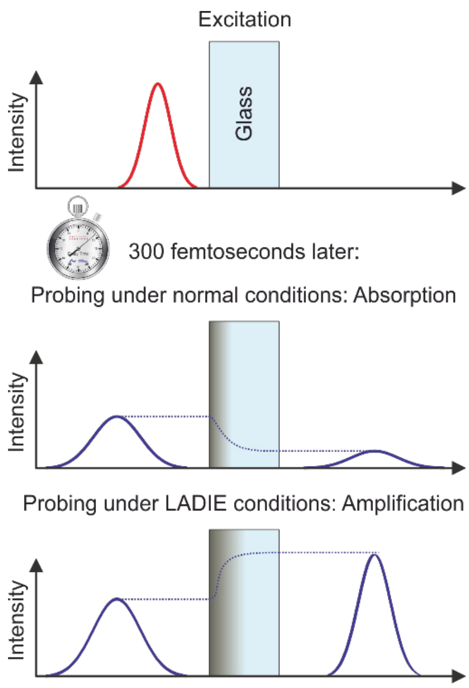
Laser amplification in excited dielectrics (LADIE)

Physicists from the Universities of Kassel and Aarhus discovered a coherent light amplification process in laser excited transparent dielectrics. Their discovery was recently published online in Nature Physics with Thomas Winkler as the first author.

Dielectric materials like glass, sapphire or water are transparent at infrared- visible and near-ultraviolet wavelengths. Yet, if highly intense and ultrashort femtosecond laser pulses are incident, the transparent behavior can drastically change due to the promotion of a large density of electrons from the valence to the conduction band, giving the material transient metallic properties. These are associated with high absorption and reflectivity. This is why optical pump-probe techniques have been an excellent choice for investigating the excitation dynamics of dielectrics. When such experiments were conducted by the Experimentalphysik – III team, led by Prof. Thomas Baumert, in cooperation with Prof. Peter Balling and coworkers from the University of Aarhus in Denmark, a much-unexpected observation was made:

Under certain, nondestructive, (laser-) excitation conditions of a thin sapphire glass, a 400 nm ultra-short probe pulse was not absorbed, but amplified locally and globally. As the amplification is directed and coherent, a stimulated emission process was suspected to be the underlying mechanism. By extending the experiments, the research team was able to derive a possible explanation of the amplification process that is based on ultra fast carrier-induced band gap shrinkage and two-photon stimulated emission. Simulations are able to reproduce the observations made in the experiment supporting the proposed mechanism. The spatial extent of the amplification can be controlled by temporal and spatial pulse shaping techniques, while the temporal dynamics are strongly coupled to the material parameters defining the electron lifetime: In sapphire, the amplification was observed to be present up to 50 ps whereas it is restricted to less than 100 fs in fused silica.

Although the discovery of the LADIE (laser amplification in excited dielectrics) effect is in itself very exciting, it promises also new applications and fields of research, ranging from highly nonlinear microscopy, the realization of ultrafast transient waveguides to simple UV lasers schemes.



Sketch of the experiment under normal, absorbing, and LADIE conditions.

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doi:10.1038/nphys4265, Nature Physics (2017) AOP

https://www.nature.com/nphys/journal/vaop/ncurrent/full/nphys4265.html

Learning machines predict properties of fs X-ray pulses

Employing learning computers, a research group, including CINSaT researchers, was able to characterize and predict pulse properties from a reduced data set efficiently and fast. X-ray free-electron lasers (XFELs) are emerging as a versatile tool for research in many fields including physics, chemistry, biology and material science. Their brightness, coherence, tunability and ability to generate multicolour pairs of few-femtosecond pulses makes them ideal sources for diffract-before-destroy imaging, resonant X-ray spectroscopy and time-resolved pump-probe measurements of picosecond to few-femtosecond dynamics in molecules and atoms.

To fully harness this potential, it is crucial to accurately know the X-ray properties: intensity, spectrum and temporal profile. Owing to the inherent fluctuations in free-electron lasers, this mandates a full characterization of the properties for each and every pulse. While diagnostics of these properties exist, they are often invasive, and many cannot operate at a high-repetition rate. In this work, a technique for circumventing this limitation is presented. Employing a machine learning strategy, it is possible to accurately predict X-ray properties for each shot using only parameters that are easily recorded at high-repetition rate, by training a model on a small set of fully diagnosed pulses. This opens the door to fully realizing the promise of next-generation high-repetition rate X-ray lasers. 'You can think of it as a language', explains CINSaT's Dr. André Knie, who was part of the research team: 'We taught the algorithm how the structure – how the "grammar" of the properties behaves'. New vocabulary can then be deduced from the context. It means that the machines can evaluate new experiments autonomously. The agreement so far was 97 %.

In a CINSaT context, not only the XFEL prediction is important. Machine learning as a general tool is becoming more and more relevant to analyze multi-dimensional data-sets. There are often results hidden in plain sight because we cannot analyze all the possible combinations – the computer can!

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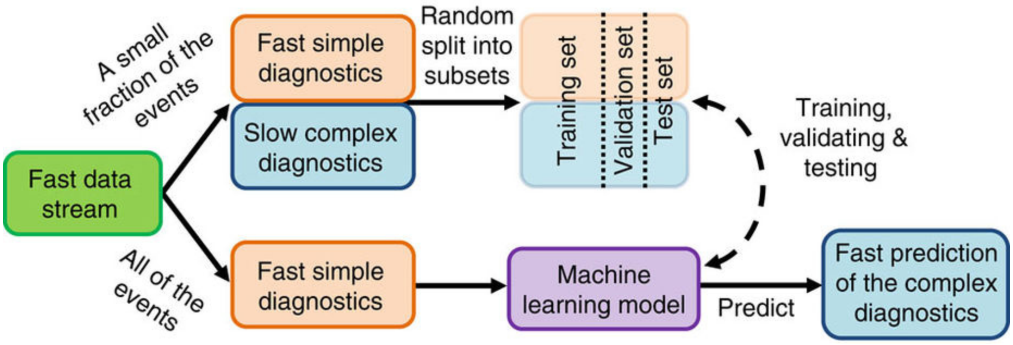
doi:10.1038/ncomms15461,
Nature Communications (2017)

https://www.nature.com/articles/ncomms15461



Schematic technique based on machine learning to predict complex diagnostics at a high repetition rate using a fraction of fully diagnosed events containing all the information obtained at a much lower repetition rate. Information from fast diagnostics is available for all the events, but information from the complex diagnostics is only available for a small fraction of the events. Once the final optimized model is trained and tested, it can be used to predict the missing information from the complex diagnostics for the remainder of the events (© A. Sanchez-Gonzalez et al., Nature Communications 8, 15461 (2017)).

Topologically protected Transport of Colloidal Particles

Ever since the 2016's Nobel Prize in physics was awarded to Thouless, Haldane, and Kosterlitz for their pioneering work on topological phases and phase transitions in superconductors, the topic of topology has been on everyone's mind. The term "topology" in general refers to a subdomain of mathematics, which considers the conservation of specific properties under continuous deformation of the underlying mathematical structure. On this basis, promising novel approaches emerged for a more fundamental understanding of physical phenomena, e.g., transport processes in which specific properties like the transport direction of a particle behave (so-called) topologically robust against external perturbations.

Within an international collaboration headed by Prof. Dr. Thomas Fischer from the University of Bayreuth it was recently demonstrated that topological concepts - which were so far primarily investigated and known for quantum mechanical systems - can also be translated to the transport behavior of colloidal particles. For this purpose, novel types of artificial micromagnetic domain patterns taking into account for all possible two-dimensional magnetic point group symmetries with equally sized unit cell vectors were realized in close collaboration with the group of the CINSaT member Prof. Dr. Arno Ehresmann and the group of Prof. Dr. Felix Stobiecki from the Institute of Molecular Physics at the Polish Academy of Sciences in Poznan (Fig. 1a)). These magnetic domain patterns stand out due to either a parallel or an antiparallel alignment of their remanent domain magnetizations with respect to the surface normal of the underlying thin film, i.e., in absence of external magnetic fields. To obtain such domain patterns, the average magnetic anisotropy of a beforehand uniform thin magnetic multilayer structure needs to be locally modified, which in this work was realized employing keV helium ion bombardment by the Ehresmann group.

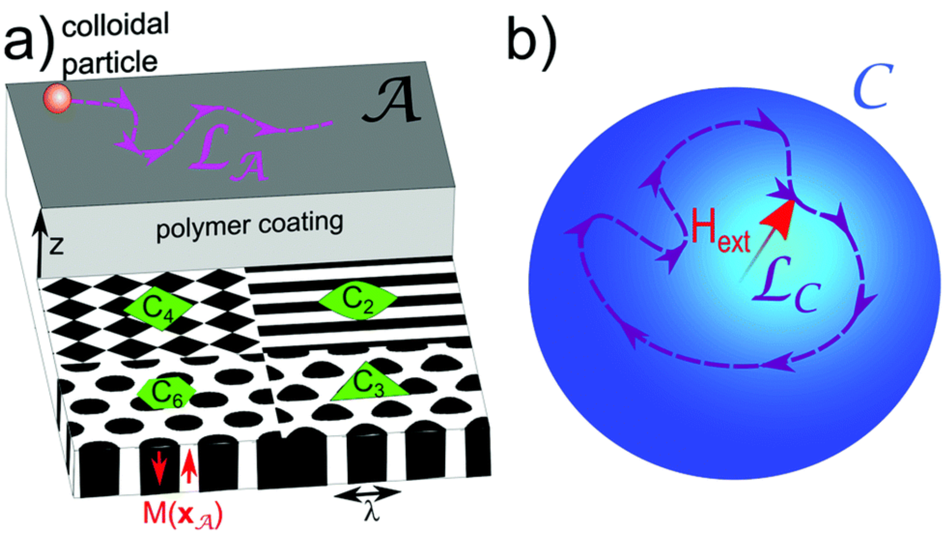


Fig. 1: a) Schematic of the magnetic domain patterns with different point symmetry groups with wavelength λ and perpendicular to plane magnetization M. The transport of the colloidal magnetic particles is realized in the action space A at elevation distances $z >> \lambda$. b) Modulation loop L_C of the external magnetic field H_{ext} within the control space C (reproduced from Loehr et al., Soft Matter 13, 5044 (2017) with permission from The Royal Society of Chemistry).

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doi:10.1039/C7SM00983F,
Soft Matter (2017)

http://pubs.rsc.org/en/content/articlelanding/2017/sm/c7sm00983f

If now colloidal magnetic particles – typically in a size range of a few microns in diameter and either possessing paramagnetic or diamagnetic properties – dispersed in a fluid are exposed to the magnetic stray field landscape as present in the proximity region of the patterned thin film, a remotely controllable transport can be realized by superimposing temporally shaped external magnetic fields, related to the so-called control space *C* (Fig. 1b)). It is these magnetic field sequences, which can be attributed to specific types of topological classes, where sequences of the same topological class introduce equivalent transport directions for the colloidal particles within the dynamically changing magnetic potential.

The unique feature of this transport is expressed in terms of its robustness against both internal and external perturbations, i.e., either local fluctuations of the stray field landscape or in case that the frequency and amplitude of the external field is changed while maintaining its topological class (Fig. 2). Interestingly, the transport features, i.e., the topological properties of the system, are strongly interlinked with the symmetry group of the underlying magnetic domain pattern as well as the magnetic properties of the colloidal particles and give therefore rise to different transport properties with respect to bulk and surface regions within the underlying domain pattern.

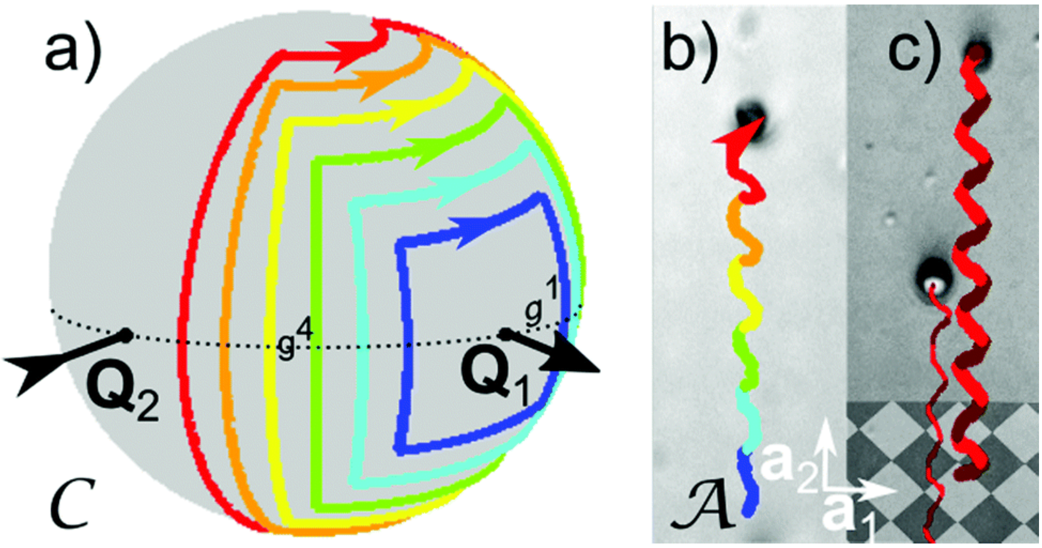

Fig. 2: a) Depiction of various modulation loops in control space C which correspond to the same topological class, i.e. the transport direction for both paramagnetic b) and diamagnetic (c), left) colloids is topologically protected and therefore robust against perturbations (reproduced from Loehr et al., Soft Matter 13, 5044 (2017) with permission from The Royal Society of Chemistry).

New Projects

Quantum-enhanced Sensing via Quantum Control (QuSCo)

Kassel University is coordinating a Marie Curie Innovative Training Network for training of early stage researchers (PhD students). The goal of the project is to develop best practices for doctoral training in the emerging field of quantum technologies.

Quantum technologies aim to exploit quantum coherence and entanglement, the two essential elements of quantum physics. Successful implementation of quantum technologies faces the challenge to preserve the relevant nonclassical features at the level of device operation. It is thus deeply linked to the ability to control open quantum systems. The currently closest to market quantum technologies are quantum communication and quantum sensing. The latter holds the promise of reaching unprecedented sensitivity, with the potential to revolutionize medical imaging or structure determination in biology or the controlled construction of novel quantum materials. Quantum control manipulates dynamical processes at the atomic or molecular scale by means of specially tailored external electromagnetic fields. The purpose of QuSCo is to demonstrate the enabling capability of quantum control for quantum sensing and quantum measurement, advancing this field by systematic use of quantum control methods. QuSCo will establish quantum control as a vital part for progress in quantum technologies. QuSCo will expose its students, at the same time, to fundamental questions of quantum mechanics and practical issues of specific applications. Albeit challenging, this reflects our view of the best possible training that the field of quantum technologies can offer. Training in scientific skills is based on the demonstrated tradition of excellence in research of the consortium. It will be complemented by training in communication and commercialization. The latter builds on strong industry participation, whereas the former existing expertise on visualization and gamification and combines it with more traditional means of outreach to realize target audience specific public engagement strategies.

Reference: http://cordis.europa.eu/project/rcn/211737_de.html

Project Partners and Principal Investigators:
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Regulation of two radical SAM/FeS modifiers by one electron donor in yeast? (DFG SPP1927)

The Division of Microbiology led by Professor Schaffrath uses Saccharomyces cerevisiae, a well-established yeast model for eukaryotic cell biology, to study protein and tRNA modification pathways that influence mRNA translation, protein synthesis and cell growth.

Recently, the group's research into iron-sulfur (Fe-S) cluster containing radical enzymes and related requirement for electron donation merged with their interest in iron-sulfur metabolism, which is crucial for cell viability among all domains of life on earth. On this basis, our aim in the SPP1927 project is to investigate potential Fe-S cluster regulation in two radical S-adenosyl methionine (SAM) modifiers by one and the same electron donor. Strikingly, the two Fe-S cluster containing enzymes both influence de novo synthesis of proteins at the level of mRNA translation elongation.

Fe-S clusters in SAM enzymes use electrons for radical formation in many biochemical reactions that often are essential for life. Accordingly, radical SAM enzyme defects can cause disease in humans. For instance, ovarian cancer is linked to mutations in a radical SAM enzyme (Dph1•Dph2) complex that decorates the essential mRNA translation elongation factor (EF2) with diphthamide (Fig. 1). Furthermore, defects in Elongator, a tRNA modifying complex with a radical SAM catalytic subunit (Elp3), link up to human neuropathies. Intriguingly, both modifiers share one electron transfer protein, Kti11 (aka Dph3). It donates electrons to Dph1•Dph2 and in complex with a helper (Kti13) was found to feed electrons to Elp3 (Fig. 1). This suggests that the modification activities of two radical SAM enzymes may be kept in-check through regulated flow of electrons to (and from) their respective Fe-S clusters.

In principle, the Kti11•Kti13 effector complex may feed electrons into both modification pathways or restrict them to Elongator (Elp3). Although there is evidence to support either option, the relevance of Kti13 in the diphthamide pathway is moot. A combination of both models, where Kti13 supports electron flow to both radical SAM enzymes but with varying preference to each, can also not be excluded yet – to this end. Interestingly, anticodon thiolation (s^2) of three Elongator substrate tRNAs, i.e. $tRNA^{Lys}$ [K], $tRNA^{Glu}$ [E] and $tRNA^{Gln}$ [Q], requires sulfur transfer by a ubiquitin-like protein (Urm1) and is catalyzed by wobble thiolase Ncs2•Ncs6 (Fig. 1), yet another Fe-S cluster containing modifier. In concert, the modifying activities of Elongator and thiolase result in a composite tRNA modification type (mcm^5s^2) that enhances codon-anticodon interaction for efficient mRNA translation in the ribosome.

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In this SPP1927 project, we aim to study the precise role of Kti13 and its ability to guide electron flow from Kti11/Dph3 to the Fe-S clusters in either Dph1•Dph2 or Elongator. Thereby, we can examine the potential of functional cross-talk between the two modification pathways. Using yeast as a model eukaryote, our investigation will provide insights into proper regulation of radical SAM catalysis and prevention of non-biological electron flow to random, potentially harmful acceptors. With the tRNA and EF2 modifiers being linked to mRNA translation, elucidation of the mode of electron flow to their Fe-S clusters may inform about regulation and functional cross-talk among the two radical SAM enzymes and their role in health and disease.

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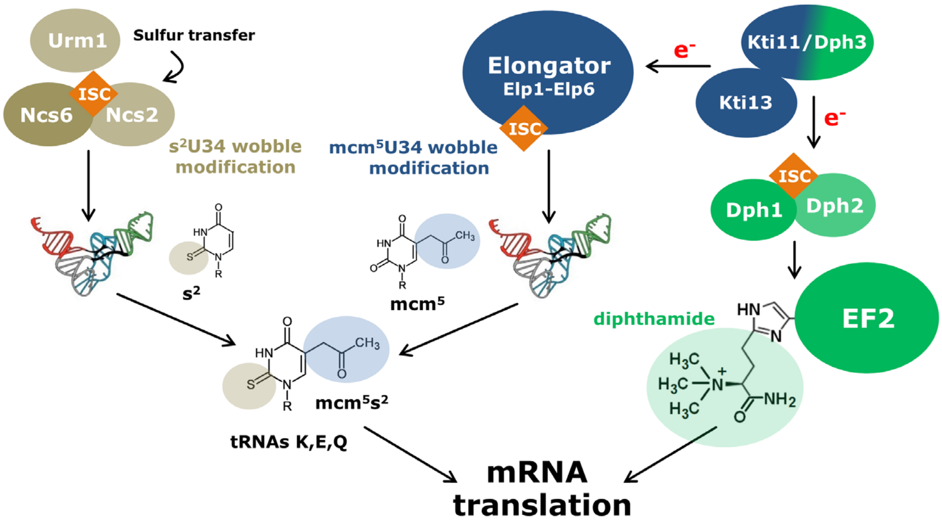

Fig. 1 . Wobble uridine modifications in tRNA anticodons and diphthamide synthesis on EF2 influence mRNA translation. Using its catalytical Fe-S cluster (ISC) subunit Elp3, the Elongator complex (Elp1-Elp6: blue) modifies wobble uridines in tRNAs at pyrimidine position C5 with a 5-methoxycarbonylmethyl (mcm^5) group. Independent of this, Elongator substrate tRNAs (tRNA-^{Lys} [K], $tRNA^{Glu}$ [E] & $tRNA^{Gln}$ [Q]) are thiolated at position C2 by another Fe-S cluster enzyme, wobble thiolase Ncs2•Ncs6 (brown), and with the help of sulfur transfer by a ubiquitin-like protein (Urm1). Diphthamide synthesis on translation elongation factor 2 (EF2) starts with Fe-S complex Dph1•Dph2 (green), which shares with the Elongator complex, electron (e^-) transfer protein Kti11 (aka Dph3, green-blue) and possibly, helper protein Kti13. A potential regulation of pathways for tRNA and diphthamide modification through electron flow by Kti11/Dph3 to the Fe-S clusters in Dph1•Dph2 and Elp3 is the main focus of our SPP1297 project.

New Coordinated Projects

SMART.Con

The project „Shape Memory Alloys in Research and Technology for Constructions (SMART.Con)" headed by Prof. Dr. Bernhard Middendorf is carried out with the participation of two further members of CINSaT within the internal funding initiative „Zukunft" of the University of Kassel.

Shape memory alloys (SMAs), which are well-known from applications in medicine, show the potential to increase the performance of building materials and constructions and, moreover, add additional functions. Two effects of SMAs will be employed in this project to realize smart constructions (SMART.Con). On the one hand, the mechanically activated pseudoelasticity (see Fig. 1a) can be used within timber (Prof. Seim) or concrete constructions (Prof. Fehling) in order to damp vibrations, which might be generated by wind or by earthquakes. The latter being the most critical load case for any construction. On the other hand, the one-way effect can be used to improve the properties of fibre-reinforced concrete (Fig. 1b). Here, SMAs will be used as fibres. Since several years, the groups of Prof. Middendorf and Prof. Fehling are investigating ultra-high performance concrete, which necessitates micro-fibres to make filigree constructions possible.

In the first period, well known, however, expensive NiTi-SMAs will be used. In the long run, the aim of the group of Prof. Niendorf is to develop suitable iron-based SMAs, which are much cheaper, opening the chance for more cost-efficient use in constructions. In order to guarantee a good and durable interconnection of the SMAs with the concrete, the group of Prof. Heim is investigating coatings in this interdisciplinary group.

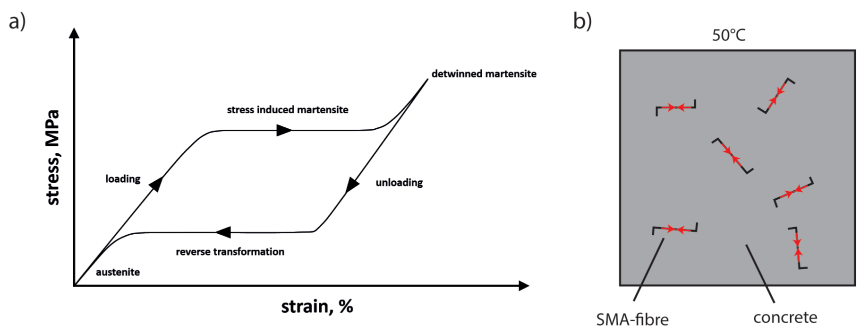

Fig.1: a) Shape memory effect. (b) Scheme of pre-stressing of concrete effected by SMA-fibres in concrete matrix.

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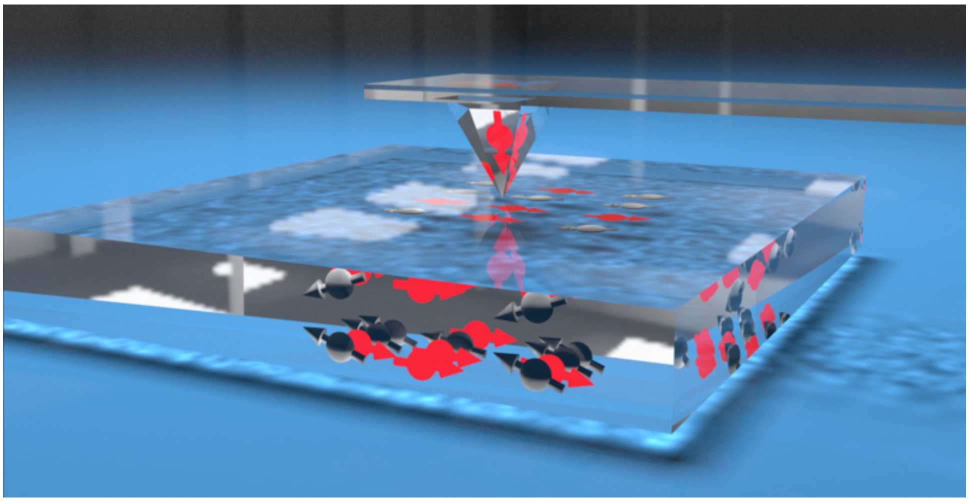
Kassel Researchers Develop Quantum Money and Quantum Sensors

Paying with quantum technology – this is what physicists from Universities in Kassel, Erlangen and Mainz hope to lay the foundations for. A team of researchers are developing a prototype for payment methods which employ a security code encoded in a diamond with quantum mechanics. The code would be unbreakable.

The diamond is intended to work like a cheque that can be cashed in with a designated receiver, such as a bank. Only the receiver can correctly read the quantum security code, whilst an attempt by anyone else would destroy it. To achieve this, the researchers want to harness the specialities of quantum mechanics by manipulating the so-called spin states in the diamond. Spin is the physics term for a particle's intrinsic angular momentum, which, like a compass needle, tends to align itself with magnetic fields. These spin states will be held for as long as 60 seconds in special superposition states that are simultaneously up and down, something only possible in the quantum world. Until now, however, these ambivalent spin states have only been maintained for a few seconds. Theoretically it should be possible to extend this to 36 hours, in which case the diamond could be used as a cheque in practice. The system that the researchers want to develop would have the additional function of being a sensor of quantum information, manyfold more sensitive than previously produced sensors. The project is supported by some 1.3 millon euros provided by the Volkswagen-Stiftung.



Schematic representation of a diamond chip with colour centres in various quantum states together with a diamond mask cantilever of a nanosensor with a colour center at the tip. Image: Uni Kassel

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University of Kassel News
https://www.uni-kassel.de/uni/universitaet/pressekommunikation/neues-vom-campus/meldung/article/kasseler-forschungsgruppe-arbeitet-an-quanten-geld-und-quanten-sensoren.html

Within this project, the teams at the Universities of Kassel, Mainz and Erlangen-Nürnberg want to take advantage of mechanisms of quantum physics which at first seem counter-intuitive, namely that a single particle can simultaneously orient itself in two opposing directions. When observed, however, the spin irreversibly reverts to one clear direction. In this way, one can write a particular information, such as a series of digits, in a collection of particles in the form of so-called quantum bits. By virtue of quantum mechanics, the only one who can read them, is the one who possesses the "key", which is the information of which type of superposition state was originally used. All others who attempt to read the information will destroy it.

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The physicists want to write the information in specially produced nano-diamonds in which they implant nitrogen ions. In doing so, they will harness a unique apparatus that was constructed under a previous Volkswagen-Stiftung project. The machine, which is the only one of its kind, can implant single ions into a material with a resolution of 10 nanometers. Thus, the researchers want to increase the lifetime of the quantum bits by both dramatically reducing the interaction of the spins with the environment and housing them at extremely low temperatures of just a few Kelvin.

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"If we can keep coherences of the quantum bits for 60 seconds, it would be a great success," explained Professor Kilian Singer, coordinator of the project and leader of the Department of Light-Matter Interaction at the University of Kassel. "It would still be a long way for practical viability of such payment methods, but the project is a first step towards a functional prototype using new quantum technologies." The mechanism could not only be used for transactions, but also for access codes or similar applications.

The research project started already in October 2016 and will run for up to 6 years. Of the 1.3 million provided by VW-Stiftung, around 1 million is allocated to the University of Kassel for the first 3 years. Taking part alongside Prof. Singer at the University of Kassel are Prof. Christiane Koch, Dr. Cyril Popov and Prof. Johann-Peter Reithmaier, and further Prof. Ferdinand Schmidt-Kaler from the University of Mainz and Prof. Eric Lutz from the University of Erlangen-Nürnberg.

Reference: public relations department University of Kassel, article by Sebastian Mense

New Members

Quantum Dynamics and Control - Faculty 10

Prof. Dr. Christiane Koch has been heading the Quantum Dynamics and Control group at the University of Kassel since 2010. She studied physics at the Humboldt University Berlin and the University of Texas in Austin and obtained a PhD from Humboldt University Berlin in 2002 for work carried out at the Fritz-Haber-Institute on modeling laser induced desorption within an open quantum system framework. After her postdoctoral research on ultracold molecules at the Laboratoire Aimé Cotton in Orsay, France and at the Hebrew University Jerusalem in Israel, she moved to the Free University Berlin to head an Emmy Noether junior research group in 2006. Since that time, quantum control has been her key research focus, with applications in atomic and molecular physics and quantum information science.

Quantum control refers to the manipulation of dynamical processes at the atomic or molecular scale. It was conceived in the mid-1980s as a means to steer chemical reaction dynamics. The goal was to make and break chemical bonds at will by using external electromagnetic fields and exploiting quantum interference. The control of bond breaking was successfully demonstrated in numerous experiments, once femtosecond lasers and pulse shaping techniques became available. To control bond formation, however, turned out to be much more difficult. In 2015, the Quantum Dynamics and Control group together with their Israeli colleagues at the Technion and the Hebrew University were able to demonstrate coherent control of bond formation, associating two magnesium atoms with shaped femtosecond laser pulses. A close collaboration between theory and experiment was key to unravelling why pulses with equal amplitude but different phases result in signals that differ by almost two orders of magnitude.

A number of further current activities of the Quantum Dynamics and Control group are closely linked to CINSaT. For the development of quantum technologies, the group uses quantum control to explore the ultimate performance bounds for various quantum information architectures including trapped ions, color centers in diamond and superconducting circuits. The group also studies prospects for quantum control in the photoionization of atoms with novel light sources and of chiral molecules.

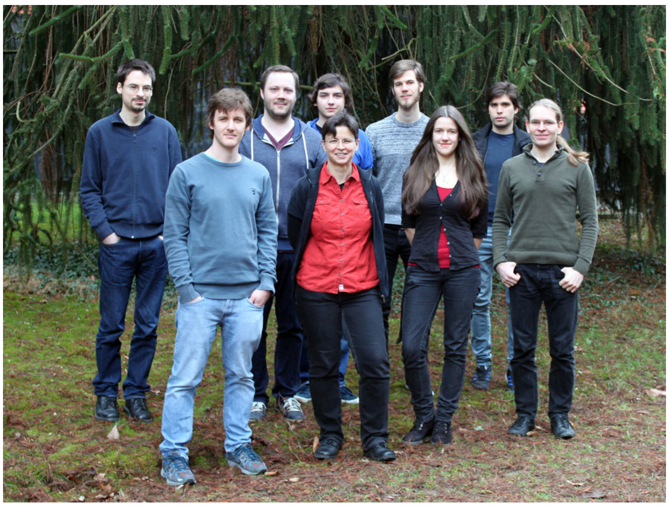

Photo of the Quantum Dynamics and Control group members.

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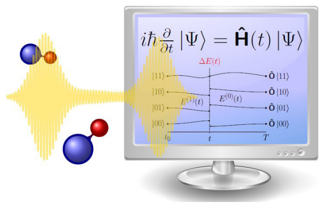
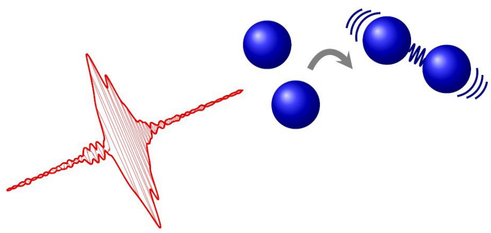
References

doi: https://doi.org/10.1103/PhysRevLett.114.233003, Physical Review Letters (2015)





A tailored laser pulse controls the formation of a molecular bond between two atoms (Levin et al., Phys. Rev. Lett. 114, 233003 (2015)).

Developmental Genetics – Faculty 10

Epithelial tissues are the major building blocks of almost all organs in the human body. The functional dynamics of epithelia is key to the homeostasis of organs and their deregulation cause severe diseases including human cancers. The Müller laboratory uses genetics and interdisciplinary approaches trying to understand how epithelial cell polarity is established and modulated during early development. The lab discovered signalling molecules, which target proteins that control epithelial cell behaviour. These molecular tools are the basis to investigate the consequences of biochemical modifications using high resolution microscopy (confocal and single plane illumination). The dynamics of tissues cannot be solely explained in molecular terms. Within CINSaT, the Müller team would like to expand the analysis of cell behaviours into physics, in particular laser-based imaging and manipulation of tissues at nano scale and explore materials and energies to measure and manipulate mechanical forces during dynamic biological processes.

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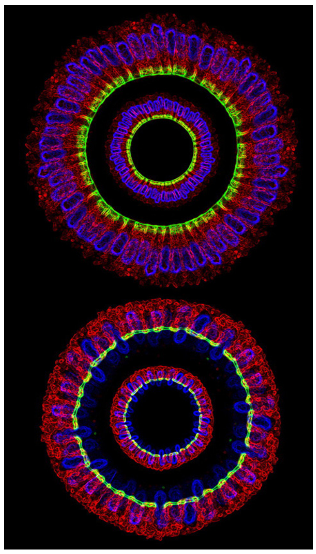
Prof. Dr. Arno Müller studied Biology at the Universities of Bonn. At the Max-Planck Institute for Developmental Biology in Tübingen, he worked on amphibian development and received his PhD in 1992. In 1994, he was awarded a postdoctoral fellowship from the DFG to work with Prof. Dr. Eric Wieschaus (Princeton University (USA)) on the genetics of cell polarity in Drosophila (fruit fly) embryos. In 1997, he established his own group at the Heinrich-Heine University of Düsseldorf, Department of Genetics, where he habilitated in 2001. As an HSFP fellow, in 1999, he spent a sabbatical at the California Institute of Technology (USA) to do a screen with Prof. Dr. B. Hay identifying new cell death genes. While at the University of Düsseldorf and as member of the SFB 590 and the SPP 1049 and SPP 1111, his group discovered novel signalling molecules of the fibroblast growth factor family and started to investigate their role for tissue morphogenesis. In 2006, he was awarded a Senior Research Fellowship from the Medical Research Council (UK) and moved his laboratory to the College of Life Sciences at the University of Dundee (Scotland). In 2015 he was appointed Professor for Developmental Genetics at the University of Kassel.

Further Information

Website: https://www.uni-kassel.de/fb10/institute/biologie/fachgebiete/entwicklungsgenetik-dach/entwicklungsgenetik/

Photo of the Developmental Genetics group members.



Measurement Technology - Faculty 16

Optical interferometry is one of the most fascinating measuring principles as it easily achieves a resolution below one nanometer in the measuring direction and, therefore, shows a wide range of applications in industry and research. However, the lateral resolution and measurement capabilities of optical interference microscopes suffer from diffraction. Hence, it is a big challenge to understand the limiting phenomena in detail and improve instruments, e. g. by combination with confocal or structured illumination techniques.

Interferometric sensors are very sensitive to vibration, scanner nonlinearity and maladjustment. Usually careful vibration isolation and high quality components are required, which sometimes contradicts industrial demands. Therefore, a part of our research aims at optimizing interferometric systems in order to use them even in harsh environments. Further, fiber-coupled interferometers represent very interesting devices, as they are inherently confocal and may substitute conventional tactile stylus systems in certain applications. Due to their sensitivity to single atomic layers their applicability is not restricted to distance measurement. Further research activities in our group are related to fringe projection and focus variation techniques. We are curious to learn novel applications of optical measuring methods within the framework of CINSaT.

Prof. Dr. Peter Lehmann received his diploma degree in physics in 1990 from the University of Karlsruhe (TH) before he moved to the University of Bremen and focused his research interests on optical metrology in engineering applications. He finished his PhD dealing with speckle metrology in 1994 and his Habilitation in measurement technology in 2002. From 1996 to 2001, he headed a research group at the University of Bremen and was a project leader in two SFBs. In 2001 he joined an industrial instrument manufacturer, where he coordinated the research activities in optical metrology. Since September 2008, he is a full professor and head of the measurement technology group at the electrical engineering faculty of the University of Kassel. He initiated a number of DFG and BMBF-projects dealing with interferometric and confocal sensors and was involved in the European FP6 project "NanoCMM".

Photo of the Measurement Technology group members.

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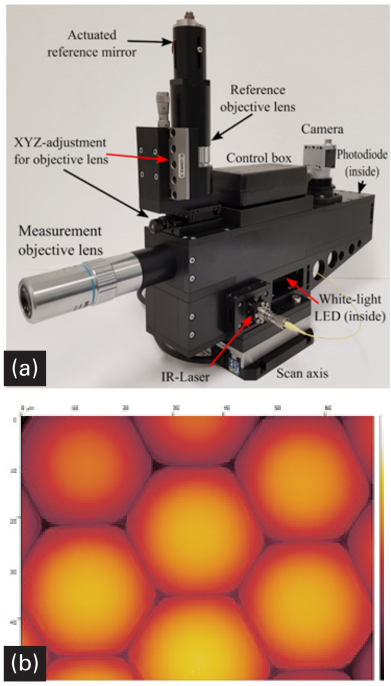

(a) Vibration compensated Linnik-interferometer developed in the measurement technology group. (b) 3D topography of the eye of a fly obtained with a high-resolution Linnik interferometer (NA = 0.9).

Research Groups

Organometallic Chemistry - Faculty 10

Prof. Dr. Ulrich Siemeling belongs to the founding members of CINSaT. His group specialises in the chemistry of metal-containing molecules, in particular so-called organometallic compounds, which exhibit metal-carbon bonds. His group has a long-standing interest in interdisciplinary collaborations with colleagues from physics. Early activities were focussed on the photophysics of metal-containing molecules and on precursor compounds for the fabrication of thin films of tailor-made solid-state materials by chemical vapour deposition (CVD). The scientific environment provided by CINSaT allowed his group to enter an additional and highly competitive field, which deals with the self-assembly of molecules on metal or semiconductor surfaces. Up to the present day, this research has resulted in ca. 30 publications with numerous internal (Prof. Ehresmann, PD Popov, Prof. Reithmaier, Prof. Träger) and external collaborators (Prof. Glaser/Bielefeld, Prof. Heinzmann/Bielefeld, Prof. Motschmann/Regensburg, Prof. Plass/Jena, Prof. Weidner/Aarhus, Prof. Wöll/KIT, Prof. Zharnikov/Heidelberg). Special attention has been given to fundamental aspects such as, for example, establishing new adsorbate systems (N-heterocyclic carbenes on metal substrates) and new tools for influencing the assembly process on the surface (magnetic stray-fields). Collaborative projects relevant to cutting-edge technological applications such as, for example, the surface self-assembly of lanthanide-based single-molecule magnets have also been executed.

In parallel, an additional focus of Prof. Siemeling's laboratory is on low-valent main-group element compounds, in particular in the context of the activation of fundamentally important small molecules which are held together by strong bonds of low polarity. Typical examples are ammonia (NH_3) or carbon monoxide (CO), which are used by the chemical industry as essential building blocks. It is a great challenge to achieve their activation under mild conditions without using very expensive, and frequently highly toxic, metals of low abundance. Prof. Siemeling's group has demonstrated that carbon monoxide is readily transformed under ambient conditions to antibiotically active chiral compounds akin to Penicillin G by using divalent carbon compounds for its activation.

Prof. Siemeling's research group in autumn 2017.

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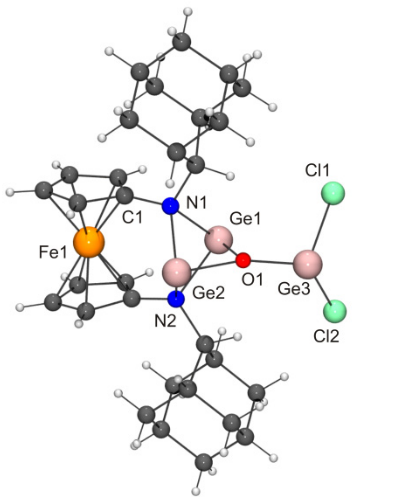


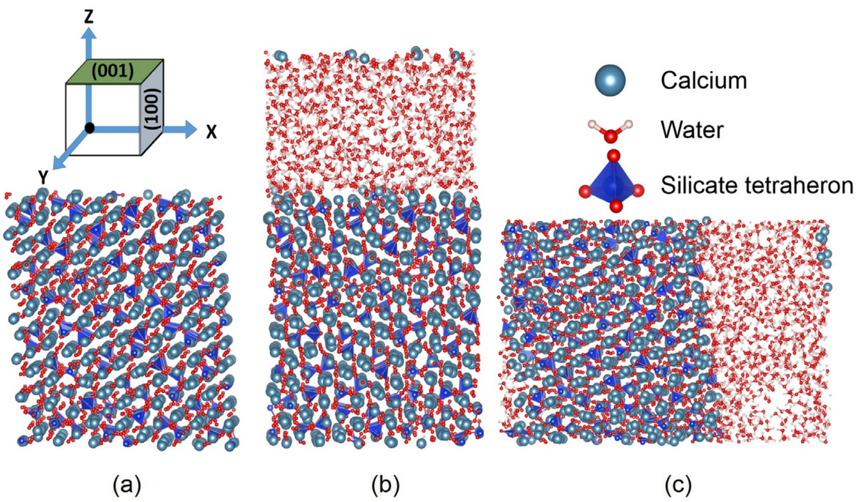
Experimentally determined molecular structure of $[\mu_2\text{-}\{Fe(\eta^5\text{-}C_5H_4\text{-}NR)_2\}Ge_2(\mu_3\text{-}O)(GeCl_2)]$(R = 1-adamantyl). The nanometer-sized entity can be viewed as containing the astrophysically relevant diatomic GeO molecule stabilized by adduct formation with two other divalent germanium components.

Structural Materials and Construction Chemistry - Faculty 14

Prof. Dr. Bernhard Middendorf is the head of the Department Structural Materials and Construction Chemistry and, together with Prof. Niendorf, the head of the research focus group "Nanostructures in Natural Sciences, Engineering sciences and the Arts". The department is focusing the research on cementitious structures and special concretes like ultra-high performance concrete (UHPC). Compared to ´normal´ concrete, the compressive strength, as well as the durability is much higher. This is due to the use of reactive fines on nanometer scale (silica fume) and the very low content of water, which in turn is only possible due to the use of superplasticizers which guarantee a good workability with such low water contents.

A major interest is directed at the mechanical properties and the correlation to the microstructure, which is analyzed by SEM, µ-CT, light microscopy, AFM and other analytical methods. However, the processes in cementitious materials are still not unraveled completely concerning the very early reactions for instance during dissolution of reactive cement clinker minerals or the nucleation of main strength giving phases summed up as calcium-silicate-hydrates (C-S-H). These processes occur on the nanoscale and below. Therefore, atomistic simulations are used in combination with experiments to improve the fundamental knowledge of the hydration mechanisms of Portland cement. Atomistic simulation using Reactive Force Fields (ReaxFF) in combination with metadynamics, can be an effective solution to study the chemical reactions at material interfaces with sufficient accuracy. This approach is used to simulate hydration of one of four major cement clinker phases and investigate full reaction path for the polymerization of silicate in C-S-H phases. Besides, a detailed experimental study will be conducted for the hydration of the pure clinker phases alite and belite in order to unravel their reactivity by comparing with atomistic simulation.

The proposed comparative study on computer modeling and laboratory experiments will yield in-depth knowledge of the yet unknown reaction mechanisms of cement hardening. This will allow a more targeted approach to improve the reactivity of cement clinkers in future developments of sustainable cements.



(a) Simulation cell of alite (orthogonal cell of 56.49 × 34.39 × 37.06 Å³). Comparison of different reactivity at different surfaces (along the z axis (b) and along the x axis (c)) of alite during hydration.

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Dr. Alexander Wetzel is associate member of CINSaT since 2013 and is working in the group of Prof. Middendorf as lecturer. His main research focus is on microstructural investigations of high performance building materials. Currently a DFG-Project started comprising the interaction of superplasticizers with inorganic particles. These superplasticizers are necessary to enable a low water/binder-ratio and therefore, for the good properties of UHPC (ultra-high performance concrete). The sizes of the superplasticizers vary in the range of 5-20 nm and are not visible with conventional microscopic methods. By staining the superplasticizers with a fluorochrome, the superplasticizer gets visible in the fluorescence microscope or confocal laser scanning microscope. Within the CINSaT cooperation, the possibility of using a laser scanning microscope is given in the group of Prof. Maniak and Prof. Müller (Faculty 10). For concrete, an increasing number of components is used. Due to the aim of CO_2 reduction, locally available supplementary cementitious materials are used instead of the well-known ordinary Portland cement. The in-situ method, which will be developed during the project, might be a helpful tool for the vision of tailoring the needed superplasticizer and other chemical admixtures for the use in concretes, which will become more complex due to the use of new and varying components.

In addition to cement based ultra-high performance concrete, recently, cement free systems were investigated reaching comparable results for the mechanical properties. These binder systems are based on alumo-silicatic source materials, which show, in comparison to cement, no strength developing reaction when mixed with water. But activated by alkali solutions they can be used as binders and reach high strength, too. Superplasticizers, as described above, are not effective in such systems with pH-value. Nevertheless, a very low water/binder-ratio of 0.2 could be realized resulting in comparable properties like the cement based UHPC due to the combination of silica fume with high alkaline activator concentrations.

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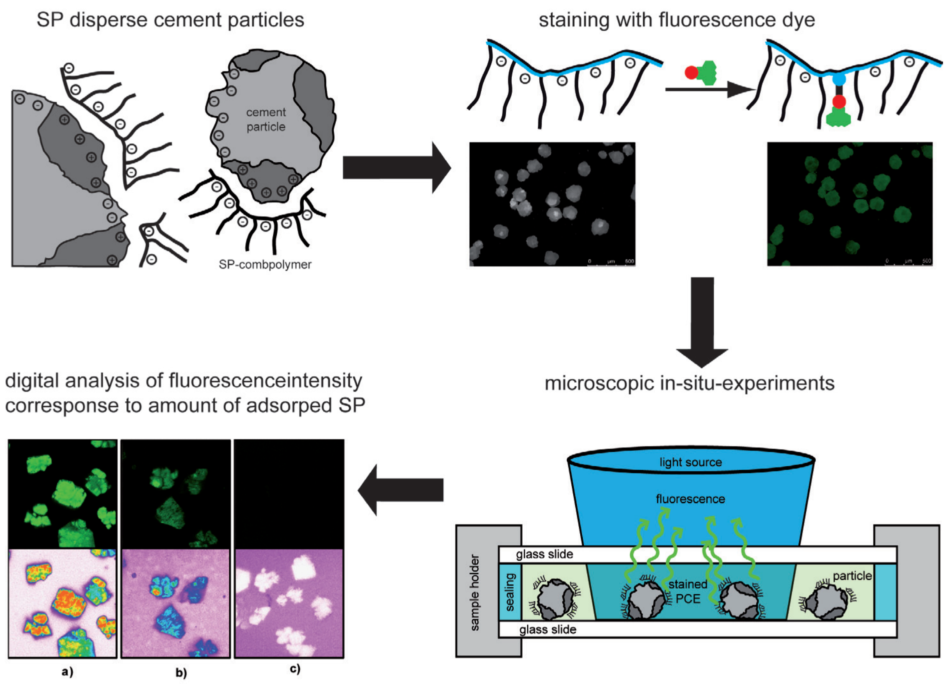

The interaction of superplasticizer (SP) and particles can be investigated in situ via fluorescence microscopy, when the superplasticizer is stained with a fluorochrome. SP-adsorption in the presence of a) 0.1 M Ca^{2+}, b) 0.05 M Ca^{2+} and c) without Ca^{2+} detected by fluorescence intensity.

Awards

Poster Award for Thomas Winkler

Thomas Winkler, PhD student in the group of Prof. Dr. Thomas Baumert, was awarded with the *Best Poster Award* at the 11th International Conference on Laser Ablation – COLA (03. - 08.09.2017) held in Marseille, France and with the *1st Place Poster Price* at the 11th International High Power Laser Ablation& Directed Energy Symposium – HPLA (04. – 07.04.2016) held in Santa Fe, USA for his poster contributions about "Laser amplification in excited dielectrics". The posters contained experimental and numerical results of the LADIE (laser amplification in excited dielectrics) effect introduced earlier in this newsletter (see page 9). Both conferences are focused on laser material processing, ranging from fundamental laser-material interaction, biological aspects, new laser sources to industrial applications. While at the COLA, the poster price was selected among 100 other contributions during one session by a committee consisting of Prof. Philippe Delaporte (CNRS, France), Prof. Thomas Lippert (PSI, Switzerland), Prof. Mitsuhiro Terakawa (Keio University, Japan) and Dr. Vassilia Zorba (Berkeley Lab, USA), at the HPLA, the prices were selected by a voting of all 120 conference participants.

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Poster Awards for Nina Felgen & Alexander Schmidt

Nina Felgen and Alexander Schmidt, PhD students of groups of PD Dr. Cyril Popov from the Institute of Nanostructure Technologies and Analytics, CINSaT, shared the first poster prize at the NATO Advanced Study Institute (ASI) on "Advanced nano-technologies for detection and defence against chemical, biological, radiological and nuclear agents". The 10-member international jury evaluated with the highest scores the posters of Ms. Felgen and Mr. Schmidt. The ASI took place between 12^{th} and 20^{th} September 2017 in Sozopol, Bulgaria and brought together about eighty participants from 18 NATO member and partner states. It addressed the latest advances in Nanoscience and Nanotechnology in fields, such as, information technology and cyber defense, biotechnology, energy management, early detection and protection against chemical, biological, radiological and nuclear agents, etc.

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Latest Reports

Autumn colloquium

Full lecture hall at this year's CINSaT autumn colloquium with fascinating talks and poster contributions on recent research highlights from biology, chemistry, physics, and engineering sciences

Opening speech by Prof. Dr. Johann Peter Reithmaier.

On Wednesday, October 25^{th}, 2017, the annual CINSaT autumn colloquium took place at Heinrich-Plett-Straße, Kassel University. The autumn colloquium is a public event that was established with the aim of providing insights into CINSaT's current research topics to interested people. These research topics are primarily represented by the interdisciplinary collaboration among the four disciplines biology, chemistry, physics, and engineering sciences. Therefore, this year's content was strongly focused on CINSaT's main research topics which were brought to the audience by external speakers presenting three-dimensional nanostructures, biosensorics, photonics, and quantum technology.

The event was opened by a cordial welcome from CINSaT speaker Prof. Dr. Johann Peter Reithmaier, who introduced the series of talks with an overview of CINSaT's research architecture. Again, many professors, PhD students, as well as master and bachelor students from different study courses were present, with the ratio of students being pleasingly high.

The first talk "RIE-RAS: In-situ etch depth control with nm precision during reactive ion etching (RIE) – by reflectance anisotropy spectroscopy (RAS)" was given by Prof. Dr. Henning Fouckhardt, who is the head of the research group Integrated optoelectronics and micro optics at TU Kaiserslautern. Subsequently, Prof. Dr. Gerhard Rempe from the Max Planck Institute of Quantum Optics in Garching illustratively presented the recent developments in the field of "Quantum Internet – Science or fiction". After finishing the talk with an exciting discussion round, the participants had the chance to get to know each other in a half hour long pause.

Guest speakers (line by line from left to right): Prof. Dr. Henning Fouckhardt (TU Kaiserslautern), Prof. Dr. Gerhard Rempe (MPI Garching), Prof. Dr. Matthias Karg (University of Düsseldorf), Dr. Ulrich Rant (Dynamic Biosensors GmbH).

Members of the audience listening to the scientific talks.

In the second part of the talk series, Prof. Dr. Matthias Karg from the University of Düsseldorf showed current research results on “Interface-mediated self-assembly of multifunctional core-shell building blocks: structural control and functional superstructures”. The impressing presentation about the fabrication and self-assembly of colloidal nanostructures was followed by a fascinating talk from Dr. Ulrich Rant (Dynamic Biosensors GmbH) about “Electro-switchable biomolecules on surfaces for sensing applications”.

As usual, the event was topped off by a copious poster session following the guest speakers’ talks, where sustenance was provided by the Studentenwerk. Here, participants were given the opportunity to gain insights into CINSaT’s latest research and to scientifically discuss the presented results.

Exciting discussions during the poster session.

The final point was the election of the three best posters by this year’s jury consisting of the CINSaT members Prof. Dr. Peter Lehmann, Prof. Dr. Arno Müller, and PD Dr. Mohammed Benyoucef. Before handing over the prizes (1st prize: tablet pc, 2nd prize: hard disk drive, 3rd prize: presenter) to the lucky winners, the jury stressed out that it has been extremely hard for them to select only three posters among the high number of high-quality contributions. As it has been the case in 2016, the poster contributions reached a record of over 50 contributions, which impressively reflected last years’ aspiring trend. This year’s first prize was received by Daniel Basilewitsch for his poster on “Cooling of a Superconducting Qubit using Quantum Optimal Control”. The second and third prizes went to Andrei Kors and Jendrik Gördes for their posters on “Telecom wavelength single quantum dots” and “Fabrication of Variously Shaped Polymeric Janus Particles with Exchange Bias Caps via Reversal Nanoimprint Lithography”, respectively.

Members of the poster jury, award winners and CINSaT speaker (f.l.t.r.): Prof. Dr. Peter Lehmann, Prof. Dr. Arno Müller, Jendrik Gördes (3rd place), Andrei Kors (2nd place), Daniel Basilewitsch (1st place), PD Dr. Mohammed Benyoucef, Prof. Dr. Johann Peter Reithmaier.

CINSaT present at the Hessentag 2017 in Rüsselsheim

Sunny weather and hot temperatures: this year's Hessentag offered the perfect occasion for visitors to get into contact with the latest research highlights from the world of nanostructures and to obtain an overview of Kassel University's nanoscientific study programs.

Again, CINSaT was present at the "Hessen schafft Wissen" section along with numerous other research projects supported by LOEWE (LandesOffensive zur Entwicklung Wissenschaftlich-ökonomischer Exzellenz) and incorporated into the corresponding research network ProLOEWE. The Hessentag is a unique format in the state of Hesse that makes science available and, most important, comprehensible to the public. For this purpose, a variety of experiments that were supposed to evoke "aha moments" were prepared, proving that science is far from being boring and in many ways related to everyday life. Among the large numbers of visitors, the Hesse State Minister of Science (and Arts) Boris Rhein could be found as well. He encouraged people to get their own impression of the state's great research achievement and to enter into dialog with the scientists.

In addition to exciting experiments, CINSaT offered the opportunity to gain insights into the bachelor and master degree programs of the internationally unique nanostructure science study program at Kassel University which is significantly supported by CINSaT's established research foci. An especially impressive example for the close interdisciplinary collaborations within CINSaT is the LOEWE-funded project ELCH (ELektronendynamik CHiraler Systeme) which by that time has become a separate research topic called "chiral systems". The ELCH project was also represented at the Hessentag, illustrating the topic "chirality" with the help of varying scents of molecules that feature the same chemical composition but different spatial arrangement of atoms, i.e., one molecule mirrors the other one – similar to the left and right hand of a person.

The most appealing and impressive experiments were the liquid nitrogen show, the manipulation of so-called ferrofluids with permanent magnets as well as the atomic force microscope replica built with LEGO Mindstorms. The latter was particularly attractive to children and adolescents who were already familiar with the programming of LEGO Mindstorms systems.

CINSaT presents itself at Kassel University's Campus Festival

The annual campus festival – celebrating its second anniversary this year – offered the ideal chance for CINSaT to provide insights into Kassel University's nanoscientific research and study facilities to local citizens. For this purpose, CINSaT presented general information about the center itself and the related nanoscience bachelor and master study programs as well as exhibits on nanotechnology core topics, the latter including the illustration of an atomic force microscope realized with LEGO Mindstorms, paper models of DNA and Buckminster fullerene molecules, data storage technology represented by hard disk drives which are based on magnetic nanostructures, or the visualization of the influence of magnetic fields on magnetic material as it is included in many everyday devices, e.g., toner cartridges for laser printers. Altogether, the campus festival succeeded in giving an understanding of CINSaT's work to the interested population.

Announcements

Spring colloquium 2018

CINSaT cordially invites all members and their staff to take part in the internal spring colloquium, taking place from **Thursday, the 22th to Friday, the 23th of February 2018** in the Ahorn Berghotel in Friedrichroda. All participants (except the members) have to submit a poster contribution during the registration (talks will be requested in individual cases until the end of January 2018).

For registration, please send an E-Mail to Dr. Dennis Holzinger including the following information:

- Name of the participants
- Preliminary title of the poster contribution(s)
- Information, if you stay over night

The **deadline for registration is Wednesday, December 20th, 2017.** The preliminary schedule will be delivered after the registration deadline has expired. We expect the colloqium to start at 9:30 a.m. (22.02.2018) and end at 5:00 p.m. (23.02.2018).

Note that all participants have to arrange for their own travel, which is not funded by CINSaT.

We are pleased to welcome you to the colloquium and look forward for your interesting contribution!

When: February, 22th - 23th, 2018

Where: Ahorn Berghotel Friedrichroda
Zum Panoramablick 1, 99894 Friedrichroda

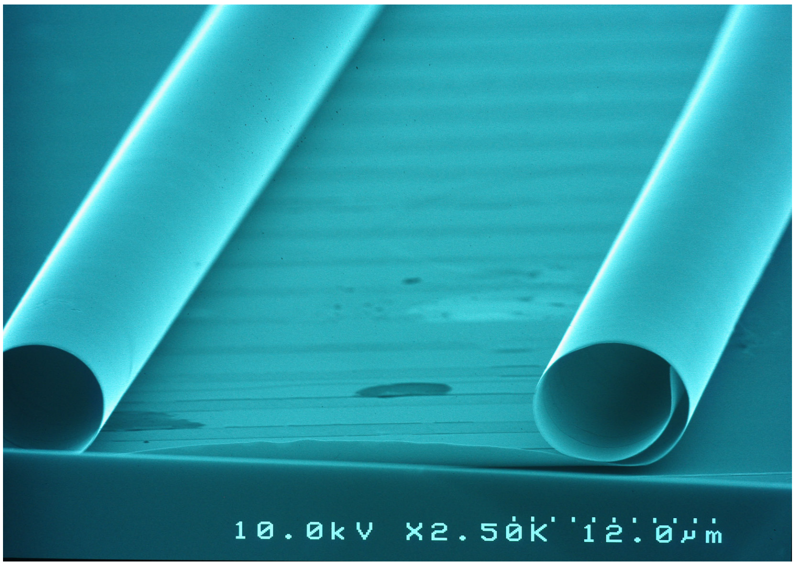
Participants of the CINSaT spring colloquium 2017.

Nano arts

In this section, artistically appealing images from the CINSaT groups will be presented. If you obtained any kind of visually appealing and fascinating data during your experiments with focus on micro- and nanometer length scales, you are cordially invited to submit your contribution to the editors.

In this edition:

Fabrication of magnetic tubular architectures by rolling up magnetically stripe patterned exchange bias thin film systems.



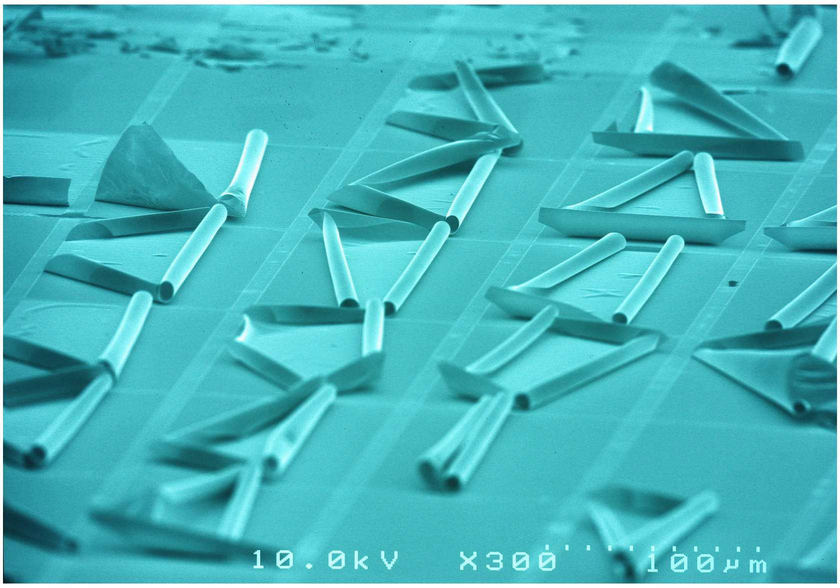


photo: AG Ehresmann, Functional Thin Films, SEM provided by INA is gratefully acknowledged

Pre-studies for electrochemical Cu deposition on top of artificial magnetic domain structures. Optical microscope image of the formation of microcrystallites at the surface of an exchange bias substrate after being exposed to a 0.01 molar aqueous copper sulfate solution for 200 s.

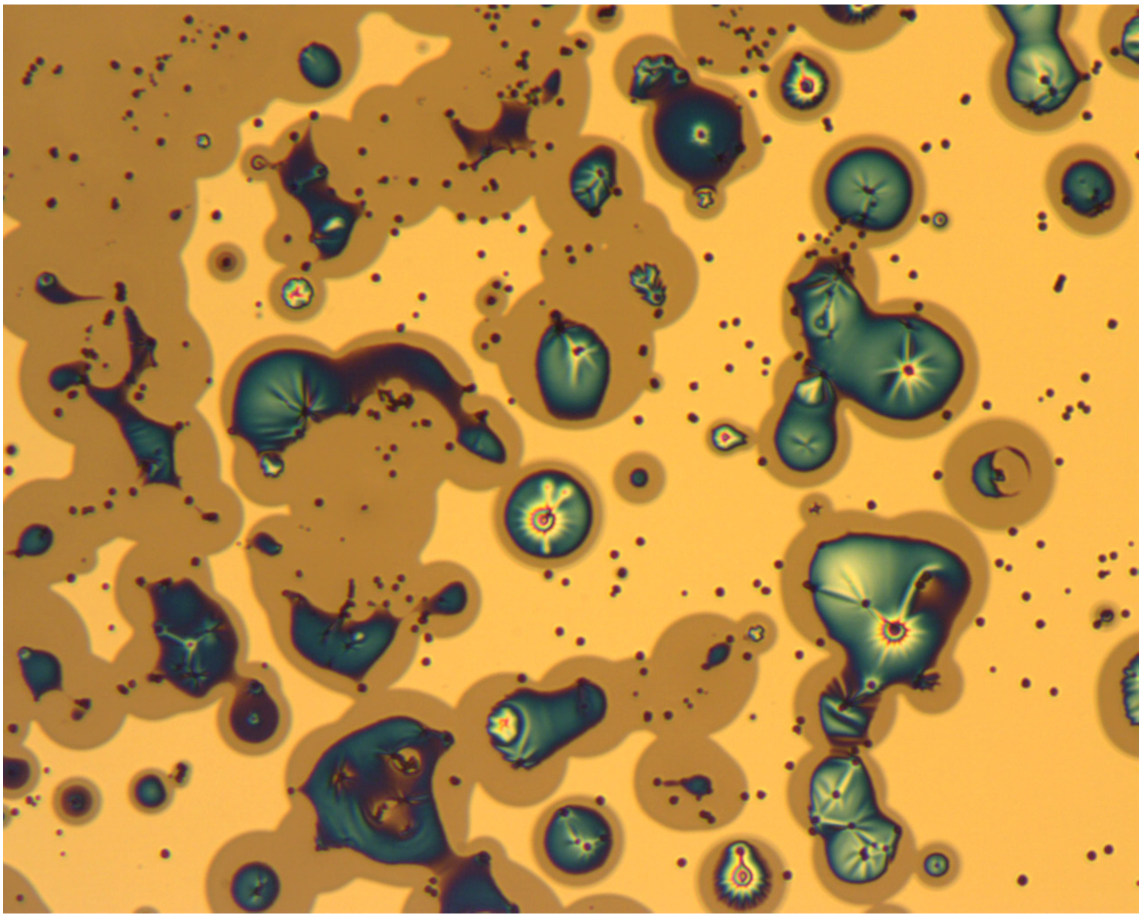


photo: AG Ehresmann, Functional Thin Films

photo: Campus Heinrich-Plett-Straße, Press and Public Relations Office University of Kassel, Studio Blåfield

Imprint

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print:
viaprinto
Martin-Luther-King-Weg 30a
48155 Münster

Responsible according to the press law (german: ViSdPR):
CINSaT executive board,
University of Kassel