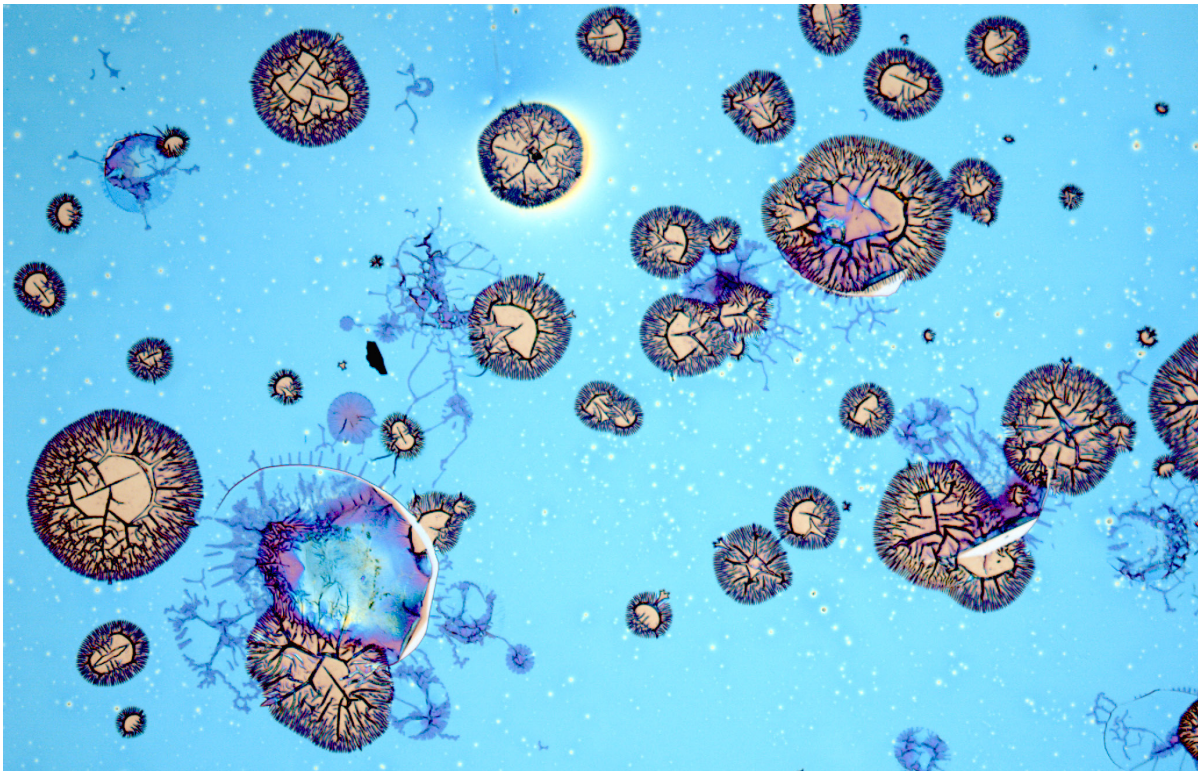
CINSaT

Center for
Interdisciplinary Nanostructure
Science and Technology

Newsletter No. 7 (December 2019)



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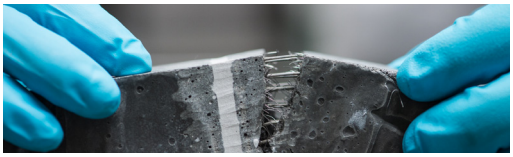


Cover image:
Christine Heume (Techn. Electronics)
Mechanical tension of SiO_2/ ZrO_2 layers and organic polymer in between

Preface

Welcome to the second CINSaT newsletter in 2019, which is now the second one in the new design. Thank again to all the article writers contributing to this issue with their stories about exciting events, new research results and presentations of new projects. I would like to take the opportunity to encourage all the CINSaT members to utilize this platform also in future for the communication and visualization of their research for students, colleagues and the interested public.

This issue starts with the educational section, reporting about the Science Slam that was organized by the local groups of “Junge Deutsche Physikalische Gesellschaft” and “JungChemikerForum” at the AVZ. Another article in this section reports on the Communication School organized by the Graduate Academy, in which young scientists were introduced to various possibilities of science communication, written, rhetorical or visual. At the closing event, the Science Night, the learned was presented to the public. Members of CINSaT groups have also taken part in this training program.

New exciting research highlights in this issue come from very different disciplines: Prof. Herberg (Biochemistry) reports about a novel switch mechanism that controls the activity of the Leucine-rich repeat kinase 2 (LRRK2), a large multidomain protein (2527 amino acids) carrying mutations linked to Parkinson’s Disease. These findings may provide a hint to understand how LRRK2 is involved in Parkinson´s pathogenicity. The second research highlight is from Prof. Niendorf (Metals group). He reports on iron-based shape memory alloys and possibilities that come with tailoring and promoting abnormal grain growth by compositional adjustments. The last article in this section is from Dr. Becker (Technological Physics group) where she highlights the demonstration of record low emission linewidths of distributed feedback lasers gained by quantum dot materials and recently published in Optica.

Several new projects were funded, including two DFG large scale equipment proposals: the first for a multi-signal far-field microscope (Prof. Dr. Brückner-Foit) and the second for a quantum optic setup (PD Dr. Benyoucef) in the frame of the LOEWE project SMolBits. Furthermore, about two coordinated projects (MOICANA and PEARLS) funded by EU and BMBF, respectively, as well as a new DFG funded new epitaxial equipment at INA are reported.

As a new member, Prof. Dr. Angelika Brückner-Foit introduces herself and tell you about her research history and current research field.

Members of CINSaT groups were honored and rewarded as reported in the awards sections. Congratulations to these achievements, keep up the good work!

As always, reports about the events that took place within the last 6 months are attached. This includes the annual CINSaT autumn colloquium as well as the day of the Hesse (Hessentag) and the campus festival of the university. There are also three announcements which you should recognize: "The HiPerMat International Symposium on Ultra-High Performance concrete and High Performance Construction Materials" on March 11-13, 2020 in Kassel, organized by CINSaT member Prof. Dr. Middendorf; "The international Symposium on Nanostructured Semiconductor Systems: Physics and Applications", on March 25-26, 2020, organized by CINSaT member apl. Prof. Dr. C. Popov, G. Eisenstein (Technion) and me. Of course, you should mark in your calendar, the next CINSaT Spring colloquium, which takes place on March 5-6, 2020 in Friedrichroda. Finally, you should not miss the nano arts.

After enjoying reading this issue, I wish you peaceful Christmas Holidays and a Happy New Year.

Johann Peter Reithmaier

General

Latest information from the CINSaT management

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

(a) Steering Committee

Since the last newsletter we had three meetings (16th of July, 15th of October and 25th of November). Following issues can be reported:

- The preparations for the prolongation of the center for the next 5 years is in full swing and the report finalized in a pre-version for the scientific advisory board
- A new member for the scientific advisory board could be won and is already approved by the Presidium: Prof. Dr. Ulrike Woggon from the TU Berlin
- The scientific advisory board meeting will take place on 18th of December
- The image film of the CINSaT was subtitled in English. In addition, the flyers have been updated and are now available in German and English.

(b) Research Coordination Committee

The Research Coordination Committee had two meetings, one on July 17th and one on November 23rd, 2019. Besides brief reports on the focal points a main topic was the preparation of the report for the prolongation of the center and the organization of the scientific advisory board meeting. Also, the next CINSaT Spring Colloquium was announced and discussed regarding its organizational structure.

(c) Member Meeting

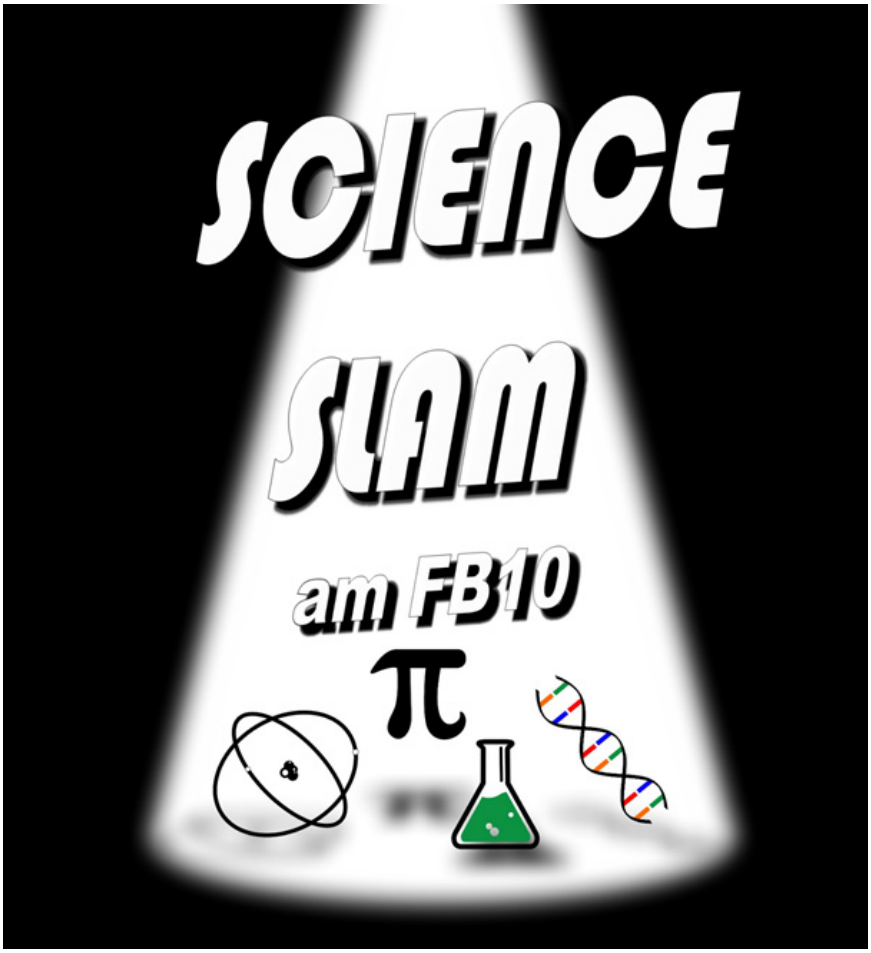
The last member meeting took place on 23rd of October. The major issues discussed were the following:

- The head of CINSaT gave a presentation on the reorganization and future plans of the CINSaT in the context of the prolongation of the center and the planned new clean-room facility for nanostructure science on the main campus. The proposed ideas were discussed extensively.
- Prof. Heim gave his introductory talk on 27th of June. The CINSaT members elected him as a full member. Approval by the Presidium is pending.
- Prof. Dr. Christiane Koch moved to FU Berlin. With that the prerequisites for a CINSaT membership no longer apply and she has been granted Alumni status.

Education

Science Slam at Faculty 10

At the end of October, the jDPG and the JCF Kassel presented a Science Slam for the second time. Students and postgraduates presented topics of their own choice. Do you know how many corners a circle has? Or how drugs work inside your brain? Also, an introduction to gas dynamics was given in a surprisingly entertaining manner. The Science Slam is, while being entertaining, a great way to see what others at our department are doing or interested in. After the official part of the slam, everyone was invited to take part in the Power Point Karaoke. This means, you get a power point file, that was made by another person for another purpose with different standards and a random topic. The spectators choose a hypothesis, not necessarily in congruence with the topic of the PPT, that you must answer in the course of your presentation. While being less professional, the entertainment value is guaranteed. If you are looking forward for the next Science Slam 2020 and would like to share your own contribution, let us know via kassel@jdpg.de



Communication School
Science Communication for early career researchers

Communicating science is fun.
Communicating science is accountability.
Communicating science (should) become a fix part of scientific work.

That is why the Graduate Academy starts the Communication School as a further education programme for early career researchers at the University of Kassel. Communicating science has become more essential in times of fake news and mistrust towards science. Furthermore, Science Communication is getting an important aspect for third party funding applications.

The Concept: Communication made to measure!

The one-week training programme supports the participants to become a Science Communicator and enables to learn more about Science Communication from different perspectives. The participants have the possibility to choose three workshops out of an offer of nine. In this manner each participant can choose the individual focus and have the possibility to develop the own concept of Science Communication. Accompanied by daily get-togethers in the morning, which present the participants existing initiatives around Science Communication, the Communication School build an extensive overview. The further education programme ends with the closing ceremony, where the participants of the Communication School create their own programme and present their research to a public audience.

Participants during the morning get-together.
Photo: J. Gerland, Uni Kassel

The first Communication School:
great research meets communication experts

The first Communication School took place in September 2019. Thanks to the incredible participants, who - with their exciting research projects, an open mind and a lot of fun - made a great week possible that was characterized by diversity and creativity. Each of our trainers highlighted an other aspect of Science Communication and presented the participants an overview from different perspectives. After the Communication School 14 out of 33 participants decided to be an active part of the closing ceremony. The so-called “Science Night - Wissen aus erster Hand” took place at the Kulturzentrum Schlachthof in November 2019 and within this short time the participants created an extensive programme. The mixture of short presentations, video clips, exhibition stands and interactive formats attracted many visitors and made the evening a success. This success shows, that it is possible to communicate science to a public audience and that people are interested in current research.

Ready for the next group of science communicators

Inspired by the first week of the Communication School and the first closing ceremony the Graduate Academy is excited to welcome the next group of early career researchers, who are ready to present their fascinating research projects to the public and have fun with Science Communication. The programme for the next round will be published in March 2020 and the Communication School will take place in autumn 2020.

The project is supported by the Hessen State Ministry for Higher Education, Research and the Arts through the Innovation- and Structural Development Budget.

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Presentation by Özge Efendi during the get-together.
Photo: J. Gerland, Uni Kassel

Group photo of the "Effective Visual Communication of Science" class
Photo: Dr. Jernej Zupanc (seyens/ www.seyens.com)

The participants work concentrated on their skills.
Photo: J. Gerland, Uni Kassel

The audience enjoyed the science quiz and all the other contributions of the participants.
Photo: M. Zens, Uni Kassel

Science communicator Sasha Vogel from sciencebirds led through the evening
Photo: M. Zens, Uni Kassel

Photo: M. Zens, Uni Kassel

Research Highlights

A novel sequence motif controls the function of the Leucine-rich repeat kinase 2 (LRRK2) involved in Parkinson's disease

Protein kinases transfer phosphate groups to target molecules and are key enzymes controlling signal transduction processes in our cells (Fig. 1). They are involved in major human diseases like cancer (Espiard et al., JCI Insight 2018), neurodegenerative diseases like Parkinson's disease (Muda et al., PNAS 2014), as well as development of human pathogens like the Malaria parasite Plasmodium falciparum (Franz et al., ACS Inf. Dis 2018).

Protein kinases undergo distinct conformational states and conformational control has been established as a concept for kinase regulation. We are investigating the underlying molecular mechanisms at the atomic level employing biophysical techniques as well as biochemical assays, supported by protein dynamics calculations. We used a novel method based on Surface Plasmon Resonance to reveal the effect of divalent metal ion on conformational control of protein kinases therefore playing an essential role in protein kinase regulation (Knape et al., ACS Chem Biol. 2015, Knape et al., Metallomics 2017). Furthermore, within the University Kassel funded research project PhosMOrg, CINSaT members with interdisciplinary expertise in kinase biology (Herberg, Müller, Schaffrath), nanochemistry (Fuhrmann-Lieker) and biomolecular modelling (Garcia) have teamed up to investigate mechanisms of phosphoproteins.

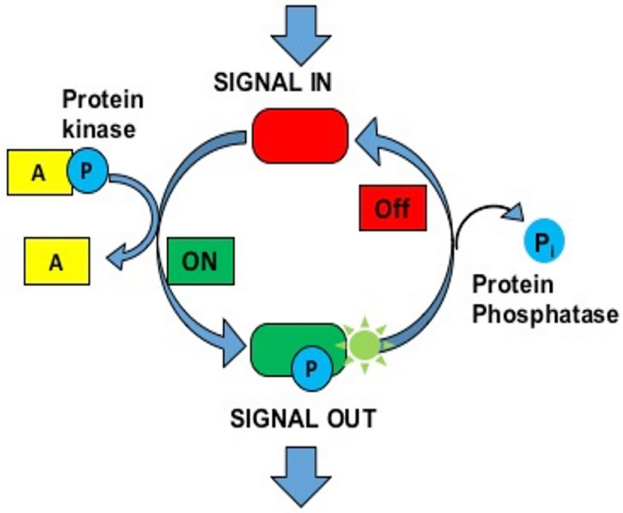

Figure 1. Protein kinases are acting as molecular 'on/off' switches that orchestrate chemical signals with proper cellular behavior (A=ADP; P=phosphate)

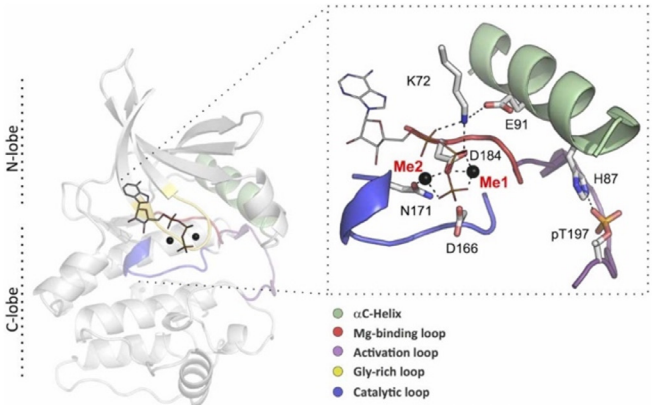

Figure 2. Eukaryotic protein kinases are defined by a bilobal structure. Two divalent metal ions (shown in black) position the polyphosphate chain of ATP for phosphoryl transfer and are thereby crucial for protein kinase function. While metal (Me)1 is coordinated by the highly conserved DFG-aspartate (D184 in PKA, see below) of the Mg-binding loop (red), Me2 is positioned by an asparagine (N171 in PKA) of the catalytic loop (blue). Modified from (Knape 2017, PDB 1ATP)

Recently we have described a novel switch mechanism that controls the activity of the Leucine-rich repeat kinase 2 (LRRK2), a large multidomain protein (2527 amino acids) carrying mutations linked to Parkinson's Disease. The protein encompasses a protein kinase domain and LRRK2 kinase activity is correlated to pathogenicity in Parkinson's disease but also diseases like Morbus Crohn. Although major research effort from basic research as well as drug companies has been channeled to understand LRRK2 function, the regulation of this protein kinase and the underlying pathogenic mechanisms are elusive. Two of the five most common familial Parkinson mutations (glycine 2019 to serine and isoleucine 2020 to threonine) are localized to the conserved DFGΨ motif (amino acids aspartate, phenylalanine and glycine, where Ψ any hydrophobic amino acid) within the kinase domain. We discovered a major regulatory mechanism embedded in the kinase core crucial for the assembly of a stabilizing structure (so-called spines, see Fig. 3 top) within the kinase termed regulatory kinase spine (R-spine). Using site-directed mutagenesis we could show that the DFGΨ motif serves as a dynamic switch that drives LRRK2 activation (Schmidt et al., PNAS 2019). We demonstrated that mutations in the DFG-motif (Fig. 3 bottom) strongly affect LRRK2 kinase activity.

In collaboration with the Univ. of California San Diego and the National Center for Microscopy and Imaging Research, San Diego we demonstrated that LRRK2 kinase activity, and most likely particular conformational states of LRRK2, induce filament formation with microtubules in cells. These findings may provide a hint to understand how LRRK2 is involved in Parkinson´s pathogenicity. Research on this topic is funded to a large part by the Michael J. Fox foundation, which was founded from the actor himself after being diagnosed with early onset Parkinson´s.

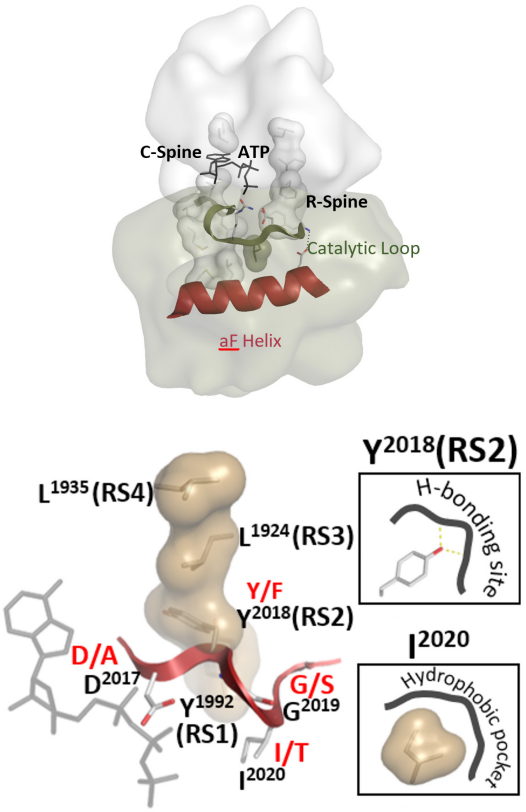

Figure 3. Two spine structures, the catalytic spine (C-spine) and the regulatory spine (R-spine, RS) stabilize the kinase core of any protein kinase. The assembly of the R-spine needs to be tightly regulated to control the conformation of the DYGψ motif and thereby, the ON and OFF states of the kinase. Pathogenic mutations in this motif (i.e., G2019S [DYGψ] and I2020T [DYGψ]) alter kinase regulation and become a driving force for Parkinson´s Disease. With Y2018F (RS2/DYGψ), we describe a mutation resembling features of the pathogenic mutants G2019S and I2020T.

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Promoting abnormal grain growth in Fe-based shape memory alloys through compositional adjustments

Iron-based shape memory alloys are promising candidates for large-scale structural applications due to their cost efficiency and the possibility of using conventional processing routes from the steel industry. By tailoring and promoting abnormal grain growth in these alloys due to compositional adjustments, it is possible to obtain very large single crystals, which are beneficial for the functional properties.

Induced by a diffusion-free solid phase transformation shape memory alloys (SMAs) are able to show high reversible strains of several percent and high stresses of several hundred megapascal. The shape memory effects can be activated either by a change in temperature, a change in the magnetic field and/or by a change of the mechanical load.

Especially iron-based shape memory alloys attracted a lot of attention in recent years and a lot of progress has been made in this field since the shape memory effect was firstly discovered in an iron-based alloy in the 1970s. However, many roadblocks need to be overcome for a successful industrial application of these SMA systems. For example, adjusting the size and orientation of nano-precipitates is of great importance for most iron-based SMAs since the precipitates strengthen the matrix, lead to local chemical inhomogeneities and shift the transformation temperatures.

Moreover, one of the most promising alloy systems, i.e. the Fe-Mn-Al-Ni system, only shows good superelastic properties if the grain size exceeds the cross-section of the components. Therefore, the component size is currently limited by the size of the grains.

In our recently published study we demonstrated a significant effect on the abnormal grain growth of the Fe-Mn-Al-Ni SMA by adding small amounts of Titanium and Chromium. The addition of Titanium increased the driving force of abnormal grain growth in a way that it was possible to obtain single crystals with a size of up to 220 mm by a simple cyclic heat treatment. Thereby, it will be feasible to build large-scale components.

As a positive side effect the quenching sensitivity of the alloy has been significantly decreased. Moreover, precipitate characteristics have been influenced and promising functional properties have been demonstrated. We expect this to be a major step towards the industrial application of iron-based shape memory alloys and believe that the mechanisms shown can contribute to tailoring abnormal grain growth in other systems with similar microstructure features.

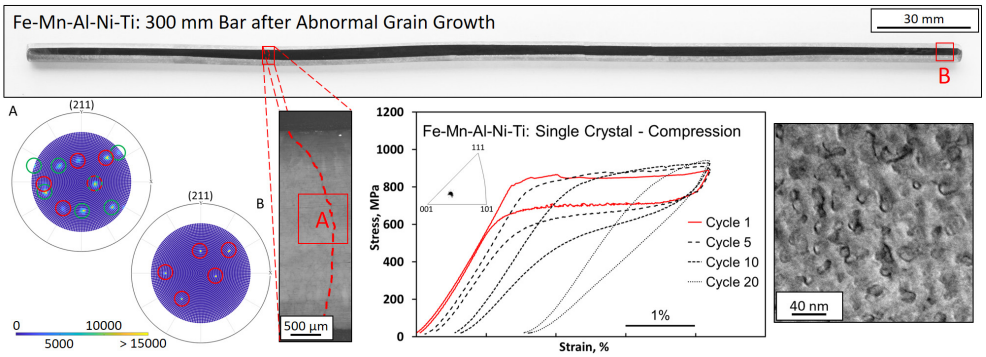

Figure 1: Enhanced abnormal grain growth in a 300 mm Fe-Mn-Al-Ni-Ti rod and functional fatigue behavior of an Fe-Mn-Al-Ni-Ti single crystal obtained by abnormal grain growth. Nano-precipitates strengthen the matrix.

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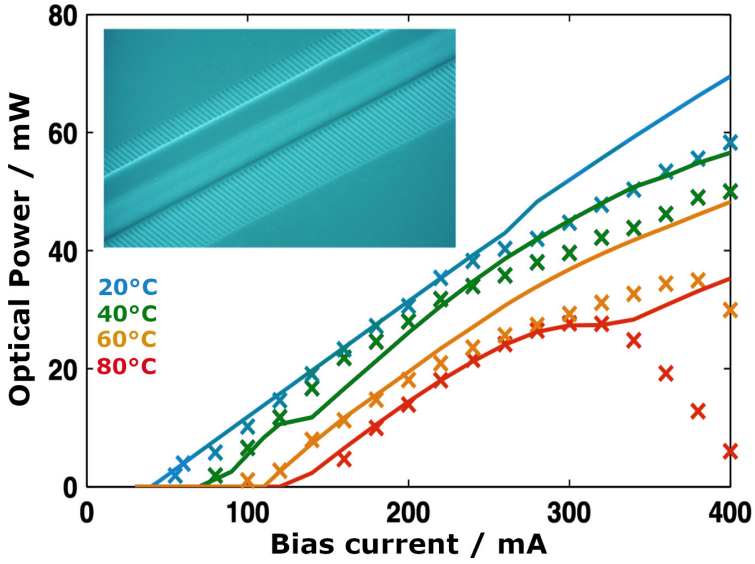
Further Information

Vollmer, M., Arold, T., Kriegel, M.J. et al. Promoting abnormal grain growth in Fe-based shape memory alloys through compositional adjustments. Nat Commun 10, 2337 (2019)

Small dots with huge effect

Scientists of the University of Kassel and the Technion – Israeli institute of Technology have demonstrated record low linewidth in quantum dot (QD) distributed feedback (DFB) lasers.

As published in Optica, scientists under the supervision of Prof. Dr. Johann Peter Reithmaier, Prof. Dr. Bernd Witzigmann and Prof. Dr. Gadi Eisenstein were able to show intrinsic linewidths as low as 30 ± 10 kHz from distributed feedback lasers emitting at 1,55 µm. This kind of lasers is a small and efficient light source for coherent telecommunication which is the state-of-the art in glass fiber transmission. Narrower linewidths will enable larger data rates in these fibers. The key to narrow linewidth are quantum dots (QD), i.e. very small islands of active material that offer almost atom-like behavior. Ideal QD will exhibit a symmetric gain spectrum with high modal gain, high efficiency and low sensitivity to temperature and back reflections that are superior to those of quantum wells (QW). Yet, the QD need to be small, very uniform and have a high dot density. For decades, the growth of QD in the InP material system was challenging. A tightly controlled growth by solid-source molecular beam epitaxy on a (100) oriented InP substrate yielded high dot densities and excellent homogeneity represented by very narrow photo luminescence linewidth together with a significant level splitting of ground state and first excited state. These properties result in a very symmetric gain function of the laser material causing a narrow linewidth. DFB lasers with weakly coupled lateral gratings and a length of roughly 1.5 mm were fabricated from this material. The device fabrication demands high accuracy in shaping of the ridges, planarization and backside polishing and especially in shaping of the gratings that will define the wavelength of the laser. Since the grating period is below the wavelength of UV light, electron beam lithography is used for definition of the gratings. Special attention needs to be directed on the distributed λ/12 phase shifts that are needed for stable single mode emission. Thorough control of the lithography is a key for high performance devices. Basic characterization showed high output powers of up to 58 mW at 20°C and decent spectral purity with side mode suppression ratios of 50 dB and more. The linewidth was measured with two different techniques. The first is the delayed self-heterodyne method exploiting the beat of the laser with a delayed fraction of itself. This technique is state-of-the-art but not so well suited for linewidths below 100 kHz. The second measurement technique was optical frequency comb interferometry in which light from a frequency comb with a linewidth stabilized to below 100 Hz. When interfering it with the laser, the measured beat will be a good approximation of the linewidth of the QD laser, since the reference laser is very narrow in comparison. Both methods determined intrinsic linewidth of 30 ± 10 kHz at 20°C concordantly, which is not only excellent for applications in optical communication and metrology, but also to our knowledge the lowest measured linewidth in this type of lasers.

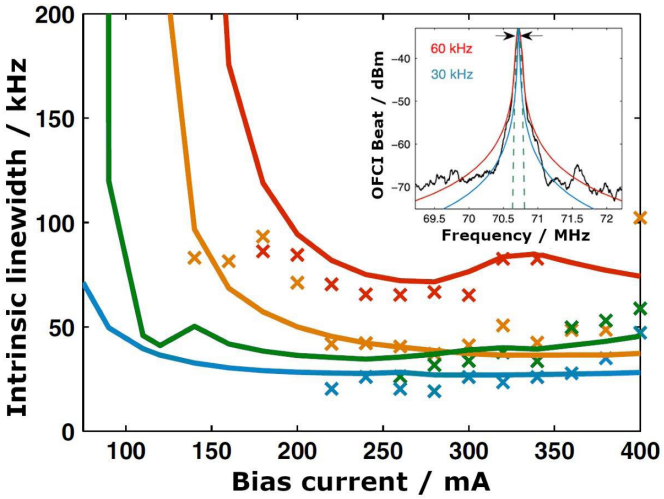


The plot shows the optical power with respect to the bias current and the temperature of the heat sink. The inset shows the ridge with adjacent lateral gratings.

Further measurements were done at higher temperatures to investigate the temperature stability. Intrinsic linewidths of 80 ± 10 kHz were found at 80°C which is considered a very good stability over a wide temperature range. A simulation based on the traveling-wave model was used to extract the temperature dependent α factor, a value used to describe the broadening of the linewidth due to fluctuations of the phase. The values are in good accordance with measurements and show a reduction of more than factor 6 compared to QW lasers. In addition, the α-factor is more temperature independent. An increase of only factor 4 over a temperature range of 40 K was determined. The results and simulations show the high potential of QD material for efficient, low-cost, stable light sources with a wide range of applications.

Further Information

Link: https://www.osapublishing.org/optica/viewmedia.cfm?uri=optica-6-8-1071&seq=0



The intrinsic linewidth is plotted with respect to the bias current at different temperatures. Far from threshold, low stable linewidth was measured. The inset shows the measured beat of the OFCI setup with fitted Voigt (red), Lorentzian (blue) and Gaussian (green) lines.

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New Projects

“Multi-signal far-field microscope” within DFG initiative for scientific instrumentation (WGI): “Novel optical microscopes”

Engineering systems subjected to mechanical or thermal loading can undergo irreversible changes of state, which start at a microscopic level and may eventually cause catastrophic failure. From a mechanical point of view, these micro-changes are accompanied by localized deformations which are accessible by optical far-field microscopy using in-situ observation and modern image-based deformation analysis. There is also a corresponding temperature field, as irreversible processes are always associated with a dissipation of energy in terms of heat. However, conventional thermography cannot be used for measuring these dissipative effects, as there are physically based limitations to its spatial resolution, which are well above the length scale of the micro-changes in question. The solution to this fundamental problem is given by exploiting thermal luminescence and combining it with far-field microscopy in the form of a multisignal far-field microscope. Such an instrument has been recently granted to the University of Kassel by DFG (German National Science Foundation).

Micro-scaled correlation of temperature and deformation or even fluid motion will greatly improve the understanding of ageing and damage processes, and will generate new and surprising engineering systems in their wake. Genuine damage processes in materials will be addressed such as micro-crack formation or ageing in polymer materials, but also fluid-structure interaction typical for heat transfer systems. An area of particular interest is tribology. In this field, the sliding motion is studied of two rough surfaces against each other, which can produce substantial amounts of heat, but also deformation induced damage in terms of gradual material removal. The classical answer to this problem is to manufacture smooth surfaces and minimize surface roughness. However, there are examples in nature and in technology where textured surfaces give better tribological answers. So, it is expected that the complete understanding of thermomechanical interactions will advance surface design for new and exciting solutions to the old problem of friction and wear.

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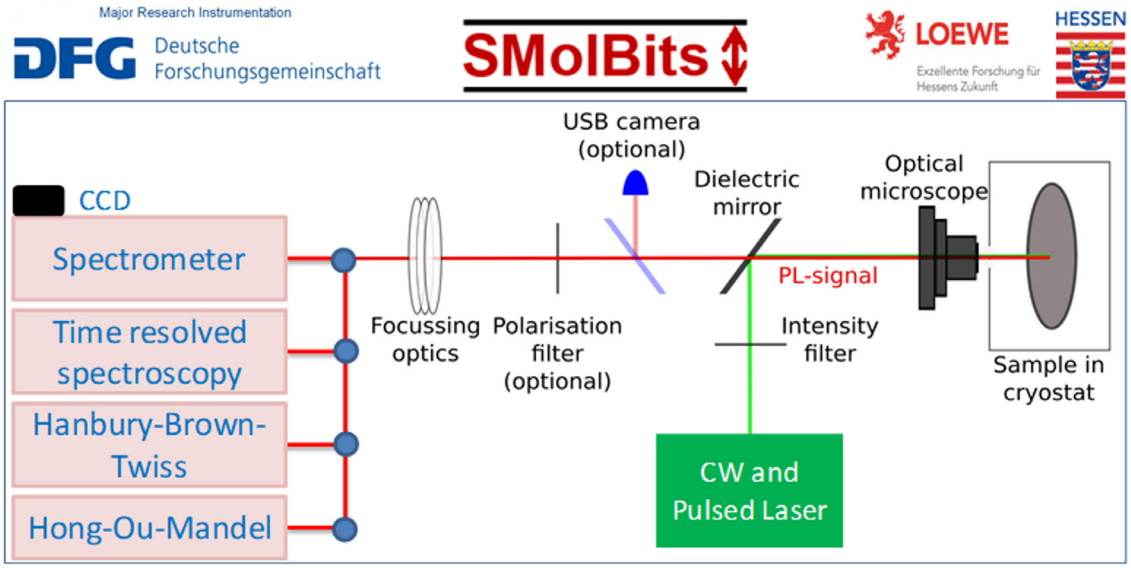
Research funding Large-scale equipment of German Research Foundation (DFG) for a new Quantum Optics Setup

In August 2019, the German Research Foundation (DFG) has approved an application with a total amount of 450 000 € for large scientific equipment to construct a new Quantum Optics Setup. The DFG will contribute with 50% of the total budget, i.e., 225 000 €. Co-financed by the University of Kassel and the state of Hesse through the LOEWE-Scalable Molecular Quantum Bits (SMolBits) project.

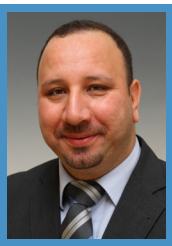
This quantum optics setup is central for characterization of the quantum physical properties of optically addressable single quantum systems such as single molecules in the LOEWE-SMolBits project. Nevertheless, the setup is also configured so that it can be used for other related research projects in quantum technology, e.g. quantum dots emitting below 1 µm, as well as for investigation of coherence and quantum entanglement properties. The setup is consisted of a high resolution spatially and time resolved photoluminescence (PL) spectroscopy as well as Michelson interferometer and Hanbury-Brown-Twiss (HBT) setups, which is to be installed in the Working Group Benyoucef. The results of these investigations form a fundamental basis for future development of quantum light sources based on molecular or/and solid-state systems, which could be used, e.g., for quantum cryptography and quantum computing application.

Further Information

Website: http://tp.ina-kassel.de/ index.php/nano_optics_eng



Schematic of the set-up



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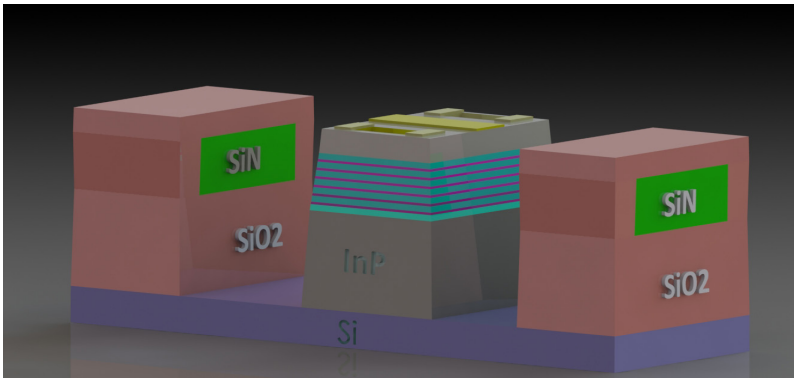
Two coordinated projects (EU and BMBF) on nanostructured group III-V on Silicon integration

For more than 30 years of research people tried to combine electronics and optoelectronics on a silicon chip. While silicon is dominating the electronics industry, active optical devices with sufficient performance couldn't be realized on silicon yet. This has to do with the low probability of electron-hole recombination in so-called indirect bandgap semiconductors. In comparison to that, direct bandgap materials such as GaAs and InP allow very efficient light emission and are the working horse in optoelectronic devices such as light emitting diodes or semiconductor lasers.

The Technological Physics group of Johann Peter Reithmaier is working in particular on the development of new nanostructured direct bandgap compound semiconductors. This so-called quantum dot (QD) materials are grown by a self-organization effect caused by the lattice mismatch of two materials, e.g., InAs on GaAs or InP substrates. Due to the nanoscale dimensions of the QDs with about 10 nm in width and 3 nm in height, the optical properties are dominated by quantum physics controlled by the QD geometry. Due to the additional internal microscopic degree of freedoms, the material properties can be tailored to the device properties and application field targeted, such as enhanced temperature stability, narrow linewidth emission (see also article on research highlights in this issue), and mechanical robustness against crystal failures or dislocations. The group is for many years the worldwide leading research group in 1.55 µm emitting QD lasers, which are dedicated for fiber based high-performance optical communication.

Due to the specific properties of QD materials for opto-electronics and their robustness, it is the first choice of materials to be integrated on silicon photonic chips. Within two larger industry driven coordinated projects, the integration of QD materials is investigated by two different techniques.

In the European project MOICANA ("Monolithic cointegration of QD-based InP on SiN as a versatile platform for the demonstration of high performance and low cost PIC transmitters", Link: moicana.eu) the laser materials are monolithically and selectively grown on a patterned silicon wafer using molecular beam epitaxy. The goal is to develop a new III-V on Silicon material platform and to demonstrate integrated devices for high-speed optical and wireless communication (e.g., next mobile standard 5G) on 100 mm silicon wafers. The consortium consists of 8 partners (5 of them from industry) and is coordinated by the University of Thessaloniki. The project started in 2018 and the University of Kassel is funded by about 840 k€ for 3 years.



Monolithic integration of InP-based QDs laser structure on SiN/Si platform.

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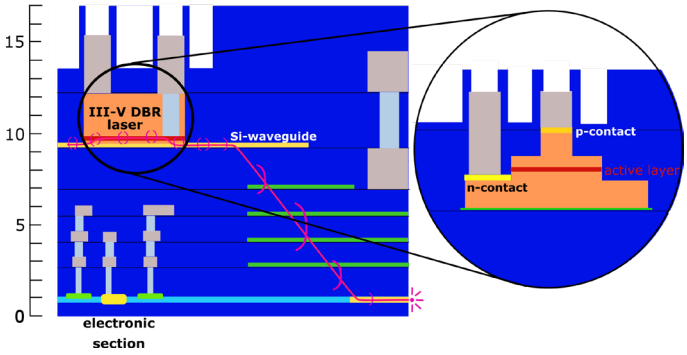
In the BMBF project PEARLS ("Photonic Embedding of Active Region Laser Chips on Silicon") a so-called transfer-printing concept should be realized based on 1.55 and 1.3 µm emitting QD lasers to integrate active devices on a silicon 200 mm wafer. For this purpose also full 200 mm III-V material processing will be the first time established at INA. The goal is a hybrid integration of optical gain material on a silicon photonic chip for data com and long reach optical communication systems. For this purpose also tunable narrow linewidth QD lasers will be realized and investigated. The project consists of 7 partners (4 companies, 2 research institutes and 1 University) and is coordinated by the company ADVA. The project started in 2019 and the University of Kassel is financially supported by about 940 k€ for 3 years.

EPIC with integrated III-V section



Schematic depiction of the electro-photonic integrated circuit chip. The detail shows the photonic III-V chip that will be fabricated at the INA.

For these and future projects on III-V on Si integration, a new double-chamber MBE was co-founded by DFG (50% of 1.7 Mio €) and University of Kassel, which allow group III-V compound semiconductors and Si/Ge epitaxy on multiple 3" up to 8" wafers. The system is under installation at INA and gets in operation beginning of 2020. This will allow us to keep a leading position in this field of nano materials and device research for the coming years.

The new MBE system located in the clean room facilities of the INA

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New Members

Prof. Dr. Angelika Brückner-Foit

I started out with sub-nano systems by majoring in theoretical physics and doing a Ph.D. in quantum field theory at the University of Karlsruhe (Prof. Dr. J. Wess). Then I got a job as a senior scientist at Karlsruhe Research Center (now KIT), and suddenly I was confronted with very macroscopic systems such as large steel structures and their failure behavior. Ever since, I have been gradually moving back to smaller length scales, as damage processes even in huge components such as propulsion systems in airplanes start at an atomistic or at least a crystallographic level. This type of process can nowadays be analyzed by using advanced image-based microscopy tools such as scanning electron microscopy or computer tomography. When I joined the University of Kassel in 2000, I started to build up a group which focuses on providing most of these tools on a fairly advanced level and combining the results with micro-structure based simulations. The main area of research is microstructure related damage processes leading to macroscopic failure for metallic materials. The scale of the phenomena of interest ranges for 100 nm to 100 µm.

Recently, we have been granted a very advanced optical microscope by DFG within the framework of a scientific instrument initiative. This microscope will help us to gain a deeper understanding on energy dissipation in damage problems at a micrometer scale.

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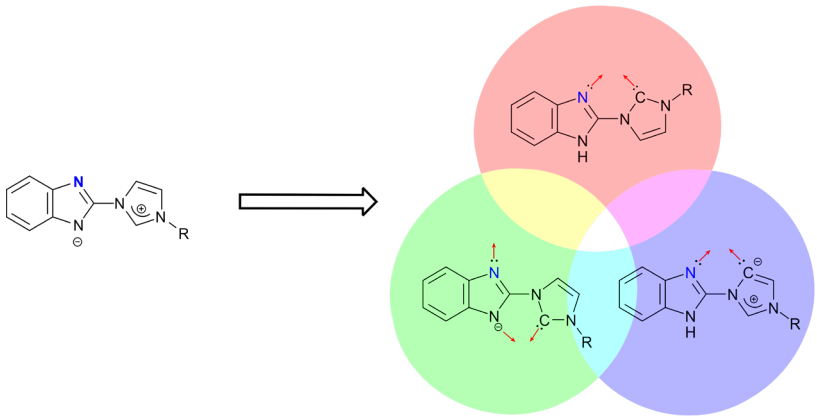
Awards

Two honors for the Siemeling Group

The communication entitled “Imidazolium-benzimidazolates as convenient sources of donor-functionalised normal and abnormal N-heterocyclic carbenes” published recently by Prof. Ulrich Siemeling and co-workers (K. Kureja, J. Zinke, C. Bruhn, U. Siemeling, Chem. Commun. 2019, 55, 9705) was selected as an Editor’s Choice article. Chemical Communications is a cutting-edge journal with an impact factor of 6.164, which covers all aspects of chemistry. It is published by the Royal Society of Chemistry (100 issues per year). The Editor’s Choice collection features articles personally chosen by Editorial Board members as their favorite recent reads. The contribution by Siemeling and co-workers belongs to only six such articles so far selected in 2019.

Prof. Ulrich Siemeling was appointed new International Advisory Board member for the International Conference on the Coordination and Organometallic Chemistry of Germanium, Tin and Lead. This conference takes place every three years. The decision was made at the 16th conference in this series held in Saitama (Japan) from September 1 – 6 this year and recognises recent achievements by Siemeling and co-workers in the chemistry of low-valent germanium, tin and lead. In this context, an article describing a nano-sized chiral heavy-metal cluster containing Fe and Pb (Angew. Chem. 2019, 131, 1401; Angew. Chem. Int. Ed. 2019, 58, 1387) was subject of a Research Highlight in the last issue of this Newsletter.



Graphical abstract of the awarded Communication

Poster awards for Daniel Merker and Julia Heupel

In September 2019 Julia Heupel and Daniel Merker from the Nano Diamond Group at the Institute of Nanostructure Technologies and Analytics, CINSaT, attended a NATO Advanced Study Institute (ASI) on “Nanoscience and Nanotechnology in Security and Protection Against CBRN Threats” in Sozopol, Bulgaria. It addressed the latest advances in Nanoscience and Nanotechnology in fields, such as novel sensors, information technology and cyber defense, biotechnology, energy management, early detection and protection against chemical, biological, radiological and nuclear agents, etc. and was attended by 79 participants from 20 NATO and Partner countries. Julia Heupel won the first prize in the first poster session, Daniel Merker the second prize in the second one as evaluated by a 7-member international jury.

Poster prize for Daniel Merker.

Poster prize for Julia Heupel

After the ASI Julia Heupel, Daniel Merker and Prof. Cyril Popov (Humboldtian since 1999) took part in a Humboldt-Kolleg “Science without Borders: Alexander von Humboldt's Concept in Today's World” in Varna, Bulgaria, dedicated to the 250th anniversary from the birth of Alexander von Humboldt, organized by the Bulgarian Humboldt Union, Alexander von Humboldt Foundation and the German Embassy in Bulgaria. In addition to the three talks given in session “Technical Sciences”, the group from CINSaT met with Dr. Enno Aufderheide, Secretary General of the Alexander von Humboldt Foundation and the German Ambassador to Bulgaria Christoph Eichhorn and participated in several activities together with Humboldtians and young researchers.

Open air poster session during the NATO ASI in Sozopol, Bulgaria

Latest Reports

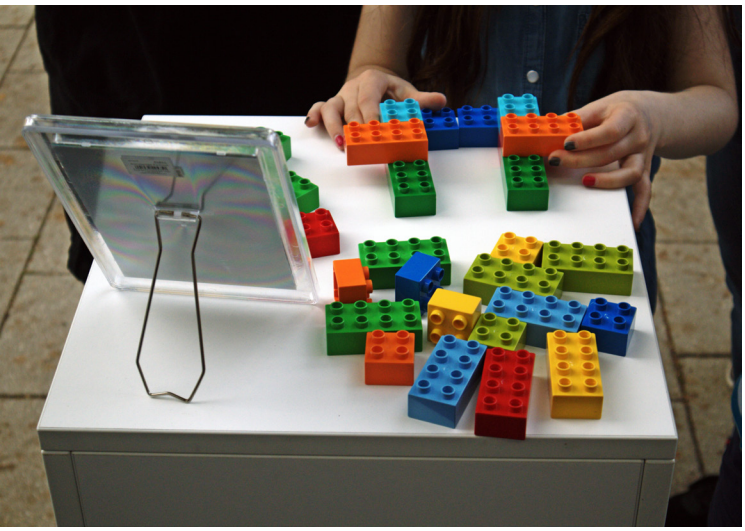
CINSaT presents itself at the Hessentag 2019 in Bad Hersfeld

The Hessentag is the largest and oldest state festival in Germany, which is held annually in various regions of Hessen. During the ten-day event, visitors are offered various exhibitions and an extensive programme of events. Also this ear CINSaT was present at the last weekend of the event.

Together with numerous research projects of proLOEWE - LandesOffensive zur Entwickelung Wissenschaftlich-ökonomischer Exzellenz - the CINSaT was represented together with the LOEWE SMolBits project and SFB ELCH at the booth of the science campaign "Hessen Schafft Wissen". This is a unique format for making science accessible to the general public and to communicate in an understandable language. In changeable weather but still summery temperatures, this year's Hesse Day in Bad Hersfeld once again provided an ideal opportunity for the visitors to gain insights into the diverse and interdisciplinary world of nanostructures, which are currently being researched at CINSaT. For this purpose, a large number of experiments and exhibits were prepared to amaze the visitors. The committed employees were able to prove that the image of science has changed dramatically in recent years and that science communication has become an important element in the meantime. Children in particular were enthusiastic about the numerous exhibits and listened eagerly to the explanations of the employees. The experiments with liquid nitrogen, the influence of magnetic fields on magnetic liquids (ferrofluids) and the replica of an atomic force microscope with LEGO Mindstorms were perceived as particularly spectacular and attractive by the young and old visitors. In addition to the exhibits, a visit to the CINSaT booth also offered the opportunity to gain insights into the diverse and, in part, internationally unique courses of study - such as the "Nanoscience" course or the newly launched orientation course "plusMINT".

Experiments with liquid nitrogen

The members of SFBELCH and CINSaT explain chirality of molecules



Visualizing the concept of chirality with LEGO Duplo ©

Gold layers of varying thicknesses

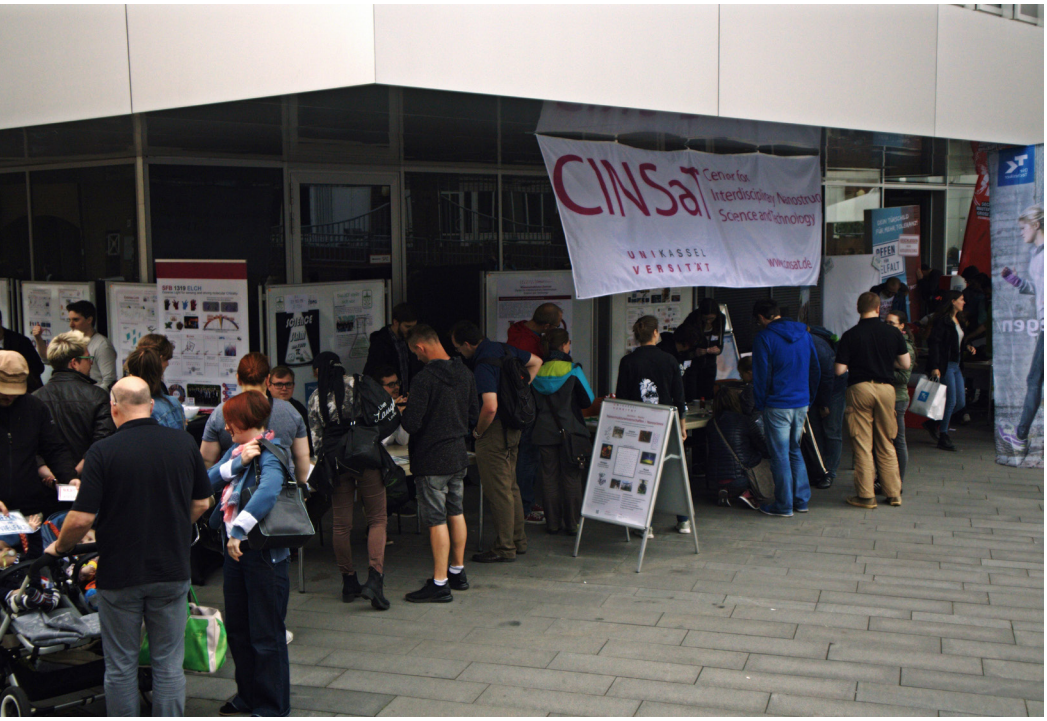
LEGO Mindstorms © replica of an atomic force microscope

CINSaT presents itself again this year on the Campusfest of the University of Kassel

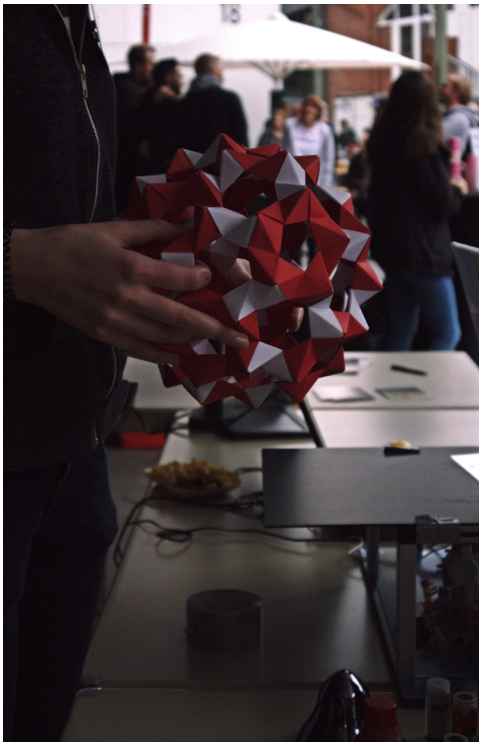
The campus festival of the University of Kassel - which celebrated its four-year anniversary this year - once again provided an ideal opportunity for CINSaT, together with the SFB ELCH, LOEWE SMolBits and the JungChemikerForum Kassel, to give insights into research and study opportunities in the field of nanotechnology at the University of Kassel. In addition to the current issues of the CINSaT Newsletter and information material on the scientific center, as well as the CINSaT-supported Bachelor and Master programs “Nanoscience” and the orientation course “plusMINT”, which will be launched in the coming winter semester, exhibits on key nanotechnology topics were also on display.

Ferrofluid interacting with an external magnetic field

One of the crowd favorites here was clearly the LEGO Mindstorms model of a scanning probe microscope. But the other exhibits, ranging from models of air-purifying molecules and the so-called football molecule "Buckminster Fullerene" to magnetic nanostructures, or the influence of magnetic material on magnetic fields aroused the interest of the visitors. The experiments with liquid nitrogen, carried out by members of the SFB ELCH and the JCF, attracted a special interest of the people passing by. Despite the slightly changeable weather, the campus festival was once again a well-attended and successful event to bring the work of the CINSaT closer to the public.



Great interest in the experiments at the booth



Paper model of the "football molecule"
Buckminster Fullerene

The volunteers answered all questions
about nanotopics for the curious visitors.

SFB ELCH and CINSaT
presenting exhibits at the
Campusfest

Autumn Colloquium 2019

This year's CINSaT Autumn Colloquium continues to thrill and attracts many professors, academic staff and students to the lecture hall.

On Wednesday, 16th of October 2019, the annual autumn colloquium of the CINSaT took place in lecture hall 282 at the Heinrich-Plett-Straße of the University of Kassel. Numerous professors, doctoral students, as well as undergraduate and graduate students from various disciplines waited excitedly for the lectures of the guest speakers. The autumn colloquium, which is open to all who are interested, offers not only the opportunity to listen to interesting topics on current nanotechnology research, but also to inform themselves about the current research contents of the CINSaT during the poster session. The colloquium started with a warm welcome speech of Prof. Dr. Johann Peter Reithmaier, head of the CINSaT, who led into the first part of the lecture series that was opened by Prof. Dr. Peter Felfer from the University of Erlangen. In his lecture " Atomic Scale Analysis of Material using Atom Probe Tomography" he explained how to obtain a 3D reconstruction of the composition of a specimen with atomic resolution. Following this, Prof. Dr. Piet O. Schmidt from the PTB Braunschweig captivated the audience with his exciting lecture "Optical Clocks" in which he addressed the usage of unconventional optical clocks for the test of fundamental physics and quantum logic spectroscopy of Ar13+ ions. After a half-hour coffee break, which was used not only to get to know each other, but also for the first review of the posters, the second part of the lecture series followed. Dr. Claudia Geisler from the Laser-Laboratorium Göttingen e.V. presented her lecture entitled "Optical Nanoscopy: Imaging beyond the Diffraction Limit" in which she talked about STED microscopy, for instance. The last talk of the session, entitled “True optical sectioning for 3D microscopy: Three-dimensional specimens in light sheet-based fluorescence microscopy (LSFM)”, was given by Prof. Dr. Ernst H.K. Stelzer from the Universität Frankfurt. In his application-oriented talk he demonstrated not only a short history of different microscopy types he

The audience listening to the scientific talks.

Prof. Dr. Peter Felfer from the University of Erlangen.

Prof. Dr. Piet O. Schmidt from the PTB Braunschweig

Prof. Dr. Ernst H.K. Stelzer from the University of Frankfurt.

developed, but also about multi-dimensional data collection. The poster session following the lectures achieved a new record with 64 posters. The foyer in front of lecture hall 282 offered not only enough space for the numerous poster contributions, but also for extensive scientific discussions and the exchange of information on current research content within the CINSaT. The catering of the Studentenwerk of the University of Kassel provided again for the well-being during the event. The interdisciplinary cooperation within the CINSaT has been pronounced through cross-working-group poster contributions or related posters of the LOEWE SMolBits Project. The conclusion of the event was the presentation of the poster prizes awarded by this year's jury - consisting of CINSaT members Prof. Dr. Thomas Giesen, Prof. Dr. Monika Stengel, Prof. Dr. Ulrich Siemeling and apl. Prof. Dr. Thomas Fuhrmann-Lieker - for the three best poster contributions was awarded (1st prize tablet, 2nd prize retro gaming console, 3rd prize external SSD). The jury emphasized the high scientific quality of the posters. This year, the first price was given to the poster "Optical and morphological characterization of lanthanide complexes" by Miriam Gerstel from the Nano Optics Group (PD Dr. Mohamed Benyoucef). The second and third prize were given to Tanja Finke (Nano Materials Group, Prof. Dr. J.P. Reithmaier) with her poster entitled "GaAs based quantum dot structures for VECSEL and MIXSEL applications" and Pablo Rojas (Theory of Ultrafast Phenomena, Prof. Dr. M. Garcia) for his presentation about “Diffusion-based minimal oscillators in transcriptional networks”, respectively. Due to the high number of participants, both in the audience as well as the poster contributions, and the thematically balanced lectures of the guest speakers, the CINSaT Autumn Colloquium was again a complete success.

CINSaT speaker Prof. Dr. Johann Peter Reithmaier together with the poster prize winners and part of the jury.

Dr. Claudia Geisler from the Laser-Laboratorium Göttingen e.V.

Impression of the poster session

Announcements

Spring Colloquium 2020

CINSaT cordially invites all members and their staff to take part in the annual internal spring colloquium from Thursday 5th to Friday 6th March 2020 at the Ahorn Berghotel in Friedrichroda.

All participants who are not members of the CINSaT are obliged to present a contribution in the form of a lecture (15 min + 5 min discussion) or poster (format: DIN A0). Please note that the participants have to organize their own travel and this is not funded by CINSaT.

The lecture series held during the colloquium will be organized by the CINSaT focal point speakers and the management. On the one hand, the speakers will make individual requests regarding the presentation of a lecture to the CINSaT members and their staff. On the other hand, you are also welcome to make inquiries regarding a presentation to the speakers or the management:

- 3-dimensional Nanostructures (Prof. H. Hillmer)
- Multiscale Bioimaging (Prof. A. Müller)
- Photonics (Prof. P. Lehmann)
- Chiral Systems (Prof T. Baumert)
- Quantum Technology (Prof. S. Singer)
- Nanostructures in natural sciences, engineering sciences and the arts (Prof. B. Middendorf, Prof. T. Niendorf)

In order to promote scientific exchange, the poster authors should also prepare a poster flash presentation.

For registration, please send an E-Mail to Nina Felgen including the following information:

- Names of the participating CINSaT members and the participating members of your working group (PhD students and PostDocs; Master students only in exceptional cases)
- Title of the contribution (if possible with additional indication of the corresponding CINSaT focal point),
- Possibly specify if you can only attend one day and/or do not stay at the hotel. Should your entire group NOT be able to participate, we still ask for a short feedback.

The deadline for the registration is Friday, 20.12.2019. The preliminary schedule of the colloquium will be sent to you after the deadline for registration has expired and the program has been compiled.

The colloquium is expected to begin on Thursday, 05.03.2020 at 9:30 h and end on Friday, 06.03.2020 at 16:00 h.

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

Impressions from the last CINSaT Spring Colloquium

HiPerMat

Materials Structures Design

UNIKASSEL VERSITÄT

5th International Symposium on

Ultra-High Performance Concrete

and High Performance Construction Materials

March 11th - 13th , 2020 in Kassel

Topics: Durability and Construction with UHPC
Strength and Deformation behaviour of UHPC
Design and Constuction Materials
Material Science
Smart Construction Materials

The central topic of this international symposium is the innovative building material Ultra-High Performance Concrete (UHPC), which continuously is investigated worldwide in basic and application-oriented research projects due to its efficiency.
Guidelines and standards for the use of UHPC are increasingly being introduced worldwide, which has led to increased use, particularly in the construction sector. These innovative UHPCs allow the creation of very thin, filigree and at the same time durable objects, such as bridges, road pavements, stairs, facade panels etc. This high-performance material is increasingly being used aside the construction sector as well: machine elements, furniture, etc. can be named here as examples.

The HiPerMat symposium offers a forum for the exchange on these topics concerning UHPC and other enhanced structural materials. Special attention is given to their development and to the construction and design of these durable and sustainable high performance structures.

During the symposium, researchers from all over the world will present their latest findings in their presentations and in poster sessions. Commercial exhibitors will show their latest technology for characterizing and applying UHPC.
Register now!

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UNIKASSEL VERSITÄT INA CINSaT RBNI

International Symposium on

Nanostructured Semiconductor Systems: Physics and Applications

March 25 - 26, 2020
University of Kassel, Physics Institute (HS 100)

The scope of this co-organized international symposium by CINSaT and RBNI (Russel Berri Nanotechnology Institute, Technion, Israel) is to bring together world leading people in the field of nanostructured semiconductors, which are working in fundamental physics and applications. The DFG-funded symposium is co-funded by RBNI and CINSaT. The following invited speakers will present their recent results:

- Prof. Dieter Bimberg (TU Berlin, Center for Green Photonics, Changchun, China)
- Prof. Frederic Grillot (Telecom-Paris Tech, Palaiseau, France)
- Prof. Stephan Reitzenstein (TU Berlin)
- Prof. Weng Chow (Sandia National Labs, Albuquerque, USA)
- Prof. Ferdinand Schmidt-Kaler (University of Mainz)
- Dr. Alfredo de Rossi (Thales Research & Technology, Palaiseau, France)
- Prof. Jonathan Finley (WSI, TU Munich)
- Prof. Manfred Bayer (TU Dortmund)
- Prof. Ursula Keller (ETH Zürich)
- PD Dr. Bernd Sumpf (FBH Berlin)
- Prof. Sebastian Lourdudoss (KTH Stockholm, Schweden)
- Prof. Andreas Waag (TU Braunschweig)
- Prof. Eli Kapon (EPF Lausanne, Switzerland)
- Prof. Fabrice Reineri (University of Paris Saclay, CNRS, Palaiseau, France)
- Dr. Michel Krakowski (III-V Lab, Palaiseau, France)
- Prof. Mariangela Gioanini (Politecnico di Torino, Italy)
- Dr. Jean Michel Gerard (CEA-Leti, Grenoble, France)
- Prof. Frank Jahnke (University of Bremen)
- Prof. Sven Höfling (University of Würzburg)
- Prof. Gerd Leuchs (MPI Physics of Light, Erlangen)
- Prof. David Gershoni (Technion, Israel)
- Prof. Grzegorz Sek (Wroclaw University of Technology, Poland)
- Prof. Jesper Mörk (Fotonik, TU Denmark)
- Prof. Jerome Faist (ETH Zürich)
- Prof. Gerd Bacher (University of Duisburg-Essen)
- Dr. Martin Walter (Fraunhofer IAF, Freiburg)
- Dr. Lars Zimmermann (IHP, Frankfurt Oder)
- Prof. Hartmut Hillmer (INA, University of Kassel)

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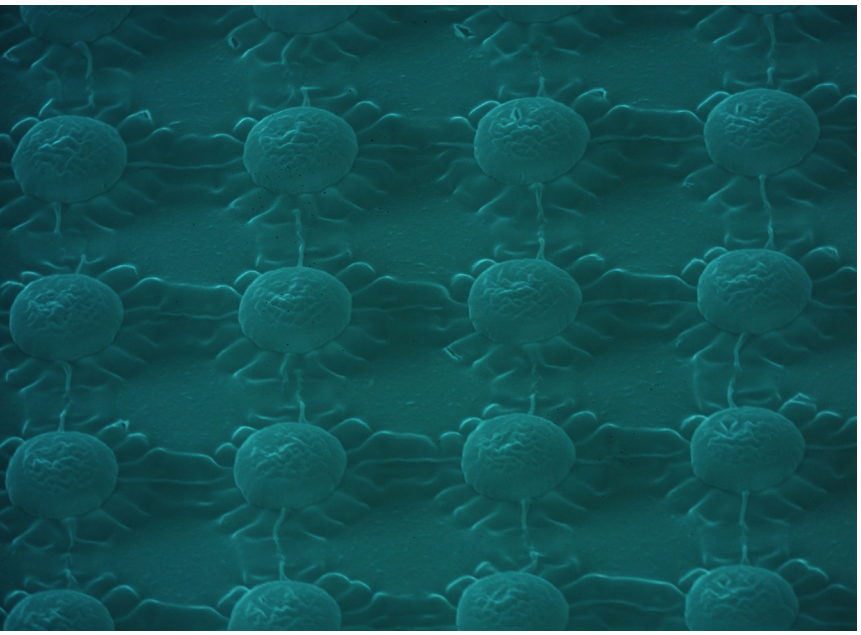
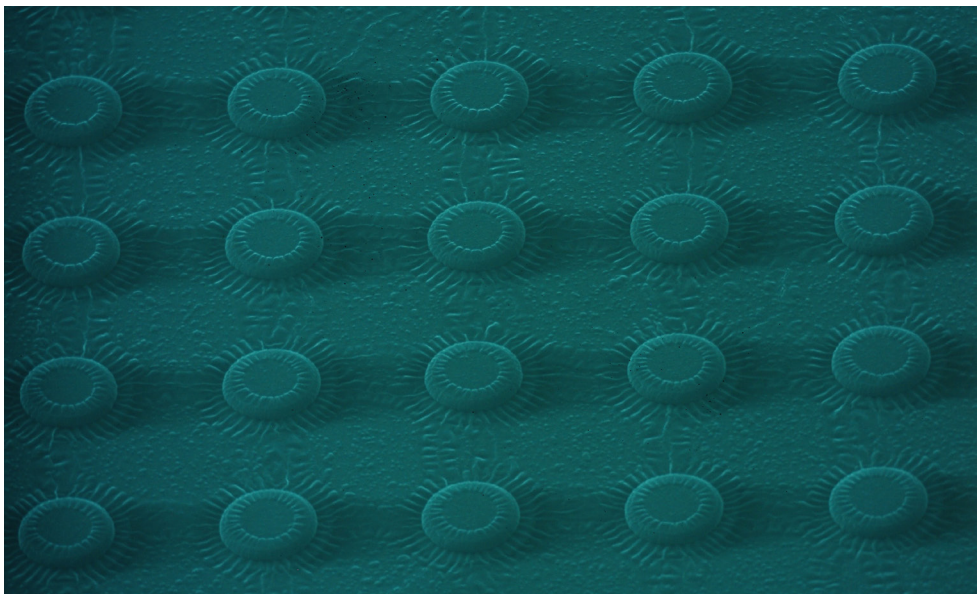
Nano arts

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.



Ellipsoidal PDMS structures after deposition of chromium.
(Eireen Käkel, Technological Electronics)



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