Universität Basel

Swiss Nanoscience Institute

SNI SWISS NANOSCIENCE INSTITUTE
A NANO INITIATIVE DER UNIVERSITÄT BASEL

SNI update July 2015

Editorial

Dear colleagues,

Before you say your goodbyes for the summer, we would like to share a few items of SNI news with you.

We have just launched the next call for Argovia proposals. You have until the end of September to submit proposals for applied research projects that partner with industrial companies from Northwestern Switzerland. We particularly want to support collaborations with companies from the Canton of Aargau.

Professor Uwe Pieles of the School of Life Sciences at the FHNW has been – and continues to be – involved in numerous Argovia projects. This edition of «SNI update» introduces him in a little more detail. Uwe's research is largely application oriented, which makes it somewhat different to the Master's thesis written by Sara Freund. Sara is this year's winner of the prize for the best Master's thesis on nanoscale science. She has produced excellent basic research on using a newly developed non-contact atomic force microscope, and will receive her prize at our annual event in September.

Planning for the annual event is already well underway. We are currently putting the final program together, and our new outreach manger Kerstin Beyer-Hans will soon be approaching you to ask for abstracts for the event documentation. Kerstin is settling into her role very well. She has participated in her first TecDay and has arranged interesting programs for visitor groups. She is also actively involved in planning the UniNacht and is developing new ideas for future events.

Recent weeks also brought welcome news in the form of a strong media response to two of our press releases. Our experience shows that it is absolutely worthwhile to provide lay audiences with «translations» of the scientific findings we publish in prestigious journals such as «Nature». Whenever you have a paper accepted by «Nature» or another important journal, please contact Christel Möller, who will be happy to arrange a suitable media release.

And now I would like to wish you all an enjoyable and relaxing summer break. I look forward to seeing as many of you as possible at our annual event in Lenzerheide in early September.

Best wishes,

Christian Schönenberger

Director Swiss Nanoscience Institute, University of Basel

Cover Story

Sara Freund Receives Prize for Best Master's Thesis in 2014

Sara Freund has won the prize for the best Master's thesis in nanoscale science at the University of Basel. This is the second time the prize has been awarded. The young French scientist, who earned her Bachelor's in Strasbourg and came to the University of Basel for her Master's, wrote her winning thesis on using a newly developed non-contact atomic force microscope.

A new microscope

Sara Freund, a 25-year-old scientist from Hegenheim in France, joined Professor Ernst Meyer's team to write her Master's thesis in February 2014. She worked with the non-contact atomic force microscope (AFM) that Dr. Gregor Fessler, one of the group's former doctoral students, had recently spent several years developing. He had successfully used it to conduct friction measurements, but no one had used it in non-contact mode to generate images of different surfaces.

Studying benzylammonium

Sara used the new AFM, which works at room temperature, to investigate the surfaces of benzylammonium (BNL) crystals. These organic compounds are the result of a collaboration between the Meyer group and Professor Decurtins of the University of Bern. Gregor Fessler had previously conducted a detailed study of BNL, which (among other distinguishing features) has anisotropic properties. This means the physical and chemical forces in BNL work differently in different spatial directions, a fact that is reflected in the variation in orientation on the surface of the crystals.

Sarah Freund wins the price for the best Master's thesis in nanosciences.

A bumpy start

The atomic imaging of BNL proved more difficult than Sara had originally anticipated. Noises and vibrations in the building were the first problem. They interfered with the measurements for months until Sara eventually acquired some insulating underlay. Next, she ran into difficulties with preparing the samples. The standard approach of attaching samples to the holder with glue, for instance, did not work because the glue melted onto the sample when it was heated up. Sara then tried an approach similar to the one that produced graphene for the first time: she used sticky tape to remove a thin slice of hot BNL. This meant she could prepare the samples in a way that would allow measurements in the ultra-high vacuum to succeed.

C_{60} molecules form islands

Once Sara had successfully imaged the crystals, she investigated how C_{60} molecules arrange themselves on BNL. She showed that they form relatively small islands, which is different to how they behave on metals or ionic crystals. The islands contain roughly 1,000 to 2,000 molecules and are either triangular or hexagonal in shape. Using the AFM tip, Sara was able to change the shape of the islands by turning triangles into hexagons and vice versa.

Seeing atoms was a dream come true

Sara's supervisor, Professor Ernst Meyer, is delighted with her work: «Sara really deserves the prize for the best Master's thesis. She did excellent work and didn't let the teething problems faze her. Her thesis shows that the new non-contact AFM is ideal for studying sensitive samples.»

Sara Freund ist fascinated by the work at her non-contact AFM.

Sara is just as fired up as her supervisor. From the moment she first learned about atoms and molecules at school, she dreamed of being able to see them one day. Since completing her nanoscience program, she has gone straight on to the next stage of her academic career. Nine days before taking her Master's examination in October 2014, Sara began working on her doctoral dissertation in Ernst Meyer's group. Sara is now using the same microscope – albeit with some alterations and improvements – to study dye-sensitized solar cells in collaboration with the group led by Professor Ed Constable and Professor Catherine Housecroft.

A hard but worthwhile transition

Sara feels at home at the University of Basel and is particularly settled in her working group. She is looking forward to the time she will spend here on her doctoral thesis. She has never regretted moving to Basel for her nanoscience Master's after earning her Bachelor's in physics in Strasbourg – even though it meant she had to put in some extra work. «I only did a bit of chemistry in Strasbourg, and no biology at all», Sara recalls, «so it was really tough at first. As well as starting my Master's program, I also had to catch up on block courses and other Bachelor's courses. But I knew straight away that I absolutely loved it.» And so she continues her research, still highly motivated and still thrilled at the sight of atoms and molecules.

We introduce...

Most SNI members know Professor Uwe Pieles, who is based in the School of Life Sciences at the University of Applied Sciences Northwestern Switzerland (FHNW). He has been actively involved in all SNI activities ever since the institute was founded. He has participated in more than ten projects in the Nano Argovia program alone, mostly as project leader. His excellent network with local industry repeatedly give rise to exciting collaborations in new subject areas. Read on to find out how Uwe arrived at the nanosciences, how he comes up with new project ideas, what drives him, and what he does when he is not working.

Fascinated by chemistry at an early age

Even as a child, Uwe Pieles was fascinated by the practical applications of science. He analyzed his ink eraser and filled his neighborhood with smoke from homemade firecrackers. Little wonder, then, that he decided to study chemistry after graduating from high school. After completing his Vordiplom at Bielefeld University, he moved to the University of Göttingen and then to the Max Planck Institute for Experimental Medicine, where he wrote

Argovia call for proposals 2015

You have until September 30 to submit proposals for new Argovia projects. More information about the Nano Argovia Program, which funds joint projects between public research institutes and industrial partners based in Northwestern Switzerland, is available here:

http://argovia.nanoscience.ch

his Master's and doctoral theses. While Uwe was working on blocking DNA replication, he learned interdisciplinary skills from being surrounded by biologists at the Max Planck Institute. Biochemistry remained his focus when he took up a postdoc position at EMBL in Heidelberg. This was where he began studying biosensors, which was an entirely new field of research back then. «I had a wonderful time at EMBL. Everything was right – the atmosphere, the facilities, the working conditions,» recalls Uwe. However, the future was uncertain for EMBL researchers. Permanent contracts were rare, so in 1991 Uwe decided to accept a position as a laboratory head at Ciba-Geigy in Basel. Once there, he continued his research into biosensors and focused on antisense DNA, which has the potential to regulate protein biosynthesis. The position at Ciba allowed Uwe to make full use of his expertise in nucleic acid chemistry. He also learned how to deal with entirely new challenges. Managing a team and taking responsibility for budgets were just two of the many tasks he had never tackled before. When Ciba unexpectedly merged with Sandoz, however, it threw the future of entire departments into doubt, and jobs that had been considered secure suddenly disappeared.

The appeal of a new start

Uwe quickly found a place in the new Novartis organization, but after seven years at Ciba/Novartis, he was ready for a complete change of professional scene. And so, in 1997, he accepted a position at Altana, a pharmaceutical company based in Konstanz, where he would be responsible for setting up a new group for nucleic acid chemistry. «It was an exciting role. We got started under excellent conditions and employed a lot of motivated young people who had a great spirit,» says Uwe. Despite the new job, however, Uwe and his wife continued living in Müllheim and it was clear to both of them that he could not do the commute forever. An offer from Professor Ernst Hugerbühler of the department of Chemistry at FHBB (the former university of applied sciences in Basel) came at just the right time. Uwe's scientific background and nearly 10 years of experience in industry meant he was an ideal candidate to set up a nanoscience group at the School of Life Sciences. As he had done with every new start in the past, Uwe approached this role with enthusiasm.

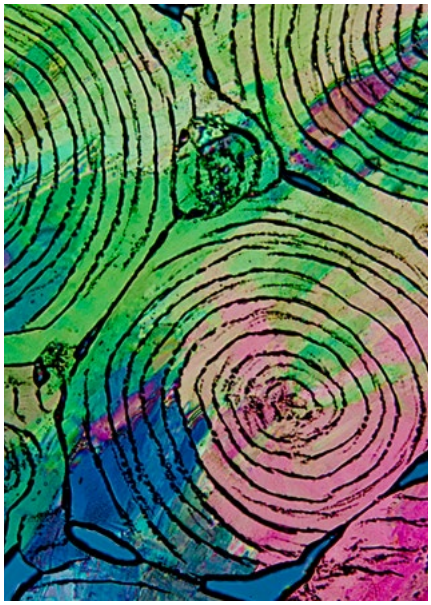
He values the freedom that he has in organizing his work. However, like all his colleagues at the School of Life Sciences, he has to finance his research via third-party funding. This means he has spent a lot of time writing applications since beginning his professorship in 2000. Uwe's ability to come up with the right ideas and sell them well is reflected in, among other things, the impressive list of Argovia projects that he has initiated. The range of subjects is remarkable, covering everything from cooling textiles and dirt-repellent coatings to catalysts for decomposing hydrogen peroxide vapor, tailor-made bone implants and treatment for dental caries. As a practitioner, Uwe finds this diversity fascinating. «I really value the fact that I can get involved with so many different topics here. Being able to expand my horizons all the time is incredibly motivating.» The SNI and the University of Basel are the main partners for his research projects, but ETH Zurich, PSI, CSEM and industrial companies also regularly participate in joint undertakings.

Working with students is stimulating

Uwe also feels enriched by his work as a doctoral supervisor, which allows him to participate in projects at the SNI graduate school. Since 2014, he and Professor Patrick Maletinsky have been supervising Marietta Batzer, a doctoral student working on NV centers in diamond. In addition to doing basic research, Batzer is also aiming to investigate whether the technology can be applied in (bio)sensors. Uwe draws a great deal of pleasure from working with students. His group also includes University of Basel students who are writing their Master's theses. Uwe likes to send his own students on placements to industrial companies so that they can acquire practical experience. This has resulted in successful collaborations with businesses based in the region. «Personal contacts are always very important,» says Uwe in response to a question about how new collaborations come about. «If we sit down together to discuss a Master's thesis, for instance, a narrowly defined topic can quickly develop into an idea for an Argovia project.» And as the past has shown, these projects often end up being continued as KTI projects. Uwe himself is about spend some time working very intensively on a single research topic. During a four-month sabbatical in Sweden, which begins this August, he will study how surfaces influence protein folding and therefore how Alzheimer's develops.

A keen photographer

When he is not working, Uwe keeps fit through jogging, squash and badminton, and loves visiting museums anywhere in the world. He is also a keen photographer. As you would expect from a nanoscientist, he particularly enjoys photographing small subjects. Unlike in his work, however, he does not look for applications, but rather simply allows himself to be caught up in the beauty of the world. His photographs have featured in the FHNW annual report for some years now, and have also been shown in exhibitions. Hopefully, Uwe will submit some of his pictures to the next Nanoimage Award so that the SNI community can discover this other side of him.



Uwe Pieles captures the beauty of the micro- and nanoworld - here of nicotinamide.

New Argovia projects

The last edition of «SNI update» presented three of the new Argovia projects for 2015. We will now look at what the «NCC Nanoprotect», «SurfFlow» and «Versalith» projects are investigating.

A layer of nanocrystals to protect buildings effectively

In the «NCC-Nanoprotect» Argovia project, a team of scientists led by Dr. Olfa Glaied is working on an effective method of protecting old buildings and monuments. With the aid of a protective layer of cellulose nanocrystals, which are embedded in a water-repellent polymer network, the researchers aim to protect limestone and marble constructions against the harmful effects of acid rain and air pollution.

Buildings damaged by air pollution

Many old buildings have already suffered extensive damage, particularly due to acid rain. The sulfuric acid released attacks calcareous stone, leading to quicker weathering. The growth of microorganisms boosts this degradation process further. Water plays a central role here. A water-repellent protective layer would therefore be ideal that would permanently reduce water contact, water adsorption and microorganisms on the surface while at the same time leaving the microstructure of the stone – and its color – unchanged. The research team led by Dr. Olfa Glaied, Professor Wolfgang Meier (Department of Chemistry, University of Basel), Professor Uwe Pieles (FHNW), Dr. Jörg Reiter and Dr. Giacomo Siragna (both from Walter Mäder AG) plans to develop protection of this kind.

The micro- and nanoscopic architecture on the surface of a lotus leaf minimizes the adhesion of water droplets.

The combination is key

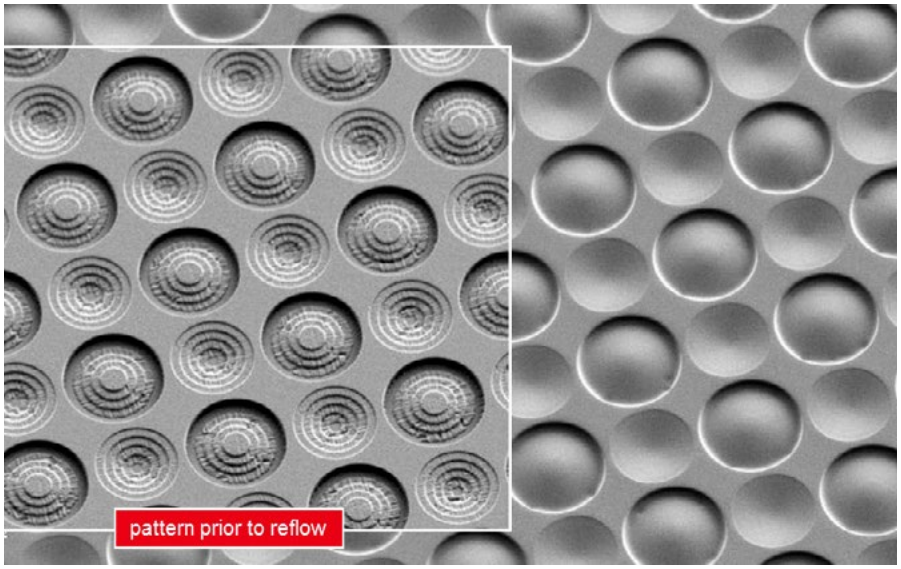
To do this, the researchers are using cellulose nanocrystals in a polymer network. The crystals give the protective layer a rough surface that allows water to run off and lends the stone a good degree of grip. The polymer network used as the basis for this also possesses water-repellent qualities and ensures that no cracks develop when the protective layer dries out. In this way, the researchers hope to provide old buildings with effective and long-lasting protection against decay.

As smooth as possible

While some Argovia projects aim for rough surfaces to achieve a lotus effect, the SurfFlow project is all about producing microlenses with very smooth surfaces that can be used for optical applications. Dr. Helmut Schift of the Paul Scherrer Institute (PSI) is leading the project team.

New methods are needed

Optical polymer microlenses are used in various devices, including in smartphones. Since they are so small, they have to be processed using novel 3D lithographic methods that build the lenses out of thin layers. However, these often result in roughness, which has adverse effects for optical applications. If a surface has to be subsequently smoothed out, it must be achieved using a method that only modifies the tiny surface and does not change the underlying layers or overall shape. The project team, led by Dr. Helmut Schift (PSI), Dr. Sonja Neuhaus (FHNW) and Mirco Altana (Heptagon Advanced Micro Optics), is studying suitable methods.



In a continuous furnace, the treated areas become smooth.

SNI Annual Event 2015

This year's annual event will be held on September 3 and 4 at Hotel Schweizerhof in Lenzerheide.

SNC 2016

The Swiss NanoConvention will return to Basel in 2016, so make sure you put the dates in your diary:

June 30 - July 1, 2016

Only the surface, not the shape

The researchers are using a method known as TASTE, which was developed at PSI. It involves selectively changing the material properties of the part of the sample that needs modification. For example, an electron beam can selectively reduce the glass transition temperature (the temperature at which the polymers change from a solid state to a viscous melt) in certain areas of the sample. If the sample is then placed in a continuous furnace and allowed to heat up slightly, the treated areas will reach transition temperature and become smooth, while the shape and the lower layers remain virtually unchanged. The scientists hope that this approach will allow them to find ways of making new 3D lithographic methods suitable for use in the production of optical lenses.

Higher resolution and different patterns

Researchers at the Paul Scherrer Institute (PSI), the University of Applied Sciences Northwestern Switzerland (FHNW) and Eulitha AG, a company based in Villingen, launched an Argovia project entitled Versalith at the start of 2015. Under the leadership of Professor Jens Gobrecht (PSI), the researchers are aiming to develop a new method that will advance Displacement Talbot UV lithography to the point where it can transfer patterns at much higher resolution than is currently possible.

Enormous progress

Recent years have seen enormous advances in lithographic methods. In particular, researchers involved in the production of semiconductor chips have developed complex processes and tools that make it possible to fit entire circuits into just a few nanometers of space. This has paved the way for producing chips that contain billions of circuits. Other applications, such as LEDs, require lower-cost production methods. However, they must still comply with specific requirements, particularly with regard to resolution.

To produce a semiconductor chip, the entire image of a photomask is scaled down and projected onto a light-sensitive photoresist. The much cheaper Displacement Talbot Lithography (DTL) method, however, uses interference effects to produce a «self-image» of the periodic structure on a photomask, which is then exposed in the photoresist. The image is created via the interference of multiple beams that are diffracted through the periodic pattern of the mask. Even using a relatively simple optical system, this can achieve a structure resolution of less than 200 nm in the photoresist (see www.eulitha.com). So far, this method has only been able to transfer simple, periodic structures. But now the Versalith researchers are investigating the production and use of complex masks that will further increase the resolution and create scope for making other patterns for which the team already have very specific applications in mind. In addition to project leader Professor Jens Gobrecht, Versalith also includes the groups led by Dr. Vitaliy Guzenk (PSI), Professor Per Magnus Kristiansen (FHNW) and Dr. Harun Solak (Eulitha AG).

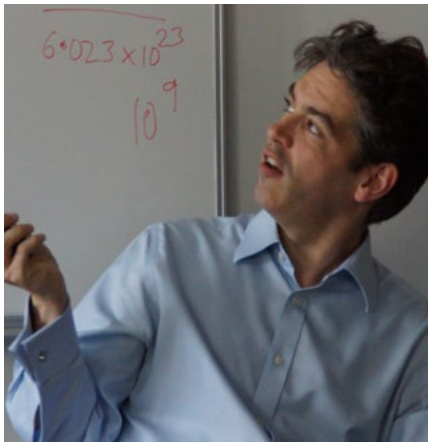
Events

Can chemical evolution produce new life forms?

The second SNI Lecture was held at the University of Basel on May 12. Professor Marcel Mayor hosted the lecture, which was given in the late afternoon by his guest, Professor Lee Cronin of the University of Glasgow. Before speaking in front of a mixed audience about his vision of producing complex chemical structures, Cronin spent nearly two hours chatting to 25 interested nanoscience students.

What is life, how did it start, and can we create new life forms in the lab? These are three of the many questions that Cronin and his team of nearly 60 researchers are trying to answer. His lab contains numerous 3D printers that he has modified and programmed to function as robots. They carry out the countless experiments that are necessary for investigating whether

inorganic molecules can undergo an evolutionary process that would lead to the emergence of life. For instance, just by mixing two reagents, Cronin has produced highly complex molecules whose formation and crystallization are, from a purely statistical perspective, extremely unlikely. Cronin does not attribute their creation to spontaneity and randomness, but rather to a process of chemical evolution. According to Cronin's theory, inorganic systems that are capable of evolving can be considered minimal life forms and, as objects of study, can provide insights into the origins of life.



Professor Lee Cronin spent nearly 2 hours with the nanostudents.

The art of a good speech: SNI PhD school holds rhetoric and presentation workshop

Early May saw some SNI doctoral students leave their laboratories and experiments far behind as they gathered in the meeting rooms at Mariastein Abbey to learn more about public speaking and presentation techniques.

Dr. Ralf Stutzki of the NCCR MSE and actor Sasha Manzotti had put together a varied program that gave all the participants plenty of space for implementing what they heard and learned during the workshop. The students analyzed speeches by various high-profile figures, gave their own talks, critiqued each other, and trained their voices.

How do I get my message across? Facial expression, gesticulation and lots of other different factors play a role.

Working in small groups, the students tested out the best ways of introducing their respective fields of research, and learned how challenging it can be to simplify highly complex topics for a lay audience. A particularly helpful aspect of the workshop was that the two coaches provided each student with recommendations and tips tailored specifically to his or her individual style.

Everyone in the group worked hard at the exercises and had a lot of fun along the way. They occasionally had to get out of their comfort zone – for instance, by reading out a recipe in a different language with such relish that it made the listeners' mouths water even though they couldn't understand a word. At the end of the two days, everyone had learned that empathizing with the topic, creating images in the mind and connecting with the audience are all key factors in giving a really good talk.

Nanosciences for schools

For many years now, the SNI has been participating in TecDays, an initiative of the Swiss Academy of Engineering Sciences (SATW) that aims to encourage school students to study science and technology. During a TecDay, students attend interactive modules of their choosing. The SNI's new outreach manager, Dr. Kerstin Beyer-Hans, attended her first TecDay in Trogen and will be implementing new ideas at the next TecDays held in the region.

Kerstin also organized SNI visits for school groups in June. To adapt the visit to each group's area of focus, she worked with SNI students and doctoral candidates to plan laboratory visits and short presentations that gave insights into the latest SNI research. The informative afternoons ended with a casual aperitif that gave the school groups the opportunity to find out more about research at the SNI and nanoscience programs at the University of Basel.

During the TecDays and during their visits to the SNI, students discussed diverse topics.

Press releases and uni news from SNI members

University of Basel, June 3, 2015: How Natural Channel Proteins Move in Artificial Membranes
Natural channel proteins are integrated into artificial membranes to facilitate the transport of ions and molecules. Researchers at the University of Basel have now measured the movement of these channel proteins for the first time. They move up to ten times slower than in their natural environment, namely the cell membrane. Reporting in the academic journal Nano Letters, the researchers say the results will help with the ongoing development of new applications such as nanoreactors and artificial organelles.

University of Basel, May 22, 2015: Basel Physicists Develop Efficient Method of Signal Transmission from Nanocomponents
Physicists have developed an innovative method that could enable the efficient use of nanocomponents in electronic circuits. To achieve this, they developed a layout in which a nanocomponent is connected to two electrical conductors that decouple the electrical signal in a highly efficient manner. The scientists at the Department of Physics and the Swiss Nanoscience Institute at the University of Basel, and their colleagues from ETH Zurich, have published their results in the scientific journal Nature Communications.

INASCON 2015

INASCON (International NAnoscience Student CONference) - an annual conference organized by students for students - takes place in Basel between 11 and 14 August 2015. The SNI is one of the main sponsors of the event.

More information at:

http://inascon.eu

Are you interested in nano events?

i.net organizes events covering different topics in nanotechnology.

www.i-net.ch/nano/events/

Uni-Nacht 2015

The University of Basel celebrates its 555 anniversary and organizes a long night of science, the Uni-Nacht, on September 18. The SNI actively particiaptes in the diverse program.

More at:
www.unibas.ch/de/Aktuell/Uni-Nacht-2015.html

University of Basel, May 11, 2015: First Theoretical Proof: Measurement of a Single Nuclear Spin in Biological Samples

Physicists from the University of Basel and the Swiss Nanoscience Institute have shown for the first time that the nuclear spins of single molecules can be detected with the help of magnetic particles at room temperature. In Nature Nanotechnology, the researchers describe a novel experimental setup with which the tiny – previously unmeasurable – magnetic fields of the nuclear spins of single biomolecules could be registered for the first time. The researchers say the concept will significantly improve medical diagnostics as well as analyses of biological and chemical samples.

Full press releases are available here:
www.nccr-nano.org/nccr/media/recent_press_releases

Selected reports are available here:
www.nanoscience.ch/nccr/media/in_the_media/2015

Please provide feedback

Please share with us your ideas, news, success stories and feedback so that we can include it in SNI update.

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