University of Basel

Swiss Nanoscience Institute

SNI SWISS NANOSCIENCE INSTITUTE

EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

SNI INSight

Showcasing research and activities of the Swiss Nanoscience Institute

September 2019

ELDICO Scientific
Roots in the Nano Argovia program

Excellent thesis
Prize for best master's thesis goes to Sebastian Scherb

Engaged and professional
High-school students win the "Jugend forscht" federal prize

ANAXAM
Bridges between cutting-edge research and industry

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Editorial

Dear colleagues and nanoscience enthusiasts,

I hope you had a relaxed and enjoyable summer and a good start to the new academic year.

Here at the University of Basel we are looking forward to meeting the new students starting in mid-September. This year, we have 24 registrations for the nanosciences degree program. As I will once again be teaching Physics I alongside Andreas Baumgartner, I will have the opportunity to meet the new students right away, and see that they find their feet and adjust to the routines of university life.

During the holidays, members of the SNI and the Department of Physics were treated to an impressive display of the scientific and research accomplishments that some university entrants already have under their belts. High school students Alex Korocencev and Felix Sewing presented their magnetically levitated (maglev) train, for which they were awarded the "Jugend forscht" (Young Researchers) prize in the Technology category. I was deeply impressed by the result, as well as the professionalism and perseverance of the two young researchers, one of whom is about to begin his physics degree here at the University of Basel. You can find out more about the project in this issue of SNI INSight and by watching the short video featuring Alex and Felix.

Another highlight of this issue is our report on the outstanding master's thesis of a former student of the nanoscience program: Sebastian Scherb's work on a novel method for the deposition of individual complex molecules on surfaces has been distinguished with this year's prize for best master's thesis.

We also present three more Nano Argovia projects running in 2019. Each year, the Nano Argovia program makes an important contribution to technology transfer between universities and local industry. Sometimes it takes a while for the Nano Argovia projects to bear fruit, but in this issue of SNI INSight we present not one but two success stories with roots in the Nano Argovia program: early this year, we saw the formation of the company ELDICO Scientific, which plans to bring an electron diffractometer to market. A crucial role in the emergence of ELDICO Scientific was played by the Nano Argovia project A3EDPI.

Meanwhile, the project Atolys has given rise to a high-caliber publication in the Journal *Applied Physics Letters*. For this project, teams led by Thomas Jung and Stefan Gödecker joined forces with the company ABB to study high-performance semiconductor materials made from silicon carbide (SiC). Silicon carbide potentially offers numerous key advantages compared to silicon, and would significantly enhance the energy efficiency of devices using it, but there are several hurdles that have yet to be overcome, as the team showed.

Another initiative devoted to technology transfer is ANAXAM – the Aargau Technology Transfer Center for Advanced Manufacturing – in which the SNI is involved. In early summer, the association supporting ANAXAM was established, with an information event for the representatives of companies to find out more about the project.

I hope you enjoy reading this issue of SNI INSight, and look forward to seeing many of you at our Annual Meeting in Lenzerheide.

Kind regards,

Christian Schönenberger

Prof. Dr. Christian Schönenberger, SNI director

With a wealth of enthusiasm and expertise

Scientists from the SNI network found "ELDICO Scientific"

In June 2019, four experienced entrepreneurs Dr. Gustavo Santiso-Quinones, Dr. Gunther Steinfeld, Dr. Eric Hovestreydt and Nils Gebhardt founded the company "ELDICO Scientific" with a view to commercializing an instrument that measures electron diffraction. This electron diffractometer can be used to determine the 3D structure of nanoscale materials whose tiny dimensions or properties meant that, until now, they were either impossible or very difficult to analyze. The foundations for establishing ELDICO Scientific were partly laid by the Nano Argovia project A3EDPI.

The four founders of "ELDICO Scientific", Dr. Gunther Steinfeld, Nils Gebhardt, Dr. Gustavo Santiso-Quinones, and Dr. Eric Hovestreydt (left to right), will commercialize an electron diffractometer for the analysis of nanoscale materials.

> "Not only have we had inquiries about electron diffractometers from all over the world, but Science also nominated the method as one of the 'Breakthroughs of the Year 2018,' and it's become clear to us that the use of electron-beam diffraction will transform the field of crystallography."

Dr. Gustavo Santiso-Quinones (Founder and CEO) and Dr. Gunther Steinfeld (Founder and CTO)

Three-dimensional structures are needed

For numerous applications, it is vital to know the precise 3D structure of a chemical compound. For example, the development and authorization of active pharmaceutical ingredients relies on a detailed understanding of the drug's exact spatial configuration. If the substances are present in the form of single, large crystals, they can be analyzed in fine detail using X-ray structural analysis. Often, however, the compounds in question are only available as powders. And crystallization is complex, time-consuming or simply impossible.

In the Nano Argovia project A3EDPI, the project team led by Dr. Tim Grüne (then at PSI, now at the University of Vienna) succeeded in demonstrating that the diffraction patterns of electron beams are ideally suited to determining the 3D structure of tiny organic nanocrystals in powder form. Given the small crystal size, X-rays or synchrotron radiation would not have produced satisfactory results with these materials.

A novel combination of existing equipment

For these measurements, the team combined existing commercially available devices and established methods to create a technique that is not only ingenious but also refreshingly simple. Specifically, they used the beam from an electron microscope in conjunction with the best detector that today is used for X ray diffraction in the synchrotron and software designed for X-ray structural analysis. In October 2018, Tim Grüne and his colleagues published the results of their successful analyses in the journal *Angewandte Chemie*, and so began the budding story of ELDICO Scientific!

Dr. Gustavo Santiso-Quinones and Dr. Gunther Steinfeld of Crystallise! AG were industry partners in the project and co-authored the publication. They were taken aback by the massive response to the paper: "It was through a blog on Science that we first realized the scale of interest worldwide in using electron diffraction for crystallography applications," the two scientists recall. "Not only have we had inquiries about electron diffractometers from all over the world, but *Science* also nominated the method as one of the "Breakthroughs of the Year 2018", and it's become clear to us that the use of electron-beam diffraction will transform the field of crystallography."

A well-coordinated team

The two chemists and crystallographers met while working as postdocs in

Scientific papers and comments that describe the application of electron diffraction for crystallography had their roots in the Nano Argovia project A3EDPI:

Angewandte Chemie
https://onlinelibrary.wiley.com/doi/full/10.1002/anie.201811318

Science
https://science.sciencemag.org/content/362/6413/389.summary

Nature
https://www.nature.com/articles/d41586-018-07213-3

Acta Crystallographica
https://journals.iucr.org/d/issues/2019/05/00/ic5107/

Nature Communications
https://www.nature.com/articles/s41467-019-11326-2

Freiburg im Breisgau in 2006. Five years ago, they plucked up the courage to go it alone and founded Crystallise! AG. Today, they handle the crystallization and X-ray analysis of a range of materials for global pharmaceutical and chemical companies. As a result, they are well aware of how expensive and time-consuming it can be to obtain crystals of sufficient size and quality for 3D structural analysis using X-rays.

Perfectly tailored to electron diffraction

“After these initial results and the positive feedback we received, we realized that we needed to take a more intensive and proactive approach to the topic of electron diffraction,” say Gustavo Santiso-Quinones and Gunther Steinfeld. With this in mind, they came up with the idea of founding a second company to develop and commercialize an electron diffractometer for crystallographic applications.

The plan was to create a device specialized in crystallographic measurements rather than simply combining commercially available components – as was the case in the Nano Argovia project. This allows them to dispense with some of the complex and expensive components of an electron microscope, which are important for high-resolution imaging but less so when it comes to recording an electron diffraction pattern. On the other hand, the diffraction mode of an electron microscope needs to be optimized for use in crystallography. For example, in order to maximize the accuracy of the results, it’s important to have a device that can be used to rotate the sample during the measurement process without moving it out of the electron beam. “In the past, it sometimes took a team of scientists several months to determine the three-dimensional structure of an unknown substance. With our device, an operator will have a reliable result in their hands within a few hours,” say the company’s founders.

Pooled expertise

Gustavo Santiso-Quinones (CEO) and Gunther Steinfeld (CTO) decided to bring Nils Gebhardt and Dr. Eric Hovestreydt on board as co-founders. A few years earlier, Nils Gebhardt helped launch and develop Park Innovaare in the role of managing director. In the process, he also supported the establishment of Crystallise! at Park Innovaare, and so he was already well acquainted with the duo behind Crystallise! AG. With his marketing and business background, Gebhardt is now CFO at ELDICO Scientific and as such is responsible for commercial aspects of the project.

With Eric Hovestreydt in the role of CSO, the team also has an additional crystallographer within its ranks. Hovestreydt has over 30 years’ experience in senior positions at Siemens and Bruker and has etched out a name for himself as an expert in X-ray equipment. “When I heard that Eric was leaving Bruker, I called him straight away to tell him about our plans,” says Gustavo Santiso-Quinones. Eric Hovestreydt was intrigued by the idea: “By elegantly combining two established techniques, it represents a radical simplification with amazing potential.”

Rapid progress

Once the founding team was assembled, everything happened in quick succession: the required patents were applied for, the business plan was written, discussions were held with potential users and customers, and all necessary preparations were made for founding the company. Since June 2019, ELDICO has been a registered joint stock company headquartered at Park Innovaare in Villigen.

As well as their sizable network of potential customers from the worlds of research and business, the four founders bring together the necessary expertise not only to put the science and technology to practical use but also to market the resulting product. In order to actually build the device, they have teamed up with the company AXILON (Cologne, Germany). They presented a model of the electron diffractometer at the European Crystallographic Meeting in Vienna this August, and by mid-2020 the first beta testers will be able to put the new devices through their paces at their own laboratories.

“By elegantly combining two established techniques, it represents a radical simplification with amazing potential.”

Dr. Eric Hovestreydt, Founder and CSO

Huge commercial potential

"We've received inquiries from about 30 potential customers so far," says Nils Gebhardt. For now, the interest has primarily come from international research groups and customers in the pharmaceutical industry. "Particularly for pharmaceutical companies, using electron diffraction for structural elucidation would save huge amounts of time and money," he adds.

Looking to the future, the founders of ELDICO also have other applications in mind for the technology. For example, they are confident that electron diffraction could be used for the quick and cost-effective detection of forgeries. It would also allow relatively easy analysis of nanomaterials such as metal-organic framework structures.

Enthusiastic chemists

When the paper on determining structures by electron diffraction was published last year, *Nature* responded with an article entitled "Why didn't we think to do this earlier? Chemists thrilled by speedy atomic structures."

The founders of ELDICO Scientific are also enthusiastic about the technology and see huge potential for developing and commercializing an electron diffractometer for use in crystallography. The SNI will continue to follow the device's development eagerly and looks forward to accompanying the team on this exciting journey!

"Particularly for pharmaceutical companies, using electron diffraction for structural elucidation would save huge amounts of time and money."

Nils Gebhardt, Founder and CFO

More information:

ELDICO Scientific
https://www.eldico-scientific.com

Complex molecules on surfaces

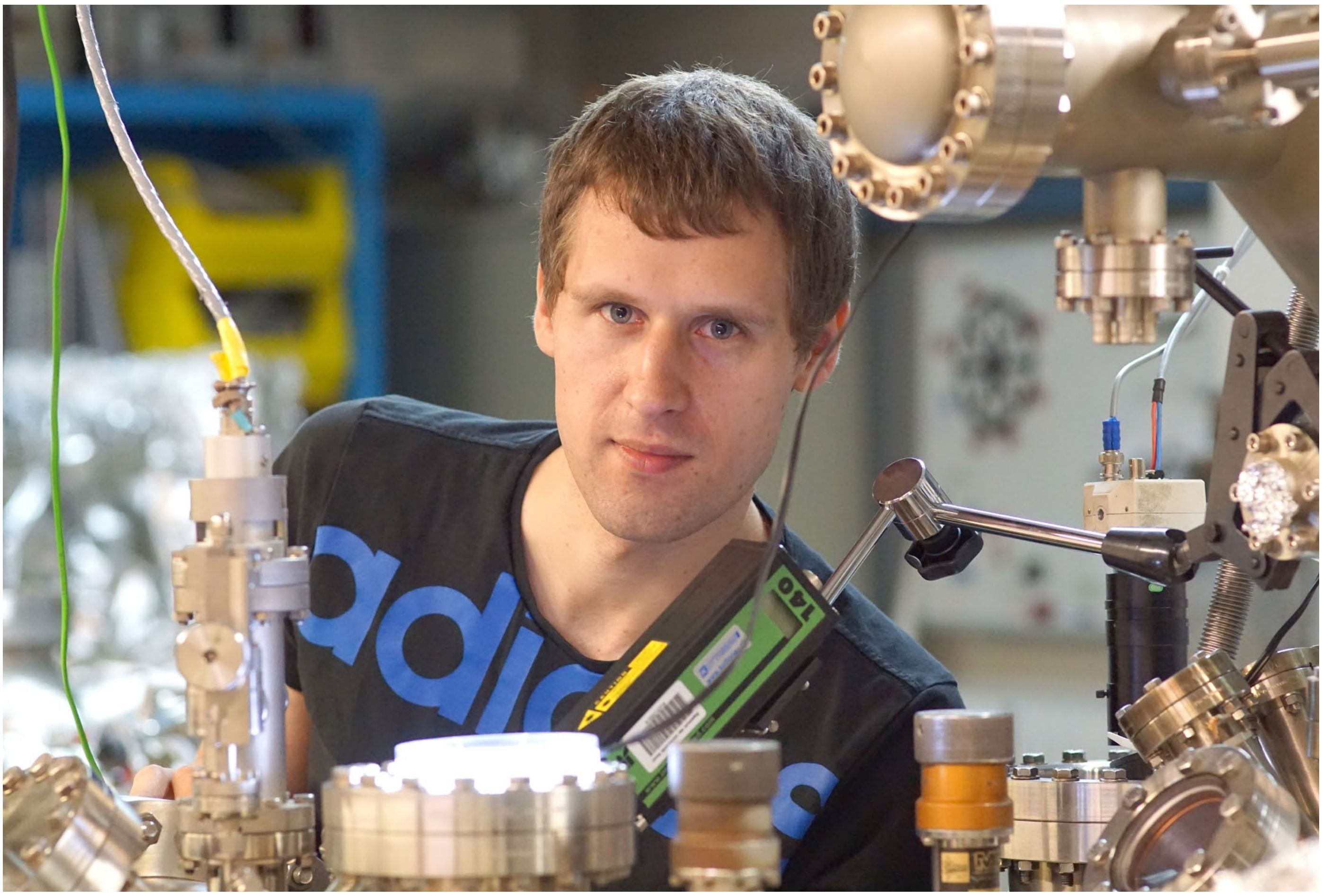
Sebastian Scherb receives the prize for the best master’s thesis in nanosciences

At the first master’s degree ceremony for nanosciences this fall, Sebastian Scherb will be awarded the prize for the best master’s thesis of 2018. As part of the team led by Professor Ernst Meyer, he investigated a new method for the surface deposition of individual complex molecules.

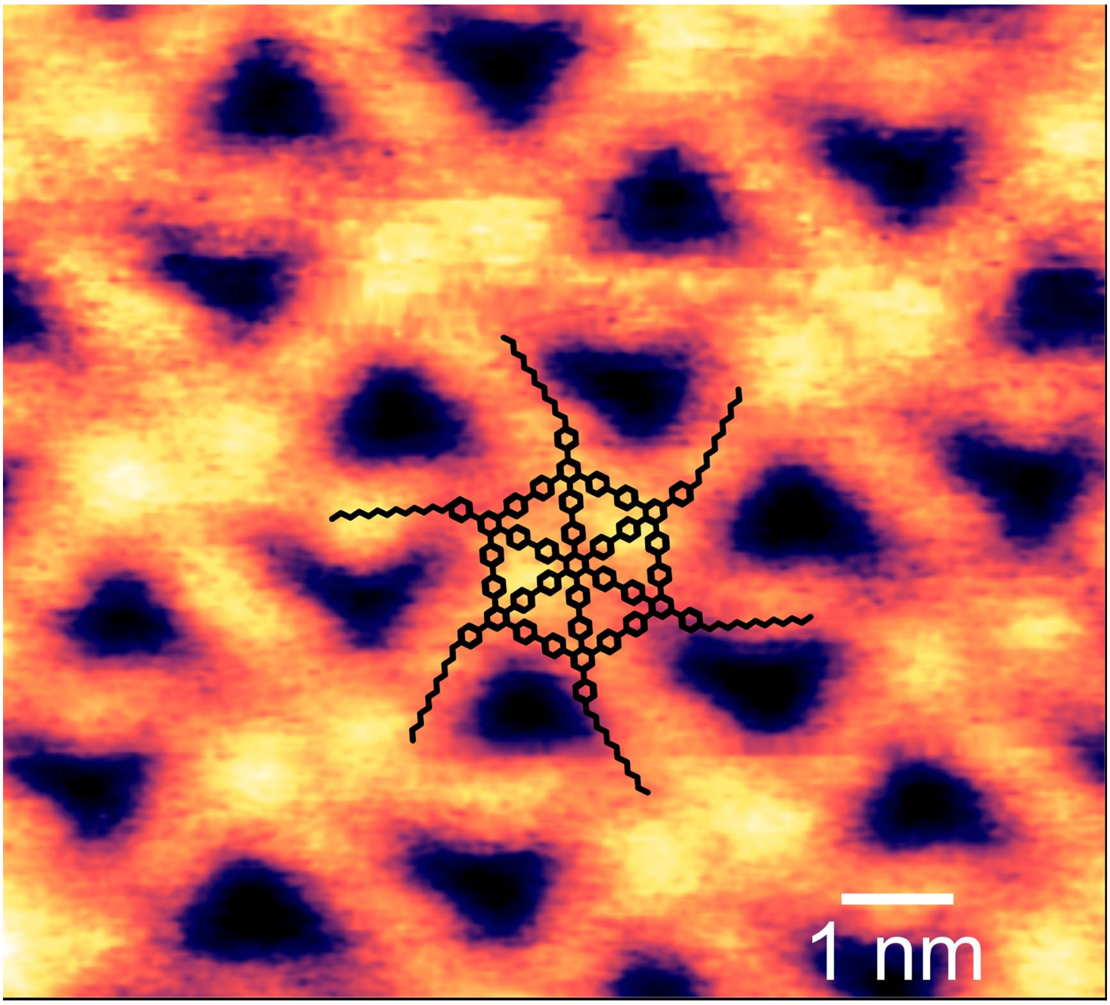
Seeking a method for large molecules

The self-assembly of molecules on surfaces can be used to create atomically precise functional surfaces with applications in many different fields, such as electronics. For smaller molecules, thermal evaporation is an established method of creating atomic coatings on surfaces such as gold or potassium bromide, but large, complex molecules generally do not survive being heated to boiling point, which is a key part of the process.

Now, in his prizewinning master’s thesis, Sebastian Scherb has investigated whether electrospray deposition can be used as an alternative. In this method, the molecules are converted from the liquid to gas state using a charge-transfer process. Then, in an ultrahigh vacuum, a differential pumping system sprays the individual molecules onto the surface, where they self-assemble into molecular layers.



Sebastian Scherb investigated a new method for the surface deposition of individual complex molecules and will be awarded the prize for the best master’s thesis in nanosciences. He has started his PhD project at the Department of Physics at the University of Basel.



Sebastian Scherb imaged graphylene-1 molecules on a gold surface (Image: Sebastian Scherb, Department of Physics, University of Basel)

A focus on graphene-like compounds
The focus here was on two graphene-like compounds that promise a wide range of applications thanks to their special electronic properties. The first, graphylene-1, is a hexagonal molecule with outer alkane chains that resembles a wagon wheel. Into this wheel, it is then possible to incorporate functional groups that give the molecule a specific set of properties. For the other compound, Sebastian studied graphene ribbons with lengths of up to 600 nanometers (graphene nanoribbons).

"It was hugely exciting for me to investigate how these complex molecules behave on different surfaces," he says when asked about which part of the work fascinated him the most. Sebastian not only studied graphylene-1 molecules at room temperature on gold and potassium bromide surfaces using a non-contact atomic force microscope, but also prepared them for atomic force and scanning tunneling microscope studies at low temperatures (5 Kelvin).

Unexpected results
When the images were compared, they revealed an interesting and unexpected side effect: at low temperatures, the individual graphylene molecules were much closer together than at room temperature. Simulations performed after the master's thesis suggest that the molecules are forced apart at higher temperatures due to increased mobility of their side chains. The extremely weak van der Waals forces responsible for holding the molecular layer together permit these different variations depending on the temperature.

Professor Ernst Meyer, who leads the group in which Sebastian completed his thesis, was very impressed with the results: "Using the electrospray method,

News from the group of Prof. Ernst Meyer, where Sebastian completed his master's thesis and now works on his PhD thesis.

Website of Ernst Meyer's group – Nanolino

https://nanolino.unibas.ch

Sebastian succeeded in preparing large molecules shaped like a wagon wheel under ultrahigh vacuum conditions. He was then able to image these molecules using high-resolution atomic force microscopy – and, interestingly, he discovered that the materials have an exceptionally high coefficient of thermal expansion."

Sebastian found this work so exciting that he stayed on in Ernst Meyer's team after finishing his master's and will now complete his doctoral dissertation there, too. "I really enjoyed taking these measurements. Besides, the group works together very effectively and has a really great atmosphere," he says in the interview.

Originally interested in chemistry

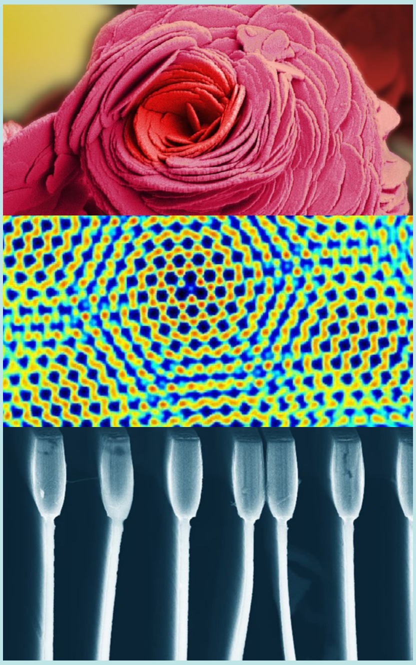
Seven years ago, when Sebastian attended an information day at the University of Basel shortly before completing his high school diploma, he couldn't have imagined that he'd now be spending many of his working days in the basement of the Department of Physics, enthusiastically analyzing molecules deposited on surfaces. "I had actually wanted to study chemistry," he recalls. "But when I attended the information day, I enjoyed the introduction to the nanosciences degree so much that I chose to do that instead."

Sebastian never looked back, but he also went through some difficult times during his studies. As a pupil at a secondary school that teaches classical languages in Lörrach, he dropped biology at an early stage and therefore had some catching up to do at university. "Sometimes you just have to get through these things. But it was worth it in the end, because my degree provided me with insights into so many different areas, and I can now apply that knowledge in my work."

During the block courses in particular, Sebastian familiarized himself with several different subject areas and working groups within the SNI network. He was especially interested in cold atoms and work involving the AFM – and these were also the topics of his two undergraduate projects. However, the practical applications of the AFM ultimately proved more fascinating to him than cold atoms, setting the stage for this excellent master's thesis.

We would like to congratulate him on receiving this prize – and we look forward to more amazing images of complex molecules deposited on surfaces.

Nano Image Award



Each fall, the SNI seeks to collect – and award prizes for – the best images from the nano world, and this year is no exception.

Please send your photos of nano and micro structures, stating the title, description and scale, by **31 October 2019** to c.moeller@unibas.ch.

The SNI management team will choose the three best photos, which will each be awarded CHF 300.

The beautifil images that we collect each year are a precious source for the illustration of communication materials. We look forward to receiving your images and will announce the winners of this year's Nano Image Award in SNI INSight, our webpage, and on our social media channels.

“Jugend forscht” federal prize for young researchers
An outstanding scientific achievement for two high-school students with support from the SNI

Felix Sewing and Alex Korocencev have been awarded the 2019 “Jugend forscht” federal prize in the area of technology. Over the last year, the two young researchers have received support from the SNI and the Department of Physics. Everyone involved had a chance to join the two prizewinners in raising a toast to this amazing achievement at a reception in late July, where they also enjoyed a demonstration and explanation of the concept behind the magnetically levitated (maglev) train.

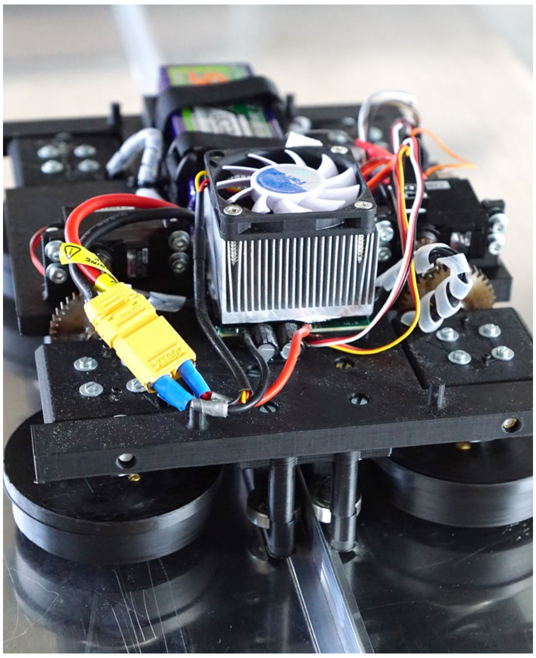
An interest that began in school

Felix Sewing and Alex Korocencev’s passion for technology and physics began back in 10th grade, when they were tasked with building a mechanical hand at their high school in Waldshut, Germany. The teacher supervising the project was so impressed with the results that he wished he had submitted it to the “Jugend forscht” competition for young researchers.

“That gave us the idea of planning a project for Jugend forscht,” says Felix in our interview. “We were inspired by Elon Musk’s Hyperloop project and came up with the idea of developing a model of a maglev train. Specifically, we wanted to develop and build a prototype that didn’t require elaborate construction work for the tracks,” Alex explains.

SNI becomes a project sponsor

Then, just over a year ago, Alex attended a tour of Professor Christian Schönenberger’s laboratory at the SNI. He found the subject matter discussed there in relation to quantum phenomena fascinating, but above all he wanted to know whether Christian Schönenberger was



Alex Korocencev and Felix Sewing have been awarded the 2019 “Jugend forscht” federal prize in the area of technology for the development of an magnetically levitated train.

You can learn more about Alex and Felix’s project in a short video.

YouTube Video (in German)
https://www.youtube.com/watch?v=1c-tiSQbDGI

able and willing to provide support for the maglev train project. A meeting was arranged so that Alex and Felix could explain their plans before drafting a project application. They won over Christian Schönenberger with their enthusiasm and were promised financial and technical assistance.

At first glance, the planned concept sounds simple. Rotating permanent magnets on the bottom of the maglev train allow it to hover above an underlying metallic surface. In this surface, the rotating magnetic field induces a current that generates an opposing magnetic field. Repulsion between the two fields causes the train to levitate, and the magnets can be tilted in order to propel the vehicle. Unlike existing maglev trains, this model does not require coils in the tracks below in order to hover, and instead simply uses a non-magnetic metallic surface.

Success thanks to careful observations
The project didn't get off to an entirely smooth start, however, despite support from Christian Schönenberger, the technology group, and the electronic and mechanical workshops of the Department of Physics. For example, there were some minor – and some not so minor – mishaps due to the magnets' tendency to become loose as they rotated, making the train highly unstable. But Alex and Felix didn't let that put them off and ultimately achieved a breakthrough by making careful observations. They realized that the circle of magnets, which were each rotated 90 degrees from the next, "didn't want" to lie horizontally in a plane. Every second magnet was always shifted slightly upwards. "We were puzzled at first, but when we decided to adopt this stable arrangement and put it to the test, it turned out to work much better," they explain.

Still, the two young researchers weren't content with simply building the prototype of a stable maglev train. Alex in particular was fascinated with the idea of simulating and modeling the planned experiments in advance. To this end, the Department of Physics gave him access to simulation software as well as computer time at the Department. "The simulations that Alex ran independently are really quite sophisticated," says Christian Schönenberger, who found himself increasingly impressed with the researchers' persistence, enthusiasm, and professionalism over the course of the project.

In July, staff of the SNI and Departement of Physics could raise a toast to this amazing achievement and discuss with Alex and Felix their concept behind the magnetically levitated train.

> "You embarked upon a complicated journey of discovery, driven by your thirst to overcome hurdles and get to grips with technical and scientific problems. With a healthy dose of passion and enthusiasm, you were able to tackle a series of obstacles and ultimately break new ground."

Prof. Christian Schönenberger congratulates the prize winners.

Culminating in a national victory

The jurors at "Jugend forscht" clearly had the same impression. In June 2019, the winners of the year's regional competitions gathered in Chemnitz to battle it out for the national prize. At a glamorous ceremony opened by German President Frank-Walter Steinmeier and slightly reminiscent of an Oscars' awards ceremony, their long journey culminated in a dream come true: Alex and Felix won first prize in the technology category – and, with it, a research prize from the German Research Foundation!

But this success story is anything but over. The two 18-year-olds – who, incidentally, have also completed their high school diplomas this year – have filed a patent application for their new magnet arrangement. And, in September, they will attend the European Union Contest for Young Scientists in Sofia, where they hope to outstrip the competition once again.

However, before the young researchers from Waldshut return to their technical and scientific work on the maglev train, they've had a few opportunities to celebrate this outstanding achievement – including at an event hosted by the SNI in Basel in late July. "You embarked upon a complicated journey of discovery, driven by your thirst to overcome hurdles and get to grips with technical and scientific problems. With a healthy dose of passion and enthusiasm, you were able to tackle a series of obstacles and ultimately break new ground," said Christian Schönenberger as he congratulated Alex and Felix on successfully reaching this milestone in the project.

We'll be able to witness the next chapter in this story first-hand, as Alex will be studying physics in Basel from this September. And, who knows, perhaps Felix will also feel the urge to return to the University of Basel after training as an IT specialist. In any event, we hope Alex and Felix enjoy their ongoing research endeavors – and we wish them every success!

Save the date!

The SNI will be hosting the Swiss NanoConvention again next year.

The SNC 2020 will be held on 2 and 3 July, 2020 in Basel. Make a note in your calendar!

Find out more about the Swiss NanoConvention at:
http://swissnanoconvention.ch/2019/

Nano Argovia projects
Regional technology transfer

Six new Nano Argovia projects were approved for 2019. We introduced three of these applied research projects, in which representatives of two research institutes team up with a company in Northwestern Switzerland, in the last issue of SNI INSight. Learn more about the other three projects here.

Call for proposals for the Nano Argovia program

The deadline for proposals for applied research projects under the SNI's Nano Argovia program is **30 September 2019**.

Each Nano Argovia project pairs at least two academic partners from the SNI network with an industrial company in Northwestern Switzerland.

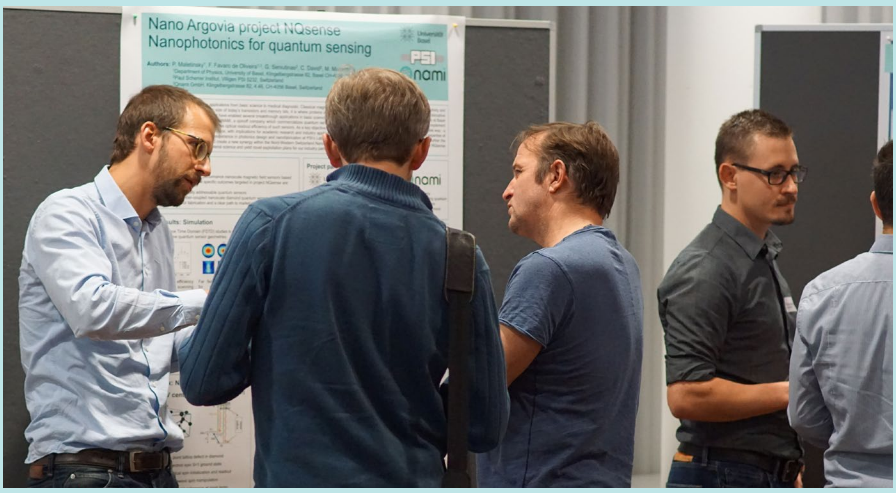
In view of our collaboration with ANAXAM (www.anaxam.ch), teams using the latest manufacturing and analysis technologies are especially encouraged to submit a proposal.

Find out more at www.nanoargovia.swiss.

Join us at the Nano-Tech Apéro

The Nano-Tech Apéro, hosted by Dectris in Dättwil on 29 October, will be an ideal opportunity to learn about the applied research projects of the SNI and the Nano Argovia program.

The event program and registration link can be found at: https://nanoscience.ch/de/ueber-uns/veranstaltungen/



Two effects with a single product

In the Nano Argovia project PERIONANO, researchers are combating inflammation around dental implants and supporting tissue regeneration

In the Nano Argovia project PERIONANO, scientists from the FHNW School of Life Sciences and the Hightech Research Center of Cranio-Maxillofacial Surgery (University of Basel) are working with industry partner credentis AG (Windisch, Aargau) to investigate a new approach for the treatment of inflammation around dental implants (peri-implantitis). The scientists are developing an easy-to-use system based on a peptide hydrogel with embedded particles that successively release antimicrobial active substances and also promote regeneration.

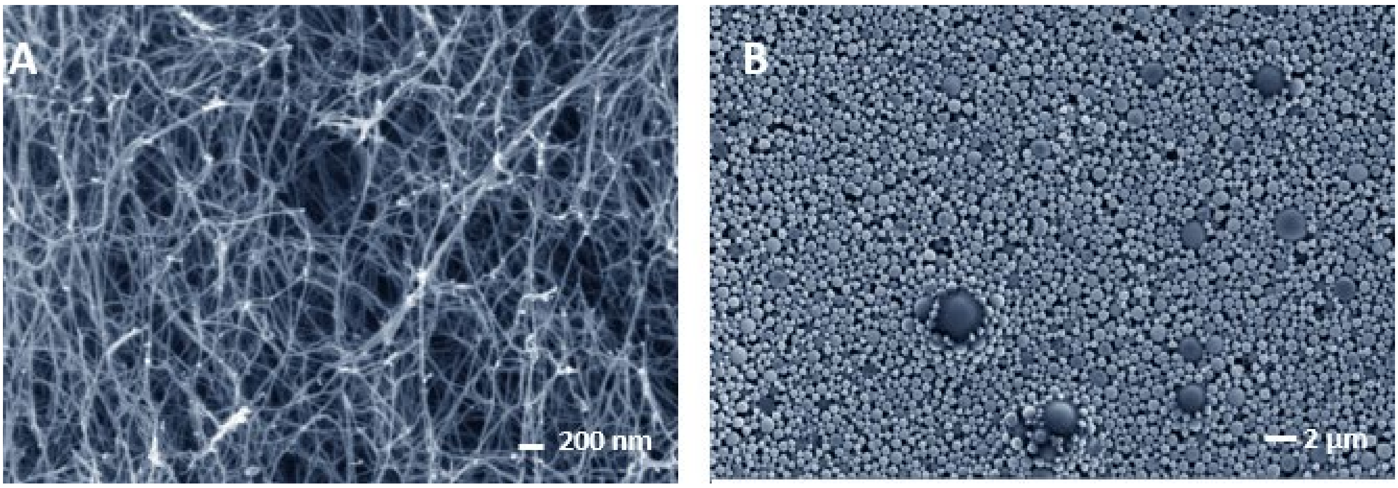
In many cases, dental implants are accompanied by inflammation due to bacterial colonization, resulting in the degradation of surrounding soft tissue and bone (peri-implantitis) and potentially leading to the loss of the implant. Peri-implantitis is usually treated using local or systemic antibiotics, but there is currently no treatment that acts against the bacteria while simultaneously encouraging regeneration of the damaged tissue.

A peptide scaffold

That is precisely the approach adopted by the team working under project leader Franziska Koch from the School of Life Sciences at the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). The scientists begin by using peptides that can form a fibrous network (Figure 1A). Into this network, they then incorporate a variety of particles (Figure 1B) that can release active substances little by little. With this technique, the researchers hope to achieve the localized release of various active substances, which would then combat different pathogenic species of bacteria in their vicinity. The fibrous scaffold of peptides is also intended to promote the regeneration of damaged soft and bony tissue.

Interdisciplinary collaboration

With an interdisciplinary team consisting of Franziska Koch, Professors Uwe Pieles and Oliver Germershaus (both from FHNW), PD Dr. Stefan Stübinger (Hightech Research Center of Cranio-Maxillofacial



Scanning electron micrograph of the fibrous peptide network (A) and microparticles (B). (Images: FHNW School of Life Sciences, Institute for Chemistry and Bioanalytics)

Surgery, University of Basel) and Michael Hug (credentis AG), the Nano Argovia project brings together partners with very different areas of expertise. Together, they are able to analyze the peptide-particle matrix with regard to active substance release, antimicrobial activity and regenerative potential translating it into a marketable product.

"By participating in the Nano Argovia project PERIONANO, we're significantly extending our Curolox® Technology. This approach supports our efforts not only to keep teeth healthy but also to take care of implants by successfully treating the inflammation around the implants and by promoting regeneration."

Michael Hug, CTO at credentis AG

More Information about the project partners.

FHNW School of Life Sciences
https://www.fhnw.ch/de/die-fhnw/hochschulen/lifesciences

Hightech Research Center HFZ
https://dbe.unibas.ch/en/research/laser-and-robotics/hightech-research-center-hfz/

credentis AG
https://www.credentis.com

Using nanoparticles to defeat cancer
In the Nano Argovia project NCT Nano, researchers are exploring a new immunotherapy approach to cancer treatment

In the Nano Argovia project NCT Nano, three interdisciplinary teams are collaborating to characterize a novel, targeted immuno-oncology approach. Scientists from TargImmune Therapeutics (Basel), the Department of Chemistry at the University of Basel, and the Department of Biosystems Science and Engineering at ETH Zurich in Basel (D-BSSE) are studying nanoparticles that smuggle a specific cargo into cancer cells. This cargo concurrently triggers targeted cancer cell killing and an anti-tumor immune response, destroying the tumors. In the Nano Argovia project NCT Nano, the researchers are identifying key parameters that are necessary to support the development of TargImmune's novel therapeutic for the clinic.

More Information about the project partners.

Department of Chemistry, University of Basel
https://chemie.unibas.ch/de/home/

D-BSSE, ETHZ in Basel
https://bsse.ethz.ch

TargImmune Therapeutics
https://www.targimmune.com

Significant advances have been made in the field of cancer therapy in the past few years. However, cancer remains a major contributor to morbidity and mortality worldwide. Numerous treatment modalities have been developed and approved for the treatment of solid tumors including small molecules, antibodies and cell-based therapies. However, due to tumor heterogeneity as well as suppression of and escape from anti-tumor immune response, resistance to treatments continuously emerges.

More recently, immune-modulatory antibodies have shown significant efficacy in several indications. Nonetheless, only a subset of the patient population is responsive, therefore leaving the majority of patients without an effective treatment.

TargImmune Therapeutics is developing a novel platform technology based on the research from the Hebrew University of Jerusalem. The technology utilizes chemical vectors that selectively enter cancer cells and smuggle in a specific cargo, bringing about cell death and simultaneously triggering an immune response against the tumor.

Safe transport
The cargo is packed with a chemical vector, forming nanoparticles. These nanoparticles should be stable and allow safe delivery of the cargo in patients, while ensuring that the cargo is not broken down by enzymes and reaches the targeted cancer cells without affecting healthy non-cancerous cells. The factors that affect nanoparticle stability and contribute to the efficacy of the treatment are being studied and optimized at the laboratory of Professor Cornelia Palivan from the Department of Chemistry at the University of Basel.

Various parameters must be identified
TargImmune's technology has proven highly effective in several mouse models. However, before the drugs can be used in human clinical trials, it is necessary to identify the optimal conditions for drug formulation. To do so, the Palivan group will test a range of key parameters relating to the nanoparticle's stability, including physico-chemical properties, reproducibility and quality control. The Palivan group will also contribute to the understanding of how the particles bind and smuggle the cargo into the targeted cells, using various microscopy techniques.

The group led by Professor Yaakov (Kobi) Benenson from the D-BSSE will use next generation sequencing to investigate the activity of the novel nanoparticles in a variety of cell lines, as part of this interdisciplinary collaboration.

"We're optimistic that our approach can help countless patients around the world in their fight against cancer. The Nano Argovia project allows us to gain important insights that will contribute to the development of our drugs to the clinic."

Dr. Maya Zigler, project manager of NCT Nano and Head of Research at TargImmune Therapeutics

Shorter light pulses thanks to nanostructured gratings

The Nano Argovia project UltraNanoGRACO is testing a new type of laser system

In the Nano Argovia project UltraNanoGRACO, a team of researchers from CSEM Muttenz, the University of Applied Sciences and Arts Northwestern Switzerland, and the startup Menhir Photonics AG (Basel) are examining a new type of laser pulse compressor to be combined with an ultrafast laser. The laser system is intended to produce extremely short, high-intensity light pulses.

Amplification required

Ultrafast lasers have many potential applications, ranging from telecommunications through metrology and machining metals to medical engineering. The light pulses from these lasers have a duration of less than 1 picosecond (10^{-12} seconds). Some applications require the pulses to be amplified. To ensure that excessive pulse intensity does not damage the amplifiers, the light pulses are first stretched and then compressed again once they have passed through the amplifier. The compression quality is a decisive factor for the final length of the pulse and the maximum intensity. These are parameters that have to be optimized for different applications.

Gratings result in superimposition

In the Nano Argovia project UltraNanoGRACO, researchers led by Dr. Fabian Lütolf from CSEM Muttenz are examining a new type of laser pulse compressor for ultrafast lasers that is intended to enable increased intensity. The stretched light pulses pass through the newly developed optical gratings. The gratings cause the wavelengths, which were previously temporally and spatially separated, to be superimposed again and produce a shorter and more intense light pulse.

The compressor studied in the project together with the partners Dr. Bojan Resan (School of Engineering, FHNW) and Dr. Florian Emaury (Menhir Photoics AG) not only individually shortens and intensifies the light pulse, but also meets the requirements for stability and economic viability with an optimized design.

The project partners are testing whether the compressor can be used together with the ultrafast Menhir Photonics laser to reliably generate pulses with wavelengths of 1550 nm that can be used for telecommunications, metrology, and nonlinear optical applications.

More Information about the project partners.

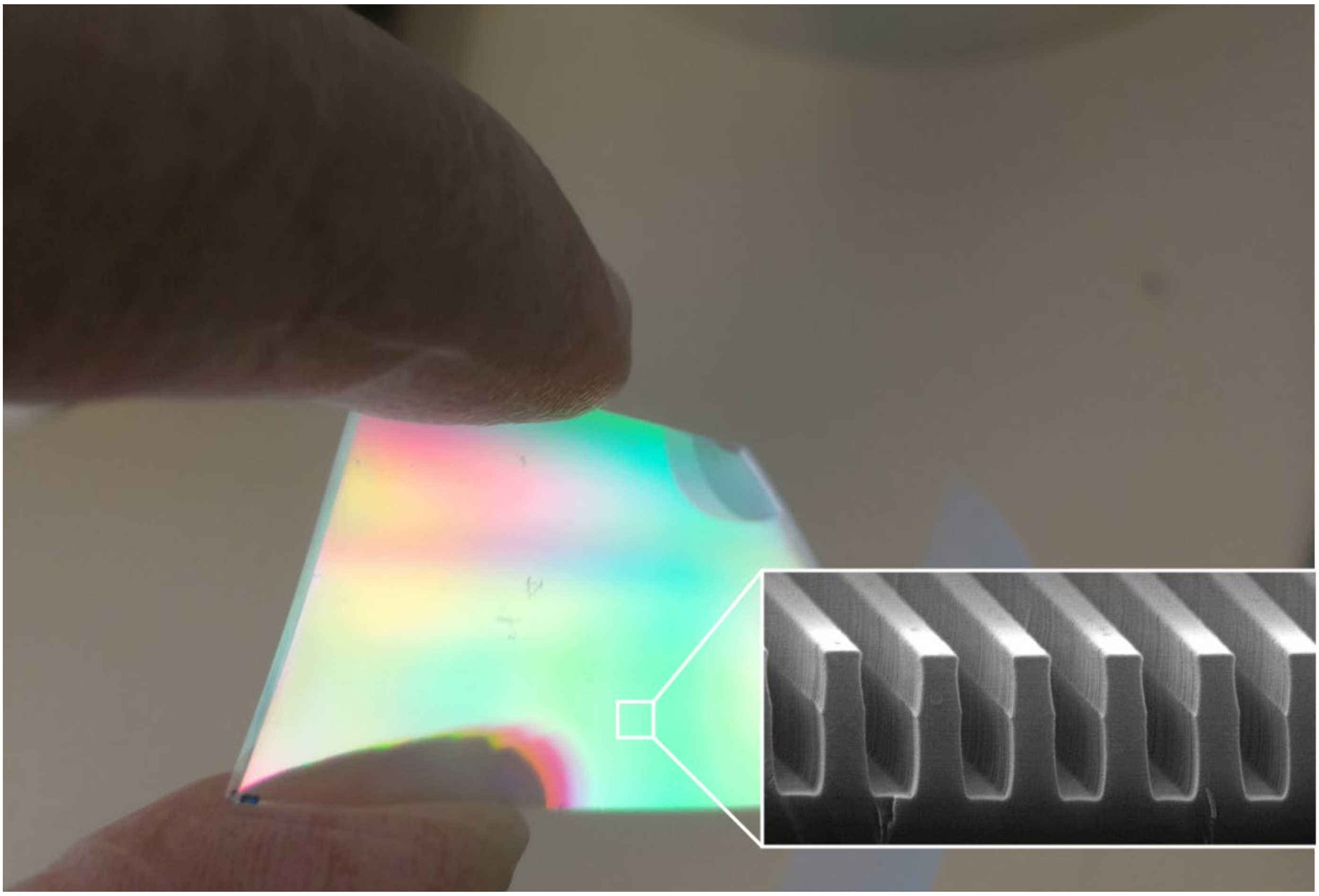
CSEM
https://www.csem.ch/home

FHNW School of Engineering
https://www.fhnw.ch/de/die-fhnw/hochschulen/ht

Menhir Photonics
https://menhir-photonics.com

"The partners involved in the Nano Argovia project UltraNanoGRACO have the perfect combination of expertise in the design and production of nanostructures and in laser research and development. For Menhir Photonics, the project is an ideal opportunity to conduct a feasibility study."

Dr. Florian Emaury, CEO and co-founder of Menhir Photonics AG



Researchers at CSEM Muttenz, the University of Applied Sciences and Arts Northwestern Switzerland, and the startup Menhir Photonics AG (Basel) use nanostructured gratings to generate extremely short high-intensity light pulses (Photo: CSEM Muttenz, FHNW, Menhir Photonics).

Apply now for the new PhD School projects!

Eight new projects were recently approved at the SNI's PhD School. Assessors had 22 submissions to choose from.

Visit www.nanoscience.ch/phd to read about the new projects and access the online application tool.

We look forward to hearing from you!

The Winter School «Nanoscience in the Snow» is one of the regular events of the SNI PhD School.

The SNI and ANAXAM

The Swiss Nanoscience Institute (SNI) is a participant in the “ANAXAM” Technology Transfer Center for Advanced Manufacturing. The association supporting the Aargau-based center was formed in June, with a launch event to give interested companies the opportunity to find out more about how ANAXAM builds bridges between cutting-edge research and industry, and how they can benefit from ANAXAM’s services themselves. The SNI will support projects within the Nano Argovia program.

ANAXAM gives companies all over Switzerland access to the expertise of the Paul Scherrer Institute (PSI), the University of Applied Sciences Northwestern Switzerland (FHNW) and the SNI. Moreover, by taking part in joint projects, industrial companies can leverage unique technological platforms and state-of-the-art materials analysis facilities, paving the way for the development of innovative products and processes.

Teams using the latest manufacturing and analysis technology are especially encouraged to submit proposals for the SNI’s Nano Argovia program.

Examples of projects supported by ANAXAM and additional information (in German):

ANAXAM website
www.anaxam.ch

ANAXAM video
https://www.youtube.com/watch?time_continue=3&v=_9JsfyociU

A stream of visitors

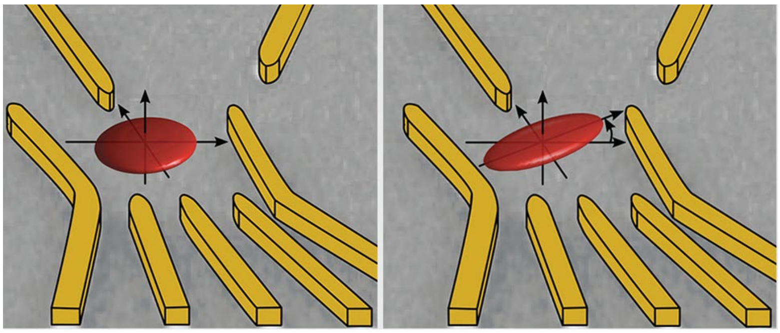
The children attending the UniKidsCamps and pupils from various schools were not the only visitors to the SNI in recent months – we also hosted the board of directors of the Hightech Zentrum Aargau (HTZ), which convened in Basel to learn about the SNI and its research activities.

In the laboratories of professors Ernst Meyer, Philipp Treutlein, Martino Poggio and Christian Schönenberger, they were given a first-hand look at the innovative work being done at the SNI and the University of Basel’s Department of Physics.

“The directors of the HTZ were highly impressed by the outstanding top-level research being conducted at the SNI and the University of Basel’s Department of Physics. They were able to form a clear picture of the areas of nanotechnology in which the foundations are being laid for prospective innovations and new materials and structures. Thanks to the SNI’s Nano Argovia program, companies in the Canton of Aargau are able to leverage this expertise again and again. The SNI is the HTZ’s most important partner in the field of nanotechnologies and cutting-edge analysis.”

Dr. Martin Bopp, managing director of the HTZ

News from the SNI network



An electron is trapped in a quantum dot, which is formed in a two-dimensional gas in a semiconductor wafer. However, the electron moves within the space and, with different probabilities corresponding to a wave function, remains in certain locations within its confinement (red ellipses). Using the gold gates applied electric fields, the geometry of this wave function can be changed. (Image: University of Basel, Departement of Physics)

The geometry of an electron determined for the first time

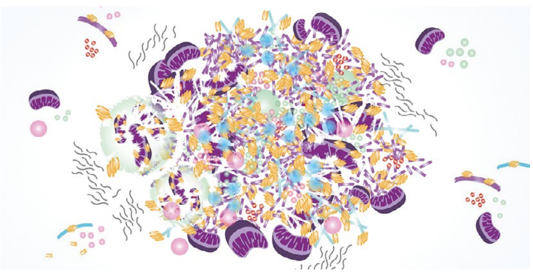
Physicists at the University of Basel are able to show for the first time how a single electron looks in an artificial atom. A newly developed method enables them to show the probability of an electron being present in a space. This allows improved control of electron spins, which could serve as the smallest information unit in a future quantum computer. The experiments were published in *Physical Review Letters* and the related theory in *Physical Review B*.

Original sources: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.122.207701, https://journals.aps.org/prb/abstract/10.1103/PhysRevB.99.085308

The aim of the National Technology Transfer Center ANAXAM is to build a bridge between research and industry: The Paul Scherrer Institute (PSI), the University of Applied Sciences and Arts Northwestern Switzerland, the Swiss Nanoscience Institute, and the Canton of Aargau are setting up an association together with industrial partners to support this endeavor.

Research institutions conduct research, industrial companies produce. The nationally active technology transfer center ANAXAM will provide a bridge between these two worlds. The Paul Scherrer Institute (PSI), the University of Applied Sciences Northwestern Switzerland (FHNW), the Swiss Nanoscience Institute (SNI), and the Canton of Aargau are applying for federal funds to establish an Advanced Manufacturing Technology Transfer Center (AM-TTC). The ANAXAM project (Analytics with Neutrons and X-Rays for Advanced Manufacturing) is founded on the globally recognized expertise at the PSI in neutron and X-Ray analysis.

Media release Canton of Aargau (in German):
https://www.ag.ch/de/aktuelles/medienportal/medienmitteilung/medienmitteilungen/mediendetails_123972.jsp



Content of Lewy bodies: The inclusions in the neurons contain mainly a membranous medley instead of the anticipated protein fibrils. (Image: University of Basel, Biozentrum)

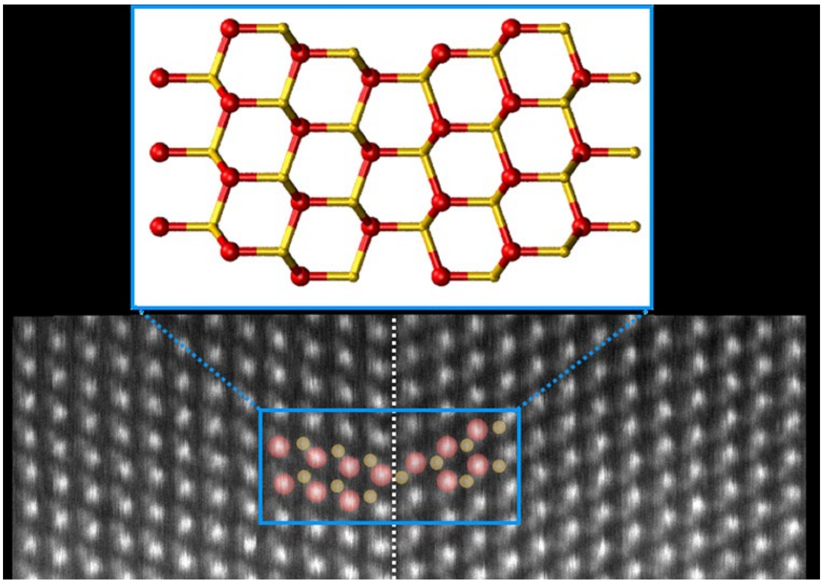
New contents: Neuronal Parkinson inclusions are different than expected

An international team of researchers involving members of the University of Basel's Biozentrum challenges the conventional understanding of the cause of Parkinson's disease. The researchers have shown that the inclusions in the brain's neurons, characteristic of Parkinson's disease, are comprised of a membranous medley rather than protein fibrils. The recently published study in *Nature Neuroscience* raises new questions about the etiology of Parkinson's disease.

Original source: https://doi.org/10.1038/s41593-019-0423-2

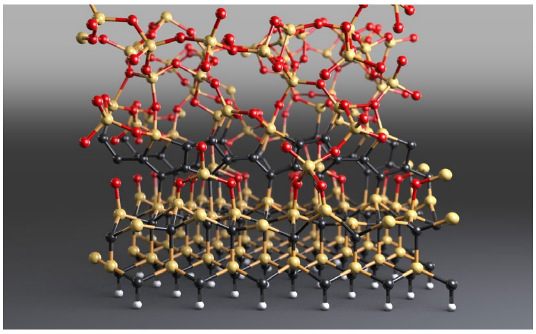
Better thermal conductivity by adjusting the arrangement of atoms
Adjusting the thermal conductivity of materials is one of the challenges nanoscience is currently facing. Together with colleagues from the Netherlands and Spain, researchers from the University of Basel have shown that the atomic vibrations that determine heat generation in nanowires can be controlled through the arrangement of atoms alone. The scientists will publish the results shortly in the journal *Nano Letters*.

Original source: http://pubs.acs.org/doi/10.1021/acs.nanolett.9b01775


Two layers of gallium phosphide twisted 60 degrees against each other. (Picture: Department of Physics, University of Basel)

Revealing the hidden face of crystals
In the Nano Argovia project A3EDPI, a team of researchers led by Dr. Tim Grüne demonstrated that electron diffraction can be used to analyze the structure of nanoscale materials. In a recent article in *Nature Communications*, they have now presented three-dimensional sample supports that enable the collection of complete datasets.

Media release University of Vienna:
https://medienportal.univie.ac.at/presse/aktuelle-pressemeldungen/detailansicht/artikel/verborgene-seiten-der-kristalle-sichtbar-machen/
Original source: https://www.nature.com/articles/s41467-019-11326-2


At the interface between silicon dioxide and silicon carbide, irregular clusters of carbon rings occur, which disturb the electronic function (Picture: Department of Physics, University of Basel)

Silicon as a semiconductor: silicon carbide would be much more efficient
In power electronics, semiconductors are based on the element silicon – but the energy efficiency of silicon carbide would be much higher. Physicists at the University of Basel, the Paul Scherrer Institute and ABB explain what exactly is preventing the use of this combination of silicon and carbon in the scientific journal *Applied Physics Letters*.

Original source: https://aip.scitation.org/doi/10.1063/1.5112779

Short summaries of these studies can be found at: https://nanoscience.ch/de/media-2/aktuelle-medienmitteilungen/

SNI INSight — Showcasing research and activities of the Swiss Nanoscience Institute
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Pictures: C. Möller and named sources

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