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

December 2020

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Approaches in the SNI network

Werner Siemens Foundation

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Editorial

Dear colleagues,

We are nearing the end of this highly unusual year, which has been full of challenges and created huge problems for many people. At the same time, 2020 was also a year in which we learned a great deal. Never before have teams of scientists around the world generated so much knowledge about a virus in such a short time, and never before have we had to make such drastic changes to our behavior or adapt so radically to changing circumstances from one day to the next. Along with the whole SNI management team, I particularly regret that the personal exchange of ideas within our network could only take place in small groups this year – and that we have not been able to hold any of the larger-scale events we had planned.

A short survey of SNI members recently provided us with confirmation of the effectiveness of this exchange across our network. Members particularly value the opportunity for discussion and collaboration between different departments and institutions, as well as the chance to obtain funding for cooperation of this kind. We will publish the survey results in the Annual Report, which we are currently working on. I would like to take this opportunity to thank everyone for their active participation and for all the positive feedback we received.

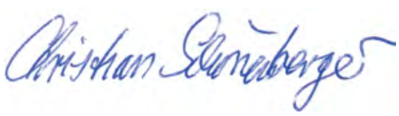
The last few months have also been challenging for our students. Although they were still able to attend some classroom courses at the start of the semester, teaching has now moved almost exclusively online. Especially for those who joined us recently and are still getting their bearings, this has not been easy. We asked four of them what it was like to begin their studies in these unusual circumstances.

Rafael Eggli, one of our master's students, will perhaps take a more positive view of 2020 – at least from a personal perspective. Although he was forced to postpone his plans for project work in New York until next year, he also became a fellow of the Werner Siemens Foundation, which presumably makes up for the temporary change of plans.

Luckily, we were able to resume our laboratory research activities in the middle of the year. Some researchers from the network are working on the intelligent application of plastics, and we have summarized their approaches to this work in this issue of SNI INSight. We also provide an overview of exciting news from other subject areas over recent weeks and months.

Now, on behalf of the whole management team, I would like to wish you a peaceful – and above all healthy – Christmas as well as a happy and healthy New Year. I'm very much looking forward to the day when we have made it through these unusual times together and can again meet in person.

With best regards,



Prof. Christian Schönenberger, SNI Director

An undeserved reputation

Plastics offer great potential

Plastics have something of an image problem at the moment. Vast amounts of artificial packaging litter the world's oceans, and there is no question that we need to reduce the amount of marine rubbish we create. But packaging our food is by no means all that plastics are good for. They offer innovative solutions for applications in medicine and in everyday life that would be impossible with other materials. Various research groups in the SNI network are devoted to the intelligent use of plastics.

Plastics are materials that consist primarily of long molecule chains known as polymers, which in turn are made up of anywhere from a few thousand to over a million repeating basic units (monomers). Some occur naturally, while others are created by altering natural polymers, and yet others are entirely synthetic, obtained for the most part from crude oil.

The spatial arrangement of the individual components determines the properties of a given plastic. Moreover, there are different ways in which the long molecule chains are linked together and interact. Accordingly, the resulting materials can be rigid, flexible or elastic, and are suited to a wide range of applications.

Telephones used to be made of Bakelite, the first plastic to be produced on a large scale (image: Shutterstock).

First created long ago

Deliberate creation of a natural plastic dates back to the 16th century. Wolfgang Seidel, a Benedictine monk from Augsburg, found out how to make casein from low-fat cheese by repeatedly heating and reducing the curds. The resulting material was used to make cups or items of jewellery. In the 18th and 19th centuries, other natural plastics arrived on the scene. Rubber and linoleum were discovered, as were nitrocellulose and celluloid, made from nitrocellulose and camphor. The first fully synthetic plastic to be industrially produced on a larger scale was Bakelite, which is made from phenol and formaldehyde and is still in use today.

Although numerous researchers in Europe and the US were involved in these initial achievements, the composition of early plastics was not well understood to begin with. It was not until the early 20th century that the chemist Hermann Staudinger published his theory that plastics were macromolecular compounds consisting of long chain molecules, laying the foundations for the field of polymer chemistry.

Since then, countless plastics have been invented to cater to a huge variety of applications, and it has become impossible to imagine our everyday life without them. Various research groups in the

SNI network are working to expand the range of intelligent applications and exploit the unique properties of different plastics.

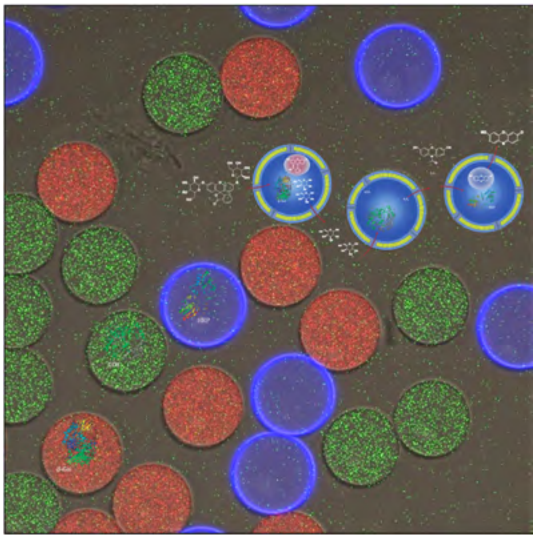
Inspired by natural membranes
The teams led by Professor Cornelia Palivan and Professor Wolfgang Meier from the University of Basel's Department of Chemistry, for instance, use artificial polymers to create tiny capsules that can be used to treat various diseases. The capsules can be loaded with active substances or enzymes that are protected by the flexible polymer membrane until they are released at the point of delivery.

To produce these capsules – or nanocontainers – the researchers use a class of materials known as block copolymers, which are constructed from at least two different monomers.

Like the building blocks of natural membranes, block copolymers have a hydrophilic and a lipophilic component. In an aqueous environment, they independently arrange themselves in such a way that the hydrophilic components shield the lipophilic components from the surrounding water, resulting in the creation of tiny capsules enveloped by a double membrane. The structure of this membrane resembles that of the phospholipid bilayer in natural cells, although the polymer membrane is significantly more robust and stable than its natural counterpart.

"Besides their greater stability, another benefit of the artificial membranes is that they can be customized as needed," explains Wolfgang Meier. "For instance, we can fine-tune their thickness and size with a high degree of precision," he adds. What is more, the researchers can incorporate natural membrane proteins into the structure that serve as gateways, allowing selective transport of certain substances into and out of the nanocontainers.

"We produce nanocontainers into which various enzymes are packed," says Cornelia Palivan, adding that "by equipping these minute containers with the right membrane proteins, we can use them to trigger a cascade of biochemical reactions." The end product of a reaction from one type of container serves as the input for a second type. In turn, the product of the second reaction acts as the substrate for a third reaction. This enables complex syntheses that are physically isolated from each other, as in a natural cell.



These tiny nanocontainers are loaded with different enzymes and equipped with corresponding membrane proteins. Various biochemical reactions can then take place separately from one another inside the containers (image: Department of Chemistry, University of Basel).

Controlled production with microfluidics
To control the production of these nanocontainers, the researchers in Basel recently developed a microfluidic platform employing a special silicon-glass chip in collaboration with IBM.

The chip features six channels that converge at a junction where the components of the polymer membrane, buffer solutions and the enzyme cargo come together. Under the right conditions, the tiny capsules join at this junction of their own accord. They are uniform in size, but envelop different enzymes as they form. During the production process, membrane proteins allowing

Sources and additional information:

Seilnacht — Didaktik der Naturwissenschaft

https://www.seilnacht.com/Lexikon/k_gesch.html

Kunststoff Deutschland:

https://www.kunststoff-deutschland.com/html/geschichte_des_kunststoffs.html

Deutsches Kunststoff-Museum

http://www.deutsches-kunststoff-museum.de/rund-um-kunststoff/zeittafel-zur-geschichte/

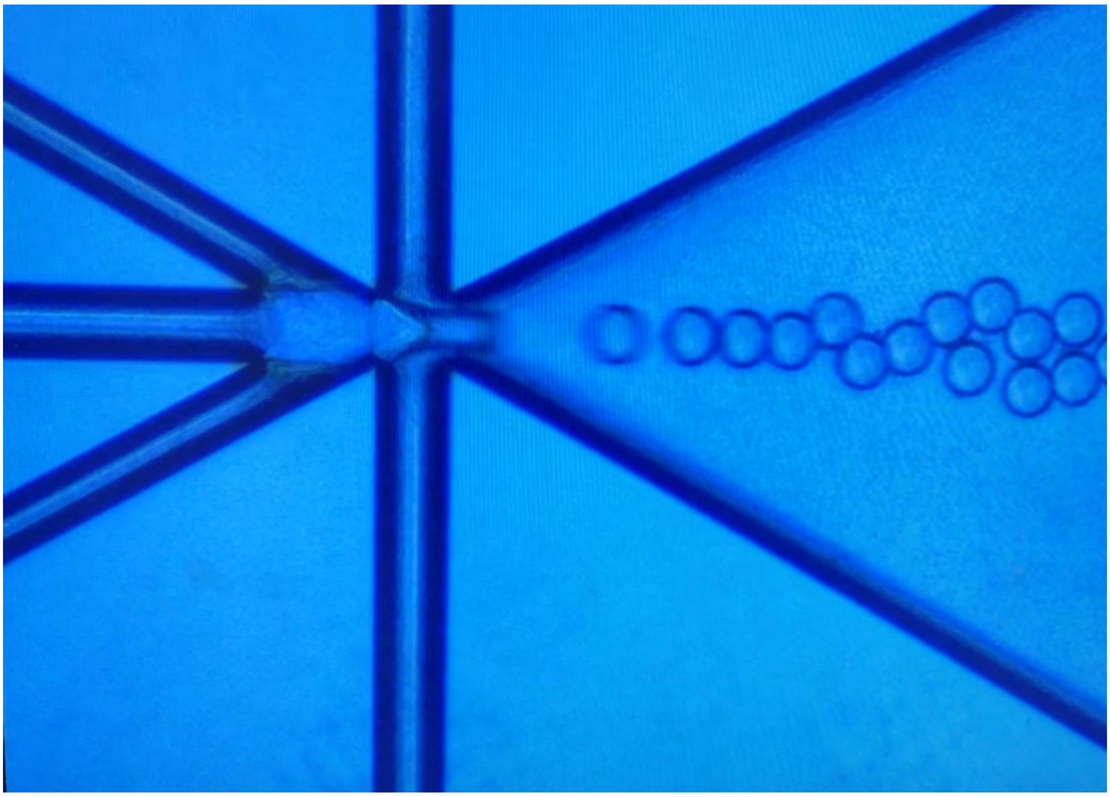
Information about block copolymers:

Advanced Materials:

https://onlinelibrary.wiley.com/doi/10.1002/adma.202004804

Video:

https://youtu.be/IftbbVRce4k



The constituents of the polymer membrane meet at the junction of the microfluidic platform. All of the capsules are formed with a uniform size but can be loaded with different cargoes (image: Swiss Nanoscience Institute, University of Basel).

Information about block copolymers:

ACS Nano

https://pubs.acs.org/doi/10.1021/acsnano.0c05574

Advanced Science

https://onlinelibrary.wiley.com/doi/full/10.1002/advs.201901923

Small

https://onlinelibrary.wiley.com/doi/pdf/10.1002/smll.201906492

transport into and out of the capsules are also incorporated into the membrane by self-assembly.

This microfluidic system was recently described by its creators in the journal Advanced Materials. For the paper, they loaded the nanocontainers with β-galactosidase, glucose oxidase or horseradish peroxidase. In a succession of steps, these three enzymes were used to transform a starting product into the end product Resorufin, which is easy to detect as a result of its distinctive color. As in a natural cell, the biochemical reactions in this artificial system occurred in spatially separate compartments.

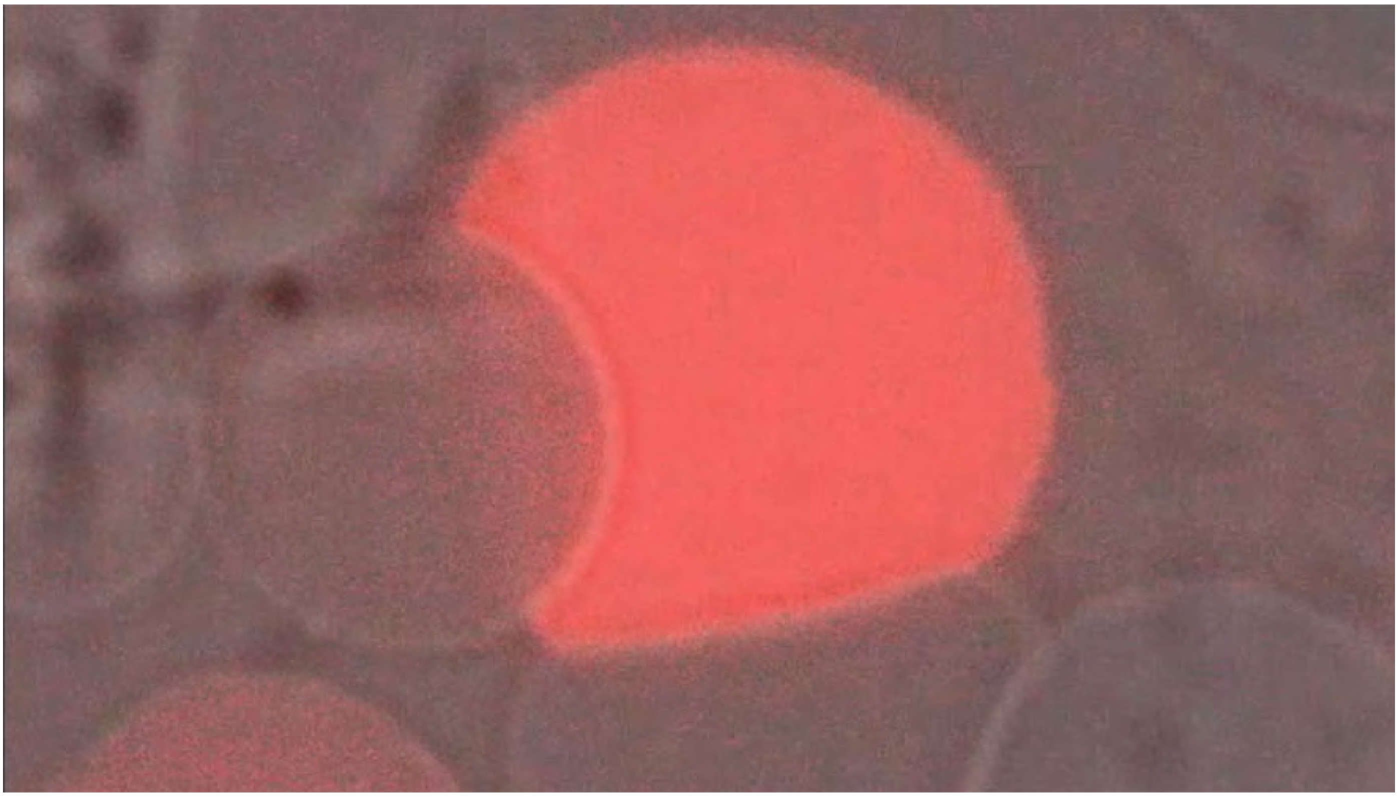
The Palivan team has also published in the journal Small that it is possible to combine the synthetic nanocontainers with natural biomolecules for a simultaneous detection and therapeutic response. The researchers showed that natural enzymes and imaging compounds function *in vitro*, allowing the therapeutic enzyme to remain effective while simultaneously enabling controlled imaging.

Active in living cells too

Further work by Palivan's team has demonstrated that nanocontainers of this sort can be introduced into living cells, where they have the ability to amplify natural signaling pathways. In a paper published in the journal ACS Nano, the researchers describe how nanocontainers working in tandem can remain functional in mammal cells for several days.

The block copolymers used protect the enzymes against degradation. As well as being robust and very simple to manufacture, they have so far shown no toxic effects in animal models, as shown by a team led by Professor Jörg Huwyler in collaboration with Palivan and Meyer's group.

"The nanocontainers are operational as soon as they have been absorbed into the cells, where they begin their synthesizing activity. In the future, they could be used to treat diseases involving malfunctions in biological signaling pathways," say Palivan and Meier, summarizing the



In molecular factories injected into zebrafish embryos, a color reaction occurs when the trapped enzyme (peroxidase) is working. The researchers thus prove that the combination of synthetic organelles and natural vesicles also works in the living organism. (Image: Department of Pharmaceutical Sciences, University of Basel)

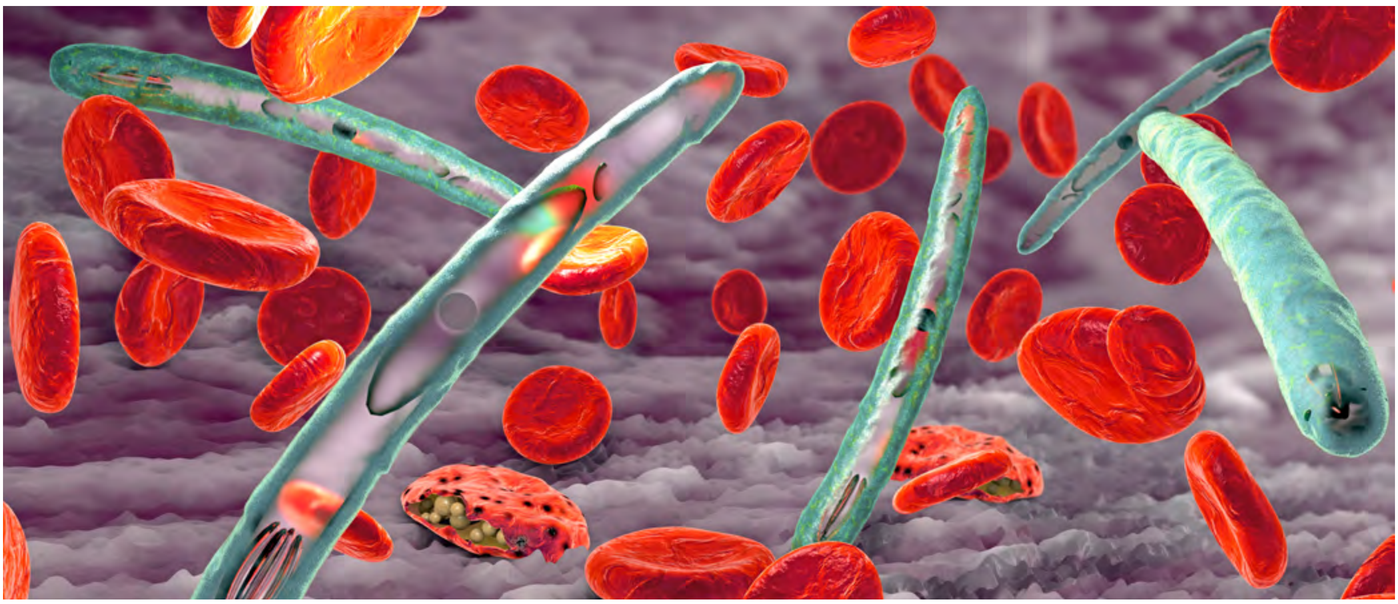
approach, which they are also pursuing at the NCCR Molecular Systems Engineering.

Fighting malaria

Another potential application of the polymer capsules is secure packaging of drugs or their precursors. A few years ago, Dr. Adrian Najer, a member of Meier and Palivan's team, developed a concept based on this idea to treat malaria infections.

Malaria is caused by a parasite of the genus *Plasmodium*, which is transmitted by mosquito bites. The parasite infects red blood cells in the human body and multiplies inside them. When these infected blood cells burst, the parasites released go on to infect new blood cells.

Najer developed a polymer capsule that contains a malaria drug and is absorbed by infected blood



In malaria, red blood cells are infected by a parasite of the genus Plasmodium that is transmitted via mosquito bites. Polymer capsules could potentially prevent the multiplication of the Plasmodium species (image: Shutterstock).

cells. The protective polymers gradually break down in response to changes in the intracellular environment caused by the Plasmodium infection, so the drug is released in the infected cells, where it can kill the parasites.

A second application of the treatment consists in using tiny polymer bubbles equipped with specific sugar molecules on their surface to make them ‘look like’ red blood cells. The parasites bind to these ‘nanomimics’, which prevents them from infecting new blood cells.

Adrian Najer is currently refining the approach in the course of his postdoc fellowship at Imperial College London.

These examples show that the block copolymers are able to perform the researchers’ intended functions. Before they can be deployed in practice, further research and detailed analysis are needed to ascertain how they behave inside the body, and what happens to their degradation products.

Optical effects produced by minute structures

A key benefit of plastics is the diverse range of ways in which their surface can be structured and functionalized, yielding entirely new properties. The Institute of Polymer Nanotechnology (INKA) of the FNHW School of Engineering and the Paul Scherrer Institute specializes in modifications of this kind.

A research team led by INKA director Professor Per Magnus Kristiansen works on countless different applications, mostly in collaboration with an industry partner. Some of their projects are supported by the SNI.

Micro and nano structures on material surfaces can be used as security features on identity documents, for example: the intricate structures reflect light in different ways and minute plastic lenses can create optical effects.

In the Nano Argovia project LASTRUPOL, the team has devised a novel surface

Additional information:

Institute of Polymer Nanotechnology (INKA):

https://www.fhnw.ch/en/die-fhnw/hochschulen/ht/institute/institut-fuer-nanotechnische-kunststoffanwendungen

Institute of Product and Production Engineering (IPPE):

https://www.fhnw.ch/en/die-fhnw/hochschulen/ht/institute/institut-fuer-produkt-und-produktionsengineering

Plastic surfaces can be structured or treated in different ways. Here, the team from the FHNW Institute of Polymer Nanotechnology (INKA) selectively treated a film with plasma so that it shows the FHNW logo (image: INKA, FHNW).

structuring fabrication process in collaboration with the company Gemalto/THALES designed to produce optical structures of this kind with a high degree of precision and surface quality as cost-effectively as possible. Also involved in the project are researchers from the Institute of Product and Production Engineering (IPPE), which the INKA has collaborated with on numerous projects in the past.

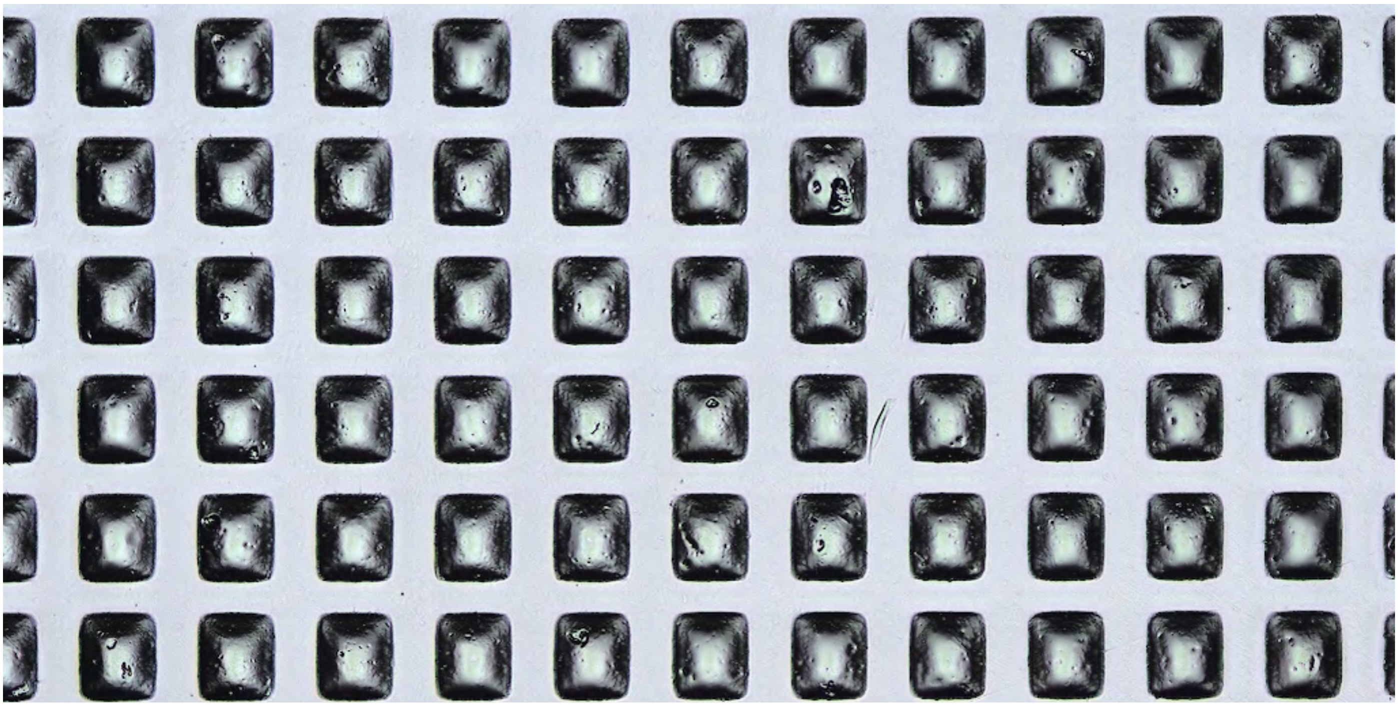
To begin with, the researchers use ultrashort laser pulses to selectively remove material from the plastic surface – a speciality of the IPPE's laser group. As the resulting microscale structured surface is too rough, however, it has to be smoothed in a subsequent production step – without altering the laser-engraved structures. This is achieved with the help of a method developed in the Nano Argovia project SurfFlow that selectively changes the material properties of part of a given sample.

Using UVC radiation, the surface is selectively modified so as to lower the temperature required for the polymers to change from a solid state into a thick molten mass, known as the glass transition temperature. When the sample is subsequently gently heated, the treated uppermost layers reach their glass transition temperature and become smooth. Deeper layers remain virtually unaffected, and the microstructure on the surface is retained.

"The technology allows us to create precise templates with which we can reproduce different security features," explains project leader Per Magnus Kristiansen. However, further work is required before this goal can be achieved: toward the end of the project, it became apparent that successful smoothing of laser-engraved structures requires a different approach. Efforts to this end will continue in a follow-on project backed by the Aargau Research Fund – once again in collaboration with the IPPE and Gemalto/THALES.

Surfaces with novel properties

Alongside surface structuring, functionalization of surfaces is another tool with great potential for a broad range of applications. For example, polymers and molecules with functional groups can be anchored to a surface using electron beams (a process known as grafting), altering its properties. In some plastics, electron beams also alter the bonds between polymers in the outer layer (cross-linking), thereby enhancing their stability. Meanwhile, coatings of different kinds can also confer new properties on surfaces. Activating plastic surfaces by means of plasma treatment, for instance, can prepare them for subsequent processing steps such as bonding, printing or back injection.



In the Nano Argovia project ReLaFunAF, coatings are applied to surfaces so that fingerprints are repelled. This image shows a coating structured using the ReLaFun process (image: INKA, FHNW).

The team led by Dr. Sonja Neuhaus of the INKA has been working on surface functionalization processes of this sort for a number of years, and has been involved in a number of Nano Argovia projects.

Smudge-free surfaces

For example, in the project ReLaFunAF the group is currently working on coatings that repel fingerprints. The process involves applying a layer to the plastic that is cured under UV light. However, the UV LED lights do not fully cure the surface: a 'sticky' layer containing reactive groups is left behind. In a second coating step, functional molecules can be applied to this layer by covalent binding and then fixed in place with further UV curing.

"As the functional layer does not come into contact with the original substrate, functionalizations that would otherwise adhere to the sample poorly or not at all become possible. This is a decisive advantage," explains Sonja Neuhaus.

If the method is successful, a variety of different objects could benefit from this coating – who among us would not welcome a fingerprint-free screen for our mobile phone?

Rapid detection of bacteria

In a project funded by the Swiss National Science Foundation, the group led by Neuhaus is currently working on the possibility of anchoring enzymes to a plastic surface. Eventually, the researchers hope to achieve this with the enzyme luciferase. This protein, which occurs in fireflies, for example, catalyzes the transformation of luciferin into oxyluciferin in the presence of oxygen. This reaction also requires ATP (adenosine triphosphate), often referred to as the 'unit of currency' of energy in living creatures. Accordingly, the luciferin/luciferase system provides quantitative evidence of ATP, and can therefore be used to detect bacterial contamination

Biomolecules like luciferase require a favorable environment on the plastic surface, ideally an absorbent hydrophilic layer. To create this layer, electron beams are used to graft functional polymers onto the substrate. A previous plasma treatment ensures optimal moistening of the surface with the polymer solution during the electron grafting process.

Before investigating luciferase anchoring, the researchers are testing a model enzyme that catalyzes a simple color reaction. This will yield quick and relatively simple confirmation that the anchored enzymes are able to function properly on the surface.

The blue color results from the activity of a model enzyme anchored on the surface (Image: INKA, FHNW).

Custom-built for each patient

Numerous other research groups in the SNI network are also working in intelligent applications for plastics.

One such group, a team of researchers from the FHNW School of Life Sciences, the Hightech Research Center of Cranio-Maxillofacial Surgery at University Hospital Basel and the company CIS Pharma AG, has developed innovative nanostructured implants that support the regeneration of bones and soft tissue in the jaw and mouth area, and can be custom-built for each patient using 3D printing technology.

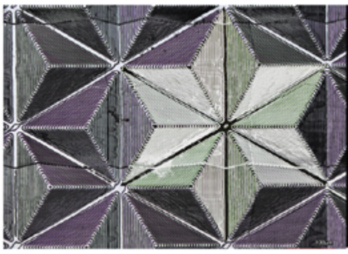
The key to these implants is a multi-layered polymer membrane based on the Cellophil technology developed by CIS Pharma. Cellophil is a combination of several natural amino acids linked by an acrylic backbone, offering a very high degree of biocompatibility. The polymers are mixed with cross-linking substances. Upon exposure to UV light, this results in membranes with different degrees of porosity depending on the amount added.

As a result, researchers can equip the various layers of the implant with different properties – according to the type of cells they will come into contact with inside the patient's body. In spite of the differences in composition among the layers, the implant can by printed in a single step and individually tailored to each patient.

A broad field with numerous challenges

These examples illustrate just a few of the numerous possible applications of modern plastics currently being researched at the SNI. Plastics have become an inextricable part of our lives, and will continue to deliver valuable benefits in a wide range of fields. Still, a great deal of work is also needed on ways to recycle and reuse plastics so as to ensure intelligent utilization of valuable resources and protect our environment.

Congratulations to the winners of the Nano Image Award

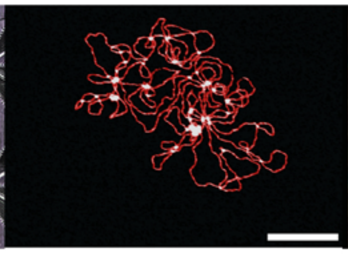


Christmas Star

Surface topology of a de-glaring foil, used for lighting solutions. The characterization was done with a confocal laser scanning microscope, and parts of the repeated pattern are recolored.

The image is the results of a collaboration between CSEM Center Muttenz & INKA, FHNW.

Tamara Aderneuer
SNI PhD Student
Micro-Nano Optics,
CSEM Muttenz

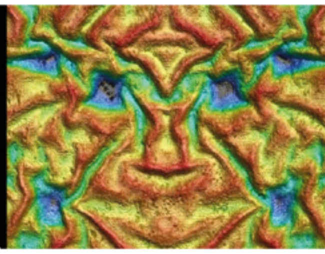


Genome tangles

Atomic force microscopy (AFM) topograhy image of a double-stranded DNA (dsDNA)

Brightly colored and entangled thread-like structures are the dsDNA fragments. The background is the freshly cleaved mica onto which the DNA fragments were adsorbed. Scale bar, 180 nm.

Selen Manioglu
PhD student
ETH Zürich/D-BSSE,
Biophysics Lab

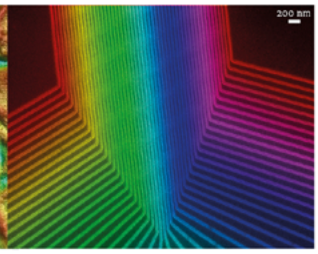


INKA Mask

Confocal Laser Scanning Microscopy image of varnish on a PET foil, casted from a laser structured steel master Scale: 280 µm x 210 µm x 16 µm

Results of a collaboration between the ALPS (Bern University of Applied Sciences) and INKA, FHNW

Dr. Laurent Feuz
Institute of Polymer Nanotechnology (INKA), FHNW



Gate Array

Scanning electron microscope image of parts of a spin qubit device which was fabricated by means of electron beam lithography.

It is colored in rainbow colors, because the structures arrange themselves at a distance a little smaller than the wavelength of visible light and show different colors depending on the viewing angle.

Jann Hinnerk Ungerer
SNI PhD Student
Department of Physics,
University of Basel

Once again, you sent us a selection of beautiful images from the micro and nano worlds, and we would like to say a big thank you to everyone who participated in this year's Nano Image Award. We're delighted to be able to use many of the images in our various communication materials.

A wide range of interests and commitments

Rafael Eggli receives a fellowship from the Werner Siemens Foundation

Rafael Eggli, who has been studying nanosciences at the University of Basel since 2016, has been awarded a fellowship by the Werner Siemens Foundation. Hailing from Switzerland, the 22-year-old has also held a scholarship from the Swiss Study Foundation since 2017. He is an enthusiastic participant in the broad program opened up to him by these awards, and he never ceases to be amazed at the opportunities that the nanosciences program in Basel offer him.

In summer, for example, he attended a summer academy in Ticino, where he spent a week learning about ethnology and globalization. Next year, he plans to take part in the National Model United Nations in New York, which will see him slip into the role of a national delegation at the United Nations General Assembly together with associates from the Swiss Study Foundation. The twist, however, is that each delegation will represent a country other than their own. It takes a great deal of preparation and sensitivity to acquaint yourself with another culture and to represent the interests of that country in the ensuing negotiations.

For Rafael, activities such as these are a great opportunity to immerse himself in a new world brimming with fresh knowledge and intriguing contacts.

A new world thanks to the scholarship

This exciting chapter of Rafael's education began in summer 2017, when he was accepted as a member of the Swiss Study Foundation after successfully completing the lengthy selection process. He qualified based on his good grades, wide range of interests and broad community engagement. "This gave me access to an amazing range of educational opportunities," Rafael explains in our interview.

The opportunities he is referring to are part of the annual program of the Swiss Study Foundation, which encompasses more than 75 courses across a wide range of subject areas. These also include seminars from the Werner Siemens Foundation, some of which Rafael has already attended. From September 2020 onward, he will now also receive financial support for a period of one year in the form of a Werner Siemens Fellowship from the foundation of the same name. This year, Rafael has been selected as one of 10 fellows who stand out due to their

Rafael Eggli received a fellowship from the Werner Siemens Foundation.

"We send Rafael our warmest congratulations on the fellowship. It's always great to hear about how and where our students are getting involved. We wish Rafael the best of luck with his plans, and we're sure we'll be hearing from him again in the future."

Prof. Dr. Christian Schönenberger, Director Swiss Nanoscience Institute

academic excellence and are prepared to commit themselves to the support and promotion of STEM subjects in wider society.

Broad engagement

This is something that Rafael is already doing in numerous ways, including by teaching math and physics as a supply teacher at Gymnasium Kirschgarten, the secondary school where he completed his own Matura (high-school diploma). He is also involved in a project that aims to prevent the extinction of *Parosphromenus*, a genus of labyrinth fish from the peat swamps of Southeast Asia. In addition, he helps out as a scout leader as needed and when time allows.

Indeed, time is often an issue for Rafael, as nanosciences is also a very time-consuming and challenging course of studies. Nevertheless, he explains that this varied and interdisciplinary degree course was precisely the right choice for him. "So many times, I've come out of a lecture and thought to myself: Now I understand just a little bit better how nature works."

Incomparable variety

The sheer diversity of block courses in the bachelor's program was a real bonus for him, and he is now also excited at the opportunity to dig deeper into different subject areas as part of his master's studies. "Since I joined the Study Foundation, I've met many students on different degree programs, including at other universities in Switzerland. None of them have the opportunity to acquaint themselves with as many different subjects, topics and methods in their course of studies as I do on the nanosciences degree here in Basel," he says.

Rafael completed his first project in Professor Richard Warburton's group, where he examined various geometries of a fin field-effect transistor (FinFET) for the realization of spin qubits. His second project, at Cornell University in New York, was actually supposed to follow on from this work – but, with his plans somewhat up in the air as a result of the coronavirus pandemic, it will now be next year before he travels to New York. Once there, he will use high-speed atomic force microscopy to study the conformational changes of an ion channel that occurs in human synapses and plays a hugely important role in medicine. In the meantime, he is working on his master's thesis at the Department of Physics in the group led by Professor Dominik Zumbühl, in research that follows on from his first project on the FinFET.

Exciting plans for the future

For Rafael, what he likes most is being part of a team conducting research into the natural sciences. Although he also enjoys teaching and training young people, he believes that research is a more fitting vocation. With that in mind, he would like to move on to a doctorate after completing his master's studies. "I still don't know whether it'll lean more toward nanophysics or nanobiology – I find both areas fascinating," he says.

At the same time, he is not only fascinated by the fundamental principles but also interested in their possible applications and commercial potential, to the extent that he is already tentatively looking into how to found a start-up. When asked about his longer-term plans for the future, he says: "I want to learn about how technology can contribute to progress in our society. What are the basic principles and processes that lead to improvements? And then I'd like to be part of that progress."

Not the norm
Beginning a nanosciences degree during the coronavirus pandemic

Starting university is an exciting time. With their school days behind them, the students are beginning an important new stage of their lives, one that is filled with new experiences and new friends – and often takes place in an unfamiliar city. Those starting their courses in 2020, however, had a vastly different experience than in previous years. Whereas some classroom courses were still possible at the start of fall semester, students have now been receiving their tuition exclusively online since the start of November. This makes it difficult for them to meet new friends and find their bearings in what is still an unfamiliar university environment. We asked four new nanoscience students how they are coping in these unusual times and what their first impressions are of the nanosciences degree program at the University of Basel.

An American in Basel

Hailing from California, Tania Beringer has traveled a long way to study nanosciences in Basel. As her parents were originally from Switzerland, Tania decided to study in Basel and take this opportunity to get to know the country a bit better. She chose the nanosciences because, as a high-school student, she was particularly interested in the natural sciences at the molecular level. “I didn’t want to limit myself to one science, and nano brings together a variety of different fields,” she says in our interview.

Tania Beringer came from the US to study nanosciences in Basel.

So far, Tania has not been disappointed. She is finding it all very exciting and has no trouble following all of the different topics. Although she initially attended classroom courses every day, stricter coronavirus measures saw all teaching move online at the start of November. This has not been easy for Tania, particularly when it comes to practical exercise courses, because it makes it harder to ask questions if anything is unclear. “But the tutors are great and always respond immediately if you have any questions,” she says.

Although there haven’t been many opportunities to meet up in person, she now knows all the students who started the nanosciences course with her, as well as a number of students from higher semesters. She has also met two other nanoscience students who share her love of photography – one of the few activities that are still possible with almost no restrictions even during the coronavirus pandemic.

Tania moved into a student dormitory in Basel, where she has also made some good connections despite the current restrictions. “There’s always someone there to do things with me if I need to,” she says.

All in all, Tania is very pleased with her first semester here in Basel. She was elected vice-president of the Nanoverein in November and is looking forward to her commitment to the association and to the time when students can once again attend lectures, take part in practical courses or simply spend time together in person.

From the other side of the border

Mina-Lou Schleith had a much shorter journey to Basel. Hailing from Weil am Rhein, Germany, she completed her school-leaving certificate at the town's Kant Gymnasium in 2019. She first came across the nanosciences a few years ago when she attended a bachelor's information day at the University of Basel.

She found biology and chemistry particularly interesting and enjoyable at school – and, above all, she was always very inquisitive about a wide range of topics. In an internship after completing high school, she learned what it was like to work in a laboratory. Unfortunately, a subsequent internship at the Paul Scherrer Institute (PSI) had to be canceled due to coronavirus restrictions. Mina-Lou used this spare time before beginning her studies to brush up on her physics, as she hadn't studied the subject at high school. "That was definitely a good idea," she says. "Because I'm now keeping up well – and enjoying it."

the support she receives from the tutors. "In physics, for example, we have a question and answer session every Friday, where we can ask about anything we like. That's really useful."

For her, the highlights were the events at the start of the semester, when people could still meet in person, including the hike organized by the nano student association and a picnic with students from the higher semesters. She also enjoyed activities such as hockey at the university sports center, but these have also been off limits since November. Luckily, she made two good friends among the new students during those initial few weeks, so she still has the opportunity to meet up with people in person occasionally.

Mina-Lou has adapted to the current circumstances well. She has no regrets about her choice of degree program and is also involved in the Nanoverein as representative of this years' students.

Studying for a master's in Basel

Andreas Ruh has already completed his bachelor's program in nanosciences and has even had the opportunity to gain some professional experience.

Mina-Lou is very pleased with the support she receives from the tutors. (Image: M.-L. Schleith).

Andreas Ruh has already completed his bachelor's program in Tübingen and has even had the opportunity to gain some professional experience.

Classroom teaching has also been suspended for Mina-Lou since the start of November. "The days are really quite monotonous," she says. "Luckily, there are a few virtual groups where we do practical exercises together and sometimes also discuss things on a one-to-one basis." Mina-Lou is very pleased with

After completing his bachelor's in nanosciences in Tübingen, he spent two years working at the company OSA Opto Light in Berlin. However, his thirst for knowledge and further progression ultimately led him to enroll on a master's in nanosciences. "I chose the University of Basel because it has an excellent reputation, plays a leading role in research and also has excellent links with industry in the region," he says.

In order to study in Basel, Andreas moved to Lörrach. As he tells us in our interview, he's very comfortable in his shared flat there and has settled in well. The lectures he has been attending so far are both interesting and enjoyable. Although he still attended one classroom lecture course at the start, he now does all of his learning from home.

He too had different expectations of starting university and finds it hard from time to time. Despite the excellent advice and support he receives from the Student Coordination Office, and having met several students at a nano student association event, he lacks personal contact with people in a similar situation to him. This is difficult, however, given that only a small number of new students come to Basel from other universities to study for a master's in nanosciences. As the bachelor's degree in Basel is very diverse and the program that the students complete is highly specific, graduates usually have to satisfy a series of requirements in order to switch to the university after their bachelor's.

Dimitrios Tripkis has learned a lot during his first block course in Basel and was delighted to work on the AFM himself.

Still some catching up to do

Andreas still has a number of classes and two block courses to attend before he can get started with the lectures for his master's program. A similar situation faces his fellow student Dimitrios Tripkis, another new arrival on the master's program in Basel in fall semester.

Dimitrios was born in Switzerland but grew up in Greece, where he also completed a bachelor's degree in materials science. He has now come to Basel to study for his master's in nanosciences, having been very impressed with the nanosciences degree program, and is also keen to get to know Switzerland better.

This semester, Dimitrios has already completed a block course on atomic force microscopy (AFM) and was delighted at the opportunity to work on such high-tech equipment himself. "In Greece, the professors showed us how the devices worked, and we just watched," he says. He also sees clear advantages to having all lectures online. "It gives you more freedom, and you can catch up on or repeat courses whenever you like," he says. That being said, he would prefer it – and be more motivated – if he could sit in a lecture hall with the other students.

Although the current circumstances are sometimes not easy, and despite the lack of contact with fellow students, both Andreas and Dimitrios say they made the right choice by coming to Basel, and neither of them has any regrets about their decision. Indeed, they are happy here and looking forward to embarking on their master's studies in earnest once they've obtained the remaining credit points.

We hope all of our students emerge happy and healthy from this difficult time and that we can welcome them back to class in person again soon.

Further information about the Nano Argovia program:

www.nano-argovia.ch

New Argovia projects

As part of the Nano Argovia program, the SNI Board recently approved nine new projects which will get underway in January 2021.

The new projects once again deal with a wide range of topics, and three relate to medical applications. In one case, researchers are investigating a way to cross the blood-brain barrier in order to deploy enzymes in therapy, while another two projects center around approaches that use hydrogels to prevent inflammation around implants and to treat ulcers in the oral mucosa. Two further projects deal with the development of new types of sensors, while others aim to develop a new laser amplifier and to improve nanostructuring using lasers. Other research topics include achromatic lenses for transmission X-ray microscopy and the development of new detectors for cryo-electron microscopy.

We'll bring you further details of the projects in the spring issue of SNI INSight.

The participants in seven of the new Nano Argovia projects include SNI members from the University of Applied Sciences and Arts Northwestern Switzerland (FHNW), while five of the projects are being conducted in collaboration with members of the University of Basel. In addition, the Paul Scherrer Institute (PSI) is involved in three of the projects, and the network partner CSEM Muttenz in one. Six of the industrial partners hail from the Canton of Aargau, and three are based in Basel-Stadt and Basel-Landschaft.

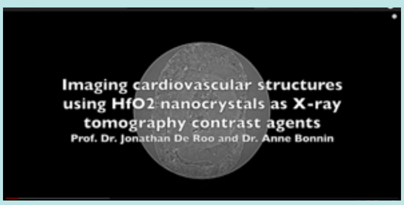
Information about the SNI PhD School:

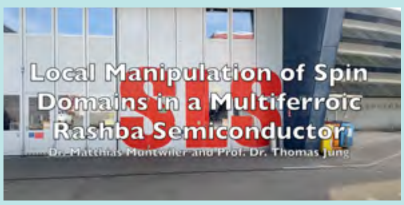
https://nanoscience.ch/en/research/phd-program/

Applications still open for new PhD projects

Early career researchers can still apply for the new projects at the SNI PhD School until the end of the year.

The program website provides not only descriptions of the projects, but in some cases also short videos produced by Dr. Michèle Wegmann in collaboration with the various project leaders.





Young winner

In spring and summer, the SNI outreach and communication team filmed numerous experiments for children to encourage them to try their hand at experimenting at home. Children, young people and adults were called upon to submit photos and videos of their own attempts in order to inspire as many families as possible to join in. An iPad mini was then raffled off among the entrants.

When the campaign ended in August, the prize went to six-year-old Alyssa, who really enjoyed experimenting and was very excited to win the top prize.

Experiments page of the SNI:

www. nanoscience.ch/experimente

> "We highly appreciate the Swiss Nanoscience Institute's series of experiments because it is such a wonderful opportunity to get to know the world of science in a playful way, being at home and using household items."

Family Heusler (Basel-Stadt)

Alyssa had a lot of fun on several occasions - experimenting, winning, and trying out the iPad.

Under suspicion
Interactive program for the digital Science Days

The twentieth anniversary of the annual Science Days event at Europa-Park in Rust (Germany) was not what the organizers had originally planned. Like so many other events, this year's edition had to be held digitally. From 19 October to 29 November, research institutions, associations and companies put on a diverse program of activities aimed at awakening young people's interest in science, just as in previous years.

A long-standing participant in the Science Days, the SNI was on hand to support the digital edition as well, both as a sponsor and a contributor with an exciting program of its own.

Teaser video:
https://www.youtube.com/watch?v=XxdnOXkTKP-M&list=UUbR9khNxj-Xbhc-Su7_cCOVw&index=9

Web page Under suspicion:
https://nanoscience.ch/en/ueber-uns/experimente-und-bastelei-en-zu-hause/adventure-unter-verdacht/

As well as providng instructions for a wide range of experiments, the SNI put together a science kit for kids to use in solving an imaginary crime. With the help of a folding microscope, various other analytical methods and a host of clues, aspiring sleuths could examine samples and collect evidence to solve the case. The experiments were put together by the SNI's Dr. Kerstin Beyer-Hans and sent to interested school classes and individuals. As she stocked up with plenty of the necessary materials, there are still a few kits left. Anyone interested in doing some detective work over the Christmas holidays is welcome to order one!

The set contains everything you need to identify the culprit.

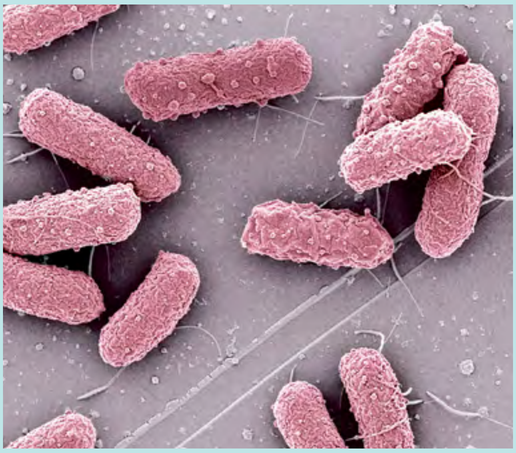
Nano Imaging Lab:
https://nanoscience.ch/en/services/nano-imaging-lab/

Stunning images at the ready

Competent support from the Nano Imaging Lab

The SNI's communications team helps SNI members draft media releases about their research projects and results. In order to appeal to as broad an audience as possible, powerful and intriguing images are especially important.

The SNI's Nano Imaging Lab is a valuable asset in this regard, reliably delivering breathtaking snapshots of the micro and nanoworld every time. Perhaps you too might like to have your research imaged by the NI Lab to make sure you have exciting images on hand when the next media release is due.



Bacteria also provide beautiful images (Images: Nano Imaging Lab, SNI, University of Basel)

News from the network

Efficient valves for electron spins

Researchers at the University of Basel in collaboration with colleagues from Pisa have developed a new concept that uses the electron spin to switch an electrical current. In addition to fundamental research, such spin valves are also the key elements in spintronics – a type of electronics that exploits the spin instead of the charge of electrons. The results were published in the scientific journal Communications Physics.

Media release
Publication in Communication Physics

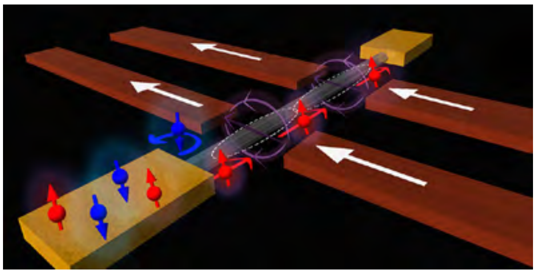
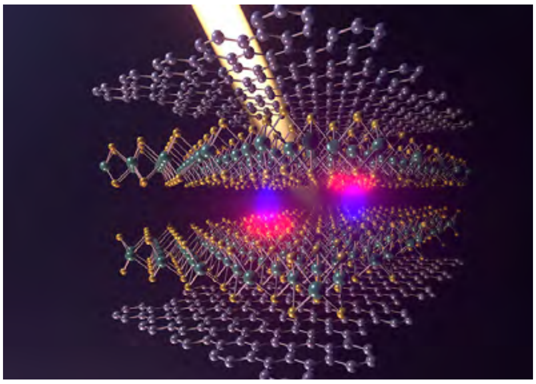


Illustration of the spin valve: Both quantum dots (dashed ellipses) on the nanowire are tuned by nanomagnets (brown bars) such that they only allow electrons with an "up" spin to pass. If the orientation of one of the magnets is changed, the current flow is suppressed.
(Illustration: Department of Physics, University of Basel)



Schematic illustration of the electron-hole pairs (electron: pink, hole: blue), which are formed by absorption of light in the two-layer molybdenum disulfide layer.
(Image: Nadine Leisgang and Lorenzo Ceccarelli, Department of Physics, University of Basel)

A highly light-absorbent and tunable material

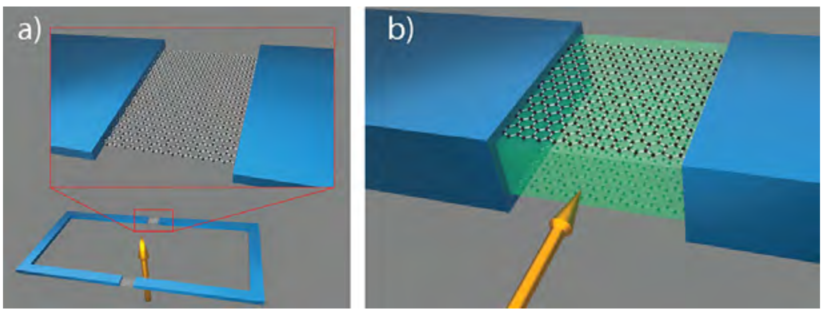
By layering different two-dimensional materials, physicists at the University of Basel have created a novel structure with the ability to absorb almost all light of a selected wavelength. The achievement relies on a double layer of molybdenum disulfide. The new structure's particular properties make it a candidate for applications in optical components or as a source of individual photons, which play a key role in quantum research. The results were published in the scientific journal Nature Nanotechnology.

Media release
Publication in «Nature Nanotechnology»

A tiny instrument to measure the faintest magnetic fields

Physicists at the University of Basel have developed a minuscule instrument able to detect extremely faint magnetic fields. At the heart of the superconducting quantum interference device are two atomically thin layers of graphene, which the researchers combined with boron nitride. Instruments like this one have applications in areas such as medicine, besides being used to research new materials.

Media release
Video
Publication in «Nano Letters»

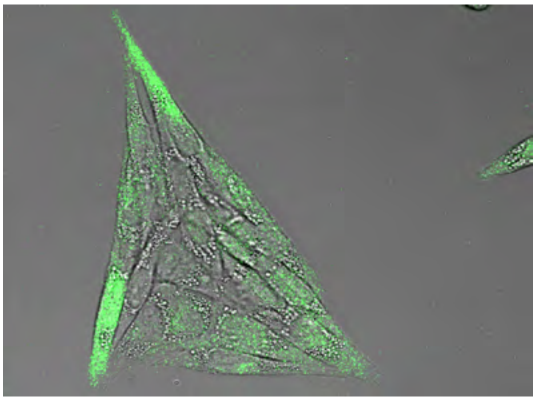


a) A conventional superconducting quantum interference device (SQUID) consists of a superconducting ring interrupted at two points by weak links (in this case a graphene layer). b) The new SQUID is made up of a stack of two-dimensional materials, including two graphene layers separated by a thin film of boron nitride.
(Image: Department of Physics, University of Basel)

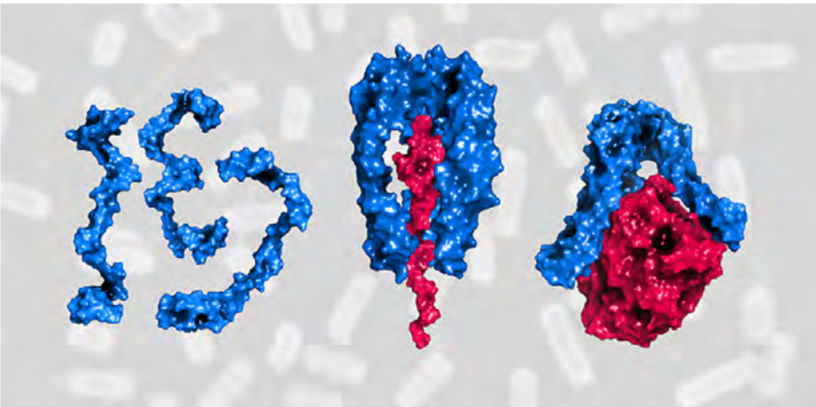
Bioactive nano-capsules to hijack cell behavior

Many diseases are caused by defects in signaling pathways of body cells. In the future, bioactive nanocapsules could become a valuable tool for medicine to control these pathways. Researchers from the University of Basel have taken an important step in this direction: They succeed in having several different nanocapsules work in tandem to amplify a natural signaling cascade and influence cell behavior.

Media release
Publication in «ACS Nano»



Enzyme-loaded nano-capsules work in tandem. The calcium level in the cells (green fluorescence) serves as an indicator that the system is working.
(Microscopic image: Department of Chemistry, University of Basel)



Three Skp proteins (blue) form a stable structure and transport unfolded outer membrane proteins (red) to their destination (from left to right).
(Illustration: Biozentrum, University of Basel)

How bacteria reinforce their protective shield

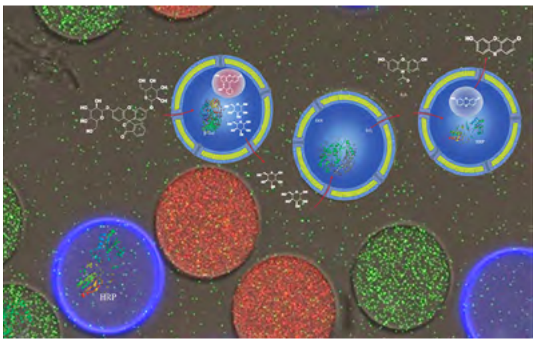
Researchers at the University of Basel have discovered a new mechanism by which bacteria ensure that their outer cell membrane remains intact and functional even under hostile conditions. This mechanism is important for the pathogen's survival in the host. The study provides new insights underlying pathogenic virulence.

Media release
Publication in «Science Advances»

An artificial cell on a chip

Researchers at the University of Basel have developed a precisely controllable system for mimicking biochemical reaction cascades in cells. Using microfluidic technology, they produce miniature polymeric reaction containers equipped with the desired properties. This "cell on a chip" is useful not only for studying processes in cells, but also for the development of new synthetic pathways for chemical applications or for biological active substances in medicine.

Media release
Video
Publication in «Advanced Materials»



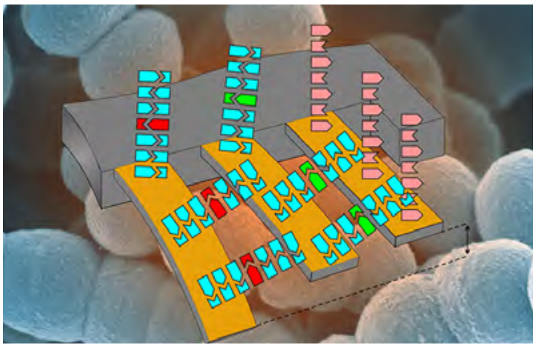
The researchers used the newly developed microfluidic platform to produce three different types of vesicles with a uniform size but different cargoes: β-galactosidase (red vesicle), glucose oxidase (green vesicle) or horseradish peroxidase (blue). The water-soluble enzymes gradually convert the starting product into the final colored product Resorufin, which — like all of the intermediates — enters the surrounding solution via selective channels in the vesicle membranes.
(Image: Department of Chemistry, University of Basel)

A ray of hope during Advent

We start with a seesaw and a candle holder from old CDs. We show how candle flames can be extinguished with vinegar and baking powder and that a candle can also burn under water.

It's getting colder outside, the nights are getting longer, and many leisure activities are currently on hold. Luckily, we're now entering the Advent season, when we can make our homes a little cozier with the help of fairy lights and cookies. What's more, the Swiss Nanoscience Institute of the University of Basel is demonstrating festive experiments that people can try out at home to keep themselves entertained over Advent.

Media release
Videos and explanations



Schematic illustration of the cantilever array to detect antibiotic resistance. (Image: Department of Physics and Nano Imaging Lab, SNI, University of Basel)

Quick and sensitive identification of multidrug-resistant germs

Researchers from the University of Basel have developed a sensitive testing system that allows the rapid and reliable detection of resistance in bacteria. The system is based on tiny, functionalized cantilevers that bend due to binding of sample material. In the analyses, the system was able to detect resistance in a sample quantity equivalent to 1–10 bacteria.

Media release
Video

Christof Sparr receives ERC Consolidator Grant

The European Research Council (ERC) awards three researchers from the University of Basel with one of the coveted ERC Consolidator Grants. One of these is Prof. Dr. Christof Sparr.

He investigates new synthetic methods to control the configuration of stereoisomers with higher-order stereogenic elements. These are chemical compounds with identical binding patterns that differ in the spatial arrangements of their atoms.

Excerpt from media release

Prof. Dr. Christof Sparr receives an ERC Consolidator grant.

SNI INSight — Showcasing research and activities of the Swiss Nanoscience Institute

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