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 at the Swiss Nanoscience Institute

August 2021

Medical nanosciences

Diverse research and education at the SNI

Swiss NanoConvention

A look behind the scenes

Excellent

Prize-winning researchers

Electron diffraction

Unique offer for SNI members

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Editorial

Dear colleagues,

Summer is here, and hopefully we'll all have a little time to relax before the vacation ends and the new semester begins.

As this issue of SNI INSight shows, the Swiss Nanoscience Institute doesn't suffer from a summer slump. Quite the opposite, in fact – we have plenty of hot topics and news to share with our network.

Michèle Wegmann, our Outreach Manager, kicks things off by summarizing what we actually understand nanomedicine to be, and the areas of nanomedicine in which the SNI is involved. It's a truly impressive overview.

Nowadays, medical nanoscience isn't just the subject of basic science projects at the PhD School or applied research in the Nano Argovia program – it also features in degree programs and outreach events. As of fall semester 2021, students on the master's program in nanoscience will be able to select "Medical Nanoscience" as a major. The SNI team also like to cover nanomedicine when they participate in the SATW TecDays.

Nanomedicine topics were also well represented at this year's Swiss NanoConvention, which took place in digital format. The start-up anavo medical, which won the Nanotechnology Start-up Award at the SNC 2021, is a good example of how nanotechnology can contribute to medical applications.

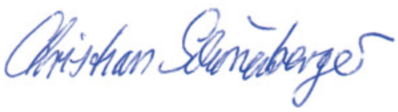
The SNC 2021 has been one of the highlights of the last few weeks. Although we were only able to meet online, I was very impressed by the event organized by the SNI. The international speakers covered a fascinating range of topics and there were excellent networking opportunities. Once again, I would like to thank the whole organizational team, particularly Kerstin Beyer-Hans and Tosca Kummli.

Our doctoral students also recently enjoyed a special event: the Innovation Workshop was supported by the Innovation Office at the University of Basel and taught them about the initial steps involved in founding a start-up.

ELDICO Scientific, a start-up based in Aargau, has already taken these steps. Founded in 2019 within the SNI network, the company is bringing an electron diffractometer to the market that can determine the structure of nanoscale materials. SNI members will soon have a unique opportunity to try out and use the new device.

I hope you enjoy this informative issue and have an opportunity to relax over the summer before we meet – hopefully in person – at Lenzerheide for our Annual Event.

Kind regards,



Professor Christian Schönenberger, SNI Director

Nanomedicine
Uniting medicine and technology

"Nanomedicine" has become a popular term in the media today. A Google search turns up nearly 35,000 hits for the German "Nanomedizin" while the English term racks up nearly 264 million entries. In this article, we want to explain what nanomedicine means and discuss the many ways in which the Swiss Nanoscience Institute is contributing to the field's wide-ranging applications.

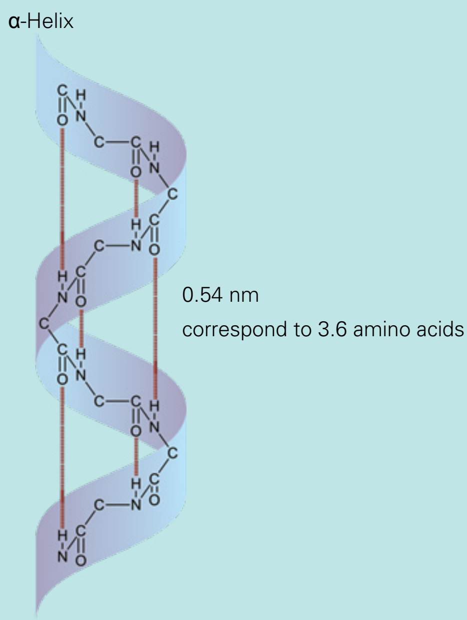
The term nanomedicine is frequently used to describe nano delivery systems and cancer therapies that rely on nanoparticles and nanocarriers. In this article, we use the term to refer generally to the use of nanotechnologies in the field of healthcare, or more specifically, the application of nanotechnological methods in medical diagnostics and treatment.

Nanomedicine is concerned with molecules and materials ranging in size from 1 to 100 nanometers. Materials of this size exhibit novel properties that do not occur in the macro world as we know it. For this reason, many past discoveries are now subject to renewed study from this fresh perspective.

In modern research, new milestones in medical science often hinge on technical advancements related to phenomena at the level of the micrometer or the nanometer. This is no real surprise, since the miniscule components that make up the machinery of our bodies operate at these tiny scales.

Nanotechnology methods and instruments can be used to study proteins and other tiny structures. Researchers in the field investigate the molecular causes of disease and develop new therapies that target these causes instead of simply treating the symptoms. For instance, they may study new biomaterials for implants and prosthetics or develop nano

Proteins
Proteins play a central role in the way our bodies work. We need them to live, and they are the primary components of every cell in our bodies. Proteins transport materials, provide structural support, navigate, and regulate processes. They are made up of vast amino acid chains that vary in length and have different three-dimensional structures. Hydrogen bonding determines the secondary structure of the protein – in this case, an alpha helix, which, with a diameter of 2 nanometers, falls within the nano range.



The «alpha helix» is a common protein structure produced by hydrogen bonding (indicated by the dotted lines). These structures have a diameter of 2 nanometers. Each amino acid contributes 0.15 nanometers to the overall length of the helix, and each twist of the helix, with a length of 0.54 nanometers, is made up of 3.6 amino acids. (Image: Shutterstock) delivery systems designed to transport pharmaceutical substances and release them exactly where they are needed.

Combining nanotechnology and medicine has also produced new diagnostic methods with improved sensor systems. Researchers are developing both miniature laboratories that fit on tiny chips and help simplify the study of cellular processes as well as novel contrast agents that sharpen medical imaging results.

Nanotechnology for implants and prosthetics

Surgery, orthodontics and dental medicine have all benefitted dramatically from advancements in nanomedicine. Current work on medical implants illustrates this point very clearly. Nanotechnology methods are being implemented to optimize the materials used to make medical implants, as these devices must comply with a lengthy list of requirements. On the one hand, they must be capable of effective force distribution, while on the other hand, they must demonstrate high biocompatibility, as they will make direct contact with the host's bone and soft tissue cells. In addition, the material must be non-toxic, sterilized, and engineered with submicrometer precision. Most implants are made from metallic substances; titanium and titanium alloy implants are particularly well suited to these applications, as they exhibit the properties listed here.

To guarantee a lasting bond between the titanium implant and the bone, bone synthesizing cells (osteoblasts) must adhere to the surface of the titanium. These osteoblasts form new bone cells and ensure that the implant gradually fuses with the bone tissue. To promote bone growth on the surface of the implant and help the implant fuse to the bone, researchers coat these implants with hydroxyapatite, a calcium phosphate compound that is also a central component of organic bone tissue.

As part of the Nano Argovia project NanoCoat, an interdisciplinary team of scientists have developed a cost-effective method to further optimize the surface properties of conventional titanium dental implants. The newly developed process involves taking the conventional microstructure of the surface and adding nanotexturing and a calcium phosphate coating that serves as a kind of synthetic bone tissue. The team is currently planning additional comprehensive studies

Sources:

Nanomedizin

https://link.springer.com/content/pdf/10.1007/s12285-010-0192-0.pdf

Nanomedizin – Chancen und Risiken

http://library.fes.de/pdf-files/stabsabteilung/05709.pdf

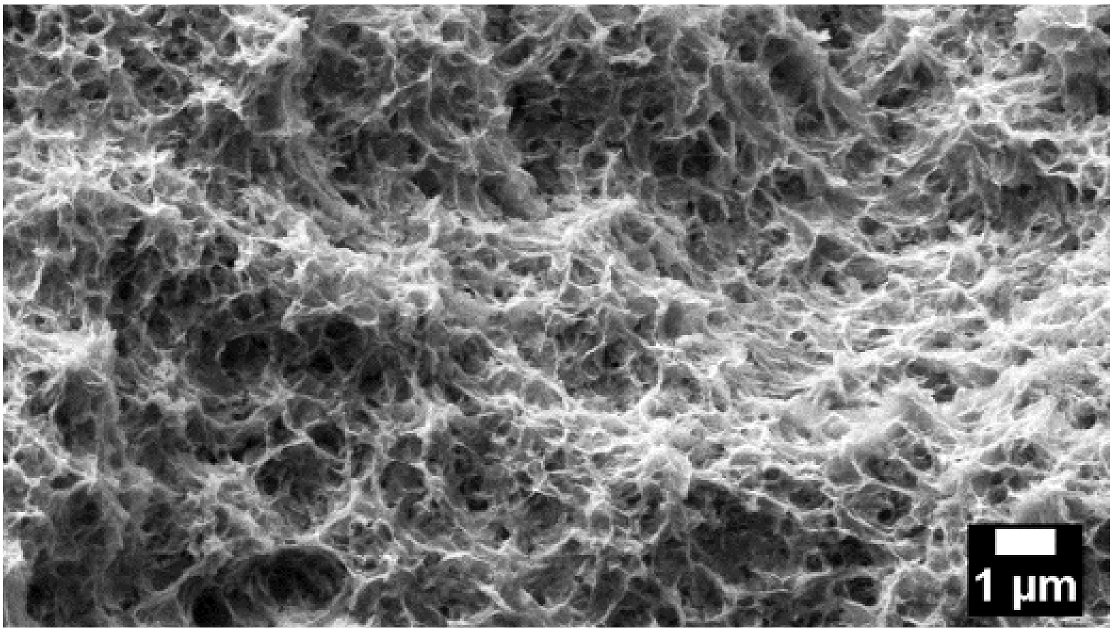
nanomedicines

https://doi.org/10.1016/j.jconrel.2019.10.020

More information about the projects:

NanoCoat

Project description



Nanostructured and calcium phosphate coated NanoCoat surface. (Image: Medicoat)

Dental implant (Image: Shutterstock)

More information:

Promucola
Project description

3D Cellophil
Project description

CIS Pharma Technology
Website

SLActive®
Website

Perionano
Project description

investigating the biocompatibility of these surfaces and the way they fuse to the surrounding bone tissue. Once the studies begin, it will be at least three years before patients can benefit from the optimized implant technology.

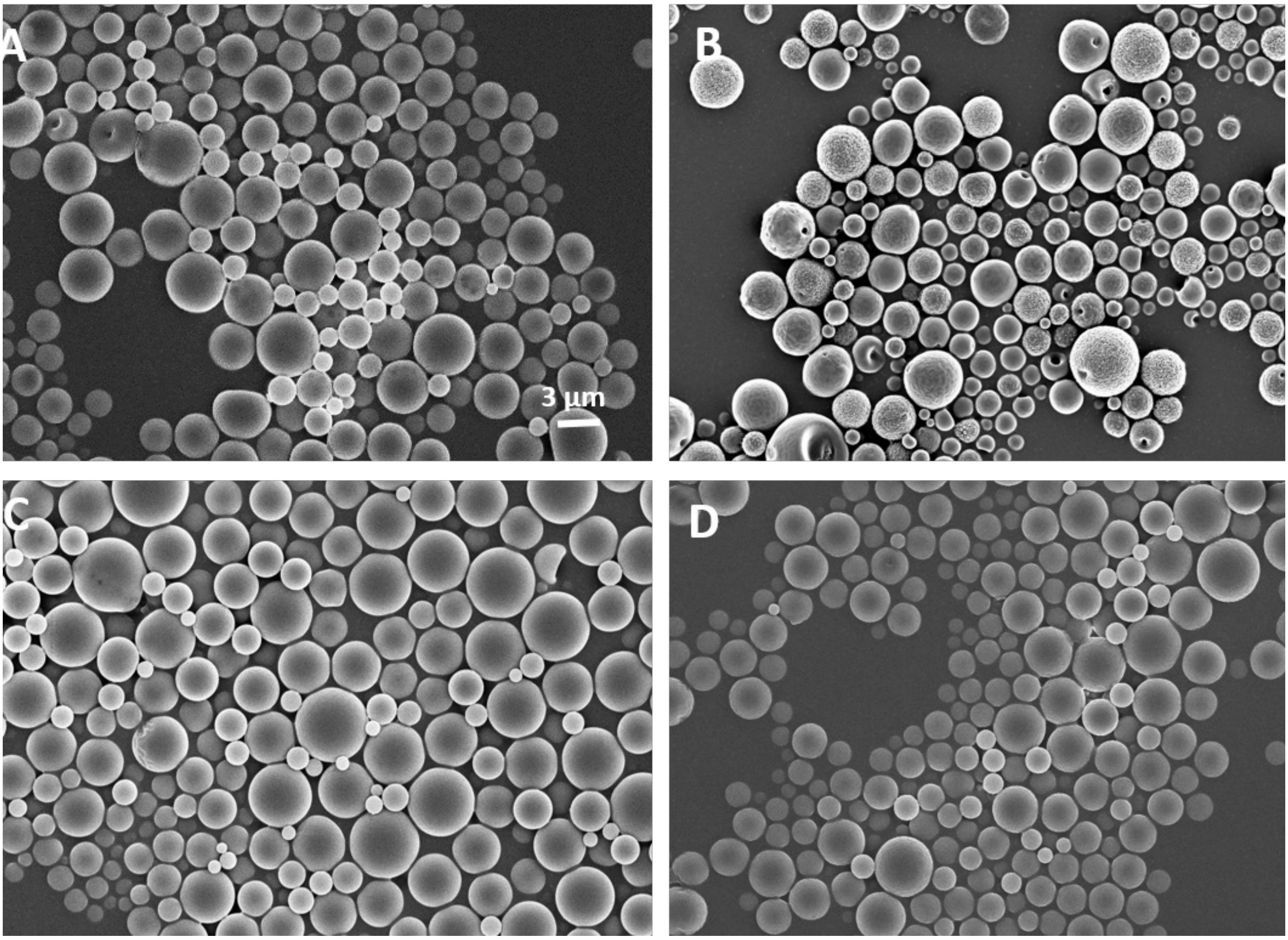
There is a second project in the Nano Argovia program that focuses on coating titanium implants. The Promucola project is slightly different in that its main objective is to minimize wear on the titanium implants. In collaboration with Orchid Orthopaedics Switzerland GmbH, the researchers use a plasma spray procedure to apply a ceramic coating that protects the implant from premature wearing. By applying a controlled coating of this new, complex, biocompatible powder mixture, researchers create a multi-component layer that vastly increases the implant's hardness and resistance to abrasion. The team is currently studying how to optimize the procedure and apply these additional coatings on an industrial scale.

Nanostructures promote early bone-to-implant integration

The field of dental implantation is also witnessing dramatic innovations. In the Nano Argovia project 3D-Cellophil, scientists have developed a triple-layered, biocompatible polymer membrane based on the Cellophil® technology pioneered by CIS Pharma. Cellophil is a combination of various natural amino acids linked by an acrylic backbone and characterized by a high degree of biocompatibility.

After exposure to UV light, the membrane layer polymerizes within seconds. The porosity of the membranes varies based on the intensity of the irradiation. With the help of this technology and an additional layer of nano hydroxyapatite crystals embedded in the membrane, this membrane meets the needs of both soft and hard tissues, thus supporting the tissue regeneration process. Although each of the three layers has a different structure, these layers can be manufactured and cross-linked one after another in a kind of stacking process. Using a 3D printer, it is possible to customize the size of the membrane to suit the needs of each individual patient.

The superhydrophilic, nanotextured surface technology SLActive® developed by Institut Straumann also helps implants fuse to the jawbone as it heals. Dental implants are coated in nanostructures made of Roxolid® (titanium-zirconium alloy) that increase the surface area of the implant. This aids in protein absorption



In the PERIONANO project, researchers studied particles loaded with antimicrobial agents (A + B) or with substances of plant origin (C + D). (Image : FHNW Muttenz)

and fibrin scaffold formation as well as bone cell mineralization. These properties are key to promoting early healing in dental implant procedures.

Using peptide scaffolds and integrated particles to fight peri-implantitis

Dental implants are frequently affected by bacterial inflammation of the surrounding tissue (peri-implantitis). Failure to treat this condition may result in the loss of the implant. To prevent major bone defects that could result in implant loss, this inflammation must be remedied early on and any lost tissue promptly regenerated.

As part of the Nano Argovia project Perionano, an interdisciplinary team of scientists is working to develop a therapy to both combat the inflammation caused by bacterial infection and regenerate damaged tissue. In this approach, peptides are used to create a nanofiber scaffold containing tiny nano- and microscale particles that gradually release pharmaceutical substances to combat pathogenic bacterial strains at a local level. The peptide fiber scaffold also helps promote regeneration of damaged soft tissue and bone tissue.

Antibacterial and antiviral surfaces

During surgical procedures and in the case of implants, it would be practical to simply prevent the spread of the bacteria responsible for causing these problems in the first place. That is why researchers are developing antibacterial surfaces designed to prevent bacterial growth.

Preventing bacterial growth

Nano Argovia's TiSpikes project is dedicated to just this approach: The team aims to prevent biofilms – or a layer of bacteria – from forming, as biofilms are extremely difficult to treat using antibiotics. This idea originally stemmed from observations of natural phenomena. The surfaces of a cicada's wings are covered in myriad tiny pillar-like structures and a gecko's skin is equipped with nanostructures; each of these adaptations prevents the formation of biofilms. TiSpikes's interdisciplinary research team developed a process that allows surfaces made from titanium and titanium alloys to be textured in different ways. They are now working to determine which of these surface textures most effectively inhibits the growth of bacteria of various sizes.

Binding viruses using silver chloride microparticles

Coated surfaces can imbue many materials with a range of new properties. In light of current events, antibacterial and antimicrobial materials have become a subject of intensive study. Components such as silver or cell-like structures known as liposomes can be used to bind and destroy viruses. HeiQ Viroblock NPJ03, developed by the Swiss firm HeiQ, a spin-off from ETH Zurich, is an example of this type of application: Positively charged silver chloride microparticles attract the negatively charged viruses and bond to them. The specially formulated liposomes extract the cholesterol from the viral envelope, depriving the virus of the protective membrane it needs to survive. This paves the way for the silver particle, which attacks the viral DNA on a chemical level, ultimately destroying the virus. The principle is currently being broadly implemented in face masks designed to protect the wearer from infection by SARS CoV-2.

Many companies are now embracing the idea of using silver as an antiviral product. In addition to producing antiviral textiles, they are also developing specialized silver coatings for common surfaces such as door handles, work surfaces and medical devices.

Detecting antibiotic resistance

Bacteria that have become resistant to a range of antibiotics present a major threat to public health. When treating bacterial infections, medical specialists need fast access to information about resistant strains in order to make the right decisions as quickly as possible. Normally, bacteria are cultured and then tested for antibiotic resistance, a process which can take between 48 and 72 hours. Some strains of bacteria, however, are very difficult to culture. Molecular biological PCR tests produce rapid results, but they are not equally effective for all types of bacteria.

More information:

TiSpikes

Project description

HeiQ Viroblock

Website

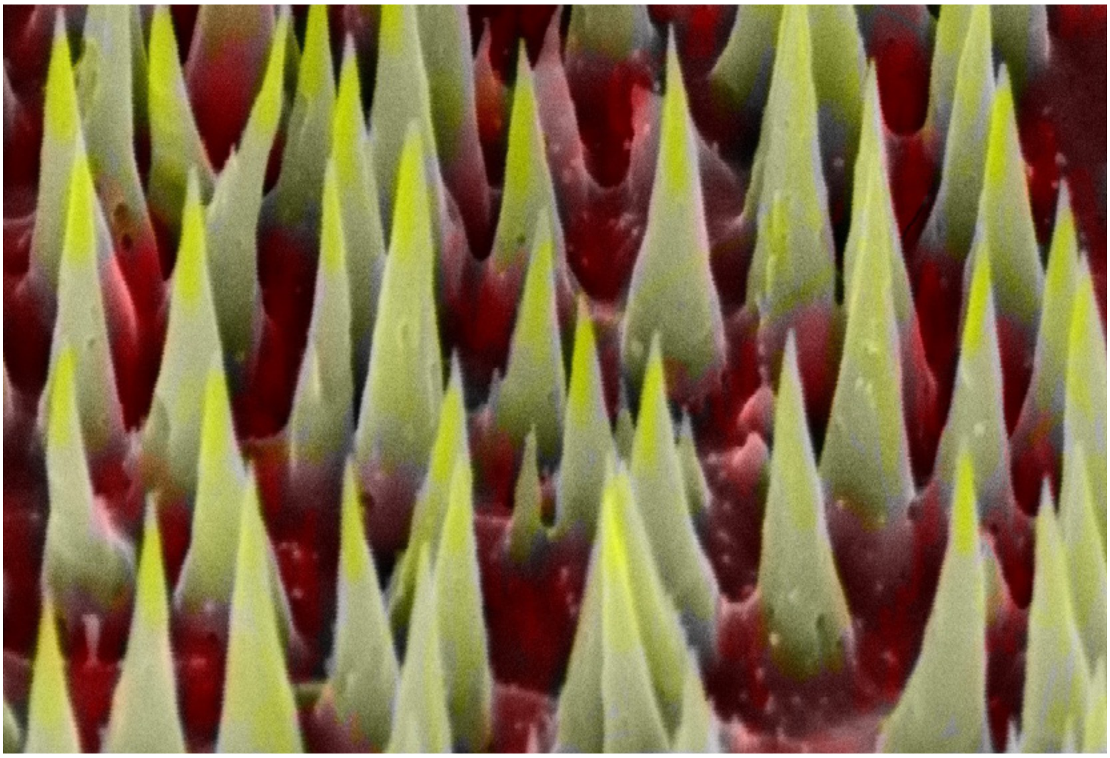
Test system for antibiotic resistance

Project description

Video

Resistell

Website



Nanostructures on titanium surfaces are being used in the TiSpikes project to mimic the wing surface of cicadas in order to keep bacteria at bay. (Image: D. Mathys, F. Sanchez, University of Basel)

Now, researchers at the University of Basel have developed a highly sensitive testing system capable of detecting bacterial antibiotic resistance quickly and effectively. The system is built around tiny cantilevers designed to bend as they bind to sample material. This type of test requires a sample size of only 1 to 10 bacterial cells to detect antibiotic resistance.

The idea pioneered by start-up Resistell is based on a very similar principle. First, a so-called nanomotion detector is used to determine whether a bacterial cell is viable. This method is based on the assumption that all living cells, such as bacteria, exhibit at least some amount of motion due to their metabolic processes. Using a technique similar to atomic force microscopy, Resistell's technology determines how bacterial pathogens respond to a specific antibiotic.

Unlike conventional antibiotic diagnostics, the technology developed by Resistell can detect antibiotic resistance within just a few hours, allowing doctors to select an effective antibiotic to treat their patients. Resistell plans to have its products on the market by September 2021. The company aims to decrease mortality rates associated with sepsis, reduce the use of broad-spectrum antibiotics and prevent the development of dangerous antibiotic-resistant bacteria.

Diagnostics

The sooner a disease can be diagnosed, the better the patient's chances for recovery. That is why it is important to identify the molecules or genes that signal the presence of different diseases. Diagnostic methods based on nanotechnology require only miniscule sample sizes, therefore allowing these so-called biomarkers to be detected more quickly using less invasive procedures.

Lab on a chip

Normally, when doctors take blood and cell samples, they send them to a laboratory for analysis since not every doctor's office is equipped with a fully stocked laboratory. Using the lab-on-a-chip technique, doctors' offices can assay tiny samples on-site.

To do this, they need a microfluidic chip attached to a pump and a sensor and software to analyze the results. The pump delivers nanoliter-scale doses of the sample material while the sensor records the necessary parameters, and the software evaluates the results. In the future, this type of technology could be used to carry out multiple assays using the same sample without requiring laborious preparation prior to testing. The smaller sample sizes reduce strain on patients, and diagnoses can be made more quickly and cost-effectively.

This device, developed by Resistell, can detect bacterial sensitivity to various antibiotics (Image: Resistell).

Digital pocket diagnostics

Some diseases require continuous monitoring; diabetes, for example, requires frequent blood glucose testing, and the spread of coronavirus can be tracked with the now familiar rapid tests. These types of diagnostics, referred to as point-of-care testing (POC), require no specialized diagnostic equipment and can be conducted wherever patients are being treated. POC testing also allows patients to monitor key markers independently from the comfort of their own homes. Moreover, it provides medical personnel with fast, easy-to-administer tests that lead to safe, more efficient treatment. In areas where personnel have limited access to specialized diagnostic facilities, these types of POC tests, which do not require any additional laboratory equipment, have enormous potential to offer.

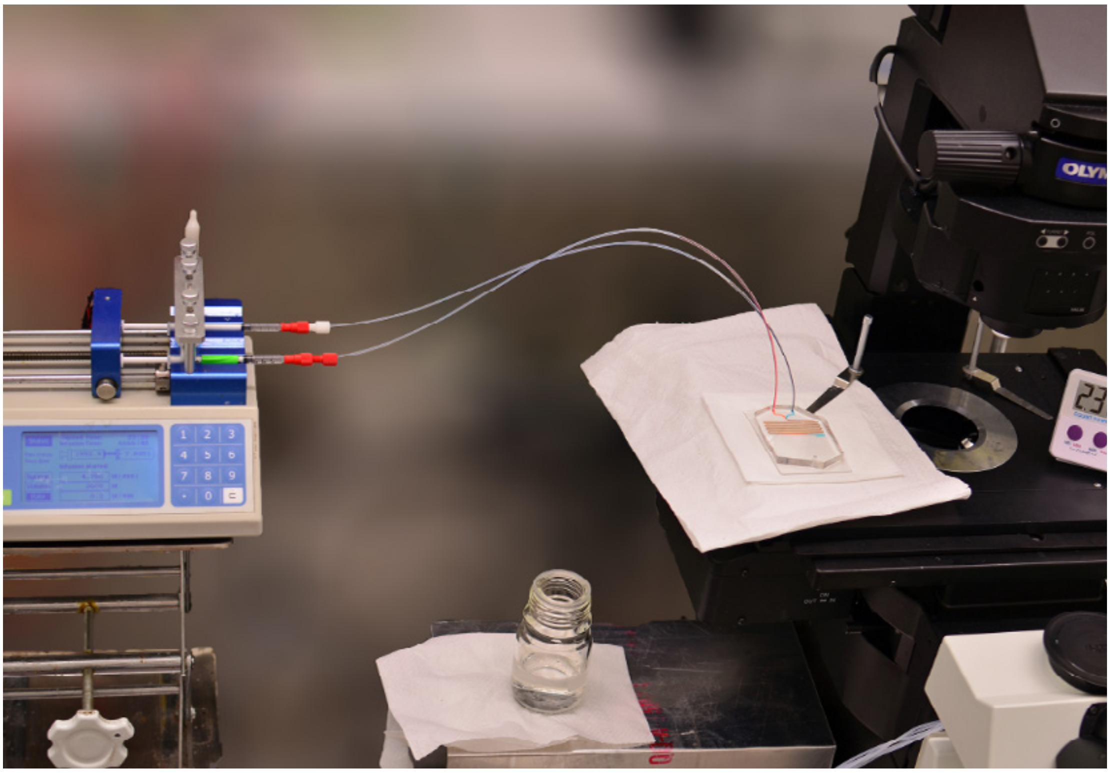
As part of the Nano Argovia project PEPS, an interdisciplinary research team is currently developing a digital POC device equipped with an electrochemical sensor designed to detect specific protein biomarkers.

The novel aspect of the approach selected for the PEPS project is the team's plan to use affordably manufactured, conductive nanocomposite electrodes. The combination of high electrical conductivity and strong antifouling properties could prove to be the key to producing highly sensitive electrochemical POC tests.

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 polymeric vesicles equipped with the desired properties. Researchers can control the exact size and composition of the vesicles to allow different biochemical reactions to

Highly sensitive electrochemical sensor, which is being developed in the PEPS project (Image: CSEM).



Lab on a chip: A microfluidic chip connected to a pump and sensor and the appropriate software to analyze the sample (Image: Shutterstock).

More information:

PEPS

Project description

Cell on a chip

Project description

Video

Artidis

Project description

Website

Contrast agents

Project description

occur inside each one without affecting any of the others – just like in the different organelles of a cell. This technology can be used for in-depth study of specific mechanisms involved in metabolic disease.

Nanomechanical biomarkers help diagnose cancer and optimize treatment methods

The company ARTIDIS, a spin-off from the University of Basel with deep roots at the SNI, has developed a platform capable of analyzing nanomechanical biomarkers for tumor diagnosis and optimized cancer therapy. The technology uses an atomic force microscope to probe individual cells. Metastatic tumor cells are much softer and more pliable than the cells of normal tissue and benign tumors.

Unlike conventional assays, which can take up to two weeks, the ARTIDIS method is capable of analyzing biopsy samples within just a few hours, sparing patients tense waiting times of days or even weeks before they receive their diagnoses. On top of that, the ARTIDIS platform paves the way for personalized cancer treatment.

Researchers have successfully completed a clinical trial in which this approach was used to treat breast cancer. Now the diagnostic method is being broadened to include lung and pancreatic cancer and is ready for clinical implementation. The dedicated team at ARTIDIS is planning to build on this nanotechnology platform, expanding beyond tumor biopsies and applying the approach to the analysis of all types of tissue.

Novel contrast agent for medical imaging procedures

Contrast agents improve the visibility of bodily structures in medical imaging techniques such as X-rays, magnetic resonance imaging (MRI) and ultrasounds. Conventional contrast agents do not always produce sufficient contrast to allow medical practitioners to identify diseases in their earliest stages. Moreover, they make it difficult to recognize the biochemical environment. Researchers at the University of Basel's Department of Chemistry have developed nanoparticles that serve as "smart" contrast agents for MRI.

Many contrast agents are based on the metal gadolinium, which is injected into the bloodstream. From there, it enters the body's tissues, boosting the visibility of the internal organs. However, gadolinium is toxic and must be chemically bonded to a carrier substance so that it is safe for humans. In a major improvement to this diagnostic technique, the newly developed contrast agent can function with far lower concentrations of gadolinium. Researchers at the University of Basel have developed nanoparticles composed of heparin-modified polymers with gadolinium ions and functionalized peptides. Trials indicate that nanoparticles consisting of these components produce a tenfold amplification of the MRI signal compared with conventional contrast agents. In addition, due to the functionalized peptides, they are able to respond to their environment, therefore allowing researchers to image inflamed or malignant tissue. The trials showed no evidence that the nanoparticles possess cell damaging or anticoagulant properties.

Nano delivery systems

One promising area of nano medical research involves nano transport systems designed to deliver pharmaceutical substances to different parts of the body. These systems employ a range of materials, such as polymers, metallic nanoparticles and liposomes. Polymers in particular are the subject of extensive study, as they demonstrate numerous beneficial properties: They are easy to manufacture, highly biocompatible and biodegradable. In addition, it is easy to load them with different substances. Some approaches undergoing study in the SNI network were described in detail in an article on plastics published in the December 2020 issue of SNI INSight.

Nano delivery systems such as these can be used for both diagnostic and therapeutic purposes. The recent trend toward combining diagnostics and therapy has gained the moniker "theranostics" and is

More information:

ForMeL

Project description

Cancer therapy with virus

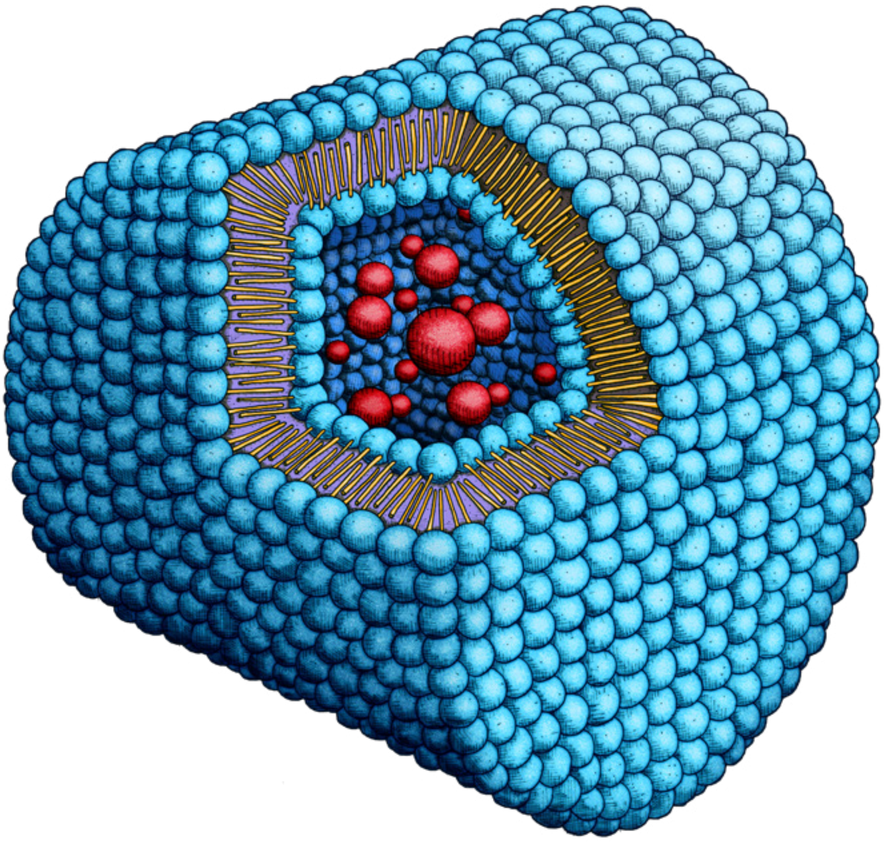
Project description

NCTNano

Project description

SNI INSight December 2020

https://nanoscience.ch/wp-content/uploads/sites/8/2020/12/en_sni-insight_dezember_2020.pdf



Artistic representation of a mechanoresponsive liposome loaded with an active ingredient (in red). (Image: Moser Graphic Design) sometimes referred to as “personalized medicine.” Some of the main components of this approach include testing for genetic predispositions, characterization of the stage of disease, and monitoring of the healing process. One of the aims of theranostics is to determine whether a particular pharmaceutical agent is suitable and effective for treating a particular disease in a specific patient.

Liposomes – reinventing the membrane

Liposomes are vesicles made of a double layer of phospholipid molecules designed to resemble a natural membrane. These phospholipid molecules have both a hydrophobic pole and a hydrophilic pole. This property causes them to self-organize in a double layer, with the hydrophobic parts facing inward and the hydrophilic parts facing outward.

Liposomes can be used to study the biophysical properties of organic membranes. And they are also the focus of intensive study in the field of drug targeting.

The Nano Argovia project ForMeL aims to develop stable, drug-loaded, mechanoresponsive liposomes for use in preclinical studies and to design a manufacturing process capable of producing these liposomes at the scale needed for a pilot project.

Mechanoresponsive liposomes respond to pressure changes in the patient’s blood vessels, for example in the case of atherosclerotic vasoconstriction. Liposomes of this kind could be used to directly target blood clots in vessels affected by arteriosclerotic narrowing without flooding the patient’s entire body with anticoagulants. In the first stage, the team will investigate different liposome formulation technologies and develop targeted analytic methods to characterize the liposomes. Subsequently, in the second stage, the researchers will design and optimize the loading process. The objective of this Nano Argovia project is to develop a complete proposal for the formulation and storage of mechanosensitive liposomes.

Cancer therapies using nanotechnologies

Over the past few years, researchers have developed numerous new and effective therapies for treating different forms of cancer. The success of tumor cells can often be attributed to their ability to outwit the immune system and the body’s built-in defenses. Researchers have discovered that immune system activation may prove to be a key tactic in the fight against cancer. That is why immune activation is central to many modern cancer therapies. Some approaches combat cancer cells using antibodies while others focus on developing therapeutic or prophylactic vaccines. One international research group led by scientists at the University of Basel, for instance, has formulated a promising therapeutic cancer vaccine. Two different weakened viruses are used as vehicles to enable the immune system to identify the cells that cause tumors, thereby prompting it to attack against tumor tissue. The approach is currently being tested in clinical studies.

Many of these therapies have already met with a measure of success but results still vary widely based on the individual patient. Another limiting factor is the process of transporting the necessary proteins to the target cells. The proteins must be protected from enzymatic degradation en route to the target cell. Once they have reached their destination, they must be absorbed by the target cell and release their cargo in the right organelle to achieve the desired effects.

Using nanoparticles to defeat cancer

TargImmune Therapeutics is currently developing a nanotechnology platform in the field of immuno-oncology. Nanoparticles are loaded with a specific cargo substance designed to mimic a viral infection, ultimately destroying tumor cells while simultaneously stimulating the body’s immune system to fight the cancer. Using a chemical vector ensures that the cargo is selectively absorbed by the cancer cells.

The main objective of this research is to optimize the formulation of the nanoparticles used to carry the cargo substance. The Nano Argovia project NCTNano is focused on identifying the optimum physiochemical properties of such nanoparticles – characteristics such as size, shape and surface tension – as they are key to the safety and efficiency of the delivery system. Furthermore, various microscopy techniques have helped to reveal how these particles form molecular bonds and deliver their cargo into the target cells.

Another significant factor is understanding exactly how the pharmaceutical cargo works. The SNI-funded project was able to employ cutting-edge sequencing methods to investigate the activity of the innovative nanoparticles in numerous different cell lines. In addition, researchers have continued development on the pharmaceutical used by TargImmune Therapeutics so that the agent can soon be approved for implementation in the first phase of a series of clinical trials.

Nanoparticles for safe and efficient gene therapy

Gene therapy is one of the methods used to treat genetic disorders, tumors or other diseases. The process involves taking some of the affected cells from the patient's body and inserting specific nucleic acid sequences (RNA or DNA). The modified cells are then cultured and injected back into the body. Depending on the type of gene therapy and technique used, the nucleic acids may either be fully integrated into the cell's genome or simply remain inside the cell for a period of time.

For gene therapy to be successful, DNA fragments need to be delivered to the target cells. A research team at the University of Basel and ETH Zurich has successfully designed a peptide-based delivery system capable of transporting DNA fragments of up to 100 nucleotides in length.

Peptides are short chains consisting of roughly 50 amino acids. It is their size alone that distinguishes them from proteins. Peptides make excellent nanocarriers because they are highly biocompatible and simply biodegrade in the body. Moreover – and even more fascinating from a biochemical perspective – they can be constructed and modified using countless different combinations of amino acids. These peptides serve as a scaffold for self-assembling nanostructures that can subsequently be used as therapeutic and diagnostic delivery systems. Peptides are also capable of carrying out functions, such as identifying and targeting molecular sequences that researchers can use to build the desired nanostructures.

In the Nano Argovia project KOKORO, the interdisciplinary project team is developing a novel three-dimensional heart model. A cellulose paper is used for this purpose, which is intended to serve as an ideal scaffold for heart muscle cells due to its nanostructure. (Image: M. Gullo, FHNW)

These micelle-like, multi-element nanoparticles retain a stable size and structure for five months when stored at 4°C. The individual components degrade at body temperature, releasing the DNA cargo.

Nanomedicine aims to reduce animal testing

For many research projects, it can be a long time before human patients to enter into the equation. And not least because once a suitable agent has been identified, the approval process can take years. Following initial testing in the laboratory, animal trials are often conducted to determine the efficacy of the pharmaceutical agent in a complex organism. Among their other objectives, nanotechnology projects also aim to reduce the number of animal tests.

As part of an original Nano Argovia research project, researchers at the University of Applied Sciences Northwestern Switzerland (FHNW), the Department of Biomedicine (DBM) at the University of Basel and Omya International AG are developing a novel, three-dimensional heart model made of cellulose paper. The model's specialized design and nanostruc-

More information:

Gene therapy

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7435460/

https://doi.org/10.1039/C9SM01990A

KOKORO

Project description

ture make it the ideal scaffold for biological cells. A 3D bioprinter is used to print fine layers of cardiac muscle cells onto the paper. These layers of cardiac tissue are then folded just like origami. This folding process allows the model to expand and contract in the manner of a biological heart.

The cells on the model are then cultured in a bioreactor and subjected to mechanical and electrical stimulation. The aim of the project is to use this model to test the efficacy of pharmaceuticals, ultimately reducing the need for animal testing.

Wide-ranging advancements in the field of nanomedicine

These projects showcase the diversity of the research currently taking place in the field of nanomedicine.

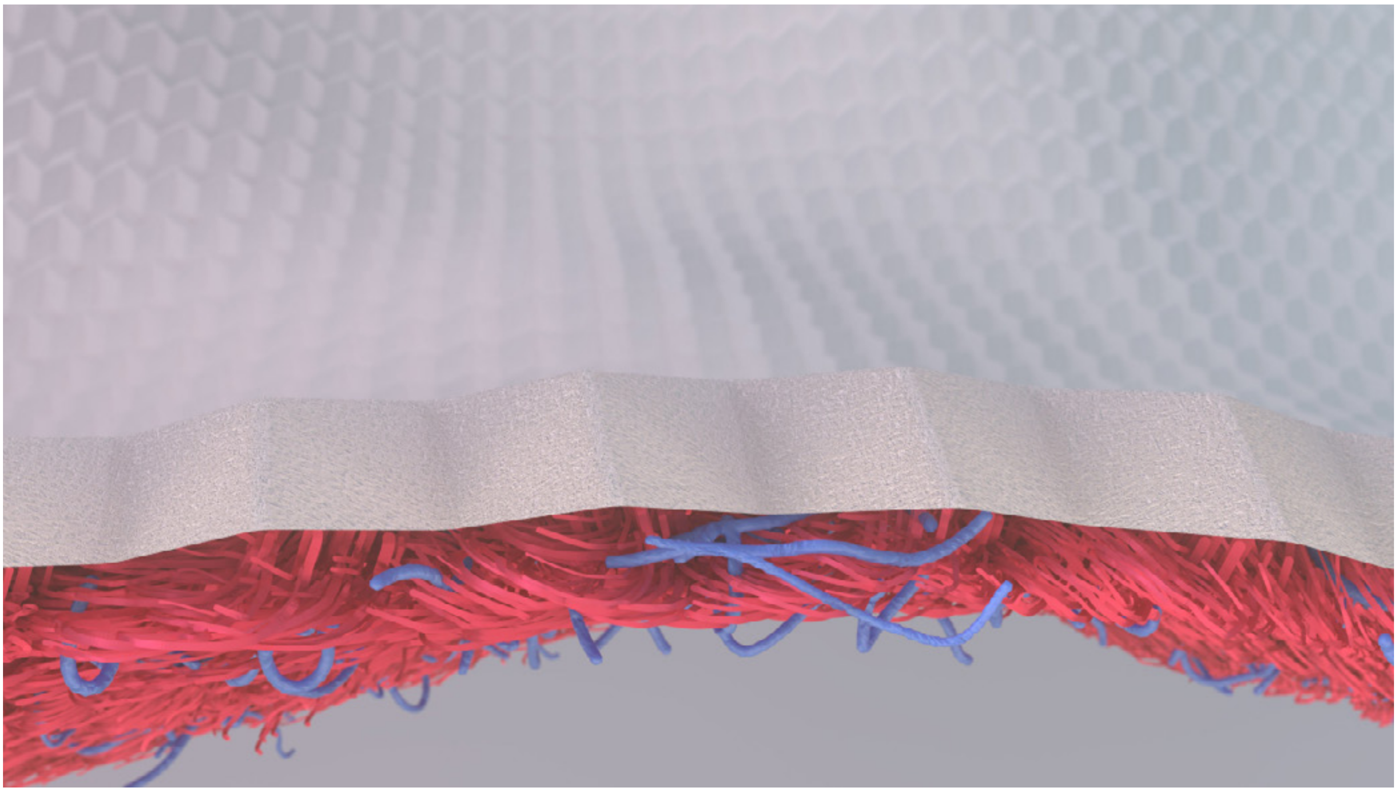
Technological progress has made it possible to produce prosthetics and implants that are more biocompatible with the body, therefore reducing costly complications. Specialized surfaces can curb the spread of bacteria and viruses, and new methods are being developed to combat the problem of antibiotic resistance.

There are also a range of approaches in the field of diagnostics that are based on developments in nanotechnology. Microfluidics is a key component of many of these breakthroughs – from the lab-on-a-chip all the way to the rapid antigen tests for COVID-19, microfluidic chips dramatically reduce diagnostic costs. Advances in nanotechnology have also significantly improved the quality of medical imaging. Atomic force microscopy, for example, delivers fast results for tumor identification, enabling medical practitioners to begin treatment promptly. Research on nano delivery systems has uncovered new insights for treating tumors and the diseases the produce them.

Researchers in the field of medical nanotechnology are currently developing other systems, such as the cell-on-a-chip or the origami heart, that precisely mimic the conditions inside the body with the aim of reducing animal testing in future pharmaceutical trials.

Before these and other innovations are actually applied, there is still a lot to be done, as not only scientific aspects play a role, but regulatory requirements must also be met.

Researchers in the interdisciplinary SNI network are using their research to ensure that the nanomedical applications described and others can be used for the benefit of patients.



Artist's impression of origami cellulose sheets (white) with cardiac muscle cells (red) and a network of vessels (blue). (Image: SiVU ©)

Medical nanosciences

The new master's program specialization

The nanosciences are becoming increasingly important in the field of medicine – and nanoscience students at the University of Basel are taking notice. About a year ago, in response to this growth in interest, Nanoscience Coordinator Dr. Anja Car began to organize the launch of the new medical nanosciences specialization for the master's degree program.

Starting soon

The new initiative kicks off in the 2021 fall semester. Students of the master's program in nanosciences can select a specialization in physics, chemistry, molecular biology and now, for the first time, medical nanosciences. Starting in the fall semester, students can choose from 17 different lectures in areas ranging from drug sciences to biomedical engineering. Additional courses will be added in the spring semester.

As in the other subject areas, master's students will be required to earn 16 credit points in lectures and practical courses in their area of specialization and complete one of their project works and the master's thesis in medical nanosciences. Students must then complete a second project in one of the other specializations: physics, chemistry or molecular biology.

Prepared for success

Nanosciences students can begin preparing for this new specialization during their bachelor's program by enrolling in one of the eight new elective lectures on the subject. This allows students to expand their knowledge of pharmaceuticals and pharmaceutical development early on in their studies so that they are prepared for their master's program in this promising new field of research.

"I'm very pleased to have settled all the formalities so that we can begin the program," says Anja Car. "We've had many constructive conversations with our colleagues in the pharmaceutical sciences and biomedical engineering that have helped us craft this exciting and comprehensive range of courses."

This new specialization is also reflected in recent changes to the teaching committee. Pharmaceuticals Professor Jörg Huwyler has joined the committee, replacing Professor Henning Stahlberg, who has taken up a position at EPF Lausanne.

Anja Car is pleased to announce that all formalities have been completed and students will be able to start the new medical nanoscience specialization in the fall semester.

Further information:

General information about the nano study program

Brochure nano study program (in German)

Website

Information about the master's program

Brochure master's program in nanosciences

SmallTalk
Finally held on-site again

Every year, bachelor students from the nanosciences program organize their own small-scale conference, known as “SmallTalk.” This event provides an opportunity to present the results they’ve obtained as part of the block courses. This year, SmallTalk was once again a real highlight – and not only because the small group size meant that the meeting could be held on-site again.

Each of the 12 students gave a 20-minute talk on a topic of their choice from one of the eight block courses that students complete at the end of the bachelor’s program. In addition, the students presented findings from another of the popular laboratory internships in the form of a poster. Just as at a large-scale conference, the poster session in particular served as an excellent opportunity for scientific exchange.

This year, in addition to the awards for the best talk and best poster, there was also an award for the best poster design. At the end of the meeting, Professor Christian Schönenberger had the great pleasure of presenting the awards to Georg Angehrn (best talk), Nevil Goepfert (best poster) and Alexa Dani (best poster design), thereby bringing the successful event to a close.

Thanks to a protective hygiene concept, “SmallTalk” was possible as an on-site event this year. For the students it was a good opportunity to discuss the results of block courses with each other. (Images: J. Wenner)

Further information:

Video

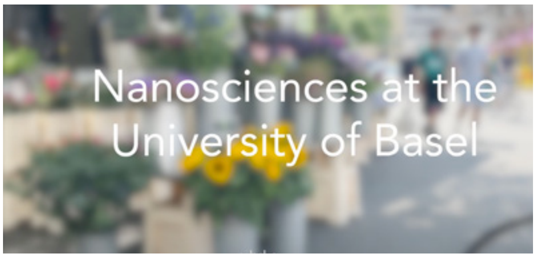
https://youtu.be/lfrQYaW6nw0

Dedicated and enthusiastic
Students on the nanoscience program talk about their experience

Some students on the Bachelor`s and Master`s program in nanoscience as well as a few former “Nanos” have participated in a video production. Three new videos are now available that give a good impression of the study program.

Why did you choose nanosciences, what is special about studying here and what do you like about Basel – these are just some of the questions that SNI intern Jule Wenner asked some nanoscience students and alumni on camera.

The result is three short videos that provide useful insights into the bachelor`s and master`s degree programs and give an idea of where nanoscience studies can lead.



Videos:

Bachelor’s program

https://youtu.be/NGr2dLGE9_I

Master’s program

https://youtu.be/jjbz1DKJ3Qc

Alumni

https://youtu.be/tRGX-ZjUgRxw

Swiss NanoConvention
A look behind the scenes

While last year’s Swiss NanoConvention (SNC) was canceled entirely due to the pandemic, the event returned this year. The difference between SNC 2021 and previous years’ events, however, was that the participants met online rather than in person. Thanks to the numerous sponsors and excellent organizational work, the SNI team laid the foundations for a successful conference – and it was then the 36 leading experts in their various fields, along with the chairs, exhibitors and all of the participants, who made SNC 2021 Online such a success.

Further information:

SNC 2021 Online

Website

Online is the best solution

The plan was to hold the Swiss NanoConvention at Congress Center Basel in July 2020, and the SNI team had already begun preparations at the start of the year. By May 2020, almost everything was on track to stage this wide-ranging conference. Given the uncertain situation in relation to the pandemic, however, the SNI organizing team took the decision to postpone the conference.

"In January 2021, we then once again faced the question of how we could share with the Swiss nano community the latest examples of research and applications in the nanosciences and nanotechnology as part of an interdisciplinary conference while also offering opportunities for networking," says Conference Chair Professor Christian Schönenberger.

At the start of the year, a fully online conference seemed to be the best option for the SNI team. Most of the speakers who had already accepted invitations in 2020 also agreed to participate in an online version of the SNC, and so the team could once again guarantee a fascinating interdisciplinary program with high-caliber talks for 2021.

A completely different planning process

Some exciting weeks and months lay ahead for Dr. Kerstin Beyer-Hans, who was the principal organizer of the event. She soon benefited from the assistance of Tosca Kummli, who had joined the SNI team as a trainee. "We first looked at and tested various platforms for digital conferences and recommended that the team select MeetAnyway as a partner because it seemed to be the most suitable platform, offering not only intuitive operation but also a wide range of capabilities," says Kerstin Beyer-Hans, Outreach Manager at the SNI.

It was important that the platform provide not only rooms for the various keynote lectures and parallel sessions, but also interactive platforms for poster sessions, poster presentations and exhibitions, as well as places where spontaneous discussions could take place. Kerstin and Tosca set up many of these virtual rooms. There would also have to be a help desk and video guides to help people register and find their way around the platform. Furthermore, all participants had the chance to take part in a sort of treasure hunt through the exhibition, select the best nano images, choose the best nano start-up and find out about vacancies at a job fair.

The approximately 500 participants had access to comprehensive information not only in digital form but also as part of a traditional conference booklet, which contained short summaries of all talks and brief information on the invited speakers. Participant lists and sponsors also appeared in the appendix to this extensive brochure.

Excellent talks and much more

On 24 June, the time had finally come. At 9:15 am on the dot, the first online Swiss NanoConvention embarked on an intensive two-day schedule. A varied program with nine excellent keynote lectures in various subject areas highlighted the diversity of the nanosciences and the areas in which nanotechnology plays a role today. Thanks to nanotechnology, there are now multiple approaches to creating a quantum computer. Not only that: computer chips are becoming more and more powerful, new chemical compounds look set to pave the way for new applications, and viruses can be used to fight diseases. Nanotechnology methods help us to understand how sophisticated natural nanomachines operate in nature and how we can use these approaches in technological applications.

It was not just the international keynote speakers – leading lights in their respective fields – who had the chance to explain their latest research to participants. The parallel sessions also gave the invited scientists an opportunity to demonstrate their latest research findings, which are receiving attention far beyond the borders of Switzerland. These sessions not only centered around basic scientific findings but also dedicated significant time to applications of nanotechnology.

In addition to the various talks, participants could also spend time on the platform watching short presentations on most of the 87 posters and from the 29 exhibitors.

Numerous prizes for outstanding achievements

At the end of this successful event, Christian Schönenberger awarded various prizes that were created by the Swiss Micro- and Nanotechnology Network (Swiss MNT Network) and that are regularly presented as part of the SNC.

He began by presenting prizes for the best publication featuring a doctoral student from a Swiss research institute as its first author. This PhD Award was also bestowed in 2020 for publications from 2019 (see SNI INSight August 2020), but it was not until this year that the prize – which is sponsored by various companies – was actually presented to Claire Meyer (University of Basel), Dr. Daniel Najer (University of Basel), Katharina Kaiser (IBM Research), Dr. Kazuhiro Morimoto (EPFL) and Dr. Shantanu Mishra (Empa).

Schönenberger also honored this year's prizewinners for outstanding publications from 2020. This time it was Dr. Luca Nela (EPFL), Nadine Leisgang (University of Basel), Dr. Thomas Karg (SNI and University of Basel), Dr. David Hälg (ETHZ) and Dr. Omar Rifaie (AMI/Fribourg) who had succeeded in winning over the interdisciplinary jury with their first-author publications.

The prize for the best nanotechnology start-up founded in the last five years went to anavo medical. Co-founder Dr. Tino Matter gave a presentation on the company to the SNC and persuaded the audience of the approach whereby inorganic nanoparticles are used to create the conditions for good wound healing. Tino studied nanosciences at the University of Basel before switching to ETH Zurich to complete his doctorate. His doctoral dissertation recently received the MaP Award 2021 from the Competence Center for Materials and Processes (MaP) of ETH Zurich.

Prizes for the best posters went to Mehdi Ramezani (SNI and University of Basel), Sami Bolat (Empa) and Oliver Erni (HEG-FR). Meanwhile, Nadine Leisgang (University of Basel), Evgeniia Gilshtein (Empa) and Filippos Kapsalidis (ETH Zurich) won the competition for the most fascinating images.

The last word came courtesy of Professor Barbara Rothen-Rutishauser, who will organize the next SNC – which will hopefully be held in person – in 2022 with her team from the Adolphe Merkle Institute at the University of Fribourg.

“My thanks go to the whole team for the hard work to put together such a great conference. Professional work paired with passion is the perfect combination!”

Dr. Pierangelo Gröning, Empa

Swiss MNT Start-up Prize
Encouraging award for young start-up anavo medical

At the Swiss NanoConvention, the young start-up anavo medical was awarded the Nanotechnology Start-up Prize from the Swiss MNT Network. Co-founder Dr. Tino Matter studied nanosciences in Basel, and in 2018 he won the prize for the best master's thesis in nanosciences at the University of Basel. Tino had already worked with bioactive nanoparticles for his master's degree, and anavo medical now wants to use these particles in wound healing.

A focus on wound healing

Tino Matter had investigated wound healing while studying nanosciences at the University of Basel. As part of his master's thesis at Empa in the group led by Professor Inge Herrmann, he then worked with bioglass nanoparticles that support rapid wound healing.

It was also in Herrmann's team that Tino completed his doctoral dissertation, for which he continued to research nanoparticles for medical applications. For example, these include the use of inorganic nanoparticles that create a localized anti-inflammatory and antibacterial environment in which wounds can heal effectively. By making specific modifications to the particles, the researchers are also able to stimulate the formation of blood vessels. In turn, the improved circulation in the tissue also supports faster wound healing.

Further Information:

Article about Tino Matter's master thesis

https://nanoscience.ch/en/2018/10/15/improving-wound-healing-with-a-nanoglue/

anavo medical

https://www.anavo.ch

https://www.linkedin.com/company/anavo-medical/

Sebastian Loy and Tino Matter had the idea of founding a start-up in their heads for quite some time. (Image: anavo medical)

The two founders are facing new challenges. (Image: anavo medical)

Tino Matter successfully completed his doctorate in September 2020 and has recently received the MaP Award 2021 for the most promising doctoral dissertation at ETH Zurich in the area of materials and processes.

Start-up idea in mind for some time

Even before completing his doctorate, Tino had begun exploring the idea of founding a start-up. Working with Sebastian Loy, who is currently completing his master's degree in Accounting and Finance at the University of St. Gallen, he carried out market analyses, clarified issues relating to patent law, investigated sources of funding and drafted a series of applications. Since November 2020, Tino has been able to devote himself fully to the start-up as an ETH Pioneer Fellow.

Since then, the anavo team has taken part in several start-up competitions such as Venture Kick and programs such as Innosuisse Coaching in order to acquire the necessary expertise and to build up contacts, as well as registering a patent and drawing up a business plan. "I also spend a lot of time with doctors in order to establish which indication we're seeking an initial approval for," says Tino Matter. "That's easier said than done for a small start-up, because we need to be in a position to carry out both preclinical and clinical trials."

Focusing on internal wounds

The anavo team initially wants to concentrate on "seromas" – accumulations of liquid in existing cavities created by the removal of a tumor, for example. In principle, these are internal wounds, which often heal very poorly. "There's almost nothing on the market that can support the healing of seromas," says Tino Matter. As patients with seromas often have no other wound-healing complications, anavo is focusing its efforts on this indication for the time being. "However, we can see other poorly healing wounds, such as diabetic feet, being added to the list in the future," says Tino.

An exciting journey lies ahead

There is still a long road ahead, however. The team recently reached a milestone when they received various approvals, including for an Innosuisse project, thereby securing funding for the near future. Tino and Sebastian are also no longer working alone – in addition to several advisers, they now have some newly appointed scientists working on the project.

"My work and focus have changed completely over the last few months," says Tino. Whereas last year he was still in the middle of his dissertation and hoping to uncover details of the underlying science, the focus is now on developing the project.

Even in his current role, he says that his nanosciences degree has been a huge help: "In conversations with both doctors and clinical research organizations, or when taking on scientific staff, who all know much more about their specialist areas than I do, I need to have broad-based but also expert knowledge – and the nanosciences program has helped me a great deal in that regard."

"The nanosciences program has helped me a great deal."

Dr. Tino Matter, former nanoscience student at the University of Basel and co-founder of anavo medical

Excellent
Prizes for outstanding doctoral students

PhD students from the SNI network have been awarded prizes at various conferences for their outstanding publications.

PhD Awards for Thomas Karg and Nadine Leisgang

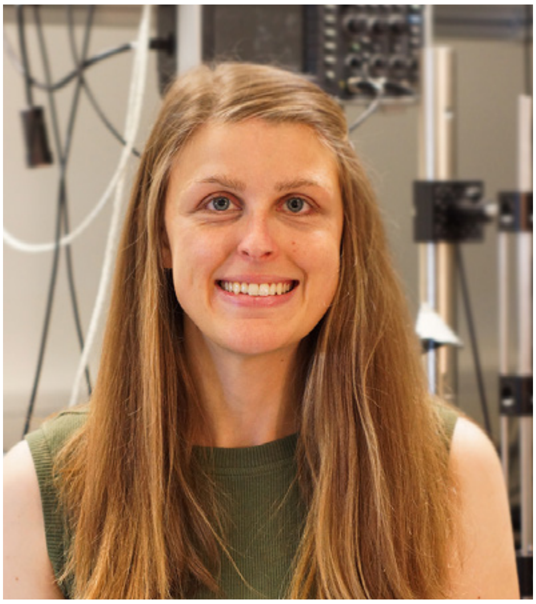
At the Swiss NanoConvention Online 2021, former SNI PhD student Dr. Thomas Karg was presented with the Swiss MNT PhD Award – which is sponsored by IBM Research – for his outstanding publication entitled “Light-mediated strong coupling between a mechanical oscillator and atomic spins 1 meter apart.”

Thomas was first author of the publication. Together with his colleagues, he observed strong coupling between a nanomechanical oscillator and an atomic spin ensemble for the first time as part of work carried out in Professor Philipp Treutlein’s team at the Department of Physics of the University of Basel. The researchers pursued an innovative approach that uses light to couple the two systems over a macroscopic distance.

A PhD Award also went to Dr. Nadine Leisgang from the Department of Physics at the University of Basel. In the prizewinning publication “Giant Stark splitting of an exciton in bilayer MoS2,” she and her colleagues described how various two-dimensional materials can be layered to create a structure with the ability to absorb almost all the light of a selected wavelength. This achievement relies on a double layer of molybdenum disulfide, and the resulting structure is a candidate for applications in optical components or as a source of individual photons.

At SNC 2021 Online, Nadine also won one of the three Nano Image Awards with her colorful image “The Art of Fabrication.”

Thomas Karg was presented with one of the Swiss MNT PhD Awards.



Nadine Leisgang also received the Swiss MNT PhD Award. (Image: provided by Nadine Leisgang)

Further information:

Publication Thomas Karg

Media release

Publication Nadine Leisgang

Media release

"Congratulations to Thomas, Nadine, Mehdi and Pooja! I am very pleased to see young researchers from our network being recognized for their excellent work."

Professor Christian Schönenberger, SNI Director

Further information:

Publication Mehdi Ramezani

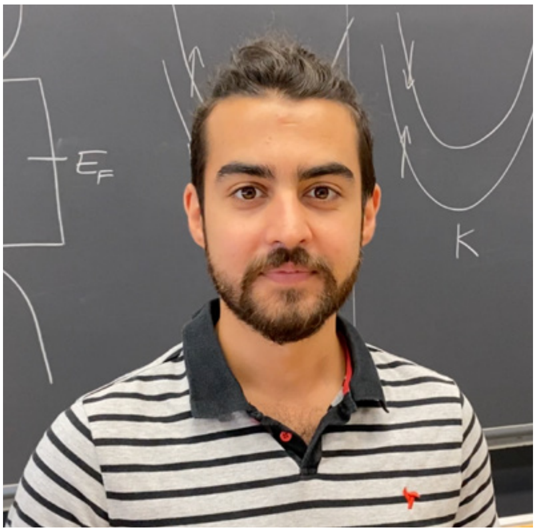
Media release

Video

Poster award for Mehdi Ramezani

One of the three awards for the best poster at SNC 2021 went to SNI doctoral student Mehdi Ramezani, whose poster demonstrated how a monolayer of the semiconductor molybdenum disulfide can be equipped with superconducting contacts.

Mehdi and his colleagues recently published this work in the journal "Nano Letters". A video giving viewers an insight into the lab work is also available and has generated significant positive feedback.



Mehdi Ramezani collected the most votes with his poster at the SNC 2021 Online.

Shoulders-Gray-Spindt Award

http://www.vacuum-nanoelectronics.org/abstracts-papers-2021/the-shoulders-gray-spindt-award-2021/

SGS award for Pooja Thakkar

Pooja Thakkar, who recently defended her doctoral dissertation at the SNI PhD School, won the Shoulders-Gray-Spindt award at the 34th Vacuum Nanoelectronics Conference for the publication "Voltage-controlled three-electron-beam interference by a three-element Boersch phase shifter with top and bottom shielding electrodes."

Pooja's work brings researchers a step closer to the goal of manipulating electron waves in order to realize a novel method for electron diffraction imaging. Funded by the PhD School of the Swiss Nanoscience Institute, the project is a collaboration between the Paul Scherrer Institute and Forschungszentrum Jülich.

The award was created in honor of the founders of vacuum nanoelectronics in order to promote early career researchers.

Pooja Thakkar was awarded the SGS Prize for her outstanding publication.

SNI Innovation Workshop
From lab to start-up

Doctoral dissertations at the SNI largely revolve around questions of fundamental science, but potential applications are sometimes just around the corner. Topics such as innovation and the founding a start-up are therefore of great interest to doctoral students. With this in mind, Dr. Andreas Baumgartner, coordinator of the SNI PhD School, worked closely with the Innovation Office at the University of Basel to create the "SNI Innovation Workshop: From Lab to Start-up" for the SNI PhD School. Early in June, doctoral students from the SNI had their first chance to develop ideas for a start-up of their own with the support of the Innovation Office and to have these ideas evaluated. Three of the ideas were subsequently awarded a prize.

The challenge set by Dr. Andreas Baumgartner, coordinator of the SNI PhD School, may have been short, but it certainly wasn't simple. Around 30 doctoral students from the SNI were tasked with developing an idea for a start-up based on the results of their own doctoral dissertation, for example. As part of a two-day workshop organized and supported by Leonie Kellner, Alessandro Mazzetti and Maarten Van Winckel from the Innovation Office at the University of Basel, the plan was to develop, flesh out and present these business ideas.

Professional jury

In the first round, a jury consisting of Andreas Baumgartner and the Innovation Office team was responsible for choosing the six most promising approaches. Once the six projects were selected, all participants were assigned to one of them for further work.

The experts from the Innovation Office gave the doctoral students individual hints for improvement and guidance on what information to include when giving a short, professional presentation to investors on a particular business idea. Distributing the tasks in the groups, the potential entrepreneurs discussed, researched and polished their "pitches," which were delivered on the second day of the workshop.

A well-prepared start

This friendly competition was ultimately won by the team led by Thomas Mortelmans along with teammates Antonia Ruffo, Tamara Aderneuer and Shichao Jia. The idea for a start-up by the name of "MagnoCell," which remains imaginary for now, was formulated in sections by Antonia, Tamara and Thomas a few weeks prior to the workshop.

The three researchers joined forces after reading the official invitation to the doctoral students, in which Andreas Baumgartner suggests the possibility of forming teams. The teammates met several times before the workshop, systematically preparing for the competition. "First of all, we each created a slide summarizing our capabilities," says Thomas Mortelmans, whose team later selected him to be CEO of the company. "Next we

Further information:

Video with members of the winning team

https://youtu.be/DdrpZ_2v7sk

Innovation at the University of Basel

https://www.unibas.ch/en/Innovation/

Innovation Office University of Basel

LinkedIn

> “From the first day onward, the participants showed a great deal of entrepreneurial spirit and were eager to develop their scientific discoveries into workable business ideas.”

Leonie Kellner, Entrepreneurship Program Manager, Innovation Office University of Basel

The winning team clearly demonstrated how the temperature of fuel cells can be measured - without having to penetrate the interior of the fuel cell. (Images: Thomas Mortelmans)

discussed which of our doctoral dissertation projects was most suitable for the potential start-up that we wanted to present at the workshop.”

Noninvasive temperature measurements
They ultimately chose the project created by Antonia Ruffo, who is developing a noninvasive method for measuring the temperature inside fuel cells at the Paul Scherrer Institute.

When it came to preparing for the first presentation, the team shared out the work based on their individual strengths. Tamara worked on the design, Antonia set out the science underpinning the idea, and Thomas dealt with the introduction to the topic and the potential applications. He also went on to deliver the successful presentation.

Thomas conveyed clearly that the company would offer a feasible solution to measure the temperature inside fuel cells – without having to open or modify the interior. So far, this has not been possible using existing methods. Noninvasive temperature measurements are key to further developing fuel cells, as it is essential to verify that the operating temperature is within the optimum temperature range.

The new method is based on ferromagnetic iron particles enclosed within the fuel cell. When exposed to a beam of neutrons, these particles exhibit different magnetic properties depending on the temperature. In the optimum temperature range of 80–100°C, the randomly arranged magnetic fields cause depolarization of the neutron beam. Above these temperatures, the nanoparticles lose their superparamagnetic proprieties and no longer affect the beam’s polarization.

This would be an ideal method for research laboratories developing fuel cells. Indeed, the worldwide boom in fuel cell research suggests that there is also a growing market for diagnostic methods that can be used for this technology, with a sizeable market world-wide.

Although the team had prepared before the workshop, they still benefited significantly from the discussions and assistance provided by Leonie Kellner and Alessandro Mazetti. For Thomas Mortelmans, who presented the business idea at the workshop, the two-day event was a great opportunity to “think outside the box,” as he puts it. “Normally we’re so immersed in scientific questions that we generally don’t give any thought to how our results could be translated into a product.”

The team of Thomas Mortelmans and Antonia Ruffo not only won the first prize at the Innovation Workshop, the two young nanoscientists also talked about the approach they took and what they learned during the workshop in a short video.

Electronics for the quantum computer

Jann Ungerer also did some thinking prior to the workshop and prepared a presentation. His business idea was to develop electronics that are needed in future quantum computers.

"We're currently seeing huge advances in the construction of quantum computers," he says. "At the moment, however, researchers can only link up a modest number of qubits. In the future, this number of coupled qubits will grow considerably – and electronics will need to keep pace with this development," he adds.

In his first presentation, Jann managed to win over the jury as well as some of his colleagues from the Department of Physics. David Jäger, Moritz Weegen, Gian-Luca Schmid and Lukas Sponfeldner joined his team after the first day of the workshop. Maarten Van Winckel from the Innovation Office then supported the five young scientists and directed them towards a professional presentation on the second day. This presentation earned the team second place in the competition.

As CEO, Jann argued persuasively that the imaginary company "Q-CIRC" would be capable of supplying scalable electronics for the exponentially expanding quantum computing market, thereby allowing the vast power of quantum computers to be put to effective use in the future.

"I had a really great time at the workshop," says Jann. The young nanophysicist had already been involved in the student company "Telejob" (ETH Zurich) and can definitely see himself getting involved in the start-up scene in the future.

Nanoparticles as transport systems

Unlike many of her colleagues, Shabnam Tarvirdipour had little opportunity to get to grips with the workshop in advance. As she was in the last throes of her doctoral dissertation and had her defense at the start of July, there simply wasn't time to work on a presentation for the Innovation Workshop.

Her approach to developing intelligent nanoparticles for gene therapy made so much headway on the first day that the jury selected the project in the first round. Shabnam therefore had the opportunity to develop her business idea further – which she did successfully with a team consisting of Claudio Alter, Mehdi Heydari and Piotr Jasko.

"The tutors provided some fantastic guidance and support. In an extremely short space of time, they

“I was impressed by the general quality of the ideas, which are not only founded on solid science but could also have implications for fundamental societal or technological challenges of our time.”

Alessandro Mazzetti, Manager Innovation Alliances, Innovation Office University of Basel

communicated the key aspects of founding a company,” says Shabnam, who acted as CEO of the imaginary company “Genotech.” This enabled the team to quickly prepare a presentation that secured them third place in the competition.

The four young researchers presented their plan for treating cancer with gene therapy, in which liposomes or peptides would be used to smuggle genes into cells. These genes would contain the necessary information so that a response of the immune system could be stimulated within the cells. In contrast to a number of existing transport systems that use viruses, the team relies on liposomal and peptide-based nanoparticles that dissolve inside the cell to release their cargo. The method could be used to combat various diseases that arise from genetic defects. Initially, however, the team has decided to focus on the constantly expanding market for cancer treatments.

Intense and informative

The workshop was an intense two days for the doctoral students who took part, but it gave them plenty of new insights to take away with them. Even the organizer, Andreas Baumgartner, learned a thing or two – and he was very impressed with the presentations that the teams gave at the end of the event: “At times, I could no longer work out which projects were made up and which were about to be listed on the stock market. We all gained a lot from the workshop, and we’re now planning to hold a similar event for the SNI PhD School on a regular basis.”

The workshop also provided some fascinating insights for the experts from the Innovation Office at the University of Basel. “From the first day onward, the participants showed a great deal of entrepreneurial spirit and were eager to develop their scientific discoveries into workable business ideas,” says Leonie Kellner, Entrepreneurship Program Manager at the Innovation Office. “They worked in teams to improve their pitches and get them ready for the presentation to investors. The winning teams showed the biggest improvements and were able to communicate their ideas both persuasively and succinctly. It was a pleasure to work with the doctoral students over the course of the two-day workshop!”

Her colleague Alessandro Mazzetti, Manager Innovation Alliances, also offered some very positive feedback: “The two things that impressed me most were the general quality of the ideas, which are not only founded on solid science but could also have implications for the fundamental societal or technological challenges of our time. Moreover, the doctoral students demonstrated an ability to put what they had learned into practice quickly. Each of the participants can be proud to have developed the pitches from zero to start-up quality in just two days. At the Innovation Office of the University of Basel, we’ll be proud to support ideas of this kind, which could be converted into real and effective business undertakings!”

Expanded range of services

News from the Nano Imaging Lab

For the past few years, the Swiss Nanoscience Institute has been able to provide excellent imaging services thanks to its new Nano Imaging Lab (NI Lab). A new co-worker in the NI Lab has helped expand the range of services available to researchers from the industrial sector and academic institutions.

Imaging expert

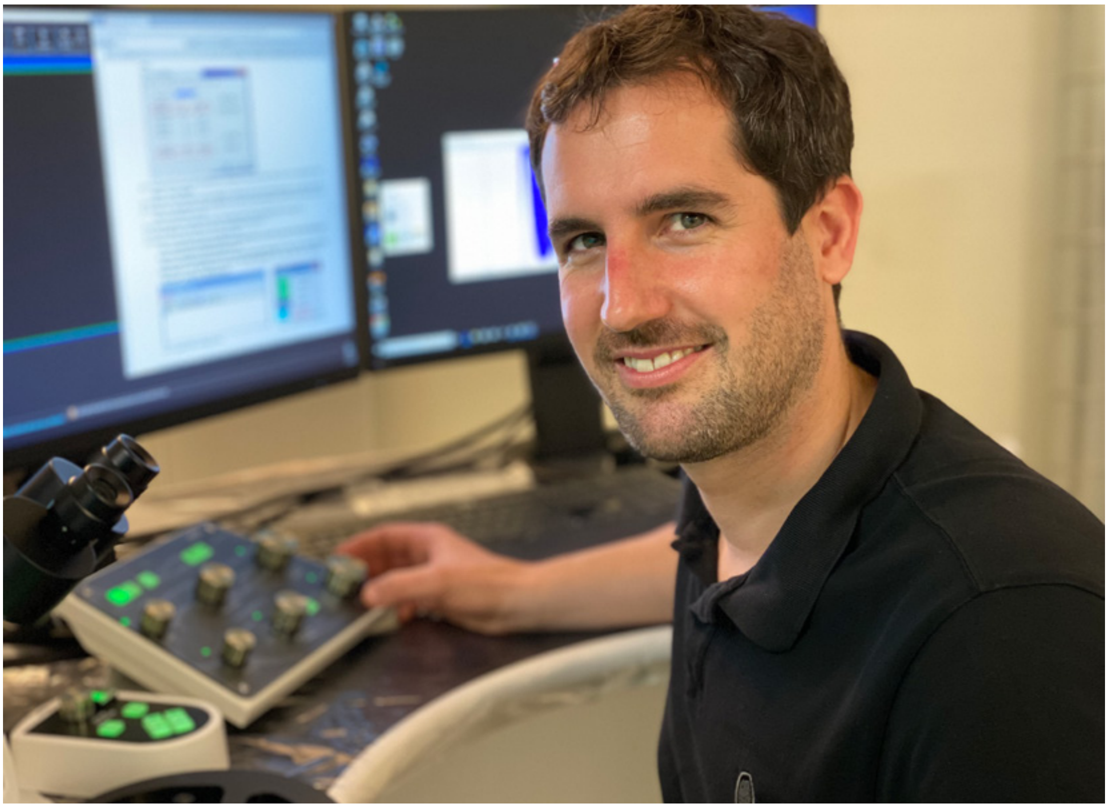
Dr. Marcus Wyss joined the NI Lab team in June 2021. He studied nanosciences at the University of Basel and worked in the group supervised by Argovia professor Martino Poggio, where he obtained his doctorate in the field of magnetic imaging techniques. Over the past two years, he has been involved in the development of novel sensors for the probe tips of scanning probe microscopes.

The Nano Imaging Lab is proud to welcome Marcus to the team as a specialist for all questions concerning focused ion beam microscopy. Marcus Wyss will be available to advise all clients on cutting-edge research projects and investigations related to imaging, analysis and sample structures down to the scale of the nanometer. Marcus is also looking forward to sharing his knowledge with

Further information about the NI Lab:

Website

https://nanoscience.ch/en/services-2/nano-imaging-lab/



Marcus Wyss joined the team at the NI Lab in June and is happy to share his expertise with lab clients.

Regarding questions about the NI Lab, please contact:

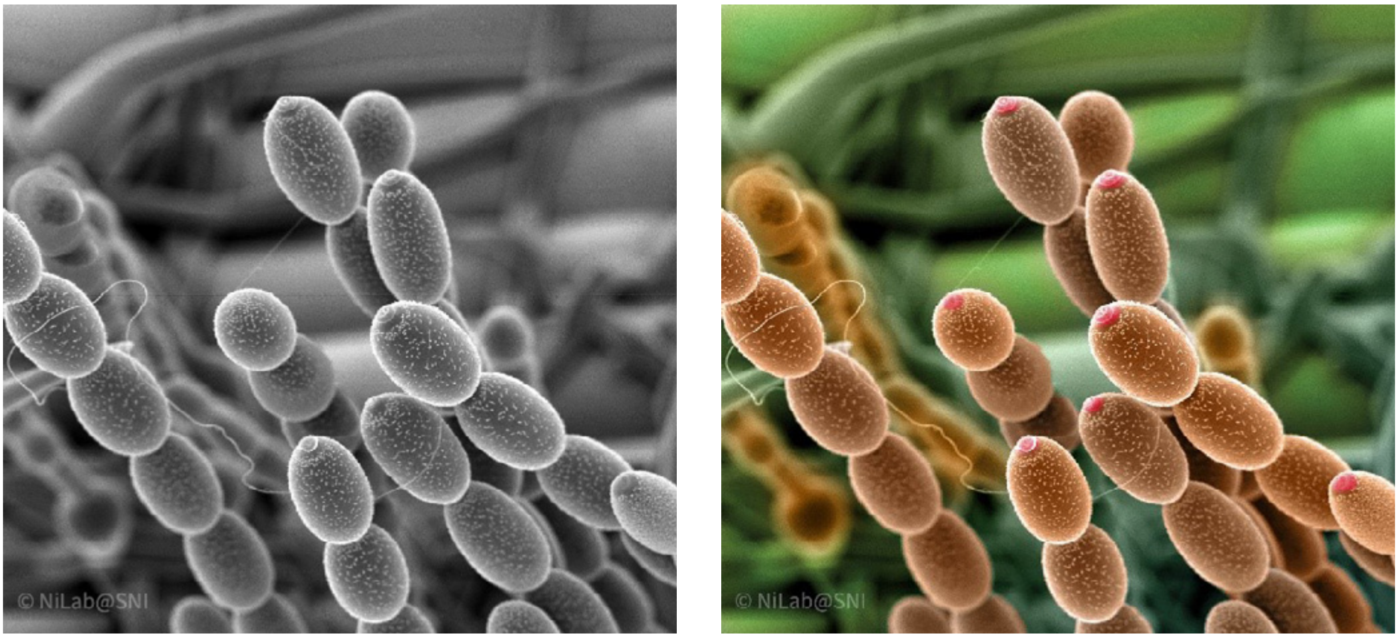
Marcus Wyss

marcus.wyss@unibas.ch

or

Markus Dürrenberger

markus.duerrenberger@unibas.ch



Colorized images can often improve the visibility of micro and nanostructures. The NI Lab now offers a new colorization service for grayscale images. (Images: Nano Imaging Lab, University of Basel)

others and making science exciting and accessible for many different target audiences.

Beautiful and informative

The NI Lab now offers colorization services for scanning electron microscope images. These color images are not only incredible, eye-catching works of art, but they also help researchers identify subtle structures that are difficult to see in the grayscale originals. There are numerous applications in which combining test results with images increases both the aesthetic and informational value of the data being presented.

For several years, Daniel Mathys has used these techniques to produce breathtaking micro and nanoscale images that help researchers illustrate their scientific findings. Due to health-related concerns, he elected to reduce his workload and now offers this new service together with the other members of the NI Lab team.

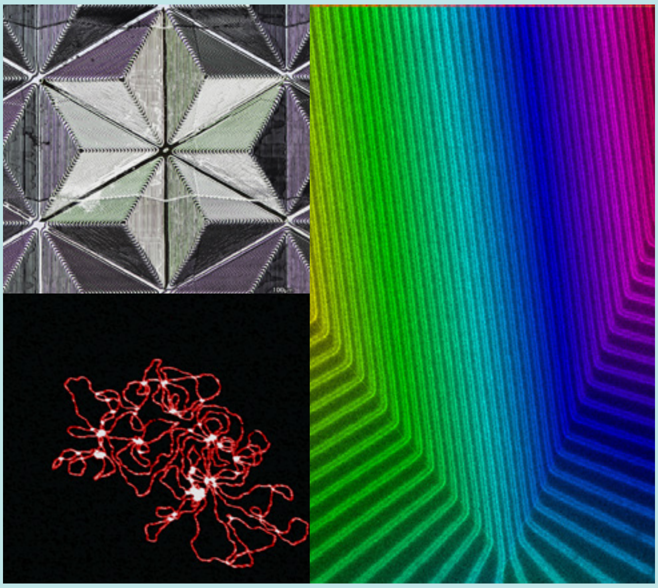
Nano Image Award

Whether in the Annual Report, in a flyer or on postcards, fascinating images from the micro and nano worlds make our communication materials particularly striking.

We are therefore once again looking forward to receiving your beautiful images submitted for the Nano Image Award.

Please send your images together with a title and a short description (including size) by 15 November, 2021 to: c.moeller@unibas.ch.

The three most outstanding images will receive prize money of 300 Swiss francs each.



Nano Argovia program: Call for proposals

We are looking forward to receiving your project proposals in the applied research program Nano Argovia.

Please submit your application containing all documents in the required form by 30 September 2021 at the latest to admin-sni@unibas.ch

Further information:

https://nanoscience.ch/en/research/applied-research/

Forms and guidelines:

https://nanoscience.ch/en/research/applied-research/call/

Experience days on soap and cleanliness

On Saturday 21 August and Sunday 22 August, 2021, our cooperation partner Museum Burghalde in Lenzburg will be hosting experience days on soap and cleanliness.

The SNI is also taking part in the event, the highlight of which will be a soapbox race on Saturday.

The SNI has been involved in the development of the current exhibition on the subject of soap, entitled “Saubere Sache“. The exhibition is open at the Burghalde Museum until 31 December, 2021.

Further information

Registration soapbox race

Electron diffraction for structural analysis
Unique opportunity for SNI members

ELDICO Scientific, a start-up that developed within the SNI network, has brought an electron diffraction instrument to market that can be used to analyze the 3D atomic structure of nanoscale materials. One of the first devices will be made available to the Electron Diffraction Innovation Platform NWCH (Innovations-plattform Electron Diffraction NWCH). ELDICO Scientific runs this platform together with the Switzerland Innovation Park Basel Area, and it can soon be used by a consortium of currently four members. The SNI is the consortium's academic partner, allowing its network to access this promising technology.

Pioneering Nano Argovia project

The 3D structure of a chemical compound is fundamental to its function, but it isn't always easy to obtain this information if substances don't take crystalline form and aren't of a particular size. This can change, however, as a sensational article in "Angewandte Chemie" showed in 2018.

Back then, Dr. Tim Grüne and an interdisciplinary team of scientists in the Nano Argovia A3EDPI project demonstrated that the diffraction patterns of electron beams are ideally suited to determining the 3D structure of tiny organic nanocrystals in powder form. While electron diffraction provided sufficient information to clarify the structure, the crystals were so small that X-rays and synchrotron radiation would not have produced satisfactory results. For this proof of concept, the researchers combined existing commercially available devices that were not optimized for measuring diffraction.

Numerous milestones achieved

ELDICO Scientific aims to change this. The start-up has developed an electron diffraction measuring device (electron diffractometer) specifically intended for crystallography applications. This fascinating journey began in May 2019 with the patent application, swiftly followed by the founding of the company in June 2019. Since then, ELDICO's four founders – Dr. Gustavo Santiso-Quinones, Dr. Gunther Steinfeld, Nils Gebhardt and Dr. Eric Hovestreydt – have achieved a great deal.

ELDICO Scientific has secured capital exceeding four million Swiss francs from various private and institutional investors. Based in Aargau, the start-up has established an excellent advisory board with some of the world's leading crystallographers. Accolades such as the Venture Kick Award 2020 and the R&D 100 Award reflect the team's professional approach. Four new employees will look after technical development, sales, communication, and application services as they help the company to evolve.

First successful measurements

The team spent most of 2020 – the year of the coronavirus pandemic – realizing, calibrating and optimizing the instrument. By May 2021, they were ready to take their first measurements with the ELDICO ED-1 (its product name) to deter-

Further information:

Article in SNI INSight

https://nanoscience.ch/en/2019/09/05/with-a-wealth-of-enthusiasm-and-expertise-scientists-from-the-sni-network-found-eldico-scientific/

ELDICO Scientific

https://www.eldico-scientific.com

Publication in "Angewandte Chemie"

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

Please send inquiries to

basel@eldico.ch

mine the 3D structure of a sample. ELDICO Scientific partnered with AXILON in Cologne (Germany) to build the diffractometer. AXILON is currently testing and improving it ahead of the official launch in August 2021.

As well as working on the diffractometer, the ELDICO team kept industry and academic experts informed of their plans, applications and results. "Since conferences were cancelled, we focused mainly on organizing a few webinars," says Nils Gebhardt, CFO at ELDICO. "We arranged for numerous international experts to give talks and more than 200 people registered for each event. This indicates huge interest within the scientific community and shows that we are making an impact."

There are also plenty of researchers in Northwestern Switzerland who would like to use electron diffraction without the laborious process of creating suitably sized crystals. And it doesn't necessarily need to be used to determine the structure of unknown compounds. "With our instrument, we can examine a substance's various crystal structures (polymorphism) or identify crystalline deposits in liquids – this could be relevant for quality control, for example. Our instrument can be used to analyze a whole range of samples – from geological mineral samples, to tiny molecules with potential pharmaceutical applications, to nanowires and other nanomaterials that have proven difficult to analyze using conventional crystallographic methods," explains CEO Dr. Eric Hovestreydt.

Unique opportunity for the SNI network

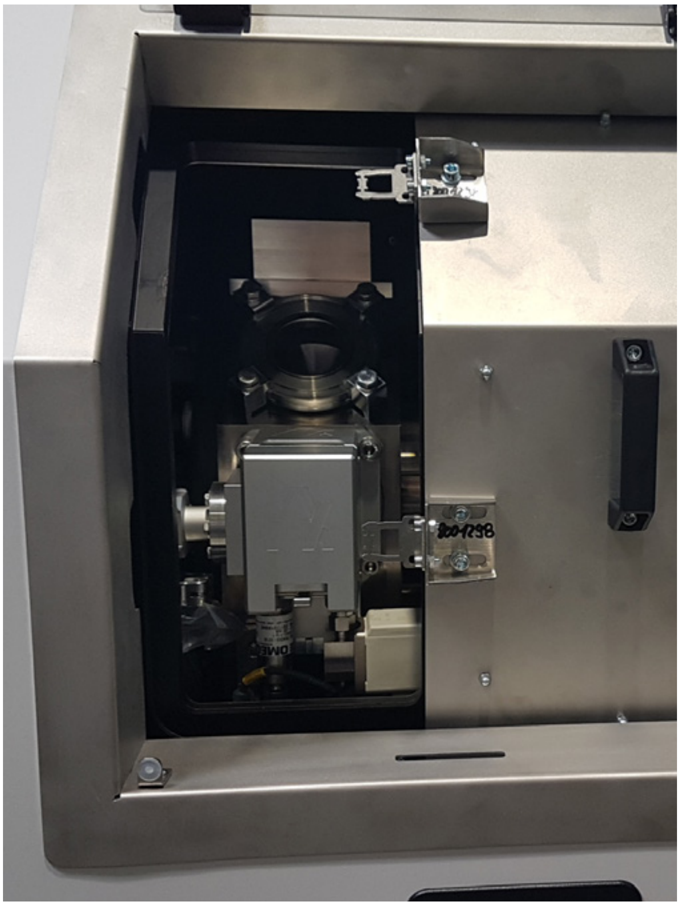
SNI network members will soon be able to test this technology on their applications and discuss their questions with the experts from ELDICO. The SNI is the academic partner in a consortium of four partners from the region who have access to the ELDICO ED-1. Dr. Arianna Lanza, Application Scientist at ELDICO, will supervise the innovation platform.

The new ELDICO ED-1 electron diffractometer, shown by Eric Hovestreydt, can soon be used by SNI members. (Image: ELDICO Scientific)

She came to the company from the Center for Nanotechnology Innovation (CNI@NEST) at the Istituto Italiano di Tecnologia in Pisa, Italy and has many years of experience in electron diffraction, nanocrystallography and structural elucidation.

All consortium partners can use the facility – they can use it themselves for larger projects (once they have received in-depth instruction) and commission smaller tasks via Dr. Lanza. “We are working on the basis that each consortium member will have around 40 measurement days,” explains Nils Gebhardt. “But it’s important that we are flexible, work together constructively and accommodate individual needs. We will share out the available measurement days so that everyone gets a turn.” It would be ideal if the resulting measurement data were published, but this is not a prerequisite for collaborating with ELDICO Scientific.

The diffractometer is expected to be set up and ready to use at Basel Area Business & Innovation in Allschwil by mid to late September 2021. The facility will later be moved from this temporary home to the GRID, the headquarters of the Switzerland Innovation Park Basel Area. “We are excited to see the projects to which we can contribute with this new technology,” says Eric Hovestreydt. “This innovation platform is a unique opportunity for us and our customers to learn from one another and to further develop electron diffraction in crystallography.”



The first samples are currently analyzed using the ELDICO ED-1. (Image: ELDICO Scientific)

News from the SNI network

Virtual booth

A virtual information booth helps the SNI to present the nanoscience degree program attractively at online events. Videos and brochures provide comprehensive information on the study program.

The booth is also part of the MINT-Map. This initiative by the Basel Chamber of Commerce, in cooperation with a number of companies aims to arouse curiosity about natural sciences, mathematics, computer science and technology as part of tun-Basel. In addition to the virtual information booth, the SNI also offered a range of exciting experiments as well as an experiment set to use at home (under "Categories" on the MINT-Map: Natural Sciences).

MINT-Map
Virtual booth
Video

The virtual booth offers information about the nanoscience degree program.

Video about the SNI

Do you need a short introduction to the SNI for a presentation? Our new short video explains in less than two minutes what the SNI actually is and what we do.

Video

Professor Michael Nash (Image: provided)

New Associate Professor of Engineering of Synthetic Systems

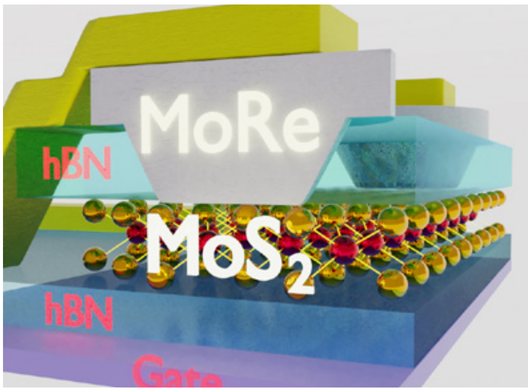
Professor Michael Nash has been appointed Associate Professor of Engineering of Synthetic Systems by the University Council. Nash has been an assistant professor at the University of Basel since 2016. His research focuses on characterizing and optimizing biophysical properties of proteins.

Information from the University of Basel

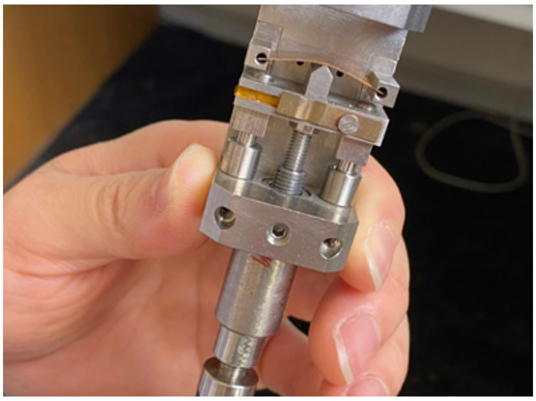
Ultrathin semiconductors electrically connected to superconductors for the first time

For the first time, University of Basel researchers have equipped an ultrathin semiconductor with superconducting contacts. These extremely thin materials with novel electronic and optical properties could pave the way for previously unimagined applications. Combined with superconductors, they are expected to give rise to new quantum phenomena and find use in quantum technology.

Media release
Video
Publication in “Nano Letters”



The monolayer of molybdenum disulfide (MoS2) is sandwiched between two protective layers of boron nitride (hBN), with molybdenum rhenium (MoRe) contacts extending through the upper one. A layer of graphene (gate) is used for electrical control. (Image: Mehdi Ramezani, Swiss Nanoscience Institute, University of Basel)


Force from below causes the component to bend. This elongates the embedded graphene layer and changes its electronic properties. (Photo: University of Basel/SNI)

Stretching changes the electronic properties of graphene

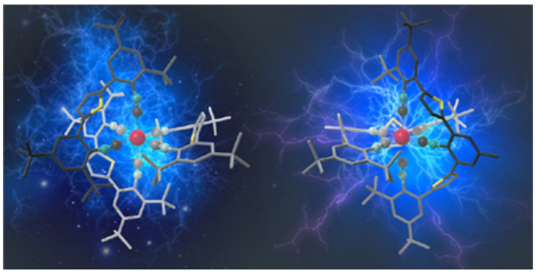
The electronic properties of graphene can be specifically modified by stretching the material evenly, say researchers at the University of Basel. These results open the door to the development of new types of electronic components.

Media release
Video
Publication in “Communications Physics”

Manganese could make luminescent materials and the conversion of sunlight more sustainable

University of Basel researchers have reached an important milestone in their quest to produce more sustainable luminescent materials and catalysts for converting sunlight into other forms of energy. Based on the cheap metal manganese, they have developed a new class of compounds with promising properties that until now have primarily been found in noble metal compounds.

Media release
Publication in “Nature Chemistry”


For the first time, manganese complexes show the types of luminescent properties and photocatalytic behavior that were primarily associated with noble metal compounds until now. (Image: Jakob Bilger)

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

Concept, text and layout: C. Möller, M. Wegmann, C. Schönenberger
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Images: C. Möller and sources as indicated

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