Empa Quarterly

RESEARCH & INNOVATION II #80 II JULY 2023

FOCUS: ACCELERATING RESEARCH

WE SHAPE TALENTS

RECYCLED ASPHALT
SNAKE POLYMERS
MICROPLASTIC

www.empaquarterly.ch

[CONTENT]

[FOCUS: ACCELERATING RESEARCH]


32


27


20


18


12

[COVER]

At Empa, chemist Dorina Opris is researching how to synthesize complex electroactive polymers. She encourages young researchers to take on the challenges of a scientific career – and strives to create an inspiring environment in her own research group.
(See p. 20.)
Image: Marion Nitsch

[IMPRINT]

PUBLISHER Empa
Überlandstrasse 129
8600 Dübendorf, Schweiz
www.empa.ch
EDITORIAL Empa Kommunikation
LAYOUT PAUL AND CAT.
www.paul-and-cat.com
CONTACT Phone +41 58 765 47 33
redaktion@empa.ch
www.empaquarterly.ch
PUBLISHING SEQUENCE
quarterly
PRODUCTION
anna.ettlin@empa.ch

ISSN 2297-7414
Empa Quarterly (English edition)

myclimate neutral Printed Matter
myclimate.org/01-23-213537

Photos: Empa (4), Marion Nitsch

CONDITIO SINE QUA NON FOR INNOVATION

Dear Readers,

What do I mean by that? Quite simply: bright minds! That's what this issue of Quarterly is all about. We regularly present innovative, sometimes groundbreaking ideas on these pages – and are often so excited about them that the people behind them almost slip into the background.

Yet it is precisely these talents that have made Switzerland one of the world's most innovative countries for years. And they need to be nurtured and supported to the best of our ability. Because the global war for talents – pardon the belligerent metaphor – is becoming increasingly fierce. It is thus only farsighted (and to a certain extent selfish) to take care of our country's only natural resource. After all, today's young researchers, students and apprentices are tomorrow's decision-makers.

Whether in a creative "battle of wits" with high school students in sketching a sustainable world of tomorrow (p. 12), in a highly topical Master's project on energy storage (p.16), or in the national "Schweizer Jugend forscht" competition, in which two of our apprentices excelled with their terahertz-based plastic waste sorter (p. 24) – talent development at Empa is enormously diverse.

By the way, our "Bright Minds" are also the stars of a new video series of the same name, with which we want to introduce you to our researchers and their clever ideas on a regular basis in the future. So tune in!

And have fun reading.
Your MICHAEL HAGMANN

THE LEARNING MACHINE
Gaming hardware at the service of science: These graphics processing units (GPUs) are being used to train deep neuronal networks for rapid classification of carbon nanotubes. Empa researchers measure large quantities of nanotubes using Raman spectroscopy and the neural network interprets the results – a method that enables significantly faster acquisition speeds of the Raman spectra. This will facilitate future applications of carbon nanotubes. The project involves researchers from Empa, ETH Zurich and EPFL and is led by Empa's Transport at Nanoscale Interfaces lab. It is a part of the Strategic Focus Area "Advanced Manufacturing" of the ETH Domain.

Further information on the topic is available at:
www.empa.ch/web/s405/high-speed-raman-imaging

Photo: Empa

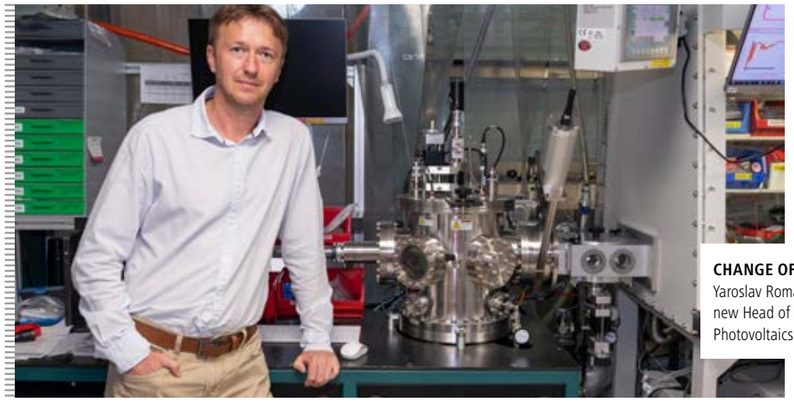
NEW HEAD OF DEPARTMENT: NATHALIE CASAS TO SUCCEED BRIGITTE BUCHMANN

NEW HEAD
Nathalie Casas will take over as Head of the Empa department Energy, Mobility and Environment on 1 October 2023.

The Empa Directorate has appointed Nathalie Casas as a successor to Brigitte Buchmann. The chemical and bioengineer and expert in CO_2 capture will take over the leadership of the department Energy, Mobility and Environment on 1 October 2023 from Brigitte Buchmann, who will retire in July. In addition to her academic track record with cutting-edge research, Nathalie Casas brings a broad range of experiences in start-ups, industry and governmental innovation promotion. Most recently, Casas headed the Research and Development department at the ETH spin-off and cleantech company Climeworks, and she is member of the Innosuisse Innovation Council.

www.empa.ch/web/empa/mobility-energy-environment

YAROSLAV ROMANYUK TAKES OVER AS NEW HEAD OF LABORATORY



CHANGE OF LEADERSHIP
Yaroslav Romanyuk will be the new Head of the Thin Films and Photovoltaics laboratory.

Yaroslav Romanyuk will take over as head of Empa's Thin Films and Photovoltaics laboratory on 1 July. He succeeds Ayodhya Tiwari, who is retiring after just over 14 years as head of the lab. Romanyuk joined Empa in 2008; since 2012, he has been a group leader in the laboratory that he will now head. In addition to his work at Empa, he is a lecturer at ETH Zurich, EPFL and the University of Zurich. After gaining his Master's degree from the Volyn State University in Ukraine, Romanyuk obtained his doctorate from EPFL and worked as a postdoc at the University of California, Berkeley.

www.empa.ch/web/s207

Photos: zvg, Empa

A WORK OF ART FOR THE CAMPUS

"NOT TO GET LOST"
The artist Julian Charrière will create his sculpture group on the new research campus "co-operate" next year.

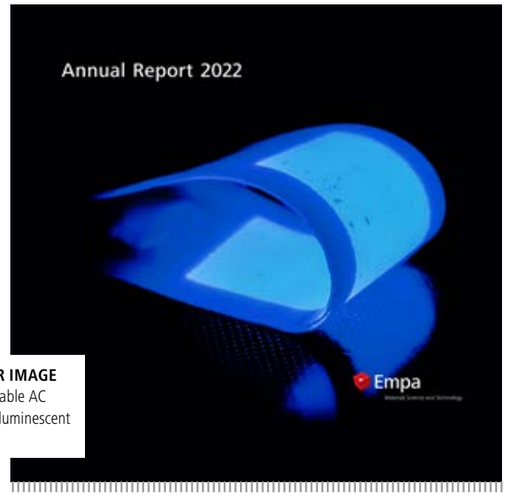
The new research campus "co-operate" of Empa and Eawag is nearing completion. To mark the opening next year, a new work of art is to give the campus a face. Originally from Lausanne, artist Julian Charrière won the art competition with his sculpture group "Not to Get Lost". The composition of boulders of different sizes and stone wedges convinced the jury also because it expressed a commonality of art and science: Both disciplines pursue – albeit in different ways – the previously unexplored. Stone working as one of the first cultural techniques of mankind introduced people to the divisibility of even the most solid materials. Today's research and its search for "the inside" of matter carries this cultural heritage further and into new dimensions.

www.empa.ch/web/s608/campus

ANNUAL REPORT 2022 IS OUT!

2022 was a year of many changes, around the globe, in Switzerland and at Empa. In our Annual Report, we look back onto our research and our collaborations and draft our course for the future. Join us on a deep dive into the world of research and innovation and experience the broad spectrum of materials science and technology at Empa.

www.empa.ch/web/s604/empa-jahresbericht-2022



COVER IMAGE
Stretchable AC electroluminescent device

Photos: Julian Charrière, Empa

PAVING THE WAY FOR MORE ASPHALT RECYCLING

Switzerland is built, at least as far as the road network is concerned. Therefore – and despite recycling –, significantly more reclaimed asphalt is generated today than can be reused in new roads. Empa researcher Martins Zaumanis has set himself the goal of increasing the recycled content of asphalt – with adapted production methods and simple instructions. Two test sections with recycled asphalt in Uster and on the Lukmanier Pass are promising.

Text: Stephan Kälin

In spring, not only snowdrops and crocuses sprout, but also construction sites on Swiss roads. Repair work, patching and renewal is everywhere. Some of the old asphalt from the Swiss road network is being recycled, but around 750,000 tons end up in landfills every year, piling up into ever higher black mountains. In principle, the federal government and the cantons, the major road owners, agree: These asphalt mountains should be put back into the Swiss roads. However, Switzerland is so well developed that hardly any new roads are being built.

It is thus all the more important that the proportion of recycled asphalt is as high as possible whenever repairs, patching and renewals are carried out. "But this requires a better understanding of the interaction between reclaimed asphalt and new material, adapted production processes and – above all – practical instructions and tools for the industry," says Empa researcher Martins Zaumanis. These are precisely the goals of the HighRAP research project, which Zaumanis carried out together with the Federal Roads Office (FEDRO), the Federal Office for the Environment (FOEN), the cantons of Zurich and Graubünden, and several industry partners from 2019 to early 2023.

NO CONSISTENT MATERIAL

Asphalt consists of an aggregate mixture and the binder bitumen, which is sometimes modified with polymers for high-load roads. The previous restrictions on the use of reclaimed asphalt pavement (RAP) for the construction of new roads are based primarily on the fact that the binder in the asphalt ages over time and thus becomes stiff. This leads to a susceptibility to cracking. What's more, the old material may not mix well with the new during the mixing process. Another problem is the frequent lack of homogeneity of RAP: Materials from different road layers and of different ages come together, and different granule sizes meet. However, the production of a high performance asphalt requires continuity. There are proven design methods for mix development and standardized tests for quality control. Only: When adding reclaimed asphalt to existing production processes, the proven methods quickly reach their limits.

In order to increase the RAP content in general, innovations are therefore required at several levels – including the removal of the old asphalt and its processing. Asphalt is usually milled from the road, then crushed. "In the best case, the original aggregate remains intact in the process, and as little dust as possible is produced, so-called filler material," explains Zaumanis. Because these two factors make reuse difficult. In his study, he presents new criteria based on practical tests that are intended to standardize the characterization of RAP processing and thus simplify the reuse of asphalt. In addition to grain size and dust content, however, the original bitumen content and its properties are crucial and can vary greatly depending on the source. Zaumanis therefore provides a simple calculation model for practitioners that determines the permissible variability depending on the future application.

He also presents a similarly pragmatic calculation model for the dosage of the "rejuvenator". These are oily substances that soften the old binder in the reclaimed asphalt and thus make it usable again. These rejuvenators are based, for example, on tall oil, a biological by-product from paper production.

The production of asphalt with RAP is significantly more complex than the

BLACK ASPHALT MOUNTAINS
Swiss reclaimed asphalt should be returned to the roads as completely as possible.

TEST TRACK ON THE LUKMANIER PASS
Roads at high altitudes are particularly susceptible to cracking.

Photos: Empa

TEST TRACK IN USTER
Busy roads call for polymer-modified asphalt.

production of new asphalt due to the large number of different materials and substances that are mixed together. Moreover, there is uncertainty about the actual properties of the materials and how they will interact. "The recipe book approach, as handled in traditional mix design, therefore falls short," Zaumanis says. Instead, he suggests incorporating performance-based testing methods into the process to examine the material for cracking or plastic deformation.

REAL TESTS ON THE ROAD

"Ultimately, however, it is mainly successful pilot projects and real test stretches that can give road owners and road builders confidence in asphalt with a high RAP content," says the Empa researcher. For this reason, HighRAP asphalt has been installed on two road sections as part of his project – on the busy Aathalstrasse in Uster on the one hand, and on the Lukmanierpassstrasse on the other, where the requirements for the road surface are significantly different due to the high altitude.

In Uster, a RAP content of 30% could easily be introduced in the wearing course without any loss of performance. "Typically today, for such a heavily trafficked road, RAP is completely omitted in the wearing course," explains Zaumanis. For the underlying binder course, Uster showed that between 40 and 50% RAP is feasible. In both cases, asphalt with polymer-modified binder is used as standard. "To increase the RAP content even more, high-polymer modified binder could be used. This would compensate for the lack of polymers in the RAP binder," Zaumanis says.

In contrast to the road in Uster, the route over the Lukmanier Pass is not exposed to heavy traffic, but to harsher climatic conditions. "At this altitude of 1900 meters, the high temperature fluctuations can cause cracks in the road surface," says Zaumanis. But in his project, he showed that an asphalt with a high RAP content could also withstand these conditions. An asphalt with 85% RAP content was paved in the foundation layer and an asphalt with 70% RAP content in the base and binder layers above: without any problems! After tests in the laboratory, the pavements also proved particularly resistant to the feared cracking due to temperature fluctuations.

LONG-TERM OBSERVATIONS

The two test sections in Uster and on the Lukmanier Pass will continue to be monitored in the coming years and will be used to study the long-term behavior of RAP asphalt. Martins Zaumanis is already optimistic, however, that the black mountains on the landfills are unlikely to grow too far in the coming years. This is partly because of projects like his, which demonstrates the technological possibilities, but also because calls have already been made at the political level for a landfill ban on reclaimed asphalt. This is intended to increase the incentives for complete recycling of reclaimed asphalt. ■

Further information on the topic is available at:
www.empa.ch/web/s308/highrap

Photos: Empa

AIMING HIGH

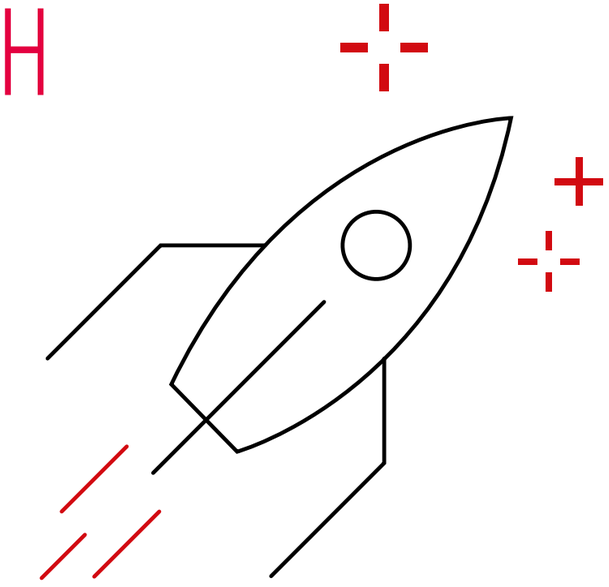


Illustration: Empa

The shortage of skilled workers is particularly pronounced in technical professions. Empa supports and promotes talented individuals at all levels, be it during their apprenticeship, studies, academic career or when starting a business. This support (both internal and external) benefits not only the recipients and Empa, but also the Swiss economy.

Text: Anna Ettlin

Switzerland has a shortage of skilled workers; numerous industries are struggling to recruit highly qualified personnel, and there is no improvement in sight. What many people may not realize: Although Empa is not a university, the research institute supplies the Swiss economy with highly trained experts.

The focus of this issue is on talented people at all academic levels who benefit from special support measures: financial or organizational, short- or long-term, supported by Empa or financed externally. The measures have one thing in common: They ensure that interns, apprentices, students, researchers and start-up founders can realize their full potential.

It starts at school: Various programs and events are designed to get children and young people excited about the world of science, technology, engineering and mathematics (STEM). Many Empa researchers are involved in outreach measures or launch their own projects to promote young talent (p. 12). Empa also wants to position itself as an attractive place to work and learn among young people, in order to attract new apprentices for the more than 40 apprenticeships in ten professions (p. 24).

ACADEMIA ALSO NEEDS SKILLED WORKERS

Many Empa researchers teach at Swiss universities, supervise students or even hold professorships. Through internships and Bachelor's and Master's theses at Empa, students enter the world of research (p. 16). If they decide to pursue an academic career, their personal development at Empa is supported by various measures, whether through the Empa Zukunftsfonds (p. 30) or through external support instruments for young (p. 18) and more experienced researchers (p. 20). Empa pays particular attention to equal opportunities and diversity, for example striving to increase the proportion of women in senior management positions, which is still (too) low in STEM professions – and thus also at Empa.

Whenever Empa researchers develop a novel material or a disruptive technology, this can give rise to a new company. Empa has already supported more than 100 start-ups and spin-offs in its incubators, which offer mentoring, financial support and networking contacts, among other things (p. 27). ■

CHILDREN HELP CREATE CIRCULAR FUTURES

When the children's creativity meets scientific expertise, new ideas are born – for example, about what the sustainable world of tomorrow might look like. Together with school children and the St. Gallen University of Teacher Education, Empa researchers are developing a children's book about circular economy that is meant to inspire both young and old.

Text: Anna Ettlin

How will we travel in the future? According to Samuel, 10, we will use solar-powered airships instead of airplanes. Lara, 10, envisions traffic moving on three underground levels – one each for cars, the subway and trains. Other children imagine cars powered by compost or wind power. And maybe, adds nine-year-old Lars, we'll take a vacation in the simulator or the cozy warm greenhouse next door and not have to travel so often in the first place.

The 13 third- to sixth-grade children gathered in a classroom at the St. Gallen University of Teacher Education (PHSG) on a Wednesday morning are bubbling over with ideas. Throughout the semester, they have been learning about topics related to the environment, energy and sustainable materials cycles in class and working in small groups to brainstorm how people might eat, live, travel and learn more sustainably in the future.

Today, the conversations in the groups are particularly lively because the children have visitors: Each table also has one or two researchers from Empa's Technology and Society laboratory. The scientists ask questions, explain contexts and provide the scientific basis for the kid's creative ideas. This is about more than just swapping ideas: Together, the children and the researchers are working on a children's book about circular economy.

VISIONS OF THE FUTURE INSTEAD OF JUST NUMBERS

The project, officially called "Co-creating Circular Futures", is supported by the Swiss National Science Foundation (SNSF) as part of the Agora program, together with the household appliance manufacturer V-Zug and the trade association SWICO. Project initiator

INSPIRING THE NEXT GENERATION

Scientific and technical professions in particular have difficulties attracting young people currently. In order to get school children interested in science and technology, various initiatives are underway at Empa. Every year, Empa welcomes around 100 children in grades 5 to 7 to the National Future Day and regularly offers guided tours for school classes. At the Smartfeld educational lab in St. Gallen, in which Empa is involved, children and young people combine technology with creativity in courses and experiment spaces. A summer camp is held every year in Dübendorf, where children gain insights into the world of research. In addition, many Empa researchers are active ambassadors, for example at the International Science Olympiads and at SATW's TecDays / TecNights.

Harald Desing came up with the idea during the Covid lockdown. "I realized that my two sons' books almost exclusively depicted the world of yesterday," the Empa researcher recounts.

In his own work, Desing deals with forward-looking topics such as the circular economy. "When we as scientists talk about a circular and sustainable future, it's very abstract," he says. "We show numbers, formulas and diagrams that are dry and often difficult to grasp." Getting society to act, the researcher is convinced, will take more than facts: It will take a vision.

This is exactly what Empa researchers are now working on together with the school children and PHSG lecturers and students. The children are contributing their creativity and open-mindedness, while the scientists are providing a grounding in reality. "Adults have fixed ideas about how our system works," Desing says. "If you ask them for solutions to our future, you will get a thousand reasons why this or that won't work. But if you ask kids, you will get a thousand ideas."

For the project, Desing is teaming up with the gifted education program at the PHSG. "You can study these topics with all children, not just the gifted ones," emphasizes Marion Rogalla, head of the gifted education program in Rorschach and Rorschacherberg and an educational scientist at the PHSG. The gifted classes are best suited for such a project primarily for organizational reasons. "The children come to us for one morning a week throughout the semester, and we have the time to explore topics in depth, for example with games, experiments, technical input, theater scenes and sketched diaries."

OF MEAT TREES AND SOLAR TRAINS

Although many adults approach sustainability issues with less than positive feelings, children have a different mindset, Harald Desing knows. "Children are open-minded. They like to be convinced by new ideas and take great pleasure in learning," he says. The kids themselves confirm this. "It's fun to use your imagination to think up things for the future," says nine-year-old Lars. "I really like our idea for a train that produces its own electricity with solar panels and also supplies the station with electricity via the overhead line."

The older children are also full of enthusiasm. "I learned a lot about the environment and sustainability. It was very interesting," says Loreleyn, aged 13. Arjan, 12, adds, "I didn't know that it takes several million years for a discarded glass bottle to decompose!" While Arjan talks pragmatically about electric cars and efficient appliances, Loreleyn is excited about the children's idea for a "meat tree". "There are many people who like to eat meat. If we could grow meat like a plant, it would be much more sustainable," she says. "Of course, the meat tree is just an idea – but there are already laboratories today where people can produce meat without killing animals," the girl knows.

Photos: Empa

And the researchers also enjoy working with the children. "The kids have brought a lot of ideas to the table and also asked us many questions," says Desing. In a first joint workshop, the children and the researchers developed visions for sustainable cities of the future. A second workshop will focus on telling a story with characters set in that future world. Based on these two workshops, designer and artist Maya Ivanova will create the illustrated children's book, which is expected to be published in early 2024. With accompanying material being developed by the PHSG, the book can then also be used in the classroom.

The children's book project is not about predicting the future and showing the only right path to a sustainable world. "We want it to provide food for thought," says Desing. And who knows – maybe one or two of the children's ideas will also provide an impetus for research. ■

Further information on the topic is available at: www.empa.ch/web/s506

HOW CAN WE SAVE ENERGY FOR LATER?

Converting electricity into hydrogen in order to store sustainable energy over a longer period is a hot topic. With the expertise and the tools of Empa researchers, a master's student at ETH Zurich has investigated whether the use of a so-called power-to-hydrogen-to-power system in a multi-family house makes sense.

Text: Loris Pandiani

STORAGE OPTION
Long-term storage of electricity from renewable sources is becoming increasingly important. One possibility: converting it to hydrogen.

Photo: Adobe Stock Images

How do you bring surplus energy from summer into winter? This is one of the central questions with regard to how we will ensure our energy supply in the future in a sustainable and at the same time secure way – especially since we want to avoid fossil fuels. This topic is also of interest to master's student Josien de Koning: "The Swiss power grid currently has excess production in the summer, while we are dependent on imports in the winter. This imbalance will be further increased by electrification and the replacement of nuclear power plants with renewable energy sources such as solar energy. It's important to find solutions to counter this." In her master's program in "Integrated Building Systems" at ETH Zurich, she therefore wanted to take a closer look at one of the possible solutions in a semester thesis. Experts from Empa's Urban Energy Systems lab supported her in this project, which she did at the beginning of 2022.

STORING ENERGY FOR MONTHS

De Koning focused on the integration of a so-called power-to-hydrogen-to-power (P2H2P) system. This is used to convert – ideally surplus – electricity into hydrogen, store it and generate electricity from it again when required. The system includes various components, such as PV systems, an electrolyzer, hydrogen tanks and fuel cells. The big advantage is that, unlike other storage methods such as batteries, the energy can be stored for months without any losses. "In my thesis, I wanted to find out whether it makes sense to integrate such a solution into an energy system. I chose an apartment building in Obersiggenthal as research object," explains de Koning.

The first step was to model the system using a special software. For this, the master's student used the so-called ehub tool, which Empa researchers had developed in recent years and from which the spin-off Sympheny ultimately emerged.

SUPPORT FOR STUDENTS

At Empa, around 100 bachelor's and master's students from a wide range of disciplines are supported each year with their semester and final theses. The knowledge and tools of the different labs are available to them. In the field of energy, in addition to the ehub tool, students also have the opportunity to use the ehub platform to address their energy questions. On this platform, thousands of historical and live data from Empa's buildings are collected and made available.

The tool models energy systems and performs calculations on them. First, de Koning defined in the software which components should be installed, which energy sources are available and what the building's energy requirements are. After this, the system needed to be further optimized. For this purpose, the student entered data from various databases into the software. These included, for example, solar radiation, CO_2 emissions and electricity prices from the Swiss power grid, as well as various technical data of the individual components.

THE OPTIMAL SOLUTION

The software then used the input data to calculate the costs and emissions of a P2H2P system and a conventional system without the hydrogen components – for now and for the year 2040. The aim was to identify whether the solution, if not today, had any potential in the future.

On one hand, the results showed that the P2H2P system was able to level out the energy imbalance as desired. Batteries and thermal storage were able to handle daily fluctuations, the hydrogen system covered seasonal differences. On the other hand, however, the P2H2P system was not found to be the optimal solution in any of the scenarios. Its integration was more expensive and had higher emissions than the conventional system in both 2020 and 2040. The main problem was the storage tank for hydrogen, the size of which had a strong impact on both costs and emissions.

Nevertheless, Josien de Koning is convinced that the system could have potential in the future: "It is possible that the P2H2P system in 2040 could be acceptable in terms of price and CO_2 emissions. To achieve this, however, we must succeed in significantly reducing the size of the hydrogen tank." The key factors for that are technological improvements and price reductions in the system itself, as well as reducing energy consumption in general.

One important point: De Koning did the analysis in the context of the Swiss power grid, which is already very clean. She assumes that in other European power grids, which have higher CO_2 emissions, the P2H2P system would perform better. Coupling it with industries that could use hydrogen in the future – for example, as a substitute for natural gas in high-temperature applications – could also make the technology more lucrative.

Therefore, if certain conditions change in future, power-to-hydrogen-to-power systems could help to transfer surplus energy from summer to winter. In any case, it is clear that the topic will continue to accompany Josien de Koning in her future studies: "From my project at Empa, I'm taking away a lot of valuable insights and follow-up questions for my further academic path." ■

Further information on the topic is available at: www.empa.ch/web/s313

CLEAN DIRT

Environmentally friendly, ubiquitously available and recyclable: Clay is a clean alternative among building materials. Empa researcher Ellina Bernard is trying to find out how the coveted material can actually be used to build in a sustainable and stable way. Her research project is being funded by the Swiss National Science Foundation (SNSF) with an Ambizione grant.

Text: Andrea Six

ALTERNATIVE BUILDING MATERIAL CLAY
Ellina Bernard with a lab sample

Photo: Empa

The built environment is both the structural foundation of a society and one of its biggest climate polluters. Cement production alone accounts for around seven percent of all greenhouse gas emissions worldwide. Empa researchers are therefore working on various ways to reduce these emissions with innovative building materials and technologies. One of these paths to clean buildings is a muddy one: Ellina Bernard from Empa's Concrete & Asphalt laboratory in Dübendorf and the Chair of Sustainable Building at ETH Zurich is currently investigating the potential of clay as a sustainable building material. This is because clay should release significantly less CO_2 than concrete. In addition, it is available in almost unlimited quantities, is recyclable and can be easily processed – even together with other "hipsters" of modern building culture such as organic waste materials from hemp processing.

EARTHEN PASTE FOR HOUSING

The potential of this concrete alternative would be enormous. Admittedly, clay could not replace concrete for all construction purposes. However, in addition to a large number of non-load-bearing constructions, load-bearing walls of residential buildings are possible. And after all, more than half of all building permits in Switzerland, for example, are issued for residential buildings. So-called poured earth can be used in a casing, pressed clay in the form of prefabricated building blocks. And these air-dried clay bricks have a more favorable energy balance than their baked counterparts, bricks.

A true miracle product? "Not yet," says Empa researcher Bernard. Although clay has been used for around 10,000 years, making it one of the more primitive building materials in human history, the earthy paste still hasn't really taken off – yet. On the one hand, the geological composition of the natural material varies all over the world, which makes standardized production and use difficult. Secondly, conventional cement is currently added to the clay to create a stable and durable building material. This addition, however, pushes the ecological footprint of clay back into the red zone. Ellina Bernard and her team thus want to explore the earthy material, define standards for its composition and mechanical strength, and at the same time develop a clean alternative building material for industrial use. For this ambitious project, the Empa researcher has been awarded one of the SNSF's Ambizione grants.

THE GENTLE POWER OF MAGNESIUM

There is something mysterious about the transformation of a muddy paste of water and earth into a rock-solid product. To unravel and ultimately control this process, Ellina Bernard delves into the very heart of the matter. Unlike cement, which is held together by chemical bonds, the fine minerals in clay form physical bonds as they air-dry. Stability like that of concrete cannot be achieved in this way. That is why the researcher is looking for a suitable stabilizing binder. She is supported by geologist Raphael Kuhn, who is currently writing his dissertation on clay additives. One promising candidate is magnesium oxide.

If it is produced in a sustainable manner, it has an excellent carbon footprint compared to calcium-containing cement, whose chemical reaction releases large amounts of CO_2. In addition, magnesium oxide shortens the drying time, counteracts the dreaded formation of lumps in clay by forming nanocrystals, and yet only gently interferes with clay's advantageous micro- and nanostructure.

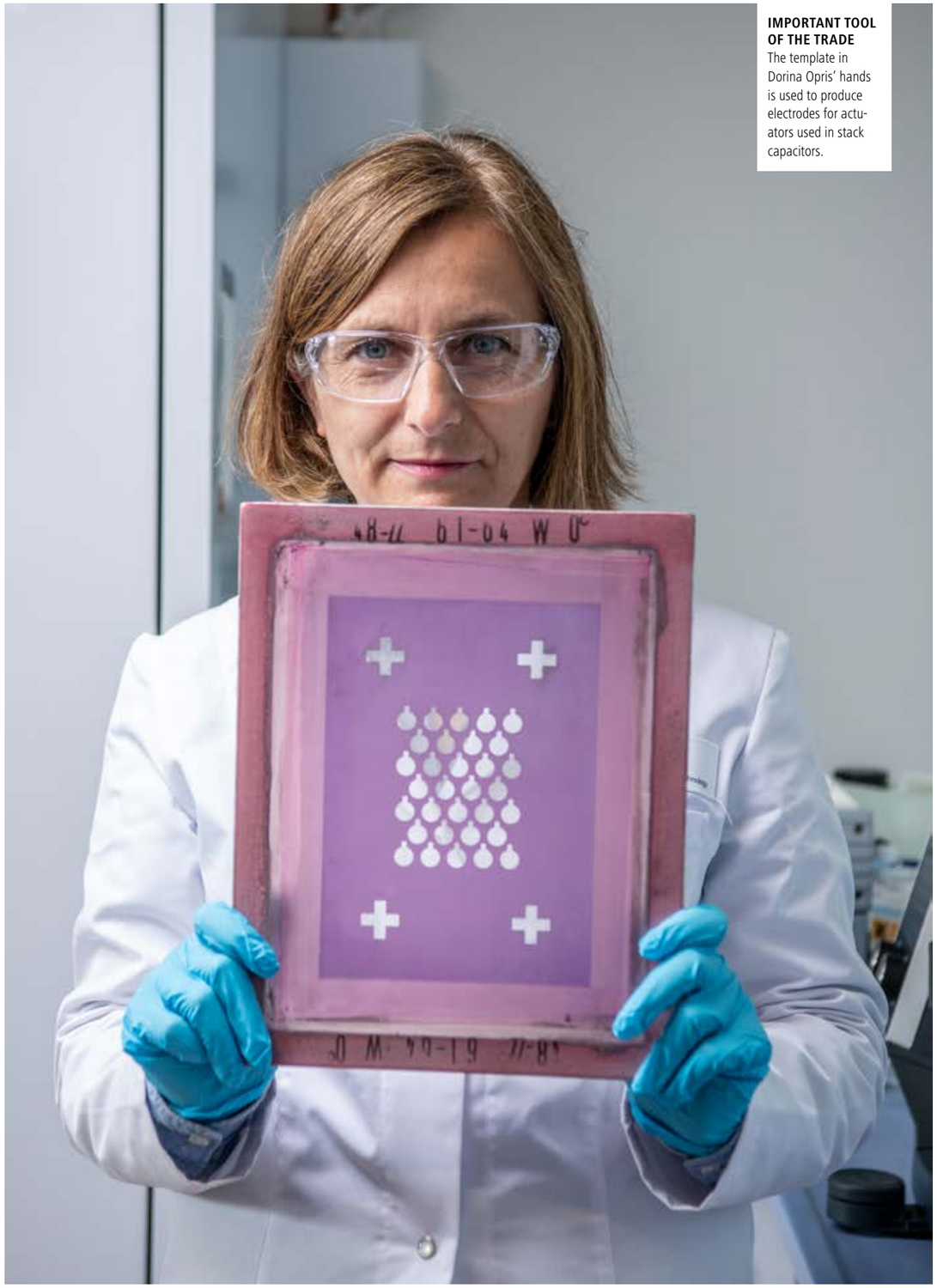
AMBIZIONE GRANT FROM THE SNSF

Ellina Bernard's project "Deciphering the role of magnesium in earth materials for sustainable construction" is being supported by the Swiss National Science Foundation (SNSF) with an Ambizione grant. The grant is awarded to outstanding young researchers with an independent project who have already completed their doctorate.

In initial laboratory experiments, the team has already achieved a compressive strength of up to 15 megapascals with the magnesium oxide clay – many times that of untreated clay. By comparison, clay with added cement reaches up to 20 megapascals, and a wall subject to rather limited load, such as inside an apartment, must be able to withstand up to 10 megapascals.

"But that's just the beginning," says Ellina Bernard. Since she wants to assess the sustainability of building materials holistically, the laboratory experiments must also be accompanied by life cycle analyses that record the durability, deconstruction and recycling of the materials. ■

Further information on the topic is available at:
www.empa.ch/web/s308



IMPORTANT TOOL OF THE TRADE
The template in Dorina Opris' hands is used to produce electrodes for actuators used in stack capacitors.

Photo: Marion Nitsch

UNTIL THE CHEMISTRY IS JUST RIGHT

At Empa, Dorina Opris is researching how to synthesize complex electroactive polymers for robotic components, sensors or batteries – a promising project that the European Research Council (ERC) is currently funding with one of its prestigious ERC Consolidator Grants. This is not the Empa chemist's first success – but the road that led to it wasn't all that easy.

Text: Norbert Raabe

At first glance, the career of Dorina Opris, born in 1974, seems like a picture-book one: from studying chemistry at Babeş-Bolyai University in Cluj, Romania, to the Free University of Berlin, to becoming a titular professor at ETH Zurich and head of the Functional Polymeric Materials research group at Empa – funded by an ERC Consolidator Grant worth around two million euros. All this with a family and the joys, worries, and duties of two children.

How does this work? With talent that was recognized and encouraged early on – even as a student in Transylvania. With a diverse education – not only in theory, but also in laboratory practice, which Opris misses in some of her students in Switzerland. And thanks to a field of research with huge potential: Novel dielectric polymers stretch under electrical voltage and can be used as ultra-thin layers in actuators or other components – for example, for artificial muscles, which have been investigated for years, for power generation and much more.

But the path to this exciting discipline was no walk in the park, but rather steep and with detours. Opris' search for a job after her daughter was born took almost two years before she was able to start at Empa. And when she started out in materials science, the trained organic chemist first had to find her field, and in some cases, even invent it – with initial setbacks. Ideas failed, research funding was not approved. How does that make you feel? "Sh…," says Opris, laughing.

So, what do you do then?

Just go on. Support came from the Swiss National Science Foundation (SNSF) and the Sciex program for three postdoctoral fellowships, all of which Opris filled with women. And finally, in 2020, the ERC Consolidator Grant for the TRANS project (see infobox), for which the researcher worked up a sweat: two weeks of meticulous preparation for a two-minute Zoom presentation and 18 minutes of Q&A with experts. "I had to be able to answer a lot of questions very quickly," she says, "but that suited me because I'm a person who gets to the point quickly and doesn't make a lot of words."

The fact that she has mastered her field from A to Z is, as she points out, also thanks to knowhow built up by colleagues at Empa – such as engineer Gabor Kovac. He drove the manufacture of stack actuators with expandable silicone discs for many years and developed them to operational maturity with his partner Lukas Düring, until their spin-off CTsystems was recently acquired by the Daetwyler Group. ▶

"The devices for measuring how actuators stretch in different electric fields were developed by them," Opris says, "We were early on this topic, and that helped me tremendously." Unlike her colleagues, however, the chemist is working not so much on the technology for printing such components, but one "floor below" – that is, on the synthesis of novel polymers suitable as non-conductive layers for stacked transistors, elastic films for power generation and other elements.

THE TRANS PROJECT

With the research project "Synthesis of novel stimuli-responsive dielectric polymers and their use in powerful transducers" (TRANS), Dorina Opris is building a multidisciplinary team to develop printable dielectric polymers. They can convert one form of energy into another – be it electrical voltage into strain or motion and temperature changes into electricity. Potential applications range from actuators and sensors to soft robotics to energy storage and solid-state cooling. The project is scheduled to run for five years until April 2026. The TRANS project was selected from more than 2,500 applications to receive an ERC Consolidator Grant. The Empa researcher is one of around 120 women who received awards in 2020 – at 37 %, this was the highest proportion of women since the introduction of the Consolidator Grant scheme.

The desired profile: as thin as possible, with the long-term goal of many layers only ten micrometers thick; easily stretchable, sensitive to low current voltage, and at the same time robust. And above all: printable, meaning no solvents for the conductive layers between which the polymers lie. "Solvents can damage the polymer layer. In addition, the material would have to dry for a long time to avoid emitting harmful vapors," explains Opris, "so we try to go without – with the right chemistry."

Diverse requirements that researchers around the world are dealing with. Suitable compounds that raise hope are polysiloxanes, which the Empa specialist is also working on. One important advantage of these polymers is that they are relatively easy to synthesize; the chemical backbone of their strands is very mobile – and they can be specifically functionalized with polar groups, i.e. plus-minus charged molecules.

SNAKE-LIKE MOLECULES

What is difficult for laypeople to understand, Dorina Opris explains with a vivid image: "You can imagine these polysiloxanes like a pot full of snakes that constantly want to move." The polar groups have a twofold effect on them. First, they make the molecular snakes more sensitive to electric fields, so they respond to low voltages. Second, they act like a kind of glue between the molecules; this "stiffens" them, reducing their elasticity. It is necessary to fine-tune both effects to achieve maximum success. For a practical application, the transition from the solid to the elastic state at low temperatures is important so that the technology can later be used at room temperature.

In addition, such polymer structures still have to be chemically crosslinked so that they can become elastic layers – for example, by UV light and with the help of so-called end groups: quasi-molecular "hats" that the snakes carry at their ends. But in laboratory practice, it has so far proved tricky to reliably provide these polymers with defined end groups. "That annoys me!" admits Opris with a smile.

Healthy ambition is needed for the TRANS project, which the chemist herself calls "very, very ambitious". The team is optimistic that earlier work has already produced encouraging results; such as a polysiloxane compound that reacted to a voltage of only 300 volts and deformed strongly – an extremely low value. Printing capacitor layers without solvents has also already been achieved. And a doctoral student recently developed a piezoelectric elastomer that, when stretched, exhibits a significantly higher electrical response than other compounds currently in use.

CREATIVITY AND TEAM SPIRIT FOR SUCCESS

To achieve successes that prove valuable for practical applications, of course, many more steps are needed – and the qualities that brought Dorina Opris to Empa and ETH Zurich. Not only stamina and the ability to turn failed attempts into progress, but also creating an inspiring environment for employees that allows for open debate and even mistakes so that good ideas can emerge.

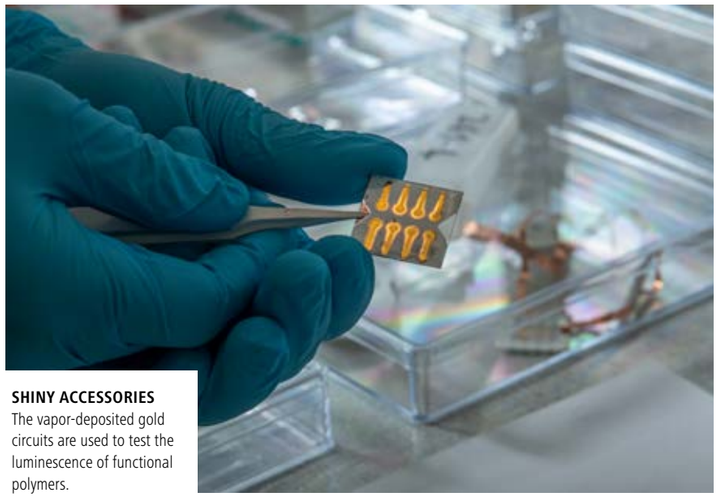
And above all: optimism. Young researchers, she thinks, should be given exciting and challenging projects and then allowed to work independently to keep them motivated. Her advice to talented women based on her own biography: "Don't wait until someone pushes you to do research. You have to be self-motivated and strong and follow through! And take a risk sometimes, too." Children and family? Not an insurmountable problem; private challenges, the researcher says, can almost always be overcome with good planning and a supportive partner. ■

DORINA OPRIS

CAREER: The researcher studied chemistry at Babeş-Bolyai University in Romania and later completed her doctorate in inorganic chemistry there and at Freie Universität Berlin. In 2006, she joined Empa's Functional Polymers lab as a postdoc. Since 2014, she has headed the Functional Polymeric Materials research group; in 2023, she was appointed titular professor at ETH Zurich. In addition to diverse work on polymers such as polysiloxanes, she performs peer-reviewing activities with renowned publishers. Dorina Opris has also been a member of Empa's Research Commission since 2016.

CONTROL WITH UV LIGHT
Dorina Opris and doctoral student Malte Beccard observe the discoloration of water, in which the excipient spiropyran is dissolved.

HIGH-TECH ON A SMALL SCALE
The printed strain sensor is only 500 micrometers thick and has self-healing capabilities. If it is "injured" by a cut, its function remains intact.



SHINY ACCESSORIES
The vapor-deposited gold circuits are used to test the luminescence of functional polymers.

Photos: Marion Nitsch

> "Don't wait until someone pushes you to do research. You have to be self-motivated and strong and follow through!"

Further information on the topic is available at: www.empa.ch/web/s209

ON TERAHERTZ WAVES TO MEXICO

An outstanding performance in the national "Schweizer Jugend forscht" competition opens up new doors. That is exactly what Sofie Gnannt and Nick Cáceres, physics lab technician apprentices at Empa's Transport at Nanoscale Interfaces Lab, have achieved. With their project "Plastic Separation with Terahertz Radiation", which was rated "outstanding", they will represent Switzerland in October at MILSET, the international young researchers' conference in Mexico.

Text: Amanda Caracas

OUTSTANDING
Physics lab technician apprentices Sofie Gnannt and Nick Cáceres presented their project on plastic separation with terahertz radiation at the finals of the 57th "Schweizer Jugend forscht" competition.

From Uster to St. Gallen – and then to Mexico! A journey that physics lab technician apprentices Sofie Gnannt and Nick Cáceres from the fourth year of their apprenticeship embarked on in November 2022 when they won both the Jury Prize and the Participant Prize for their project "Plastic Separation with Terahertz Radiation" at the Züri-Oberland apprenticeship competition – an exhibition with 34 projects and a four-digit number of visitors.

After their success in Uster, the two went on to St. Gallen in April 2023 for the finals of the 57th National Competition of "Schweizer Jugend forscht" (SJF), where Sofie and Nick were given the opportunity to compete against youths – mainly grammar school students – from all over Switzerland. After the SJF preliminaries in January 2023 in Bern, the two were supported by an expert from SJF and were able to deepen their research. This led to a project that was presented to a jury of experts as well as to the general public – and was finally awarded the rating "outstanding" as well as the special prize MILSET Expo-Sciences International (ESI), sponsored by the Metrohm Foundation.

EVERYDAY PROBLEMS – SMART SOLUTIONS

The focus of the two young researchers' project was on developing efficient methods for recycling plastics – a topic that is considered particularly important in the current era of reuse and recycling. This was also the motivation for Nick: "In today's world there are many problems, one of which is plastic waste pollution. This motivated us to develop a possible solution approach with our project." To achieve a reliable classification of plastics for recycling, the two apprentices investigated Terahertz Time Domain Spectroscopy (THz-TDS) as a method for extracting macromolecular information from unknown polymers, which was possible due to the relatively high transparency of plastics. This yielded important insights into how a specific polymer material interacts with Terahertz radiation. As for terahertz radiation, these are non-ionizing, electromagnetic waves – with wavelengths that lie between the microwave and infrared range. This technique was chosen for the research project because the two apprentices had been practicing it since their first year of apprenticeship and it was suitable for the experiment. Machine learning was used to train the model with data from everyday plastics to distinguish them from each other and classify them into four of the most important recyclable classes.

SORTING RAYS
A piece of plastic is examined for its interaction with radiation using Terahertz Time Domain Spectroscopy and then classified.

SUCCESS THROUGH TEAMWORK AND MENTORING

The fact that research means much more than in-depth study in one field is something Sofie and Nick can confirm through their newfound experiences. It also requires perseverance, diligence and support from like-minded people. One particular challenge, for example, was compiling the written documentation and the extensive literature research it required. "This work showed us how we can combine our learned knowledge with practical work," says Sofie. In doing so, the two apprentices proceeded in a very determined and structured manner, as the SJF expert Gregory Gäumann emphasized in his acknowledgment.

Moreover, the two apprentices demonstrated with their solid approach how solutions to an existing social problem can be successfully developed and implemented. The vocational trainer of the two apprentices at Empa, Dominik Bachmann, was impressed by how independently the two had familiarized themselves with the topic, obtained relevant literature and, when they had questions, turned not only to him but also to experts within Empa. He says: "I found Sofie and Nick to be very motivated and saw how they spurred each other on to top performance through committed teamwork. I think that's what made them so successful." Sofie and Nick's path shows: By working together, the doors are wide open. ■

Further information on the topic is available at: www.empa.ch/web/s606/lehreanderempa

FOSTERING APPRENTICESHIPS

Empa is a committed, multi-award-winning training company for apprentices and vocational specialists. In Dübendorf, St. Gallen and Thun, around 40 apprentices are trained in 10 different professions: Mechanic, electrician, laboratory technician specializing in chemistry, biology, physics and textiles, IT specialist for platform development, management assistant, design engineer, specialist in operational maintenance. Competent instructors pass on their knowledge with heart and soul. Empa offers opportunities for internships with various industrial partners during the apprenticeship, as well as attendance of vocational baccalaureate schools. Language study trips and project weeks are financially supported, and outstanding performance at Empa as well as at school is rewarded. This much commitment pays off: The success rate for an apprenticeship at Empa is almost 100 percent.

Photos: "Schweizer Jugend forscht"

OUR APPRENTICESHIP ACES

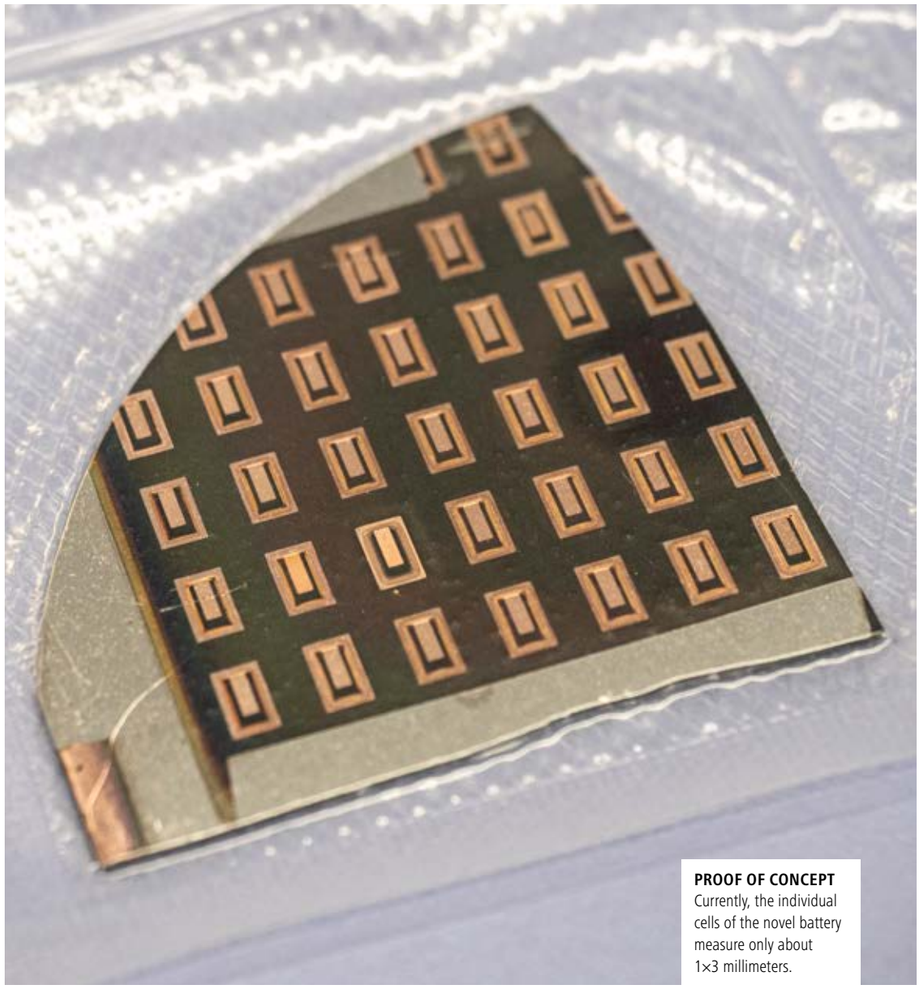
An apprenticeship at Empa is a rewarding experience. Every year, apprentices successfully complete their training in the ten apprenticeship professions in Dübendorf, St. Gallen and Thun. Whether they are IT specialists, electricians or physics lab technicians – they are all aces in their field. And all of them also have special superpowers.

Photos and illustration: Empa

RECHARGEABLE REVOLUTION

The Empa spin-off BTRY wants to revolutionize rechargeable batteries: Their thin-film batteries are not only safer and longer-lasting than conventional lithium-ion batteries, they are also much more environmentally friendly to manufacture and can be charged and discharged in just one minute. For now, the battery is very small, but the founders have big plans for it.

Text: Anna Ettlin



PROOF OF CONCEPT
Currently, the individual cells of the novel battery measure only about 1×3 millimeters.

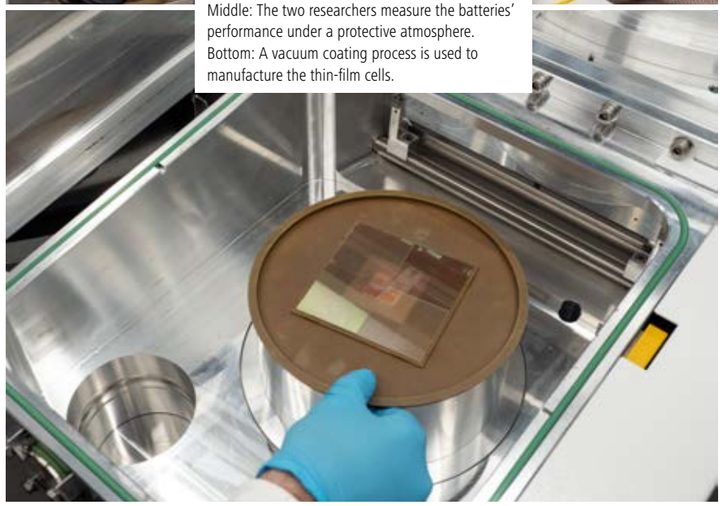
Photo: Empa

Lithium-ion batteries are everywhere: from smartphones and laptops to cars and even satellites. It is currently our most mature battery technology. Yet it is not ideal for many applications. Lithium-ion batteries lose capacity with every charge and discharge cycle, charge relatively slowly and only work well in a narrow temperature range.

According to Empa researchers Abdessalem Aribia and Moritz Futscher from Empa's Thin Films and Photovoltaics laboratory, it is time to rethink battery technology. Compared to other existing or developing technologies, their lithium metal-based solid-state battery brings some significant advantages: It can be charged and discharged within one minute, lasts about ten times as long as a lithium-ion battery, and is insensitive to temperature fluctuations.

In addition, unlike lithium-ion batteries, it is not flammable – a major advantage, because today's rechargeable batteries are considered hazardous materials. Incorrect handling or damage to a conventional lithium-ion cell can lead to a fire that releases toxic gases and is extremely difficult to extinguish. "By contrast, if you cut our battery with scissors," Aribia says, "you will simply get two batteries that are half as good."

Aribia and Futscher now want to bring this promising technology to market. Together with lab head Yaroslav Romanyuk, they have founded a spin-off called BTRY (pronounced "battery"). Aribia, who takes on the role of CTO at BTRY, had never previously thought of starting his own company. CEO Moritz Futscher, on the other hand, has been interested in startups since he was a student. The two researchers have been working together on the battery project for years and are



INNOVATION IN PROGRESS
Top: CEO Moritz Futscher and CTO Abdessalem Aribia in Empa's Coating Competence Center. Middle: The two researchers measure the batteries' performance under a protective atmosphere. Bottom: A vacuum coating process is used to manufacture the thin-film cells.

Photos: Empa

a well-established team. "We are convinced that our product can offer real added value," says Futscher.

HIGH-PRECISION MANUFACTURING

The new battery is a so-called thin-film solid-state battery. The technology itself is not new: Such batteries have been known since the 1980s. However, due to the very low mass of their thin-film components – the entire cell is only a few micrometers thick – they have been able to store very little energy so far. Futscher and Aribia have succeeded in stacking the thin-film cells on top of each other, increasing their capacity.

This makes the battery very promising for commercial applications. The thin-film cells are manufactured using vacuum coating: The desired materials are atomized in a vacuum chamber to form individual atoms, which are then deposited in a precisely controlled layer on the target substrate. "Such manufacturing methods are currently used on a large scale in the production of semiconductor chips and glass coatings," Futscher says. "That's an advantage for us, because the machines and know-how to manufacture our battery are largely in place already."

> "If you cut our battery in half with scissors, you will get two batteries that are half as good."

The high-precision manufacturing method has an additional advantage: "In contrast to the traditional method of battery production, our method does not use toxic solvents," explains Aribia. However, it also makes the thin-film battery more expensive. The researchers therefore see its application primarily in products where the battery only accounts for a small part of the overall cost of the device – for example, in smartphones and smartwatches or in satellites. "There, the advantages of our technology more than make up for the higher price," Aribia states.

WANTED: INVESTORS!

The researchers are not the only ones who believe their product has a lot of potential. BTRY was supported by Innosuisse and made it into the business incubator of the European Space Agency (ESA). In addition, Aribia received an Empa Entrepreneur Fellowship, which supports young researchers who want to found a company.

But before the first thin-film batteries launch into space or supply smartphones with electricity, there is still a lot of work to do, both on the administrative and on the technical side. In the meantime, the two founders are using the equipment and facilities at Empa's Coating Competence Center to create bigger and more powerful battery prototypes in order to show potential investors that the technology is worth backing.

Over the next two years, the researchers want to increase both the surface area of the battery and the number of layers. "Currently, our batteries consist of only two layers of about 1×3 millimeters," Aribia says. "Next, we want to make a battery of about one square centimeter with two to three layers. We can't power a satellite with that yet – but we can very well show that our technology is scalable." ■

SUPPORT FOR START-UP FOUNDERS

The Empa Entrepreneur Fellowship is awarded to Empa researchers who want to found a start-up based on their research. The fellowships are awarded on a competitive basis and include financial support for twelve months. Empa spin-offs and start-ups receive additional support in the two business incubators glatec in Dübendorf and Startfeld in St. Gallen.

Further information on the topic is available at: www.empa.ch/web/s207

CELLS FIGHT CANCER

INFLUENCING MACROPHAGES SPECIFICALLY AND EFFICIENTLY
Empa researcher Katharina Hast

Biophysicist Katharina Hast is developing a hydrogel at Empa in St. Gallen that makes the body's own phagocytes fit for treating cancer or chronic wounds. The Uniscientia Foundation in Vaduz is funding the project, which was recently launched.

Text: Andrea Six

PROMOTING TALENT

Empa's Zukunftsfonds is looking for private donors for exceptionally talented young researchers and for outstanding research projects that are not (yet) supported elsewhere. The Vaduz-based Uniscientia Foundation is funding the present project.

Humans have about 1000 billion immune cells. Some of them patrol the blood and are summoned by messenger substances to wherever there is a fire. Masses of immune cells, for example, act as specialized scavenger cells, so-called macrophages, and go wherever infectious agents invade or foreign objects interfere. Tumors, however, have the ability to evade macrophage attacks: They send out signals that literally rob the phagocytes of their appetite. While macrophages need to be "awakened" to fight tumors, they are too active in other disease processes, such as chronic wounds. Empa researchers from the Particles-Biology Interactions, Biointerfaces and Biomimetic Membranes and Textiles labs in St.Gallen are therefore joining forces to sensitize the macrophages to match the disease process in the body.

For this purpose, active substances are to be embedded in a hydrogel, a scaffold made of a biodegradable polymer, which attract macrophages and "reprogram" them appropriately. Biophysicist Katharina Hast recently started her doctoral thesis within the project. The Empa researcher is convinced that the strategy of introducing nanoparticle active substances via a smart material has several advantages: "The hydrogel should be able to influence macrophages precisely and efficiently." This should also make it possible to reduce the side effects of treatments, she says. ■

Further information on the topic is available at:
www.empa.ch/web/s401 / www.empa.ch/web/s403
www.empa.ch/web/s404

Photo: Empa

HOW MUCH MICROPLASTICS IS THERE IN SWISS RIVERS AND LAKES?

Plastic particles less than five millimeters in size, also known as microplastics, often settle far away from their point of origin. Empa researchers have now developed a model that can be used to calculate the concentration of microplastics in Swiss lakes and rivers.

Text: Anna Ettlin

BIG TO SMALL
One of the ways microplastics gets into the environment is by degradation and abrasion of larger pieces of plastic.

Every year, 14,000 tons of plastic end up in Swiss soils and waters, in part in the form of microplastics: Particles in the micro to millimeter range. Microplastics comes from many sources, such as cosmetics or synthetic fiber clothing. The tiny particles are also produced by abrasion and decomposition of larger pieces of plastic, so-called macroplastics.

Due to their small size, microplastics particles readily enter waterways. Around 15 tons of microplastics enter Swiss rivers and lakes every year. Measuring their concentration in water is not an easy task, because the tiny polymer pieces are often difficult to distinguish from particles of natural origin, and their quantity varies greatly with the time and place of measurement as well as with the measurement method.

Photos: Empa

SEVEN MOST COMMON PLASTICS

In order to get an overview of microplastics pollution in the rivers and lakes of a larger region, for instance for all of Switzerland, measurements alone are often insufficient. That is why Empa researchers David Mennekes and Bernd Nowack have developed a model for the Federal Office for the Environment (FOEN) that can predict the concentration of microplastics in waterbodies nationwide.

As a basis, the researchers used a model developed in 2020, which shows where and in what quantities the seven most common polymers are released into the environment as both macro- and microplastics: polyethylene (LD-PE and HD-PE), polypropylene, polystyrene and expanded polystyrene, PVC and PET, as used in packaging, textiles, insulation and agricultural films. “After we were able to show where and in what amounts plastic enters the environment, the logical next step was to show its concentration,” Nowack explains.

LARGE CITIES ARE POLLUTING WATER BODIES

According to the new model, around half of the microplastics that enters Swiss waters remains in the country. Around a third of the total amount settles in lakes, the remainder in rivers. However, the exact distribution of microplastics can be complex: A longer river does not automatically retain more particles than a shorter one. Rather, the river basin, the barrages and the lakes determine how much microplastics remains in the river and how much is transported further.

Not surprisingly, particularly high levels of microplastics pollution can be found downstream from major cities. The Rhine near Basel contains the highest concentration of microplastics: The river transports around 4,500 tons of them toward Germany every year. This is also due to the Aare, which, together with its tributaries Reuss and Limmat, drains three of Switzerland’s largest cities before flowing into the Rhine: Bern, Zurich and Lucerne.

“Measurements are only possible at specific locations. With our model, on the other hand, we can calculate the microplastics load throughout the country,” Nowack sums up. “Furthermore, it allows us to estimate what effects behavioral changes or government measures would have on microplastics concentrations.” The scientists recently published their findings in the new journal Nature Water.

The model can also be applied to other countries and areas. Nowack and Mennekes, meanwhile, are focusing on Switzerland. They are already developing a comparable model to predict the amount of macroplastics – such as PET bottles and plastic bags – in bodies of water. In a next step, the modeled plastic concentrations could also be used to estimate the risk to the environment in the respective regions. ■

PERVASIVE
Pieces of plastics measuring less than 5 millimeters in size easily end up in bodies of water such as lakes.

Further information on the topic is available at:
www.empa.ch/web/s506

BIOTECH VIOLIN "MISTAKEN" FOR MASTER INSTRUMENT

In a long-term research project, Empa researchers led by Francis Schwarze have developed a process, in which a white rot fungus is induced to break down wood cells in a targeted manner. This produces so-called mycowood with improved acoustic properties. A replica of an antique Guarneri del Gesù violin made of mycowood was now able to compete with other violins in a blind test in front of experts in music, materials science and violin making at the EPFL during the event "musique et matériau". The audience of experts matched the sound of the Empa biotech violin to an antique Gagliano violin from 1774. A commendable mix-up for the biotech violin, thought also Walter Fischli whose foundation funded the Empa research project.

www.empa.ch/web/s302

FUNGUS RESEARCHER
Empa scientist Francis Schwarze with the mycowood violin

MEDTECH MEETS CLEANTECH

LIVELY DISCUSSION
Empa Director Tanja Zimmermann (left) in conversation with experts from industry

Just as in science, interdisciplinarity can enable breakthroughs in business as well, paving the way for innovation. That's why the Innovation Zürich event on 20 April was dedicated to cross-industry innovation, with a special focus on medtech and cleantech. Empa Director Tanja Zimmermann presented Empa's recipe for success in innovation and then discussed the challenges and opportunities of cross-industry innovation with industry representatives.

innovation.zuerich

Photos: Empa; Amt für Wirtschaft und Arbeit, Kanton Zürich

SUCCESS FOR SWISSLOOP TUNNELING

TEAMWORK IN TEXAS
Swissloop Tunneling technicians preparing for the competition

The student team from Swissloop Tunneling, which is developing its technology at the Empa campus in Dübendorf, has achieved another success: At the Not-A-Boring-Competition in Bastrop, Texas, the team achieved second place on 1 April. In addition, the jury of the competition, which was launched by Tesla founder Elon Musk, awarded the team the innovation prize for the design of its Groundhog Beta drilling machine. Among the five finalists, only the Swiss and the winning team from the Technical University of Munich managed to successfully drill a tunnel with their prototypes. The competition promotes innovative concepts with a view to future Hyperloop systems: high-speed transport in vacuum tubes, which is being worked on worldwide.

swissloopтunneling.ch

Photo: Swissloop Tunneling

EVENTS
(IN GERMAN AND ENGLISH)

15. – 17. AUGUST 2023
Konferenz: International Symposium on Non-destructive Characterization of Materials (ISNCM)
Zielpublikum: Wissenschaft
www.empa-akademie.ch/isndcm23
Empa, Dübendorf

06. UND 07. SEPTEMBER 2023
Kurs: 3D-Drucken in der Medizintechnik
Zielpublikum: Industrie und Wirtschaft
www.empa-akademie.ch/medizintech
Swiss m4m Center, Bettlach

28. SEPTEMBER 2023
Tage der Technik 2023 – Die Ressourcenknappheit als Innovationstreiberin
Zielpublikum: Öffentlichkeit
www.tage-der-technik.ch
Empa, Dübendorf

05. OKTOBER 2023
Kurs: Energy Harvesting
Zielpublikum: Industrie und Wirtschaft
www.empa-akademie.ch/harvesting
Empa, Dübendorf

Details and further events at: www.empa-akademie.ch

THE PLACE WHERE INNOVATION STARTS.

Empa

Materials Science and Technology