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Czech Advanced Technology and Research Institute

NEWSLETTER 01/2023

New technology treats waste from biodiesel production

Improving properties of biofuel

European project BEST CROP

Generating new barley varieties

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Success of CATRIN´s researchers

Interview with A. Dömling

Together we can achieve great discoveries

New technology treats waste from biodiesel production and improves its properties

A graphene-based biomaterial is the core of a breakthrough technology that turns biodiesel production waste—glycerol—into a useful product, improving the efficiency of existing biofuels. Moreover, the non-toxic and fully recyclable material can replace acids previously used to convert glycerol. The discovery, published in Nature Communications, was made by scientists from the Czech Advanced Technology and Research Institute (CATRIN), Palacký University Olomouc and the CEET and IT4Innovations research centres of the Technical University of Ostrava in collaboration with colleagues in India.

The consumption of biofuels has increased dramatically worldwide and will continue to play an important role in the coming years. Therefore, it is necessary to optimize their production processes. Biodiesel is an ecological fuel of plant origin, which, when added to diesel, significantly reduces the emission of toxic gases into the air. However, the production of biodiesel from vegetable oils produces glycerol as a waste product, also known as glycerine, which is used, e.g. in antifreeze for cars.

"Our goal was to find a way to convert glycerol into a chemical form that can be reused in biofuels. We have developed a graphene-based carbon material chemically modified with a natural amino acid", explained Radek Zbořil.

This eco-friendly material can accelerate the conversion of glycerol into a high-value-added compound with the highest efficiency to date. "The resulting alcohol, called solketal, when added to the fuel, significantly improves its quality and octane rating, reduces the undesired formation of microparticles, as well as the emission of carbon monoxide and other organic toxic substances. In addition, it increases the viscosity and stability of the biofuel, important for the long-term storage of biodiesel", said Aby Cheruvathoor Poulose, first author of the publication.

The development of new nanomaterials derived from the Nobel Prize winning material graphene has been a long-standing focus of Olomouc scientists funded by prestigious European Research Council (ERC) projects. This time, the anchoring of a simple amino acid into the structure of graphene helped to achieve the desired result.

"Experimental and computational studies have shown that this particular amino acid significantly increases the ability of graphene to bind reaction components, in this case acetone and glycerol, to its surface. The new biomaterial is significantly more efficient for glycerol conversion than the acids currently used by industry, such as sulphuric or hydrochloric acid. However, unlike them, it is environmentally friendly", added Aristeidis Bakandritsos.

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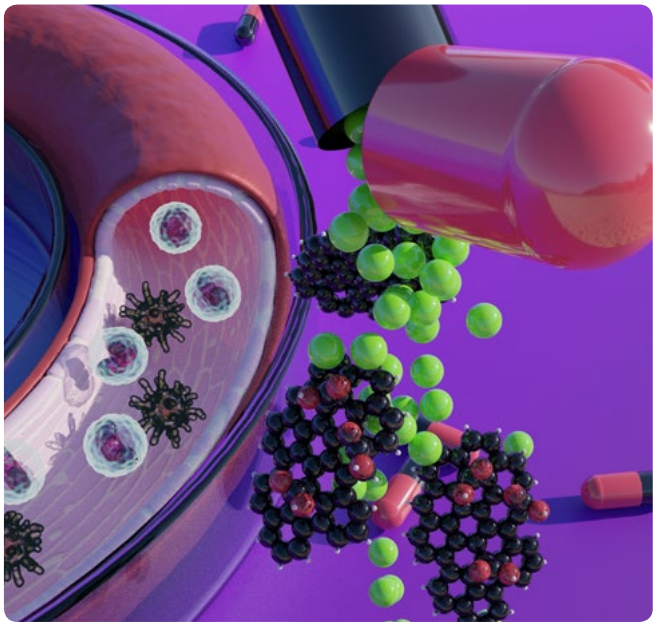
In 2021, the market for biofuels exceeded $110 billion and is expected to double by 2030. Biodiesel can be used directly as an environmentally friendly fuel in diesel engines, but it is mainly added to petroleum-derived diesel. The production of biodiesel generates around 40 billion tonnes of waste glycerol per year, which poses an enormous challenge, particularly in the context of circular economy principles.

Cheruvathoor Poulose A., Medved' M., Bakuru V.R., Sharma A., Singh D., Kalidindi S.B, Bares H., Otyepka M., Kolleboyina J., Bakandritsos A., Zbořil R.: Acidic graphene organocatalyst for the superior transformation of wastes into high-added-value chemicals. Nature Communications 2023, 1373. IF = 14.919

Scientists demonstrate the potential of new graphene derivatives



Graphene acid (carboxygraphene) and cyanographene, some of the newest graphene derivatives developed at CATRIN-RCPTM offer considerable promise in heterogeneous catalysis, water remediation, energy storage and antimicrobial technologies .

However, their interaction with human immunocompetent cells, which crucially affects the applicability of these derivatives in medicine, especially regarding the targeted transport of drugs and biologically active molecules, has not yet been studied in detail. In this field of nanomedicine, the most studied carbon material is graphene oxide, but its use is hampered by several limitations, such as low colloidal stability and very complex and poorly reproducible chemical composition. Therefore, in a joint study with colleagues from the Swiss research institute EMPA, CATRIN scientists investigated the biocompatibility of new 2D nanomaterials, focusing on their interaction with endothelial and immune cells. To study toxicity, they used some unique analyses, including a new dynamic model that simulated behaviour in a simple vascular environment to better reflect real circulatory conditions after intravenous administration.

The results showed the excellent biocompatibility of both graphene acid and cyanographene, without any indications of acute inflammation or endothelial disruption. Owing to their well-defined chemical composition and excellent colloidal stability, both young graphene derivatives offer considerable opportunities for the targeted transportation of drugs or genes.

Malina T., Hirsch C., Rippl A., Panacek D., Polakova K., Sedajova V., Scheibe M., Zboril R., Wick P.: Safety assessment of graphene acid and cyanographene: Towards new carbon-based nanomedicine. Carbon 2023, 11, 118093. IF = 11.307

Biosensor with new nanomaterial detects antibiotic residues in water

A new biosensor has been developed that can immediately detect very small antibiotic residues, namely ampicillin, in water or dairy products. The sensor utilises a tailor-made nanomaterial derived from fluorographene developed by scientists from the Czech Advanced Technology and Research Institute (CATRIN) of Palacký University and its Faculty of Science. They used "click chemistry", pioneers of which were awarded the Nobel Prize in Chemistry last year (2022). The development of the biosensor was reported by CATRIN scientists in the journal Small. A key attribute is it can be incorporated in a small box connected to a mobile phone.

David Panáček from CATRIN explained that "via alkyne groups bonded to graphene, we immobilized an aptamer—a molecule that is capable of detecting an antibiotic, i.e. ampicillin. We decided to use the method of click chemistry, which allows precise and fast binding of molecules. The uniqueness of this strategy lies not only in the procedure but also the possibility of connecting the sensor to a mobile phone. Such equipment could enable anyone to make measurements, e.g. in a home environment or directly in the field".

The effectiveness of the sensor was verified by researchers on tap water, in dairy products and in human saliva. They found that the biosensor could detect even lower amounts of drug residues in drinking water than the limit set by the European Union. The method is very simple—an electrode with the applied nanomaterial is immersed in a contaminated solution and the amount of ampicillin is measured by a mobile phone. Until now, the detection and further analysis of ampicillin have required expensive instruments and trained staff.

Flauzino J. M. R., Nalepa M. A., Chronopoulos D. D., Šedajová V., Panáček D., Jakubec P., Kührová P., Pykal M., Banáš P., Panáček A., Bakandritsos A., Otyepka M.: Click and Detect: Versatile Ampicillin Aptasensor Enabled by Click Chemistry on a Graphene–Alkyne Derivative. Small 2023, 2207216. IF = 15.153

Siderophores—a promising route for diagnosing microbial infections

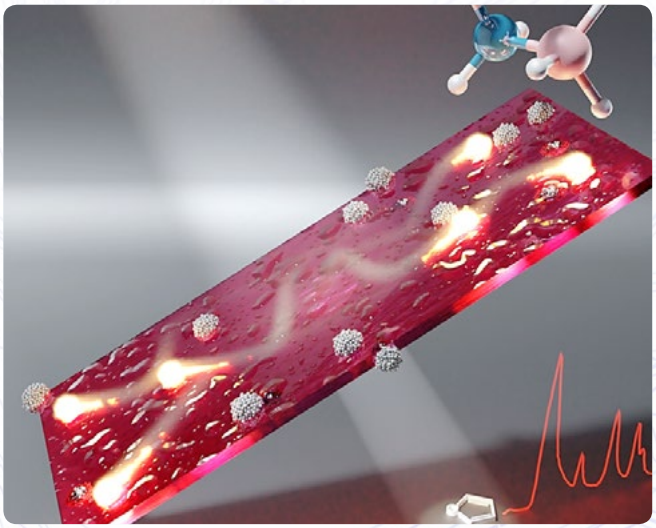
***Burkholderia cepacia complex (BCC)* is a group of Gram-negative bacteria commonly found in the environment that are generally considered non-pathogenic to a healthy population. However, some species can cause serious infections, including surgical wound infections, urinary tract infections, septicaemia and pneumonia. Therefore, there is a high demand for the development of modern tools for the detection and diagnosis of BCC. One promising strategy is to use radiolabelled siderophores. A contribution to this topic was made by scientists from CATRIN-IMTM and the Faculty of Medicine and Dentistry of Palacký University in a study published in the Journal of Medicinal Chemistry.**

„Siderophores are low-molecular-weight substances produced by most microorganisms that uptake essential iron. Replacing iron in siderophores with a suitable radionuclide opens up approaches for the targeted imaging of infections using nuclear medicine techniques. We describe how gallium-68-labeled ornibactin can be used for the specific imaging of BCC infections using positron emission tomography", said corresponding author Miloš Petřík.

Hospital-acquired pneumonias are most common in immunocompromised patients. Colonization of the airways by BCC in these individuals may be unpredictable and is generally associated with a poor prognosis. In addition, infections caused by BCC are dangerous because of their frequent resistance to antibiotics and disinfectants. However, not only the therapy but also the diagnosis of BCC remains challenging and affects the prognosis of patients. Current diagnostic methods often lack specificity and sensitivity and may be too invasive or time-consuming for critically ill patients.

Bendova K., Raclavsky V., Novotny R., Luptakova D., Popper M., Novy Z., Hajduch M., Petrik M.: [68Ga]Ga-Ornibactin for Burkholderia cepacia complex Infection Imaging Using Positron Emission Tomography. Journal of Medicinal Chemistry 2023, 66 (11), 7584–7593. IF = 8, 039

CATRIN Researchers Advance Colloidal Plasmonic Nanomaterials

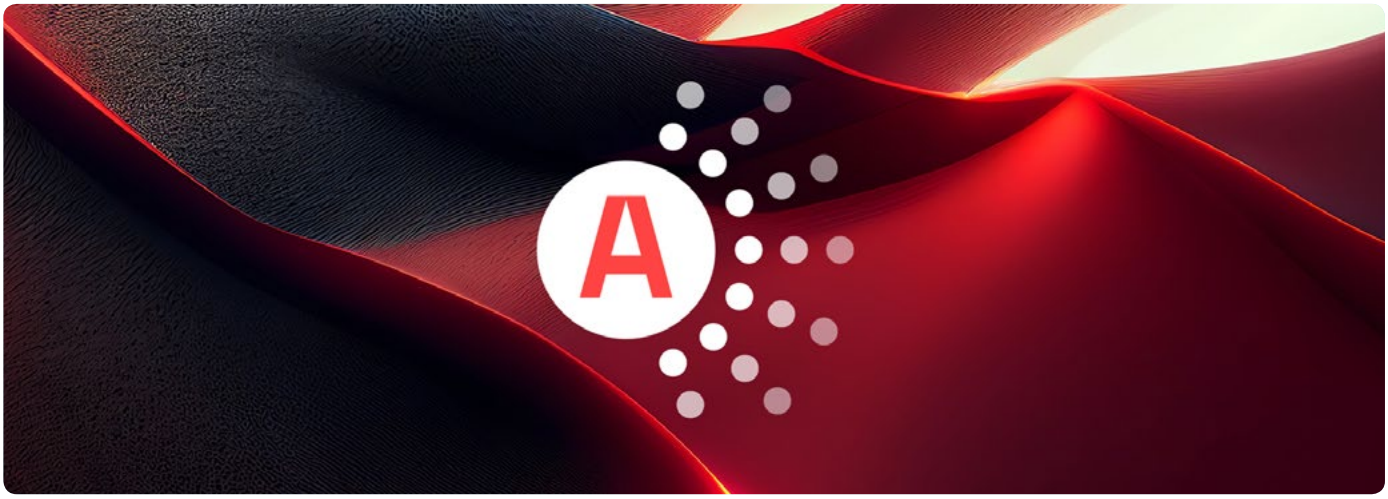


Researchers at CATRIN have made significant strides in developing colloidal plasmonic nanomaterials with a high carrier density and broad spectral capabilities. Their breakthrough study describes the successful fabrication of titanium nitride (TiN) nanobars through a two-step process: synthesis of TiO2 nanowires via a wet chemical route and subsequent high-temperature annealing in an ammonia flow.

Electromagnetic simulations of the resulting TiN nanobars revealed a remarkable range of optical resonances, including transverse, longitudinal and mixed plasmonic modes. These resonances spanned from the visible spectrum to the mid-infrared (MIR) region, offering vast possibilities for diverse applications. To enhance the photocatalytic properties, Pt cocatalyst nanocrystals were incorporated onto the TiN nanobars. This integration significantly improved photocatalytic hydrogen evolution compared to when using isotropic TiN nanospheres and nanocubes of similar size. Notably, the enhancement was most prominent when excited by near-infrared light at 940 nm due to increased hot electron generation.

Additionally, the researchers demonstrated the potential of plasmonic TiN nanobars in detecting furfural molecular vibrations. By exploiting the nanobars' strong surface-enhanced infrared absorption (SEIRA) effect in the MIR region, they demonstrated impressive capabilities beyond photocatalysis. CATRIN's groundbreaking research represents a significant advancement in the field of nanomaterials, opening new avenues for catalysis, sensing and optoelectronics. The successful fabrication of TiN nanobars with exceptional properties is an important step towards achieving colloidal plasmonic nanomaterials that can operate across a wide electromagnetic spectrum.

Rej S., Santiago E. Y., Baturina O., Zhang Y., Burger S., Kment S., Govorov A. O., Naldoni A.: Colloidal titanium nitride nanobars for broadband inexpensive plasmonics and photochemistry from visible to mid-IR wavelengths. Nano Energy 2023, 104, 107989. IF = 19.069



World-renowned chemist gathers a new research group to conduct pioneering research on sustainability

Miniaturisation and automation, which allow sustainable chemistry while contributing to more efficient development of new drugs, nanomaterials or plant protection substances or biostimulants, will be the central research topic of a new group led by the world-renowned chemist Alexander Dömling. The scientist, who is a leader in organic synthetic chemistry and has extensive experience in applying research results into practice, is assembling an international team in Olomouc thanks to an ERA Chair ACCELERATOR project, which has received funding of about 2.5 million euros from the Horizon Europe programme. He aims to bring other outstanding scientists to the university, support talent and cooperate closely with commercial partners.

The miniaturisation and acceleration of synthetic chemistry are critically important for the rapid optimisation of the properties of chemicals being developed in pharmaceutical, agrochemical and materials research and development. However, in most laboratories, organic synthesis is still carried out slowly, with great demands on the material and is not verified for multiple substrate combinations. The main pillar of Professor Dömling's research is multi-component organic reactions, which allow the preparation and testing of tens of thousands of chemicals at a time.

"Sustainability in chemistry is becoming extremely important in the face of globalisation and problems related to the ever-growing world population. In addressing these issues, multi-component reactions can help. I will continue to use them in medical chemistry, where my colleagues and I will focus on the areas of (immuno)oncology and development of new antibiotics or antivirals. I look forward to working with the Phenotyping Laboratory towards the discovery of more sustainable plant protection substances as well as biostimulants that can increase plants' resistance to a wide range of stress factors. Together with CATRIN-RCPTM, we will develop nanotechnologies with the aim of discovering new generation materials for a sustainable future", explained Dömling.

The project, known as the ERA Chair for Accelerated Synthetic Chemistry Technologies at Palacký University Olomouc (ACCELERATOR), will run until the end of January 2028. It represents the largest financial contribution to UP received to date from all EU Framework Programmes.

European project to generate improved barley varieties

The aim of the international project BEST CROP (Boosting photosynthESis To deliver novel CROPs for the circular bioeconomy) funded by the European Union programme Horizon Europe is to generate new barley lines with improved photosynthetic properties that will be able to assimilate ozone from the air, provide higher yields and produce customised straw for industrial use through breakthrough technologies.

A multidisciplinary consortium led by the University of Milan that brings together 18 European research institutions, breeding companies and industrial partners will strive to achieve these goals. The only Czech academic participant is CATRIN of Palacký University Olomouc. "Our task will be to use, in collaboration with partners from the project consortium, new breeding techniques for the preparation of modified barley lines and further preparation of accreditations and coordination of field experiments that will be carried out by the company Úsovsko", said Ivo Frébort from CATRIN.

Barley is a major crop worldwide. The European Union is the largest producer of barley, with around 10 percent of the EU's arable land under cultivation and almost 55 million tonnes of grain and the same amount of straw produced annually in the member states.

Marie Skłodowska-Curie Action Individual Fellowship to support zinc-ion battery development

The prestigious Marie Skłodowska-Curie Action Individual Fellowship (MSCA) from Horizon Europe has been awarded to Shashank Sundriyal from CATRIN. Thanks to this support, he has been working since January on the Z-ION project to contribute to the development of safer and greener zinc-based batteries. Aristides Bakandritsos from CATRIN is the mentor of the two-year project entitled "Z-ION Teaming Conductivity and Chemical Functionality in Metal-Organic Frameworks for Zinc-Ion Batteries".

"Zinc-ion batteries are among the most promising electrochemical energy storage technologies because they are cheap, sustainable and safe, and in principle offer one of the highest volumetric energy densities necessary for storing large amounts of energy per volume unit. The Z-ION project is in line with the United Nations Sustainable Development Goals, which include clean and sustainable transport as well as affordable and clean energy for all. The project aims to make a significant contribution towards transport decarbonisation and ensuring the flexibility and efficiency of our current electricity grid system, enabling increased use of renewable energy sources", said Bakandritsos.

CATRIN is part of a national centre of competence focused on polymers

Experts from several research groups of CATRIN will be involved in projects of the National Centre of Competence (NCK) of Polymer Materials and Technologies for the 21st Century (POLY-ENVI21), which has successfully obtained funding from the Czech Technology Agency. The projects will bring together research teams from nine research institutions and 16 companies under the leadership of Tomas Bata University in Zlín. Scientists from Olomouc will focus, for example, on the development of additives for polymers and technologies for the elimination of microplastics in wastewater.

"The project is largely focused on the circular economy and recycling of plastic waste, as well as on improving the properties of plastics. We will build on our previous experience from the former Centre of Competence ALTERBIO and partly on the environmental research carried out within the project NANOBIOWAT. However, some areas will be relatively new to us", said Jan Filip from CATRIN.

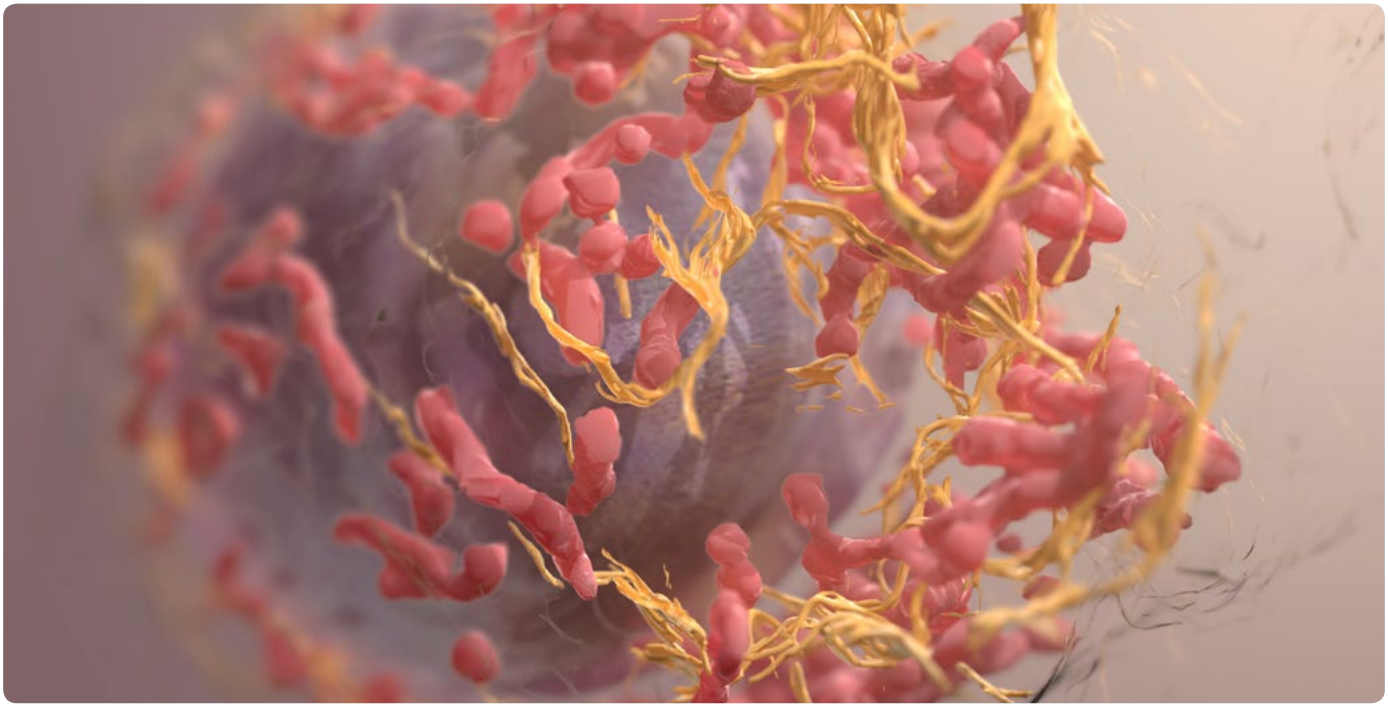
One of the tasks will be designing methods for the detection and elimination of microplastics in wastewater. Another challenge will be the labelling of plastics using nanostructures, which may also enable easier separation of plastic waste.

Automation to replace manual work in gene banks

This project focuses on development of new automated systems for gene banks, which are crucial for saving species diversity on our planet but currently rely on manual work to handle thousands of plant seeds. Scientists from Palacký University CATRIN in Olomouc are collaborating with the largest domestic gene bank of the Crop Research Institute in Prague-Ruzyně thanks to support from the Technology Agency of the Czech Republic. Large global gene banks have already shown interest in the proposed technologies.

Gene banks were mostly established at the beginning of the last century and have not yet evolved to take advantage of advances in technology. "They usually rely on demanding manual work, which limits their further growth and efficient functioning. To regularly verify the viability of stored material, mostly seeds, employees have to manually prepare thousands of samples. Therefore, our goal is to develop an automated system for sample preparation, i.e. manipulation of seeds, and a germination control system. These systems must be robust, fast and reliable.

We will test them directly in operation of the Prague gene bank, which is a model institution for us", said the main investigator of the project, Pavel Mazura from the CATRIN Phenotyping research group.



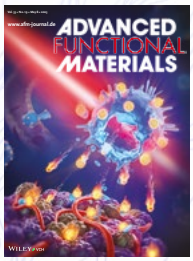
Scientists evaluate results towards developing a device to help treat neuroblastoma

Results obtained during the first year of the international GLEBBIOASSAY project, which aims to develop a biosensor to monitor the effectiveness of treatment for the child cancer neuroblastoma, have been evaluated by researchers from CATRIN, the Catalan Institute for Nanoscience and Nanotechnology (ICN2) and the Spanish organization Fundació Sant Joan de Déu (FSJD) at a meeting in Olomouc. They set out a research strategy for the next period of the three-year project, which is supported by the Technology Agency of the Czech Republic under the international call EuroNanoMed2021.

"The aim of the meeting was to inform each other about what we are working on, to discuss achievements and difficulties so far and search for solutions together. We need to combine our efforts, expertise and technologies to achieve a result that will be beneficial in the fight against this specific disease, which is very problematic in children", said the project's principal investigator Arben Merkoçi from ICN2, which is one of the world leaders in the field of sensor systems.

Neuroblastoma is the most common cancer affecting children in the first year of life, with survival rates for patients remaining below 40 percent. Immunotherapy has made huge advances in treatment in recent years. However, its effectiveness is hampered by the development of HAHA antibodies, which are produced in the human body in response to treatment. Although these can be detected by an enzyme-linked immunosorbent assay (ELISA), it is time-consuming, complex and requires trained personnel and expensive laboratory equipment.

Our latest reviews



I. Tantis, S. Talande, V. Tzitzios, G. Basina, V. Shrivastav, A. Bakandritsos and R. Zboril

M. Xie, M. Gao, Y. Yun, M. Malmsten, V. M. Rotello, R. Zboril, O. Akhavan, A. Kraskouski, J. Amalraj, X. Cai, J. Lu, H. Zheng and R. Li

„Non-van der Waals 2D Materials for Electrochemical Energy Storage",

Advanced Functional Materials, 33 (19), 2209360. IF=19.924

„Antibacterial Nanomaterials: Mechanisms, Impacts on Antimicrobial Resistance and Design Principles",

Angewandte Chemie International Edition 2023, 62 (17), e202217345. IF = 16.823

Alexander Dömling is a world-renowned scientist in the fields of miniaturization, synthetic chemistry automation and multicomponent reaction chemistry. A key theme of his research is the sustainability of chemistry, which he will develop at CATRIN thanks to prestigious ERA Chair and ERC Advanced projects.

Together we can achieve great discoveries and contribute to solving the world's problems

As a world-renowned scientist, what brought you to CATRIN?

During a visit to Palacký University a few years ago, I was intrigued by the work of the Plant Phenotyping group led by Lukáš Spíchal. High-throughput phenotyping combined with my research may be a way to sustainably provide enough food for an ever-expanding world population. When I heard about the ERA Chair programme from the EU, I submitted a joint application with Palacký University Olomouc, and we were successful.

The project, known as the "ERA Chair for Accelerated Synthetic Chemistry Technologies at Palacký University Olomouc (ACCELERATOR)", will run until the end of January 2028. What is its goal?

In the face of globalisation and problems associated with an ever-growing world population, questions about sustainability in chemistry are becoming increasingly important. They may be addressed by multicomponent reactions, which I have been working on for a long time. I will continue their use in medicinal chemistry, where my colleagues and I will focus on the fields of (immuno)oncology and the discovery of new antibiotics or antivirals. In addition, I am looking forward to working with the phenotyping lab here to discover more sustainable plant protection agents as well as biostimulants to promote plants' resistance to a wide range of stress factors. Together with CATRIN-RCPTM, we will develop nanotechnologies to discover next-generation materials for a sustainable future. In addition, I look forward to working with the young scientists and students who will join my group and to whom I can pass on my knowledge and experience. My aim is to foster their creativity and create an environment in which they can develop their scientific potential. Together, we can make great scientific discoveries and contribute to solving global challenges.

How big will the group be and what stage are you at?

The ERA Chair and other (international) funding will allow me to build a new group of scientists from the ground up. It will consist of experienced postdocs, PhD students and MSc students. Future challenges can only be met through international collaboration, so it is very important to be able to communicate effectively with other cultures. So, based on my previous strategy, I am building an international group of talented and passionate scientists. I consider a team of about 20 people to be ideal. I hope that by the end of this year my labs will be fully prepared, filled with collaborators and we can start working productively. We have also recruited MSCA fellows from Italy and Greece who will work on the theoretical aspects of the research.

In addition to the prestigious ERA Chair project, you have recently received an equally valuable ERC Advanced grant. What will be its main focus?

Yes, I was pleasantly surprised by this news in April. The ERC Advanced grant is the most important personal grant in Europe for exceptional scientists involved in pioneering projects. The project is titled "Automated, Miniaturized and Accelerated Drug Discovery (AMADEUS)". In this field, which I have been involved in for a long time, millions of tonnes of toxic waste are generated every year, which is not sustainable. That's why I intend to develop a breakthrough technology platform, AMADEUS, that aims to revolutionise the drug discovery and optimization process through an autonomous, AI-driven and highly miniaturized automated compound identification process.

What will this revolutionary change entail?

Unlike current industry approaches, which rely on synthesis on a larger scale, my approach will operate on a scale approximately 100,000 times smaller. This shrinkage of scale will significantly reduce the amount of toxic waste generated while accelerating the drug discovery process. I expect this platform to make drug development more sustainable and more cost and time efficient. Reducing the time to market is not only an economic driver but also benefits patients enormously, allowing new scientific findings to be put into practice more quickly. However, I am also considering applying this technology in catalysis, e.g. to optimise the properties of materials or plants. I anticipate that AMADEUS will mark a significant step towards achieving sustainability in research and development, encouraging innovation and progress in various scientific fields.

How will the two projects be linked?

I am very happy to have received both grants at the same time as they will help me to accelerate my research and exploit synergies for the research taking place at CATRIN at the highest international level. The two projects are very complementary. While the ERA Chair ACCELERATOR aims to support the three components of CATRIN, i.e. the RCPTM, CRH and IMTM, the ERC grant AMADEUS will provide the foundations for a new and revolutionary technology for the discovery and optimisation of new compounds that can benefit the whole of society. To achieve these ambitious goals, collaboration and a strong team of motivated people are key. I am fortunate to be able to select exceptional colleagues who share the same commitment and passion for research and development of the technology platform. I look forward to embarking on this adventurous journey over the next decade in Olomouc. It is an exciting opportunity for me to push the boundaries of scientific research, make significant contributions to our fields, and ultimately have a positive impact on the world.

prof. Alexander Dömling, Ph.D.

In the first decade of his professional life, Professor Alexander Dömling studied Chemistry and Biology at the Technical University of Munich. He received his doctorate under the supervision of world-renowned scientist Ivar Ugi. He spent his postdoctoral period with two-time Nobel laureate Barry Sharpless at the Scripps Research Institute in California. He went on to work at the University of Pittsburgh, where he received several large grants and gained experience in computational and structural biology, which he used, e.g. in drug design.

Subsequently, he worked as Head of the Department of Drug Design at the University of Groningen, where he built up a department of about 30 students and collaborators. Professor Dömling has extensive experience in commercialising research results. He has obtained more than 70 patents and co-founded six biotechnology companies.

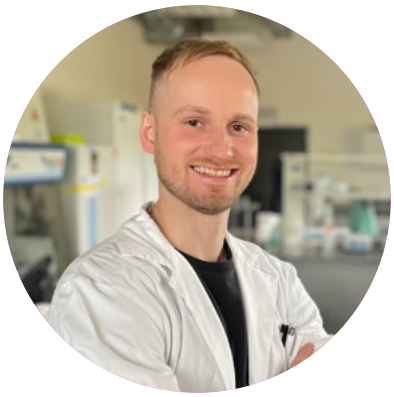
Lenka Dzurová
Science is a never-ending job, you have to love it

Already during her studies, Lenka Dzurová was fascinated by proteins. So, at the end of her PhD, when she happened to see an advertisement for a researcher in the field at a research centre in Olomouc, it was an obvious choice. The graduate of the Pavel Jozef Šafárik University in Košice, she completed her doctorate in biophysics in January 2013, and a month later, she was working at the Centre of the Region Haná for Biotechnological and Agricultural Research, one of the current CATRIN units.

"It was my dream assignment, so I didn't hesitate. I first worked on the preparation and characterisation of recombinant proteins and, after returning from parental leave, moved on to the production of the antimicrobial peptide cathelicidin in transgenic barley. We are trying to develop an efficient way to extract this protein from barley and are also looking at how to use barley as a bioreactor for other proteins", said Dzurová, who has also gained experience at universities in Germany, France and Italy.

She managed to prepare an application for an Aurora mini-grant, of which she is the principal investigator. The aim is to establish partnerships with other research institutions, increase the chances of the mini-consortium in future grant calls and strengthen the European university alliance. She has chosen to collaborate with foreign institutes that, like her home department, are working on protein engineering.

She enjoys teaching students and promoting science. "Science is a never-ending job, you have to love it. I love working in the lab and doing experiments, especially if they go well. I don't set big goals and chase achievements but take one step at a time. When I look back, perhaps I can say that I have already achieved something. At the same time, I know that I still have a lot to learn. I consider the fact that I managed to combine science and family life my biggest achievement, because sometimes it is quite challenging", concluded the mother of two.



Martin Ondra
Being at the birth of a solution to a problem fascinates me

Being right in the middle of the problem and finding the tools to fix it. This was one of the reasons why Martin Ondra decided to study cell and molecular biology and pursue a career as a scientist years ago. He tapped into research during his undergraduate studies and is now working on three projects as part of his PhD at the Institute of Molecular and Translational Medicine, the results of which could in the future contribute to treatments for cystic fibrosis or damage to the cornea of the eye, as well as detection of sentinel lymph nodes in breast cancer patients.

"The common denominator of these projects is the creation of new cell models, mostly for the high-throughput testing of chemicals. For example, in the case of cystic fibrosis, we are using models to find new modifiers and correctors of the CFTR protein, whose mutations cause this disease. Another project is related to cornea research. If the cornea is damaged, there is no option but to transplant it from another patient. Of course, there are not enough donors, so we are trying to force the cells to divide to produce more material for the patients. The third project concerns the visualisation of lymph nodes, where I am working on the creation of in vitro models to validate the use of nanodiamonds in collaboration with the Institute of Organic Chemistry and Biochemistry of the CAS", explained Ondra.

His biggest success so far is shared first authorship of a publication in Advanced Functional Materials. It presents comprehensive research from the preparation of nanodiamonds to the first in vivo validation. The research continues and so does the young scientist's enthusiasm. His goal is to complete his PhD this year and then eventually go to Canada, where he has already completed a six-month internship.

"It fascinates me to be the first person to find a solution to a problem. However, not every idea works out," he concludes.

Aby Cheruvathoor Poulose
My dream is a biomass catalytic converter

Aby Cheruvathoor Poulose became interested in the nanoworld during his Master's degree studies in Chemistry at Mahatma Gandhi University in Kerala, India. After gaining a PhD from Japan, he decided to relocate to Olomouc five years ago and has been researching nanomaterials based on commonly available and non-toxic elements for energy and catalytic applications at CATRIN. This year alone, he was first author of two papers in the renowned journals Nature Nanotechnology and Nature Communications.

He met scientists from RCPTM, now part of CATRIN, back in 2012. At that time, as a PhD student at the University of Tokyo and holder of a prestigious scholarship from the Japanese government, he visited Brno for the Nanocon conference. When he decided on a career change from industry to academic research, he chose Olomouc.

"I was impressed by how quickly the young science centre has established itself as a thriving institute and by its groundbreaking research results and modern instrumentation. I considered it an opportunity for my professional growth, and I am glad that I can do cutting-edge research here thanks to the international environment and friendly colleagues", said the scientist.

His scientific interests relate to the conversion of biomass into useful products, such as fuels, chemicals and materials. "My dream is to develop a nanomaterial catalyst that can maximise the use of biomass, promote sustainability and reduce dependence on fossil fuels, which goes hand in hand with principles of bioeconomy.

Aby and his family enjoy living in Olomouc. "The warm atmosphere, historical heritage and many cultural events make Olomouc an attractive choice for those looking for a balanced and affordable lifestyle", he said.

CATRIN contributes to Sustainability and Civilisation exhibition

Medialogue has prepared the third part of a series of exhibitions by Egyptologist Miroslav Bárta, this time entitled "Sustainability and Civilisation", which opened on May 12 on Kampa Island in Prague. It presents 39 panels focusing on the concepts of sustainability, the role of natural materials and the acquisition of clean energy. Seven panels were prepared by CATRIN scientists, namely Veronika Veselská, Michal Otyepka, Ivo Frébort, Jan Filip and Vojtěch Kupka, who contributed to panels entitled "How to Feed Humanity", "Recycling of Plastics", "Energy in Your Pocket" and "Carbon on the Scene".

"It was very important for me to participate in this exhibition. Already during the preparation and at the opening, I met a number of important people in this field, from academia as well as industry. The issue of recycling is partly related to our research and is very important to me, both professionally and personally", said Filip.

The main theme of the exhibition is that our civilisation is the first to date to be unable to return most of what it produces to nature or recycle it. The individual panels focus on the concepts of sustainability, the role of natural materials and the acquisition of clean energy. They present technological advances in these areas, showing positive examples to help change public thinking and behaviour.

Chamber of Deputies hosts a debate on antibiotic resistance

On April 11, participants of an expert roundtable discussed in the Chamber of Deputies of the Parliament of the Czech Republic the issue of antibiotic resistance. CATRIN representatives Radek Zbořil and David Panáček, involved in research in this area, were invited to the meeting.

The scientific director of CATRIN-RCPTM Radek Zbořil gave a presentation entitled "The Use of Nanomaterials in Antibacterial Applications and their Modification for the prevention of Antimicrobial Resistance". Among other things, he presented the results of research conducted by CATRIN in collaboration with colleagues from the Faculty of Medicine of UP and the University Hospital Olomouc.

"We focus on the prevention of hospital infections through the development of new antimicrobial nanosurfaces and modification of medical devices. But those present were also interested in new graphene technologies that prevent the development of bacterial resistance to nanomaterials and could be used to challenge resistant strains", Zbořil said. According to data, 33,000 people in Europe die annually from infection

Young scientists represent CATRIN at the Science Fair

This year's edition of the largest domestic celebration of science promotion—the Science Fair of the CAS, which took place at the beginning of June in Prague's Letňany, was not short of researchers from CATRIN. Plant and material research was presented to the public by the youngest scientific generation of the university institute.

Through experiments and fun games, they explained different areas of research in nanomaterials, nanotechnology, plant and biotechnology development, e.g. how iron nanoparticles can be used to purify water from hazardous substances, how nanomaterials can be used in energy storage devices and how the secrets of plant life can be decoded.

Visitors could participate in a plant memory game, create DNA origami or try their hand at isolating DNA from a banana.

Collaboration with AFO continues

As in the previous year, CATRIN was one of the main partners of the 58th edition of the Academia Film Olomouc International Film Festival

The audience debated the development of genetics but also the possibilities of contemporary science, e.g. in the treatment of rare genetic diseases or in the field of plant genome editing, after the screening of the film "A Confidential History of the Gene". Their discussion partners were Jeff Cole, President of the European Federation of Biotechnology (EFB) and member of the CATRIN Scientific Board, and Ivo Frébort, Vice President of the EFB and Head of CATRIN-CRH.

The panel Talent in Science, which focused on the importance of leaders in scientific work, included former CATRIN scientist Veronika Šedajová. In a pre-recorded video, she shared important aspects that contributed to the launch of her successful scientific career.

CATRIN also took part in the accompanying Science in the Streets programme. Using graphic presentations and experiments, researchers showed how genetic analyses of insects can add to our knowledge of biodiversity, why plant research is important and how nanotechnology and nanoparticles can be used for various applications.

At C4B, scientists and investors sought common ground

In an effort to connect the worlds of science and business, CATRIN hosted the first edition of C4B - CATRIN for Business. Researchers presented results they considered suitable for transfer into practice to company representatives and technology transfer experts.

"The aim of the meeting was to deepen links between science and business in a significant way. We know that there is a large gap between these sectors that needs to be bridged during the technology transfer process. In order to do this, we prepared presentations of recently developed technologies that we considered promising. I believe that C4B will not be a one-off event, but we will start a new tradition", said CATRIN Director Pavel Banáš.

The technologies presented included graphene derivatives for use in energy storage devices, graphene biosensors, effervescent iron nanoparticle tablets for water purification, catalysts to speed up and reduce the cost of industrial production of many important drugs and chemicals, biostimulants for agricultural applications and technology for the "production" of the antibacterial peptide cathelicidin in barley, etc.

CATRIN interested in deepening cooperation with Israel

Nanotechnologies for sustainable energy were presented by CATRIN representatives on a joint mission of Czech research institutions to Israel, which was organized by the Ministry of Foreign Affairs of the Czech Republic in May. In addition to a visit to Bar-Ilan University (BIU) in Tel Aviv, which CATRIN cooperates with, the program included tours of Israeli companies GenCell, Electreon and the Israeli Electric Company in Hadera. Subsequently, CATRIN representatives attended the Czech-Israeli University Conference in the Chamber of Deputies of the Parliament of the Czech Republic.

"We presented the new materials we are developing for electrical energy storage devices, especially lithium batteries. We were also able to share the experience of the existing cooperation with our Israeli partner", said Petr Jakubec, who attended the mission together with CATRIN Director Pavel Banáš. The aim of the Israeli mission was to establish possible cooperation in testing and developing technologies for electromobility or smart city solutions to meet the needs of Israeli and Czech municipalities.

Exploiting synergies in education, research and technology transfer between the two countries was also a central theme of the Czech-Israeli University Conference, which took place on May 24 in the Chamber of Deputies of the Parliament of the Czech Republic. CATRIN Director Pavel Banáš and CATRIN-RCPTM Head Michal Otyepka attended the conference and presented details of the cooperation with the Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) at BIU.

Workshop outlines possibilities for further cooperation with IT4Innovations

Carbon dots, one of the most studied nanomaterials of today, were the central topic of a joint meeting of CATRIN and the IT4Innovations National Supercomputing Center called a "Workshop on the Future of Carbon Dots", which took place in May in Ostrava. Scientists presented the results of many years of research, often published in prestigious journals, focusing on the design, synthesis and especially use of these materials.

Carbon dots have several unique properties, e.g. high stability, biocompatibility, low toxicity, and intense photoluminescence. This makes them suitable for a wide range of applications, from medicine to optoelectronics.

"CATRIN has become a natural partner for collaboration in the field of materials science and nanotechnology. It is evident that combining IT4I's knowhow in HPC and AI with the experience of CATRIN teams in developing new nanomaterials, procedures for their rational design and computer simulations of biomolecules is yielding interesting scientific results. I firmly believe that further significant research results will be achieved in the field of carbon dot research, which was the focus of this workshop", said IT4I Director Vít Vondrák.

Nikola Kořínková joins the GeneSprout initiative

Nikola Kořínková from the CATRIN Plant Genetics and Engineering research group has joined the GeneSprout initiative, which brings together young scientists in the field of plant research. She is the only Czech representative in the international initiative, whose main goal is to support and promote new plant breeding techniques.

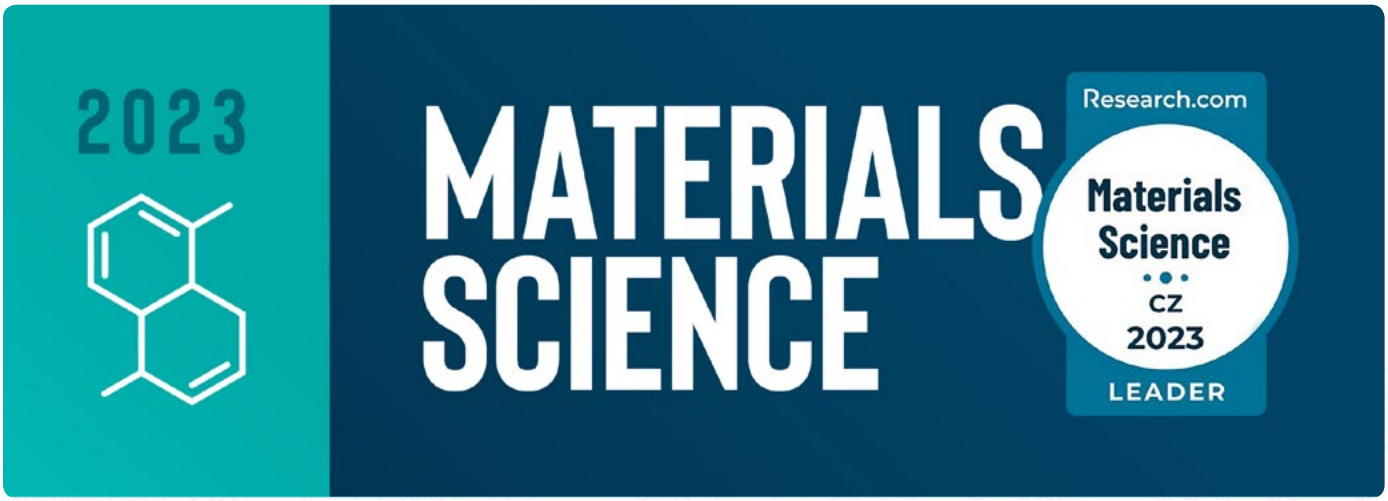
"GeneSprout brings together young scientists who know that new breeding techniques, especially CRISPR, offer great opportunities for addressing how to ensure sustainable food production in the future. We use these methods ourselves, but for our research to be meaningful, they must have practical applications. The current European regulations on new genomic methods prevent this, which is very demotivating for us. That is why one of our goals is to try to be a voice for young plant scientists in policy making on new plant breeding techniques in Europe", explained Kořínková, who welcomes the opportunity to network with colleagues from other countries.

Czech Chemical Society recognises Radek Zbořil's accomplishments

The Miloš Hudlický Prize for a significant contribution published within the Chemistry Europe consortium was awarded to physical chemist Radek Zbořil from CATRIN, Palacký University, on May 30 during the executive board meeting of the Czech Chemical Society (CChS). As one of the most prominent Czech chemists and materials scientists, he was corresponding author of a paper that reported the development of a simple electrochemical nanosensor for detection of the broad-spectrum antibiotic chloramphenicol.

"I am honoured to have been granted this award by the Czech chemical community and approved by the committee of the Czech Chemical Society, as I would be to receive any award in the Czech Republic or abroad. However, the award belongs to all the co-authors, whom I would like to thank for their effort", said Zbořil. Petr Jakubec, Veronika Urbanová and Zdenka Medříková were among the authors.
The paper that caught the attention of CChS members was published in 2016 in Chemistry: A European Journal under the title "Advanced Sensing of Antibiotics with Magnetic Gold Nanocomposite: Electrochemical Detection of Chloramphenicol". The researchers used magnetic nanostructures in combination with gold nanoparticles to prepare the nanosensor.

CATRIN scientists succeed in Research.com



Several CATRIN researchers have featured in this year's edition of Research.com's international rankings. CATRIN-RCPTM's Scientific Director Radek Zbořil was the highest ranked materials scientist in the national ranking and ranked 471st in the global list. The highest position, this time in the field of chemistry, belongs to Pavel Hobza, who reached the 223rd position in the world ranking.

The second edition of Research.com's ranking of the top materials scientists was based on data collected from various sources, including OpenAlex and CrossRef. The ranking position is based on a scientist's D-index (Discipline H-index), which includes only papers and citations for the relevant discipline. The bibliometric data for the evaluation of citation-based metrics was collected on December 21, 2022. Among domestic materials scientists, Michal Otyepka ranks 4th and Pavel Jelinek was 15th. This was the first edition that included the field of chemistry. In addition to Professor Hobza, it ranked Radek Zbořil at 3rd, Jiří Šponer at 5th and Michal Otyepka at 12th place nationally.

The Research.com ranking provides rankings of scientists in more than 20 fields, including natural sciences, medicine and social sciences.

CATRIN looks for ways to expand collaboration with Spanish scientists

The recent lecture by Dimas G. de Oteyza of the Research Centre for Nanomaterials and Nanotechnologies (CINN), who was accompanied by Bernardo Lopez Lopez-Rios, representative of the Embassy of Spain in Prague, should help to enhance cooperation with Spanish partners. Both guests visited the laboratories of the research centre and got acquainted with the local research.

"Within the two and a half years of CATRIN's existence, we have built a strategic partnership with the Catalan Institute of Nanoscience and Nanotechnology (ICN2), have joint European projects with other institutions in Spain, and Spanish scientists are strongly represented in our teams. Therefore, it is logical that we are establishing Czech-Spanish contacts also on a diplomatic level and we believe that this will further promote mutual cooperation between CATRIN and Palacký University on one side and Spanish institutions on the other," said CATRIN Director Pavel Banáš.

Ostrava hosted the first summer school of the SAN4FUEL project

Participants in a summer school, which took place in the multifunctional auditorium of the Dolní Vítkovice region as the opening act of the international conference Nano Ostrava 2023, discussed the development of new materials using atomic engineering, alongside their characterization, as well as the preparation of publications for prestigious scientific journals or possibilities to succeed in the project calls of the Horizon Europe programme. The summer school was organized under the Horizon Europe project SAN4FUEL, which brings together scientists from CATRIN of Palacký University, the Centre for Energy and Environmental Technologies of VSB-TUO, the University of Trieste, and the University of Erlangen-Nuremberg, Germany.

"As part of the SAN4FUEL project, a total of three summer schools will take place, with the Ostrava school being the first to run. Especially for PhD students and post-docs, we prepared lectures on the main topic of our project, which is hydrogen production by solar water splitting, electrochemical transformation of waste carbon dioxide and especially the preparation of new materials by engineering of single-atoms; however, other issues that could broaden the horizons of young scientists were also discussed," said the main organizer of this event and the Principal Investigator of the project, Štěpán Kment.

Veronika Šedajová leaves for the University of Cambridge

Physical chemist Veronika Šedajová headed from CATRIN to the University of Cambridge at the end of April. At the prestigious Yusuf Hamied Department of Chemistry, she will spend the next two years focusing on materials research closely connected with industry. The young scientist has gained experience in this field due to her involvement in international projects of the European Research Council and the European Innovation Council under the principal investigator Michal Otyepka. That is why she can now fulfil her dream.

"I will be involved in more projects at my new workplace. The main task will be to study the mechanisms of (de)lithiation or degradation of a range of materials, including cathode materials with high nickel content and anode materials using mainly operando experimental techniques. At the same time, the position involves collaboration with the commercial sector", said Šedajová, who recently completed her PhD in Physical Chemistry at the Faculty of Science, her mentors being mainly Aristeidis Bakandritsos and Michal Otyepka.

CATRIN-RCPTM Award goes to three young scientists

Researchers Aby Cheruvathoor Poulose, Luca Mascaretti and Benjamin Jose Mallada Faes are this year's CATRIN-RCPTM Award winners, following the tradition of the RCPTM Award given in previous years for outstanding scientific work. This year's award was handed out to the winners at the annual CATRIN-RCPTM conference.

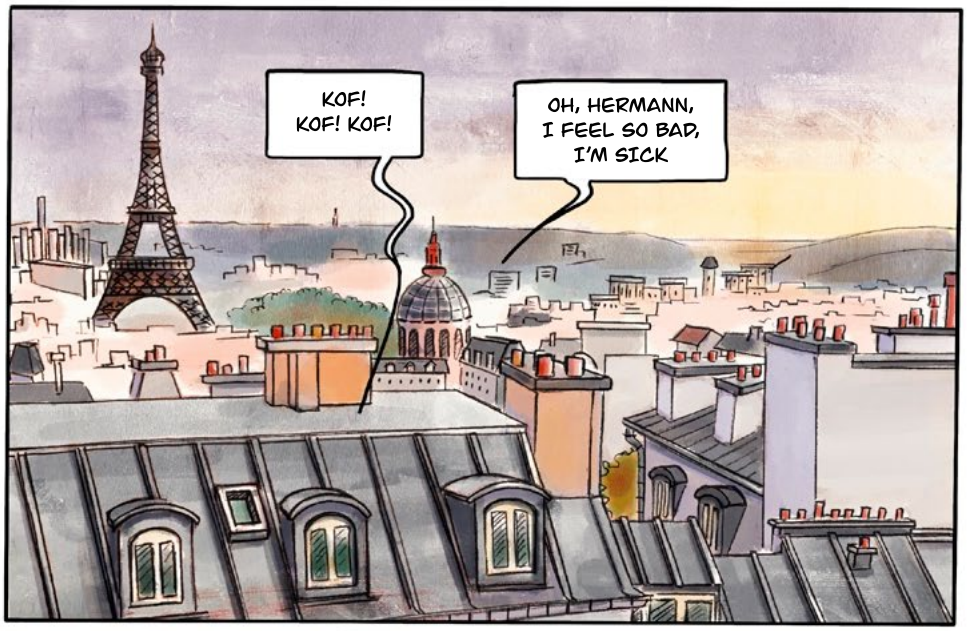
"The aim was to reward young scientists in particular for outstanding scientific achievements. The laureates, one of whom is a PhD student and two of whom are postdocs, have contributed to outstanding publications, including in the journals Nature Nanotechnology and Science", explained CATRIN-RCPTM Scientific Director, Radek Zbořil.

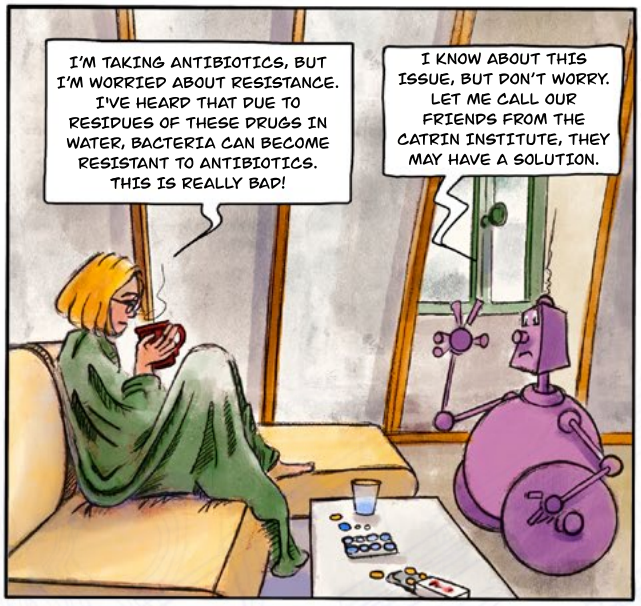
Luca Mascaretti from the Photoelectrochemistry research group won the award for his contributions in the field of photoelectrochemistry and photocatalysis. In the case of Benjamin Jose Mallada Faes, the CATRIN-RCPTM leadership highlighted his work related to the study of molecules using UHV STM, and in particular, his first-author article in the journal Science. Aby Cheruvathoor Poulose impressed the jury with his results in the field of heterogeneous catalysis. Among other publications, last year he was the first author of an article published in the journal Nature Nanotechnology.

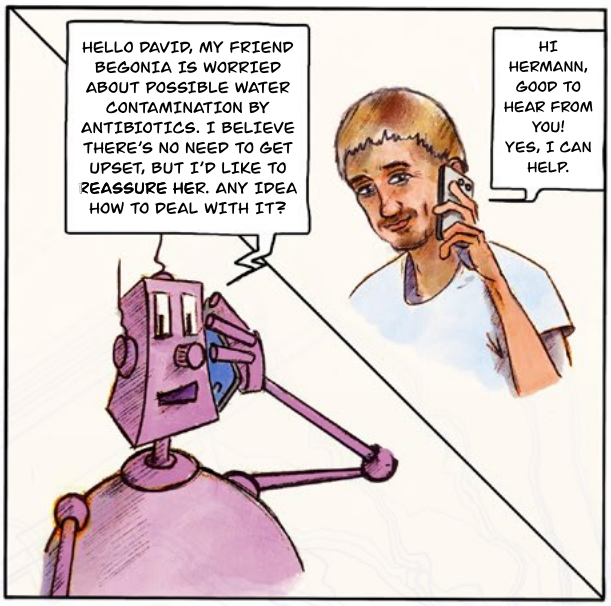
Hermann and Begonia

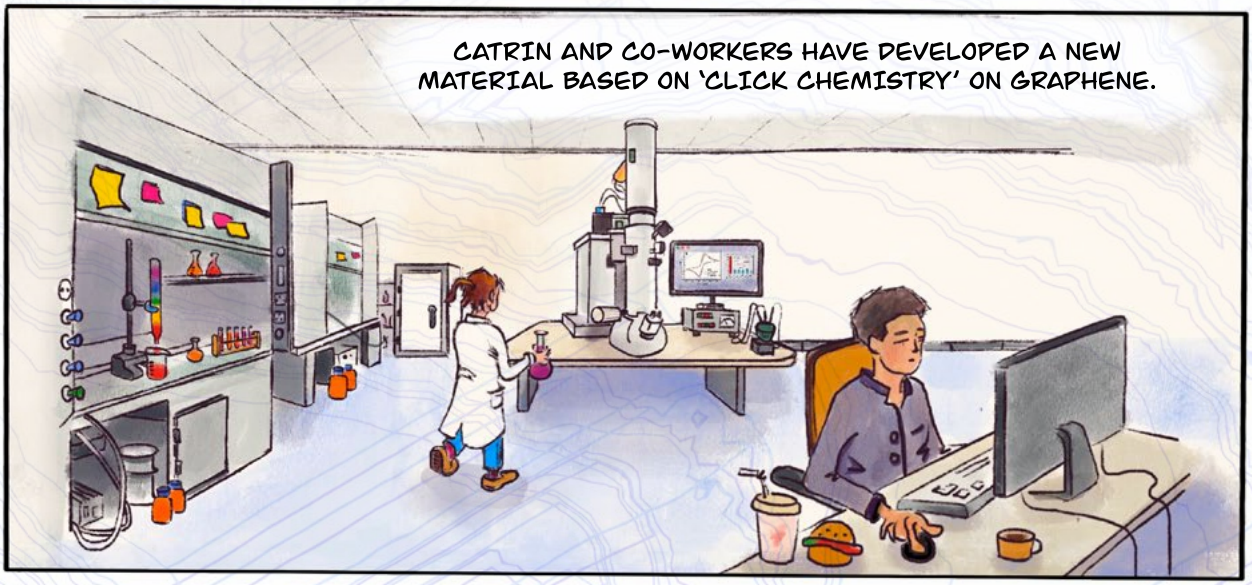
The mystery of antibiotics in water revealed

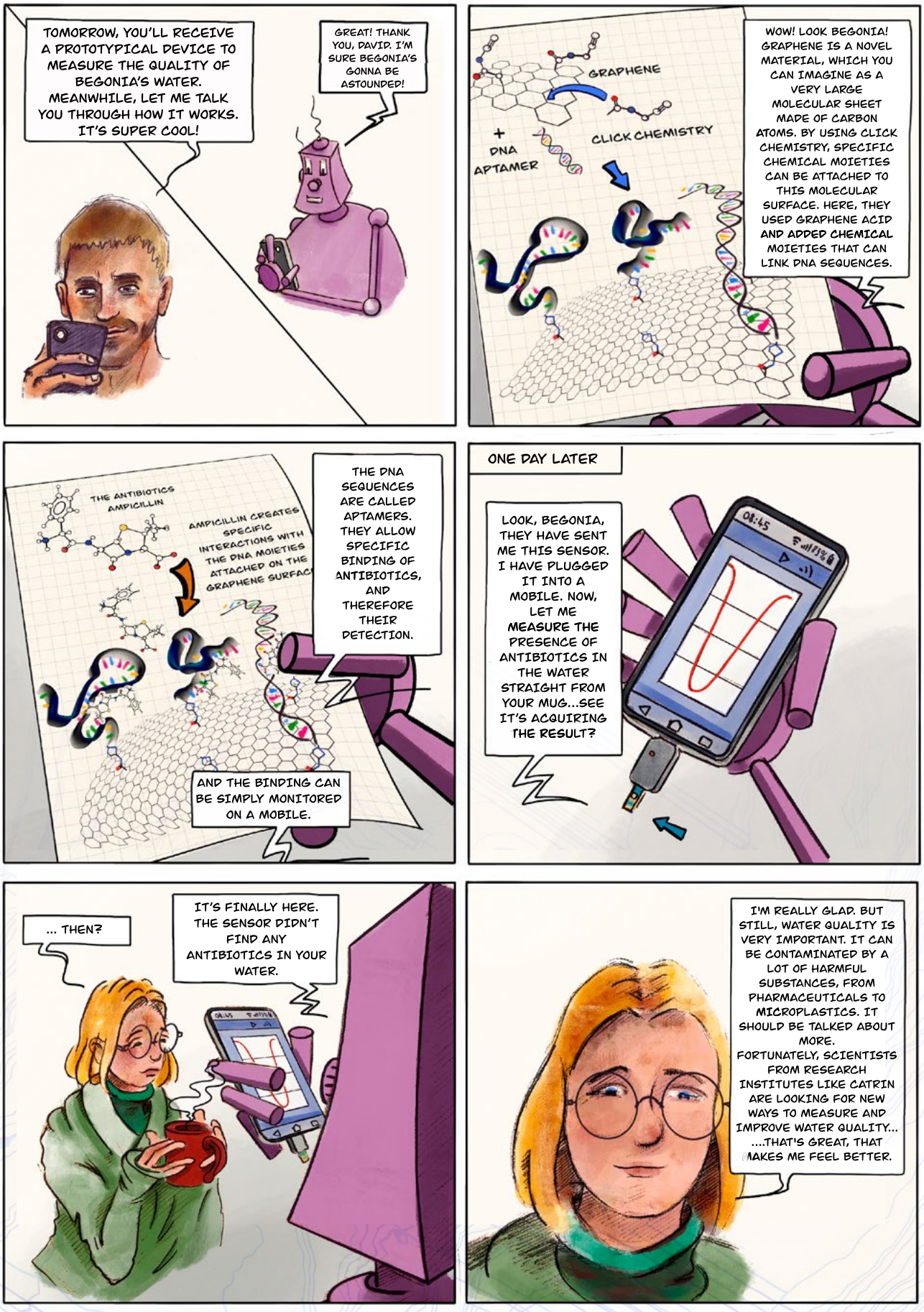
BY P.TROUILLAS










TOMORROW, YOU'LL RECEIVE A PROTOTYPICAL DEVICE TO MEASURE THE QUALITY OF BEGONIA'S WATER. MEANWHILE, LET ME TALK YOU THROUGH HOW IT WORKS. IT'S SUPER COOL!
GREAT! THANK YOU, DAVID. I'M SURE BEGONIA'S GONNA BE ASTOUNDED!
GRAPHENE
+
DNA APTAMER
CLICK CHEMISTRY
WOW! LOOK BEGONIA! GRAPHENE IS A NOVEL MATERIAL, WHICH YOU CAN IMAGINE AS A VERY LARGE MOLECULAR SHEET MADE OF CARBON ATOMS. BY USING CLICK CHEMISTRY, SPECIFIC CHEMICAL MOIETIES CAN BE ATTACHED TO THIS MOLECULAR SURFACE. HERE, THEY USED GRAPHENE ACID AND ADDED CHEMICAL MOIETIES THAT CAN LINK DNA SEQUENCES.
THE ANTIBIOTICS AMPICILLIN
AMPICILLIN CREATES SPECIFIC INTERACTIONS WITH THE DNA MOIETIES ATTACHED ON THE GRAPHENE SURFAC
THE DNA SEQUENCES ARE CALLED APTAMERS. THEY ALLOW SPECIFIC BINDING OF ANTIBIOTICS, AND THEREFORE THEIR DETECTION.
AND THE BINDING CAN BE SIMPLY MONITORED ON A MOBILE.
ONE DAY LATER
LOOK, BEGONIA, THEY HAVE SENT ME THIS SENSOR. I HAVE PLUGGED IT INTO A MOBILE. NOW, LET ME MEASURE THE PRESENCE OF ANTIBIOTICS IN THE WATER STRAIGHT FROM YOUR MUG...SEE IT'S ACQUIRING THE RESULT?
08:45
... THEN?
IT'S FINALLY HERE. THE SENSOR DIDN'T FIND ANY ANTIBIOTICS IN YOUR WATER.
I'M REALLY GLAD. BUT STILL, WATER QUALITY IS VERY IMPORTANT. IT CAN BE CONTAMINATED BY A LOT OF HARMFUL SUBSTANCES, FROM PHARMACEUTICALS TO MICROPLASTICS. IT SHOULD BE TALKED ABOUT MORE.
FORTUNATELY, SCIENTISTS FROM RESEARCH INSTITUTES LIKE CATRIN ARE LOOKING FOR NEW WAYS TO MEASURE AND IMPROVE WATER QUALITY...
....THAT'S GREAT, THAT MAKES ME FEEL BETTER.


270 °
180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