CATRIN

Czech Advanced Technology and Research Institute

NEWSLETTER 02/2023

Scientists push the boundaries of nanotechnology in energy and medicine

Representatives of natural and social sciences join forces in a multidisciplinary OP JAK project

A fourth ERC grant

ERC Proof of Concept grant to support ink development for biosensors

New Generation Crops

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TECHSCALE

Scientists push the boundaries of nanotechnology in energy and medicine

New nanomaterials and technologies that can offer solutions for two current global challenges, i.e. the acquisition and storage of renewable energy and the development of new materials to improve the quality of life, are the main goal of the Technology Beyond Nanoscale (TECHSCALE) project from the Jan Amos Komenský Operational Programme (OP JAK). It will also include an assessment of societal impacts and public acceptance of new technologies. The multidisciplinary research will involve naturalists from Charles University and CEITEC VUT, as well as representatives of five faculties of Palacký University, under the leadership of the Czech Advanced Technology and Research Institute (CATRIN).

"I consider securing funding for this project from this prestigious and challenging call to be a huge accomplishment. I am convinced that we succeeded not only because of the very urgent and well-targeted topic but also because of the experience of our researchers and the interdisciplinary focus of our research, which is, after all, one of the key missions of CATRIN. Thanks to this, we can strengthen our research efforts, achieve even more significant results and make an important contribution to the development of science and technology in our society," said CATRIN Director Pavel Banáš.

The main task of the scientists is to design, prepare and use a new class of materials, which they will prepare using a groundbreaking method of single-atom engineering. "We expect fundamental discoveries that will push the boundaries of current nanotechnologies and allow new applications, for example in energy storage, chemical catalysis in the chemical and pharmaceutical industries, diagnosis of some diseases as well as their treatment. The project will also include the development of new materials for antimicrobial therapy and the fight against bacterial resistance to antibiotics," said the principal investigator of the project Michal Otyepka from CATRIN.

Funding for the five-year project amounts to CZK 481.7 million. As part of the project, colleagues from the Faculty of Science of Charles University will focus on the targeted synthesis of new types of zeolites and other porous materials. "Our task is to develop new, highly active and selective catalysts for the preparation of special chemicals and to use them, for example, in cascade reactions or in the preparation of chiral molecules important for the pharmaceutical industry," explained the team leader of Charles University Jiří Čejka. The research into a new class of materials based on single-atom engineering, which will be crucial for the preparation of reliable and affordable sensors in the field of environment, biomedicine and biomedical therapies, will be the domain of the CEITEC VUT team under the leadership of Martin Pumera.

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>
> Pavel Banáš

In addition to CATRIN, Palacký University is represented in the project by the Faculty of Medicine and Dentistry, Faculty of Arts, Sts Cyril and Methodius Faculty of Theology, Faculty of Law and Faculty of Health Sciences.

"I believe that by involving a wide range of experts from natural sciences to social sciences and legal sciences, we will be able to change the paradigm of developing new materials and technologies because they can be verified as safe and responsible from the outset," added Otyepka.

The teams from CATRIN have also contributed to the success of two other supported projects from OP JAK and will participate in their implementation.

The existence of π holes experimentally verified

Scientists from Palacký University Olomouc, the Institute of Organic Chemistry and Biochemistry (IOCB) and the Institute of Physics of the Czech Academy of Sciences have uncovered some mysteries of the world of molecules and atoms. They have experimentally confirmed the correctness of a decades-old theory that assumed an inhomogeneous distribution of electron density in aromatic molecules. The research, published in Nature Communications, extends the range of possibilities for designing new nanomaterials.

In a previous groundbreaking study published in Science, the same team of authors described the inhomogeneous distribution of electrons in an atom, termed σ-hole. Now, the researchers have confirmed the existence of a so-called π-hole. In aromatic hydrocarbons, aromatic electrons exist in clouds above and below the plane of carbon atoms. If we replace the peripheral hydrogens with more electronegative atoms or groups of atoms that pull electrons away, the originally negatively charged clouds turn into positively charged electron holes. This phenomenon significantly affects the physicochemical properties of molecules as well as their interactions. Scientists have taken the advanced method of scanning electron microscopy and pushed its capabilities further. According to Bruno de la Torre, leader of a Molecular Nanostructures on Surfaces research group at CATRIN, the success of the described experiment is mainly due to the advanced equipment in his laboratories and talented doctoral students conducting the work.

"Thanks to our previous experience with the Kelvin probe force microscopy (KPFM) technique, we were able to refine our measurements and acquire very complete datasets that helped us to deepen our understanding not only of how the charge is distributed in the molecules but also of what observables can be obtained with the technique," he added. Pavel Hobza, one of the most highly cited Czech researchers in the IOCB, made a significant contribution to this work.

Mallada B., Ondráček M., Lamanec M., Gallardo A., Jiménez-Martín A., de la Torre B., Hobza P., Jelínek P.: Visualization of π-hole in molecules by means of Kelvin probe force microscopy. Nature Communications 2023, 14 (1), 4954. IF = 14.919

Unprecedented approach for amide synthesis opens up new opportunities

New possibilities for designing novel amides, important and ubiquitous organic compounds, have been proposed by scientists from CATRIN and the Institute of Molecular and Translational Medicine of Palacký University in collaboration with colleagues from the University of Groningen in the Netherlands and Jagiellonian University in Krakow. Thanks to a revolutionary method that uses the unique properties of isocyanides, they have overcome the existing boundaries of amide synthesis and opened up new possibilities in organic chemistry. The study was recently published in the prestigious journal Nature Communications.

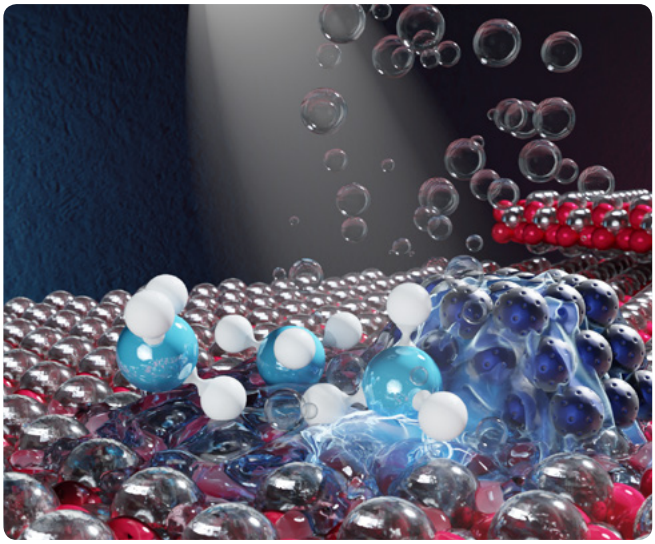
Amides are found in peptides, proteins, drugs and various functional materials. Traditionally, they are synthesized almost exclusively by coupling carboxylic acids and amines through non-green, unsustainable routes. Now, scientists are offering a surprising and complementary method. Based on 30 years of experience in isocyanide chemistry, the world-renowned researcher Alexander Dömling has employed the properties of isocyanides to create a novel three-component reaction.

"This reaction involves isocyanides, alkyl halides and water, leading to the rapid formation of very valuable amides. What makes this method truly remarkable is the scope and versatility it offers. We have demonstrated that it can be applied to a wide range of substrates, including alkyl halides with different leaving groups, various isocyanides and even complex

heterocyclic structures. The possibilities are almost endless, allowing the synthesis of diverse and complex compounds that were previously considered challenging or impractical or required expensive or unavailable building blocks," said Professor Dömling, a holder of a prestigious ERA Chair project grant. According to Domling, the isocyanide-based synthesis is not only efficient but also sustainable and suitable for industrial applications.

Patil P., Zheng Q., Kurpiewska K., Dömling A.: The isocyanide SN2 reaction. Nature Communications 2023, 14 (1), 5807. IF = 14.919

“Green” hydrogen can be made from cheap and environmentally friendly produced hematene



Researchers at CATRIN and VSB-TUO have unveiled an environmentally-friendly method for the production of hematene, a two-dimensional material derived from iron ore. Their work, featured in Applied Materials Today, paves the way for sustainable applications in clean energy and environmental technologies, garnering the prestigious cover-page position in the journal.

Hematene is a relatively young material with intriguing electrochemical and photocatalytic properties that are desirable for a variety of technological applications, such as the photocatalytic decomposition of ammonia to generate hydrogen as a sustainable fuel. However, previous approaches to produce hematene were not very environmentally friendly as they required toxic organic solvents. “In this study, we developed an ecologically responsible method for synthesizing 2D hematene through the exfoliation of readily available iron oxide in a pure aqueous solution, aided by ultrasound. The resulting hematene layers were only a few nanometres thick and exhibited exceptional electrochemical properties in the field of charge transfer, rendering them well-suited for photocatalytic applications. This pioneering approach may unlock the potential for sustainable production of various 2D materials based on metal oxides using layered minerals and water as primary feedstocks and ultrasound as the energy source for facilitating chemical exfoliation,” explained Radek Zbořil.

By adding metal ruthenium to a conductive hematene substrate, the researchers were able to successfully break down ammonia into hydrogen and nitrogen, an important reaction for hydrogen storage technologies. This demonstrated that ruthenium-doped hematene could be used as an environmentally friendly photocatalyst in clean energy production and storage technologies.

Dzíbelová J., Hejazi S. H., Šedajová V., Panáček D., Jakubec P., Baďura Z., Malina O., Kašlík J., Filip J., Kment Š., Otyepka M., Zbořil R.: Hematene: A sustainable 2D conductive platform for visible-light-driven photocatalytic ammonia decomposition. Applied Materials Today 2023, 34, 101881. IF = 8.663

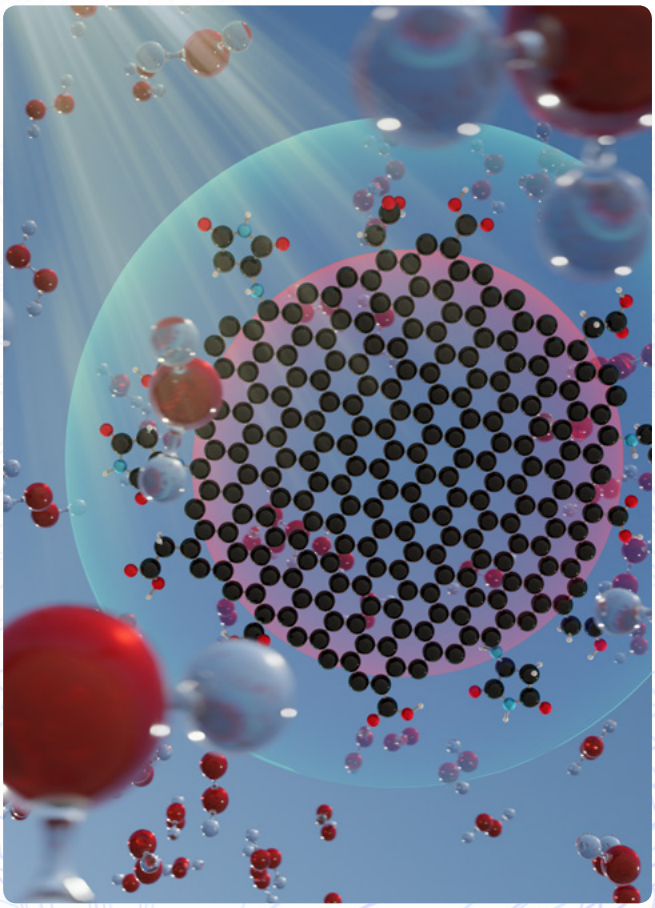
Carbon dots can be used for light-induced hydrogen peroxide production

New possibilities in the field of sustainable energy have been opened up with a breakthrough discovery of the photoluminescent properties of carbon dots (CDs) made by scientists from CATRIN in cooperation with the VSB-Technical University of Ostrava. The researchers found that after irradiation with light, magnetically active polaron states are formed in carbon dots, which can then be used for light-induced hydrogen peroxide production. These research results were published in the esteemed journal Small.

Carbon dots are nanoscale carbon-based particles that can be easily prepared. They are non-toxic and have a wide range of applications. The main aim of the research was to investigate their photophysical and photocatalytic properties. The presence of magnetic polarons was revealed by experiments carried out using electron paramagnetic resonance. Subsequently, using advanced quantum chemical calculations, the researchers explained how polarons can be formed in the structures of carbon dots.

Magnetic polarons, which are specially coupled states of electrons, were shown to be crucial in the photoproduction of hydrogen peroxide — a versatile compound with a wide range of applications in healthcare, environmental remediation and energy. “The ability of carbon dots to convert light into catalytically active magnetic polarons may enable major advances in the use of these environmentally friendly nanomaterials, especially in the field of photocatalysis and technologies for converting solar energy into chemical energy,” said the main author of the study Lukáš Zdražil.

Zdražil L., Baďura Z., Langer M., Kalytchuk S., Panáček D., Scheibe M., Kment Š., Kmentová H., Thottappali M. A., Mohammadi E., Medveď M., Bakandritsos A., Zoppellaro G., Zbořil R., Otyepka M.: Magnetic Polaron States in Photoluminescent Carbon Dots Enable Hydrogen Peroxide Photoproduction. Small 2023, 19 (32), 2206587. IF = 15.153



Computational chemists from CATRIN help to elucidate molecular photoswitches

Computational chemists from CATRIN in collaboration with world-renowned teams, including that of the Nobel Prize Winner Ben L. Feringa at the University of Groningen, have contributed to the elucidation of the photochromic behaviour of another important class of molecular photoswitches. This time round, they focused on azonium ions, which photoisomerize — convert their structure between two isomers — using red light under physiological conditions. This property makes them attractive as molecular components for the photocontrol of physiological processes. The details were reported in the Journal of the American Chemical Society.

For the rational application of azonium ions as well as the design of their derivatives with improved properties, a mechanistic understanding of the photoisomerization process and subsequent thermal relaxation is crucial, i.e. when the photoisomerized molecule returns to its original state at normal temperature in the absence of further exposure to light or other stimulus. "Using ultrafast spectroscopy and quantum chemical calculations, we fully explained the reaction mechanisms of photoisomerization and thermal relaxation, as well as their pH dependence. Based on this knowledge, among others, we are now investigating new derivatives for applications in optoacoustic imaging," says Miroslav Medveď, the first co-author of the JACS paper.

The collaboration with international teams of colleagues from the universities of Nantes, Amsterdam and Florence lasts for several years and has produced several joint publications (JACS 2017, Angew. Chem.-Int. Edit 2018, Nat. Commun. 2019, Chem. Sci. 2021). The latest article in JACS is the result of about three years of research in collaboration with another top group of Professor G. Andrew Woolley's from the University of Toronto.

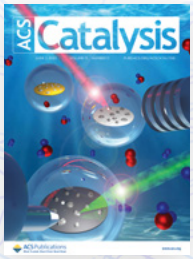
Medveď M., Di Donato M., Buma W. J., Laurent A. D., Lameijer L., Hrivnák T., Romanov I., Tran S., Feringa B. L., Szymanski W., Woolley G. A.: Mechanistic Basis for Red Light Switching of Azonium Ions. Journal of the American Chemical Society 2023, 145 (36), 19894–19902. IF = 16.383

Our latest reviews

V. K. Sharma, X. Ma and R. Zboril

"Single atom catalyst-mediated generation of reactive species in water treatment"

Chemical Society Reviews, vol. 52, iss. 22, pp. 7673-7686, 2023. IF = 60.615



E. Zhao, W. Zhang, L. Dong, R. Zbořil and Z. Chen

"Photocatalytic Transfer Hydrogenation Reactions Using Water as the Proton Source"

ACS Catalysis 2023, 13, 11, 7557–7567. IF = 13.7

Collaboration is the only way to move forward and remain internationally competitive

Thanks to CATRIN, Palacký University has won the prestigious TECHSCALE (Technology Beyond Nanoscale) project from the Excellent Research OP JAK call with a budget of almost half a billion Czech koruna. The multidisciplinary team will be led by the physical chemist Michal Otyepka.

Many scientists in the Czech Republic have recently applied to the Excellent Research call from the Operational Programme Jan Amos Komenský. The TECHSCALE project led by you succeeded amongst stiff competition. Moreover, it garnered high ratings in its field. What does this success mean to you?

We devoted a huge effort to the preparation of the project proposal, and in this pre-Christmas period, I recall the sleepless nights and several near-heart attacks that the whole team went through this time last year. But the incredible stress then turned into great joy when the results were announced. I view the second place we were awarded in such a prestigious project call not only with satisfaction but also as a mark of appreciation of the consistent and long-term work of ourselves and our partners from Charles University and CEITEC-VUT. I also think that we have managed to assemble a great interdisciplinary team that includes the humanities as well as natural sciences. Together we have been looking for ways of cooperation that will allow us to significantly push the boundaries of the current world of nanomaterials towards technologies that work with single atoms.

You have a number of other achievements to your credit, including four times success in the European Research Council's grant competition. Did this experience help?

We build on our experience when preparing new projects, and thus continuously improve project proposals. It's a never-ending story. I think that CATRIN has moved forward enormously in the field of international project grants over the last two years; we are capitalizing on our investment in this area and are now seeing the first results. In addition to science itself, international projects highlight a number of other topics that deal with implementation and impacts. We have certainly benefited from our experience with international projects within TECHSCALE.

You expect major discoveries that will push the boundaries of current nanotechnologies and find applications in a wide range of areas. What exactly can we look forward to?

Nowadays, nanomaterials and nanotechnologies are among well-established scientific disciplines that have advanced our knowledge and attract a huge number of applications. The whole project has a unifying theme, which is to push the boundaries of the nanoworld and achieve precision in tuning properties up to the level of single atoms. We want to design such materials and prepare them in a controlled way. Already during the design phase, we will consider the safety of materials and possible social impacts. We will then target three major areas where we envisage the greatest potential for application, i.e. sensors, catalysis and energy storage. I believe that we will be able to prepare new materials that will change the paradigm, for example, in the fight against antibiotic resistance, alongside designing very effective catalysts for industrial production or preparing selective and sensitive sensors.

In what way do you think the project is unique?

A unique element of the project is the interconnection of four pillars. These are computer design, synthesis and characterization of new materials, their application, as well as safety and social impacts. Recent crises have taught us that technicians and natural scientists must work closely with experts from social science. Such cooperation allows new topics to be tackled, reveals entirely new perspectives and raises questions that natural scientists do not normally ask. I think this organic interconnection of disciplines was also highly appreciated by the evaluators of the project.

How do you and your colleagues in the social sciences learn to find common ground?

Honestly, it's a slow evolution. It's not easy for either side. I'd compare it to a very coy courtship. I know from previous projects that sometimes it only takes about a year to find common ground. The great thing is that we all are seeking a way to accommodate each other because we see the enormous potential that effective interconnection can provide. I'm convinced that this effort will soon bear fruit.

The project has already achieved its first results in the form of publications in prestigious journals. Can you describe some of them?

We are just starting a number of new joint projects. The existing cooperation has certainly accelerated everything. For example, we have recently managed to find a way to improve ammonia production with our colleagues from CEITEC Energy. In addition, we have used the computing capacity of the IT4Innovations National Supercomputing Centre at VSB – Technical University of Ostrava. These achievements clearly show that broad cooperation is the only way to progress and remain internationally competitive. I believe that this project will enable us to intensify our cooperation at home and abroad. I also believe that our International Scientific Board, which includes six of the world's leading experts, will help us in this.

Other UP partners:

Faculty of Medicine and Dentistry

Faculty of Arts

Faculty of Health Sciences

Faculty of Law

Sts Cyril and Methodius Faculty of Theology

More details available on **www.techscale.cz.**

Prof. RNDr. Michal Otyepka, Ph.D. (*1975)

Prof. Michal Otyepka studied physical chemistry at Palacký University Olomouc. From 2008 to 2020, he was Head of the Department of Physical Chemistry. He now heads the Regional Centre of Advanced Technologies and Materials at the Czech Advanced Technology and Research Institute (CATRIN-RCPTM) and works at the IT4Innovations National Supercomputer Centre at VSB-TUO.

He studies the structure and properties of nanomaterials and biomacromolecules. He played a key role in the discovery of the thinnest isolator in the world — fluorographene — and was involved in the development of the first non-metallic magnet. In 2014, he received a Neuron Impuls grant from the Neuron Foundation. In 2015, he was awarded a grant from the European Research Council (ERC) and the first EIC Transition grant in the Czech Republic. In 2020, he was the first ever Czech scientist to receive an ERC Proof of Concept grant, and in the following years, he repeated this success twice.

ERC Proof of Concept grant to support ink development for biosensors

The development of an innovative "graphene" ink for the production of stable, sensitive and selective electrodes used in various biosensors and its verification under laboratory conditions are the main goals of a prestigious ERC Proof of Concept grant (PoC) awarded to Prof. Michal Otyepka, a physical chemist from CATRIN.

Electrochemical biosensors play a crucial role in various fields, from medicine to environmental monitoring. They offer rapid detection methods for microbes, antibiotics, pollutants in water, pesticides and markers of disease. Their key component is electrodes, for which graphene-based materials are ideal owing to their large surface and unique electrochemical properties. "For printing the electrodes, we will use ink containing our graphene derivative. Currently, there is no ink on the market that is sufficiently sensitive and suitable for electrochemical detection of various substances and at the same time compatible with available ink printing technologies," said Otyepka, explaining the research innovation potential. Over the next 18 months, the research team will verify and optimize the technology in the laboratory. The scientists expect to prepare hundreds of millilitres of ink. The next step will be to transfer the approach into practice. The researchers have already started negotiations with several industrial partners who are very interested in the commercialization of the technology.

Michal has succeeded in the ERC grant competition for the fourth time. Three of his previous grants were intended to support the implementation of the research results into practice. The ERC awarded a total of 66 PoC grants in the second round of the competition this year, with only one going to the Czech Republic.

Scientists are developing an innovative system for early and simple detection of Alzheimer's disease

The four-year European project 2D-BioPAD from Horizon Europe, coordinated by CATRIN, aims to develop a rapid, reliable, affordable and digitally supported system for early detection of Alzheimer's disease. A consortium of 11 partners from 8 countries will share a budget of nearly €6 million. CATRIN is the only domestic institution involved.

"We will use our extensive experience of advanced 2D materials, such as graphene and its derivatives, to increase the sensitivity and efficiency of the sensor. The aim is to detect up to five blood biomarkers of Alzheimer's disease at the same time. To do this, a user-friendly mobile application will be developed to provide health professionals with real-time results. We also envisage using artificial intelligence to optimize the system," said the project's coordinator Aristeidis Bakandritsos from CATRIN.

The development of the device responds to the current demand for point-of-care (PoC) analysers that allow rapid examination of patients directly in healthcare facilities. The functionality of the system will be verified by two clinical pilot studies, which will take place in three European clinical centres. The consortium involves universities, research institutions and medical facilities, as well as companies from Denmark, Finland, France, Germany, Greece, Ireland and Spain. As one of the key members of the Graphene Flagship initiative, 2D-BioPAD is part of a large network of academic and industrial bodies that contribute to strengthening Europe's strategic autonomy in graphene-based technologies and other 2D materials.

Scientists test safety of graphene materials for brain implants

CATRIN experts are involved in the development of a new generation of brain implants using the Nobel Prize winning material graphene. Thanks to their success in the Horizon Europe Hop On Facility grant call, they have joined the European Innovation Council's (EIC) international MINIGRAPH project, which is already underway. Their task will be to verify the non-toxicity of graphene implants to living cells and, if necessary, propose a solution without adverse effects. In the first ever Hop On Facility call, only five applicants were supported in the Czech Republic.

Since July, the project, termed MINIGRAPH2, has been a separate work package of the MINIGRAPH project coordinated by the Catalan Insti-

tute for Nanoscience and Nanotechnology (ICN2) in Barcelona. The aim of the project is to develop and validate a new generation of brain implants that can be gently placed in the skull and use precise electronics to stimulate the brain's neural activity to treat or improve neurological diseases, such as Parkinson's disease. Miniature electrodes comprising graphene, with which CATRIN scientists have extensive experience, will play an important role in the entire system.

"Our goal is to test the cytotoxicity of graphene neural implants at the cellular and molecular level. In this way, we can identify their potential side effects and contribute to the design of better materials. In fact, it is essential to establish their safety before they can be used in human medicine. Therefore, our team makes an important contribution to the consortium and could play a key role in regulatory approval processes," said the team leader Kateřina Poláková. The Olomouc scientists are collaborating with seven other partners from five European countries. Throughout the project, junior researchers and PhD students from Palacký University will be able to collaborate with academic and commercial entities in the field of neuroimplants.

New portable Mössbauer spectrometer for industrial applications

Palacký University's Iron Analytics spin-off company, in collaboration with CATRIN, aims to create the first portable Mössbauer spectrometer that is similar in size to a Coca-Cola can. This cutting-edge device will enable rapid and precise analysis of iron-containing materials directly within industrial operations. This unprecedented project has been funded by the Technology Agency CR, with a substantial budget of CZK 6.5 million under the Trend Nováčci programme. Over the course of three years, the team will develop a fully functional prototype of the portable Mössbauer spectrometer and construct a comprehensive knowledge database dedicated to the analysis of iron-containing materials.

"Right from the outset, our focus lies in constructing a spectrometer tailored for industrial deployment. To achieve this, we are meticulously designing the dimensions, ensuring simple functionality and streamlining operations to align with industry standards and requirements, including factors like dust resistance and other specific industrial demands. Traditionally, companies have relied on sending their samples to laboratories. However, we are flipping the paradigm, enabling companies to conduct measurements on their own terms, effortlessly and swiftly, through our cutting-edge spectrometer. By embracing modularity, our system will be incredibly versatile, allowing it to be readily adapted to the unique needs of each client," explained the project's principal investigator and managing director of Iron Analytics Jakub Navařík. According to Navařík, the vision is to develop a miniaturized device with straightforward operation that can draw power from a regular power bank and be controlled through any smart mobile phone or tablet. While regular laboratory Mössbauer spectrometers are typically around 70 centimetres in length and weigh approximately 15 kilograms, this portable industrial device will be no larger than an ordinary beverage can.

The co-investigators from CATRIN, which will receive almost half of the funding, will focus on creating a knowledge database. This will demonstrate the advantages of Mössbauer spectrometer measurement compared to other techniques currently used by industry as standard.

Europe seeks protection from potato contagion

Protecting European potato production from diseases, in particular the insect-borne disease "zebra chip", is the main objective of the European project PATAFEST under the Horizon Europe RIA programme. Since June this year, 18 partners from academia and commerce have been working together, with CATRIN being the only Czech representative. The EU will support the four-year research programme with roughly €10 million.

"The aim of the project is to prepare Europe for the possible emergence of a quarantine disease called 'zebra chip', which, particularly in the Americas, significantly reduces potato production, negatively affects the visual quality of the tubers and prevents their sale. Our joint task is to develop a strategy to monitor the occurrence and symptoms of this disease, as well as other known post-harvest diseases in Europe, and to develop technologies that can protect potatoes from these," said Nuria De Diego, head of the Olomouc research team.

In potatoes affected by zebra chip, dark, unattractive stripes appear inside the tubers. This visual defect makes the crop unmarketable. However, the disease also affects the plants themselves and their development, significantly reducing their production. The disease is caused by a pathogen transmitted by a small insect of the mera family. The consortium aims to describe the pathway of the disease spread at a molecular level and identify potato varieties resistant to selected pathogens. The ultimate goal is to ensure effective pre-harvest treatment of plants and soil against insect vectors and soil pathogens and develop post-harvest technologies to control soil pathogens and maintain the quality of stored potato tubers.

The PATAFEST (potato crop effective management strategies to tackle future pest threats) project involves partners from Spain, Italy, Israel, Belgium, Germany, France, the UK and Ecuador, with the Spanish research company FUNDITEC as the main coordinator.

CATRIN becomes a partner of an OP JAK project focused on breeding new generation crops

CATRIN researchers will contribute to the TANGENC project supported by the Jan Amos Komenský Operational Programme (OP JAK), which focuses on breeding new, resistant crops with higher yields under the leadership of the Institute of Experimental Botany of CAS.

"CATRIN scientists will conduct research on seedlings and roots and their response to stress as well develop methodologies for genome editing. There are six main research objectives. The one I am leading includes activities to prepare society and breeders for the use of new breeding techniques. These have been designed to help produce climate-resilient crops with the help of new tools and knowledge. In addition to sharing knowledge and experience with Czech growers, it will be important to exchange scientific knowledge in the context of regulatory policies in EU member countries, for which we will use our extensive contacts within the EU-SAGE network and the European Federation of Biotechnology (EFB)," explained research package leader Ivo Frébort, who is also Vice President of the EFB.

The research consortium will receive €435 million for the five-year project, entitled New Findings for Next Generation Crops, which will start in October. Eight top scientific teams, not only from IEB and CATRIN but also the Institute of Biophysics of the CAS, Charles University, Masaryk University and Palacký University, will participate in the project.

Patrik Schmuki wins the Heinz Gerischer Prize

Patrik Schmuki, a world-renowned expert in the field of electrochemistry and one of CATRIN's most accomplished scientists, has been awarded the prestigious Heinz Gerischer Prize. Since 2001, the award has been presented by the Electrochemical Society to scientists who have made significant breakthroughs in the fields of semiconductor electrochemistry and photoelectrochemistry, as well as physical and materials chemistry.

"It is truly a great honour for me. This is one of the most important awards I have ever received. The list of previous laureates includes eminent scientific leaders in the field of electrochemistry, such as Professors Allen Bard, Michael Grätzel and Akira Fujishima. The award has therefore placed me among the best in our field," said Patrik Schmuki, who was previously a recipient of the Natta Award 2020.

The Heinz Gerischer Prize recognizes his lifelong contribution to the field of electrochemistry and photoelectrochemistry, from work on the preparation of titanium dioxide nanotubes and their use in photocatalysis to the application of single-atom engineering, and includes his research at Friedrich-Alexander Universität Erlangen-Nürnberg as well as at CATRIN. In Olomouc, he has established the Photoelectrochemistry research group and was, among other responsibilities, the key figure in the project entitled Advanced Hybrid Nanostructures for Renewable Energy Applications from the Operational Programme Research, Development and Education, which focused on the production of hydrogen as a fuel of the future by the photocatalytic decomposition of water using titanium dioxide in the form of nanotubes. He is currently the principal investigator of the EXPRO project. He has received almost 50 million CZK of support for his research on single-atom 2D photocatalysts.

Josef Srovnal
The main goal is to benefit cancer patients

When as a fresh graduate from the First Faculty of Medicine, Charles University, Josef Srovnal applied for a doctorate in Olomouc 20 years ago with the aim of getting a job as a paediatrician at the local university hospital, he had not given much thought to a career as a researcher. But science kindled his interest and he became involved in the development of non-invasive methods that refine the diagnosis or monitoring of cancer diseases. In addition, Josef devotes himself to students and, as a paediatrician and geneticist, to patients. It is his efforts to benefit the sick that matter the most to him.

At the start of his career, detection of circulating tumour cells was a largely unexplored topic. Coincidentally, he was able to participate in projects in a laboratory at the Children's Clinic led by the current head of the Institute of Molecular and Translational Medicine (IMTM) Marián Hajdúch, where, together with colleagues, he was able to develop sensitive and non-invasive methods. "Specifically, this involves the detection of biomarkers in the blood of patients with tumour disease, which can detect the disease, monitor it and provide information about the course of treatment in a timely manner. The monitored biomarkers can also signal any return of the disease," he explained. The acquired knowledge equips doctors with new possibilities. Some of the oncological diseases against which they were previously helpless can now be treated and could perhaps be cured in the foreseeable future. This would not be possible without basic research, including that initially conducted at the IMTM.

"Most of what we research here may not radically change the world, but we're adding tiny pieces to the overall mosaic of knowledge in an effort to benefit patients. The process is, of course, lengthy. But, I can see that the methods we developed years ago have now been translated into practice, and patients can benefit from them," he said.

Gabriela Schneider Rauber
Motivated to research alternative drug delivery routes by personal experience

Her work combines materials science with biomedicine. This possibility was one of the reasons why Gabriela Schneider Rauber decided to work at CATRIN about two years ago. As a member of the Nanomaterials in Biomedicine research group, she focuses on the development of new pharmaceutical materials in the form of nanopreparations that can, for example, be administered via the skin.

Gabriela graduated as a pharmacist from the Federal University of Santa Catarina (UFSC), Brazil and received her PhD in chemistry from the University of Cambridge. She has worked as a postdoctoral fellow at UFSC and at Politecnico di Torino in Italy, as well as with pharmaceutical companies. The start of her career in Olomouc is linked to a Crystal4skin—ERA Talents Fellowship.

"I research crystal engineering applied to pharmaceutical manufacturing and drug delivery. At the moment, I am interested in how the crystals I'm preparing in the laboratory can be used for alternative delivery routes. This is especially important for patients who cannot take medications orally due to other associated conditions. The work at CATRIN is great because I can fully characterize my synthetic materials and perform bioassays in one place," she said.

She confessed that her research has been motivated by personal experience. She was close to her mother, who needed palliative care after being diagnosed with a terminal disease. "That experience has shaped my recent career and interests. It has changed my perspective on how medications are administered to patients with specific clinical conditions, especially the elderly," said the researcher, for whom it is also important to combine career with family life.

She feels very comfortable in Olomouc. "It is a lovely city, which brings a sense of peace, gentleness and grounding! And I have met great people here. I love the parks, the historical centre and the woods around the zoo," she said.

Francisco Ignacio Jasso Robles
Studying plant-pathogen interactions

Francisco Ignacio Jasso Robles wanted to be a scientist since childhood but never imagined working outside his native Mexico. Meeting his current colleagues Nuria De Diego and Lukáš Spíchal at a conference in Argentina started a big transformation. Francisco has now been at CATRIN for two years working on plant-pathogen interactions in the Phenotyping research group.

"I am specifically interested in polyamine metabolism and its key role in combating biotic stress. My approach involves the use of non-invasive methods of high-throughput phenotyping and metabolomics, as well as molecular biological and biochemical analyses. The aim is to comprehensively understand the spatio-temporal dynamics of infection development in plant cells and gain insights into the subtle interplay that controls a plant´s response to disease agents," explained the young scientist, who studied Biochemistry and Molecular Biology with a focus on plants at the Universidad de San Luis Potosí and also taught students.

It was the experience of Olomouc scientists in this field and the sophisticated instrumentation available that inspired him come to CATRN. He describes this decision as his greatest success so far. "An important milestone on this journey is my recent success in winning a Palacký University grant for young researchers. It allows me to advance my research, but I also consider it a great achievement for a Mexican scientist abroad. It strengthens my commitment to contribute to the results of our scientific community, while at the same time overcoming barriers and showing that it is good to connect researchers from different backgrounds," he added.

In the future, he wants to expand his multidisciplinary collaboration and would also like to inspire and motivate the next generation of scientists. "When I think about my current position, I find that I am living the dream I have had since I was a child — becoming a scientist ," he concluded.

British Ambassador to the Czech Republic Matt Field praises CATRIN research

During his visit to the Olomouc Region and Palacký University, the British Ambassador to the Czech Republic, Matt Field, seized the opportunity to see CATRIN. As part of a short presentation, he was introduced to the institute's research activities, its results and, last but not least, to the diverse collaboration with other universities and research institutions in Great Britain. The British diplomat was also given a tour of CATRIN's laboratories for materials and plant research.

"I am very glad that during my visit to the Olomouc Region, I was able to visit CATRIN, which is a symbol of top Czech science. I am very pleased with its collaboration with British universities, including the University of Cambridge and Imperial College London, which I believe will bring new scientific discoveries and applied technologies to benefit society in general. I thank the centre very much for allowing me to see, for example, the microscope, which shows individual atoms and their bonds. I look forward to my next visit," said the ambassador, summarizing his impressions. He visited CATRIN together with the scientific attaché of the British Embassy in Prague, Otakar Fojt.

"It was nice to see Field's enthusiasm for the interconnection of basic and applied research at CATRIN. We discussed specific topics where we see common potential and the ambassador promised active participation in the search for further collaboration between research institutions in Great Britain and the CATRIN team towards common projects in the Horizon Europe calls," said the Scientific Director of CATRIN-RCPTM Radek Zbořil.

Week of the Academy of Sciences festival — tour and lectures

About a hundred high school students relished the opportunity to visit CATRIN's laboratories and attend a lecture in the Fort Science centre as part of the third year of the 'Week of the Academy of Sciences' festival.

In an interactive programme called Exploring a World of Small Dimensions but Big Possibilities, CATRIN's researchers introduced students to materials research. They explained the advantages of nanomaterials and nanotechnologies as well as the possibilities of their real-world applications. The visitors were then invited to try their own simple experiments. Regular attendees of this event include students from Střední škola polygrafická, Olomouc. "I want to bring science closer to my students so that they know what directions it is currently taking. Our school does not focus on natural sciences, but it still may be possible that the information obtained here can kindle students' interest towards these disciplines. Knowing the current trends and advancements in science, especially those in our home town, is, in my opinion, part of general knowledge," said Petra Skopalová, a teacher at the school. Students from the school also attended the Fort Science centre for a lecture called Cannabis, Threat or Challenge delivered by the leader of the Phytochemistry research group at CATRIN, Petr Tarkowski.

The Week of the Academy of Sciences of the Czech Republic is the largest scientific festival in the Czech Republic and includes lectures, exhibitions and many other activities across the whole country and all scientific disciplines.

Researchers' Night again enjoys great success

Helping to discover and enjoy knowledge — with this aim in mind, CATRIN participated in this year's "Researchers' Night" to promote science. On Friday, October 7, several hundred visitors came to its laboratories with the aim of unravelling some of the mysteries of science. 'Secret' was the central theme of this year's event. Encouragingly, the number of foreign visitors, including children, was significantly higher than during past events.

As in previous years, tours of the centre were a highlight as they enabled visitors to look inside the laboratories and provided a brief insight into the major directions of research. Through the use of experiments, adults as well as children unravelled some of the secrets of nanomaterials and modern methods of plant breeding, learned about catalysis and radioactivity, saw a levitating magnet and gained insights into the habitat of pollinators.

Visitors were even able to look down microscopes that are used by scientists for their research. The development of microscopy and its benefits were also explained in an exhibition entitled Journey to the Inside of Matter, which was prepared by CATRIN experts and was on view at UPoint in the city centre. "The long-term effort to look into the interior of objects that surround us resulted in a number of amazing discoveries in the field of microscopy, including the invention of electron microscopes. At the end of the 20th century, using scanning probe microscopy and later electron microscopy, we were able to image atoms for the first time. Further progress in recent years has allowed us to look at individual atoms, i.e., at the atomic level, and to display bonds between individual atoms as well as the electron structure of materials," said the co-author of the exhibition Klára Čépe.

SAN4Fuel workshop ignites fresh ideas for further collaboration

The possibilities of using computational methodologies for the design of advanced materials and analysis of their effect in catalytic applications for energy, biomedicine and the environment were discussed at a workshop of the SAN4Fuel project in Ostrava on 19 September. VSB-TUO, the University of Trieste and University of Erlangen–Nuremberg, Germany are important partners of this project.

The goal of the European project SAN4Fuel is to develop new materials for sustainable energy and environmental chemistry applications deploying single-atom catalysts. This innovative approach to the design of new materials and analysis of reaction mechanisms combines advanced theoretical models and calculations. This part of the research is being conducted by the VSB-TUO partner, who will use one of the most powerful European supercomputers of the national supercomputer centre IT4Innovations.

"For this reason, we chose VSB-TUO as the venue to gather experts from the respective fields. We not only discussed the latest research results in the interconnected areas but also identified new directions and other possibilities for advancing these scientific topics," said the principal investigator of the project Štěpán Kment.

Cannabis without prejudice

Since ancient times, people have considered hemp to be an important and useful crop with a wide range of industrial, agricultural and commercial uses. Today, however, we are largely unable to exploit the potential of this crop, not least because of regulations. This and other interesting facts were mentioned at this year´s discussion on cannabis in the Fort Science centre hosted by Petr Tarkowski, head of the Phytochemistry Research Group at CATRIN.

The guests of the debate were Zlatuše Krejčová from the company Hemp Production CZ, Jan Vacek from the Institute of Medical Chemistry and Biochemistry of the Medical Faculty of UP and František Švejda from CzecHemp. They talked, for example, about cultivating hemp in food processing, CBD products and related legislation, the benefits of using hemp products in human and veterinary medicine and regulation of the use of hemp for recreational purposes.

Public interest in the issue was clear, not only based on the large attendance at the event but also the number of questions asked by the audience. "I am glad that the debates have become a tradition. Indeed, this is the fourth year they have taken place," Tarkowski concluded the meeting.

Štěpán Kment at Colours of Ostrava

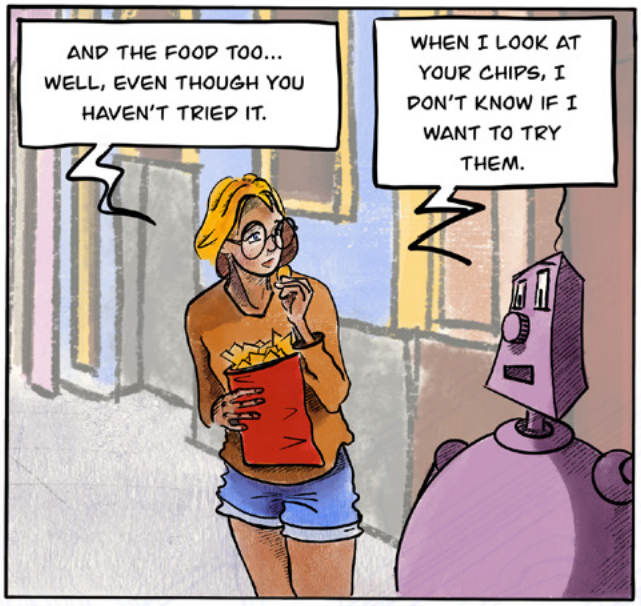
Palacký University participated in the Colours of Ostrava festival for the first time ever. Štěpán Kment, head of the Photoelectrochemistry group at CATRIN, was among five speakers sent by the University to Europe's largest discussion forum Meltingpot.

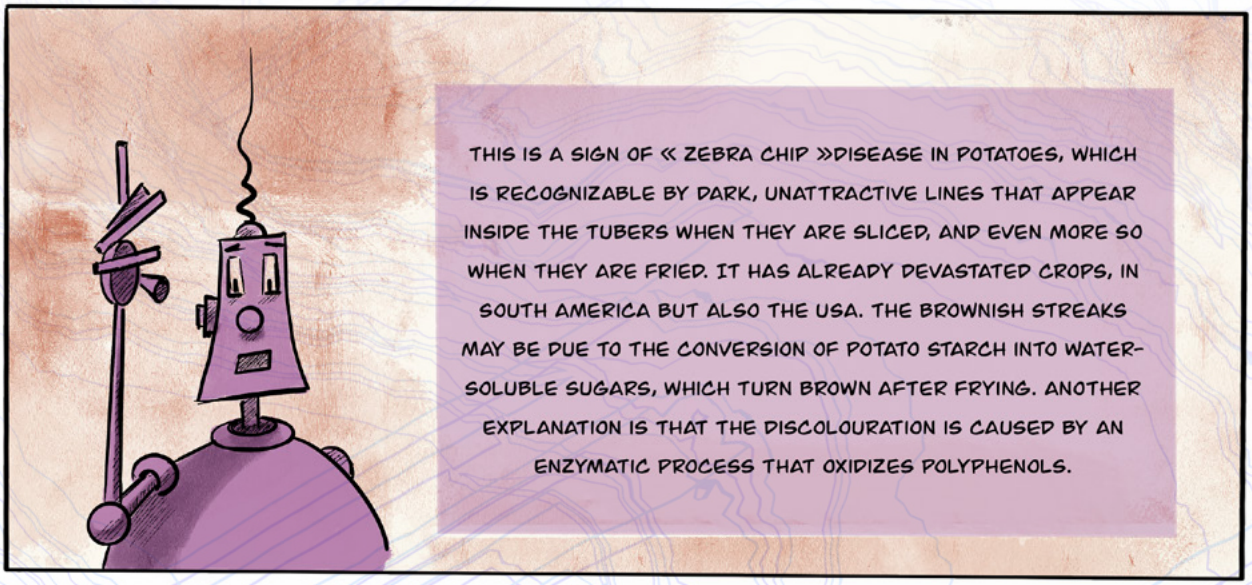
The energy and climate crisis, environmental protection, sustainable and safe energy, hydrogen as a fuel of the future, and nanomaterials and cutting-edge research. These were some of the key themes of lectures on offer for people interested in innovation and sustainable development. "We talked about solar water splitting and the reduction of waste carbon dioxide to obtain sustainable energy sources, such as hydrogen, methanol and ethanol. The development of materials to speed up, lower the cost and reduce the energy consumption of many existing production processes was a very topical issue," Kment said.

At Meltingpot, a unique combination of a music festival and multidisciplinary discussion forum in the industrial area of Dolní Vítkovice, over two hundred personalities from all over the world performed on eleven discussion stages.

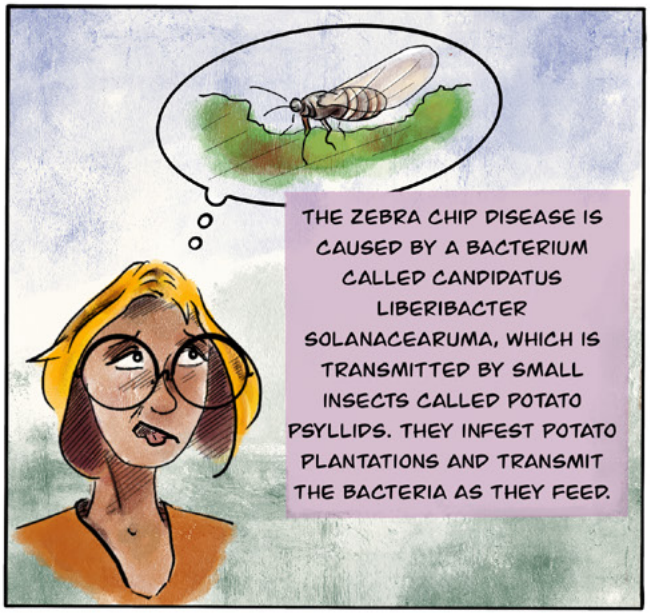
HERMAN AND BÉGONIA AND THE ZEBRA CHIPS

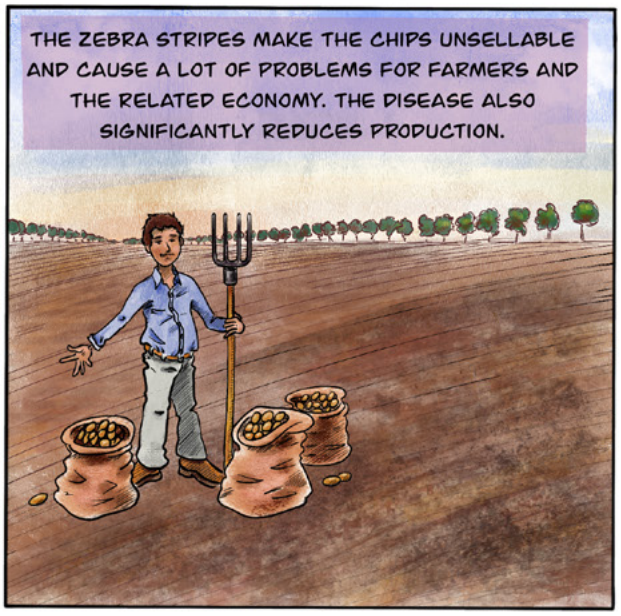
BY P.TROUILLAS

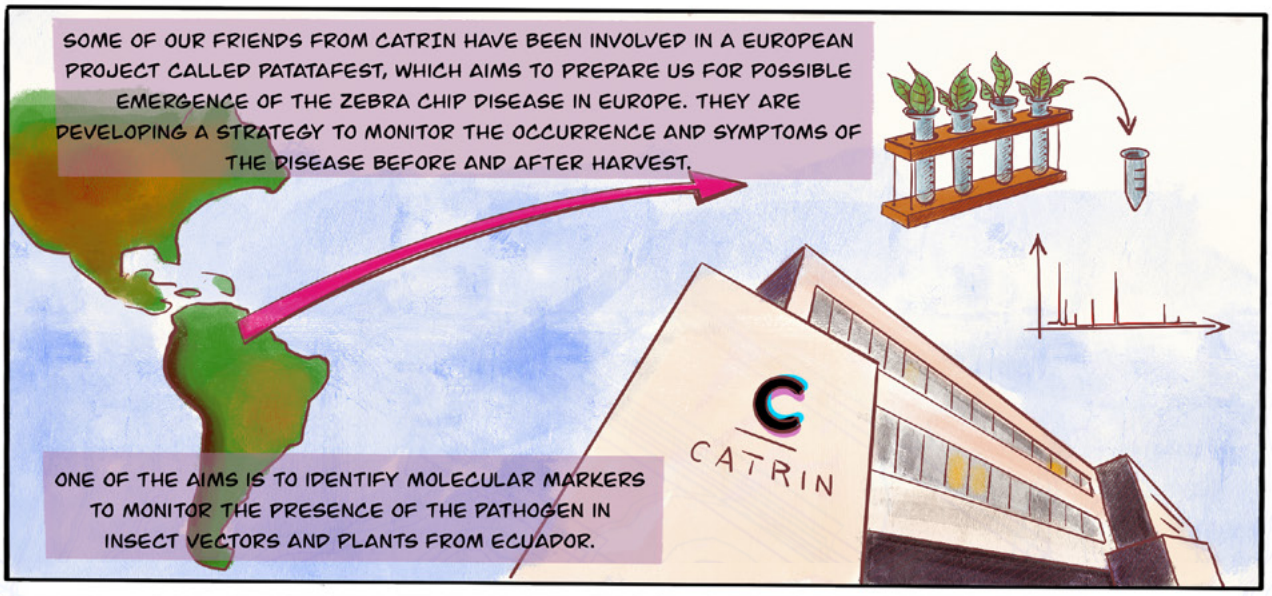


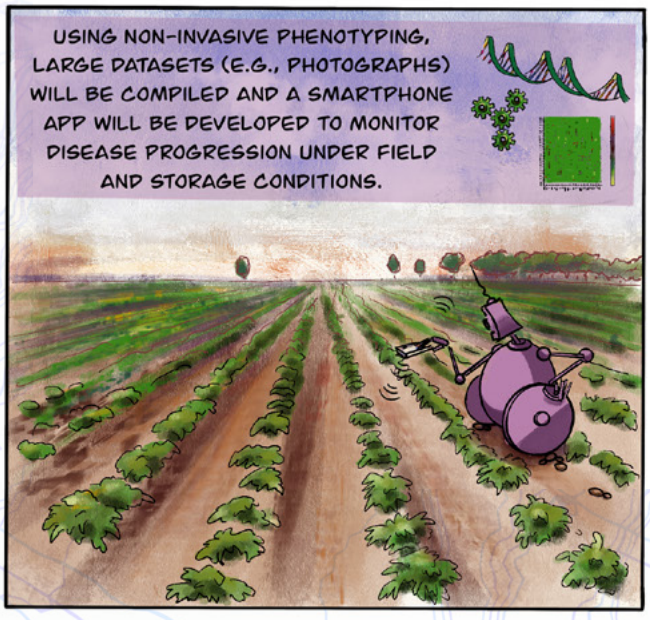


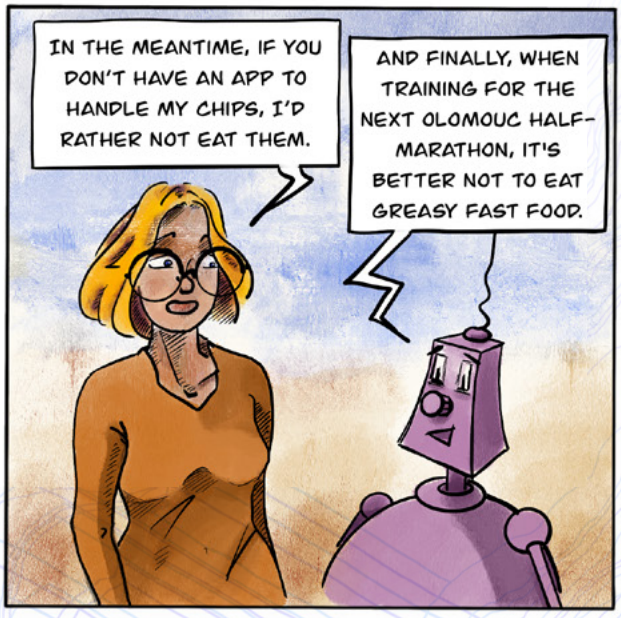
THIS IS A SIGN OF « ZEBRA CHIP »DISEASE IN POTATOES, WHICH IS RECOGNIZABLE BY DARK, UNATTRACTIVE LINES THAT APPEAR INSIDE THE TUBERS WHEN THEY ARE SLICED, AND EVEN MORE SO WHEN THEY ARE FRIED. IT HAS ALREADY DEVASTATED CROPS, IN SOUTH AMERICA BUT ALSO THE USA. THE BROWNISH STREAKS MAY BE DUE TO THE CONVERSION OF POTATO STARCH INTO WATER-SOLUBLE SUGARS, WHICH TURN BROWN AFTER FRYING. ANOTHER EXPLANATION IS THAT THE DISCOLOURATION IS CAUSED BY AN ENZYMATIC PROCESS THAT OXIDIZES POLYPHENOLS.


THE ZEBRA CHIP DISEASE IS CAUSED BY A BACTERIUM CALLED CANDIDATUS LIBERIBACTER SOLANACEARUMA, WHICH IS TRANSMITTED BY SMALL INSECTS CALLED POTATO PSYLLIDS. THEY INFEST POTATO PLANTATIONS AND TRANSMIT THE BACTERIA AS THEY FEED.


THE ZEBRA STRIPES MAKE THE CHIPS UNSELLABLE AND CAUSE A LOT OF PROBLEMS FOR FARMERS AND THE RELATED ECONOMY. THE DISEASE ALSO SIGNIFICANTLY REDUCES PRODUCTION.


SOME OF OUR FRIENDS FROM CATRIN HAVE BEEN INVOLVED IN A EUROPEAN PROJECT CALLED PATATAFEST, WHICH AIMS TO PREPARE US FOR POSSIBLE EMERGENCE OF THE ZEBRA CHIP DISEASE IN EUROPE. THEY ARE DEVELOPING A STRATEGY TO MONITOR THE OCCURRENCE AND SYMPTOMS OF THE DISEASE BEFORE AND AFTER HARVEST.
ONE OF THE AIMS IS TO IDENTIFY MOLECULAR MARKERS TO MONITOR THE PRESENCE OF THE PATHOGEN IN INSECT VECTORS AND PLANTS FROM ECUADOR.
CATRIN


USING NON-INVASIVE PHENOTYPING, LARGE DATASETS (E.G., PHOTOGRAPHS) WILL BE COMPILED AND A SMARTPHONE APP WILL BE DEVELOPED TO MONITOR DISEASE PROGRESSION UNDER FIELD AND STORAGE CONDITIONS.


IN THE MEANTIME, IF YOU DON'T HAVE AN APP TO HANDLE MY CHIPS, I'D RATHER NOT EAT THEM.
AND FINALLY, WHEN TRAINING FOR THE NEXT OLOMOUC HALF-MARATHON, IT'S BETTER NOT TO EAT GREASY FAST FOOD.

Univerzita Palackého
v Olomouci

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