

# Nanomaterial can detect and remove heavy metals from water

Major role played by graphene dots

### New EXPRO project

Targets single-atom 2D photocatalysts

## Fireflies glow to woo mates

New study published in Science and Nature

### Interview with J. A. Cole

Scientific evidence over prejudice

## A nanomaterial from Olomouc could remove heavy metals from water

#### A cheap, efficient, and recyclable nanomaterial that can both detect and remove heavy metals from water has been created through a collaboration between scientists from CATRIN, VSB-TUO, and the ICN2 in Barcelona.

The material can be used repeatedly

and is recyclable. Moreover, it is non-

toxic to the environment and can be

produced on a large scale.

**Michal Otyepka** 

The contamination of wastewater by industrial pollutants is a major problem today, with the heavy metals lead, cadmium, and mercury being among the most toxic of these substances. Their release into the environment causes extensive damage to aqueous ecosystems and contamination of agricultural crops. In humans, long-term exposure to these heavy metals can cause serious failure of organs and vital functions. Moreover, they are known carcinogens.

"There is a clear need for a cheap technology that can detect these highly harmful substances in water, even in small quantities, and also eliminate them effectively. The newly developed material can do both— when used on paper sensors, it reliably identifies cadmium or lead, and when used in the form of nanoparticles it removes these metals with unprece-

dented efficiency. This is the direction that modern technologies are taking. A similar approach is being used in medicine, where it is becoming increasingly common for a single substance to be used to both diagnose a human disease and to treat it," said one of the study's authors, Radek Zbořil. The results of the research were published in the journal Small and a patent has already been filed. Graphene dots, which the Olomouc scien-

tists have studied for many years, have several unusual properties that include photoluminescence. This means that they glow when irradiated, and it was this property that played the key role in the study.

"We discovered that if cadmium or lead is attached to the surface of our sensor, its photoluminescence is extinguished. This allows us to detect even very small amounts of these metals at concentrations many times below those permitted in drinking water according to European Union regulations," said the first author David Panáček from CATRIN. The disadvantage of existing technologies for detecting heavy metals is the need for special and expensive technical equipment along with trained

staff. To avoid this complication, scientists have developed a unique paper detector. "The base consists of cheap chromatographic paper, on which we have applied the nanomaterial. Such a detector is extremely cheap and easy to use. After immersing the paper in water, we can tell whether heavy metals are present using the naked eye," explained Panáček.

Compared to previously developed materials that can detect heavy metals in water, the new material has several advantages. The most important is the ability to remove heavy metals from water as well as detecting them. "The developed material can also be reused, i.e., it is recyclable. Moreover, it is a carbon material that is non-toxic to the environment and can be produced on a large scale. It could be used, for example, in filters to prevent contamination of water by dangerous lead or cadmium," ad-

ded another author, Michal Otyepka.

The research began about two years ago, when David Panáček visited the Barcelona Institute as part of his PhD studies. He worked in the group of Arben Merkoçi, a world-renowned expert in the field of sensors. "We had a clear plan for collaboration right from the beginning. We developed a carbon nanomaterial with the

optical properties needed to detect heavy metals, and our colleagues from Spain helped with its testing and optimization. Thanks to this excellent synergy, we have created a product with considerable commercial potential," added Panáček. Photoluminescent carbon dots have been studied by CATRIN scientists for several years and have also proven to be useful in medical diagnostics for measuring temperatures in living cells and diagnosing lung cancer.

Panáček D., Zdražil L., Langer M., Šedajová V., Baďura Z., Zoppellaro G., Yang Q., Nguyen E. P., Álvarez-Diduk R., Hrubý V., Kolařík J., Chalmpes N., Bourlinos A. B., Zbořil R., Merkoçi A., Bakandritsos A., Otyepka M.: Graphene Nanobeacons with High-Affinity Pockets for Combined, Selective, and Effective Decontamination and Reagentless Detection of Heavy Metals. Small 2022, 18 (33), 2201003. IF = 15.153

## Scientists open the door to applications of graphene

An international team of scientists including CATRIN researchers has overcome a fundamental barrier to the use of nanographene as a successor to silicon components in electronic devices. Their innovative solution for the surface treatment of graphene nanoribbons was published in the journal Nature Chemistry.

The remarkable electronic properties of graphene nanoribbons predispose them to serve as building blocks for nanoelectronics. However, their limited chemical stability has made it difficult to use them in this way. Nanographene nanoribbons with thicknesses of a single atom and widths of two to three nanometres are usually synthesized in a vacuum. However, when preparing nanotransistors, the nanoribbons are exposed to the atmosphere, leading to undesired oxidation and degradation of their electronic properties. "Our multidisciplinary team of physicists and chemists has succeeded in developing a method of chemically protecting the edges of graphene nanoribbons to eliminate this problem," explained Pavel Jelínek.

The proposed two-stage method involves controlled oxidation of the edges of the nanoribbons to prevent unwanted oxidation in the atmosphere followed by treatment with atomic hydrogen. "The new approach enables the preparation of stable chemically modified nanographene nanoribbons that are stable in the atmosphere. This opens up opportunities to improve the transport properties of nanographene-based transistors," said Bruno de la Torre.

Scientists from the Institute of Physics of the Czech Academy of Scienc-



es, CATRIN of Palacký University, the Spanish Material Physics Center, the University of Santiago de Compostela, The Nanomaterials and Nanotechnology Research Center (CINN), and the Basque Foundation for Science (IKERBASQUE) participated in the research.

Lawrence J., Berdonces-Layunta A., Edalatmanesh S., Castro-Esteban J., Wang T., Jimenez-Martin A., de la Torre B., Castrillo-Bodero R., Angulo-Portugal P., Mohammed S. G. M., Matěj A., Vilas-Varela M., Schiller F., Corso M., Jelinek P., Peña D., de Oteyza D. G.: <u>Circumventing the stability problems of graphene nanoribbon zigzag edges</u>. Nature Chemistry 2022, IF = 24.274

## Adult fireflies started glowing to improve their sexual communication



An international team of scientists with two members from CATRIN has concluded that fireflies use bioluminescence for courtship. Their work, which is based on analyses of large amounts of molecular data and fossil samples from 25-99 million years ago, puts an end to years of conjecture. The team's results were published in the Proceedings of the Royal Society B: Biological Sciences and have been mentioned as a scientific matter of interest in the journal Nature.

"While firefly larvae glow to indicate that they are not palatable food, adults probably started using bioluminescence to woo mates. In fact, we have established that fireflies acquired this ability over 133 million years ago, long before their natural predators, the birds and bats of today, appeared on Earth. The most probable explanation is therefore that light emission in adults emerged to improve sexual communication," said one of the study's authors, Dominik Kusý from CATRIN. The research was done by the Olomouc scientists in collaboration with long-standing partners from several research institutions in the USA who have been studying the evolutionary history of fireflies, their luminous relatives (Sinopyrophoridae, Phengodidae, and Rhagophthalmidae), and snapping beetles (Elateridae). The team wanted to determine when bioluminescence arose during the evolution of this group of beetles. To this end, they reconstructed the relationships between a large number of genes and examined a new set of fossils, including one from Burmese amber dated to the Mesozoic Cretaceous. Using molecular dating, they determined when and in which evolutionary lineage the capacity for bioluminescence arose in adults, and from this they inferred the reason for this evolutionary change.

Powell G.S., Saxton N. A., Pacheco Y. M., Stanger-Hall K. F., Martin G. J., Kusy D., Da Silveira L. F. L, Bocak L., Branham M. A., Bybee S. M.: Beetle bioluminescence outshines extant aerial predators. Proceedings of the Royal Society B 2022, 289, 20220821. IF=5.53



### **Czech Universities Join Forces with European Leaders in Green Energy**

Improving research focused on harnessing sustainable and green energy, sharing knowledge with top foreign experts, and further increasing success rates in large international grant competitions are the goals of the grant project from the Twinning call of the Horizon Europe programme. The Twinning consortium will connect researchers from CATRIN and VSB-TUO with world-renowned research teams in Germany and Italy. The three-year project's budget is about 1.5 million euros.

"In recent years we have developed several unique nanomaterials that can efficiently convert solar energy into heat or produce hydrogen as an alternative source of green energy. Although our team has achieved several significant results, we still need to gain knowledge and experience to help develop practical applications of selected technologies," said the project's Principal Investigator, Štěpán Kment from CATRIN. This project will allow Czech scientists to work with experts from Italy and Germany who have vast experience with applications including electrochemical carbon dioxide removal and hydrogen extraction by solar splitting of water.

The scientific focus of the project, which is called "Single Atom Based Nanohybrid Photocatalyts for Green Fuels", is on the study and development of nanomaterials whose efficiency in new energy and environmental technologies will be increased by anchoring single metal atoms to their surface. This will involve engineering at the level of single atoms—a revolutionary scientific process that enables precise control over the chemical and electronic properties of single atoms and molecules and their exploitation in practical applications.

The TWINNING call (HORIZON-WIDERA-2021-ACCESS-03-01), which closed in January this year, awarded approximately 100 grants that were shared among a total of 21 countries. Nine of these grants were won by Czech research teams and universities.

## A prestigious EXPRO project will focus on single-atom 2D photocatalysts

The Czech Science Foundation will finance ten new EXPRO projects, starting next year, one of which will be conducted at CATRIN. Patrik Schmuki, a world-renowned scientist in the field of photoelectrochemistry, has won funding of almost 50 million Czech koruna to support his research on single-atom 2D photocatalysts.

"I am greatly looking forward to implementing this project. We have a unique opportunity to realize a longstanding dream in chemistry by arranging single atoms on suitable surfaces to create exceptional reactivity. This grant will enable our team to compete strongly with research groups working in this area around the world. Our efforts in single-atom manipulation will focus on producing hydrogen, the fuel of the future, using only sunlight and water or even sunlight and waste. We aim to do this simply by adding a small amount of a cheap and environmentally friendly 'magic powder'— a photocatalyst—to the aqueous solution," said Schmuki.

The team's two main challenges over the next five years will be to explore the interactions between single-atom-based cocatalysts and thin-semiconductor photocatalytic surfaces, and to understand the behaviours of single atom cocatalysts in order to identify the most efficient surfaces for



photocatalytic and electrochemical reactions.

The aim of EXPRO grants, which are intended primarily for experienced researchers, is to create the conditions for the development of excellent research. One of the requirements for the principal investigator is to sub-

mit an application for an ERC grant. Ten projects were funded in this year's competition – three will be conducted at Masaryk University and two each at the institutes of the Czech Academy of Sciences, CTU in Prague, and Charles University. In total, over 450 million Czech koruna has been allocated for their implementation.

## SUSNANO project to support Albanian colleagues



The exchange of experience and knowledge as well as the development of an electrochemical sensor for water quality control are the main objectives of the international SUSNANO project, which is being conducted within the Horizon Europe framework. The project partners are CATRIN, the University of Tirana, ICN2 in Barcelona, and Intelligentsia Consultans Sarl.

"The primary objective of the project is for CATRIN and ICN2 to share knowledge and expertise with Albanian colleagues to help them increase the prestige of their research and support the development of their institution. We will focus on detecting pollutants in surface waters, which is a substantial problem in Albania. The aim is to develop a simple sensor that will be able to detect heavy metals, antibiotics, or pesticides in water. We will provide our nanomaterials, our Spanish colleagues will provide insights into the development of such sensors, and the Albanian scientists will perform on-site analyses," said Petr Jakubec, a member of the CA-TRIN research team. The knowledge transfer between experienced and early-stage researchers is already taking place in the form of staff exchanges. Training sessions, summer schools, and joint workshops have also been planned and will take place as the project is implemented.

SUSNANO—Twinning to Boost the Scientific and Innovation Capacity of the Universiteti i Tiranes to Develop Sustainable Nanosensors for Water Pollution Detection—is a three-year project funded by the European Union under the Twinning Western Balkans call (HORIZON-WIDE-RA-2021-ACCESS-02) as part of the Horizon programme. The aim of this call is to support countries in the Western Balkans in order to accelerate their economic recovery, promote ecological and digital transfer, and enhance their integration and convergence with the European Union.

## **CATRIN's international cooperation thanks to COST**

CATRIN scientists are involved in a large project under the COST programme called Confined Molecular Systems: From a New Generation of Materials to the Stars (COSY), which is intended to support international research cooperation, multidisciplinarity, and young researchers. Computational chemists Michal Otyepka and Miroslav Medved' will work to develop new carbon materials for photochemical and biomedical applications and to expand the field of single-atom catalysis within one of 129 participating research groups from 33 countries.

"This new grant is the result of a long-term collaboration and the efforts of a consortium of research groups from all over Europe that has already completed several successful projects under the COST programme in the fields of modern spectroscopy and computational chemistry. The COSY project aims to redefine the state of the art in the field of confined molecular systems and find innovative ways to translate academic discoveries into applications in sustainable industry to facilitate the transition to greener technologies, in accordance with the EU Green Deal programme. It is a broad-scoped project intended to establish a platform for cooperation between important theoretical and experimental scientific groups in Europe and partner countries," said Medved, who is also a member of the project's Management Committee.



Scientists from Olomouc (photo) will be particularly active in research on reactivity and the design of new materials with applications in fields including (photo)catalysis, sensing, imaging, and biomedicine.

## Thanks to a Junior Star project, Bruno de la Torre will start his own experimental group



Bruno de la Torre from CATRIN won a JUNIOR STAR grant for outstanding early career scientists from the Czech Science Foundation. The 14.7 million Czech koruna awarded to Bruno will allow him to establish an experimental research group focused on the interdisciplinary area of molecular electronics. Over the coming five years, his group will investigate the laws governing charge mobility in light-harvesting molecular nanomodels.

"The proposed research aims to determine the basic electronic and structural properties of a new class of 'molecular components' and evaluate their potential to serve as prototypes of molecular devices. This work will have a fundamental scientific impact because it will involve characterizing conjugated molecular systems at a sub-angstrom spatial resolution and studies on charge transfer at the single-electron level," said Bruno de la Torre, who was on the team of scientists that made the world's first observations of the inhomogeneous distribution of electronic charge around a halogen atom—a so-called sigma hole. Their results were published last year in the journal Science.

The new project, which is called 'Atomic-Scale Control and Visualization of Charge Delocalization in Light-Harvesting Molecular Nanomodels', will directly support the development of a new laboratory, enable research in the highly interdisciplinary field of molecular electronics, and facilitate collaboration in the field of organic semiconductors. It will also benefit PhD students and undergraduate students at Palacký University.

JUNIOR STAR grants are intended to support outstanding young scientists within 8 years of receiving their Ph.D. who have published in prestigious international journals and have significant experience at research centres outside the Czech Republic. The grants provide funding for five years, giving winners the opportunity to become scientifically independent and establish their own research groups, thereby expanding the horizons of Czech science. Only a small fraction of the submitted proposals are funded—just 23 were successful this year.

## **Our Recent Reviews**



K. Jayaramulu, S. Mukherjee, D. M. Morales, D. P. Dubal, A. K. Nanjundan, A. Schneemann, J. Masa, S. Kment, W. Schuhmann, M. Otyepka, R. Zbořil and R. A. Fischer



N. De Diego, L. Spíchal

"Graphene-Based Metal-Organic Framework Hybrids for Applications in Catalysis, Environmental, and Energy Technologies",

Chemical Reviews, in press, 2022. IF=72.087

## ping approaches in biostimulant research and development",

"Presence and future of plant phenoty-

Journal of Experimental Botany, vol. 73, iss. 15, 5199–5212, 2022. IF = 7.298



**Cintia Marchetti** I am grateful for the years spent in Czechia

Cintia Marchetti came to Olomouc nine years ago for a month-long stay as part of an international cooperation between Argentina and the Czech Republic. The following year she started her doctoral studies here, which she has successfully completed. As a member of CATRIN's Plant Genetics and Engineering research group, she focuses on hormonal regulation of plant growth, especially under water stress conditions.

"When I was finishing my Master's degree in Argentina, I was thinking of going abroad to get my PhD. I wanted to experience how science is done outside my country and grow as a researcher. I chose Olomouc as a destination after visiting as an exchange student because there were great experts on the topic of plant hormones in cereals, which was the topic that interested me the most," said Marchetti, explaining her motivation for working in Olomouc.

She considers plants to be amazing organisms because they cannot run away from challenging conditions and have therefore developed the ability to tolerate them instead. "What allows them to survive is an astonishing set of metabolic and hormonal changes. Understanding the mechanisms governing these changes will be crucial for humanity because we must confront climate change and the risk of water scarcity in major agricultural regions," she warned. She hopes that her work will contribute to the development of more sustainable and efficient agriculture. "At the moment, I am very happy with the research we are doing in our groups and I hope that we will soon produce interesting results that will bring us closer to our goal," she said

In addition to plant research, which she enjoys very much, she appreciates the international environment at CATRIN. "I am very happy to have a number of international scientists working in our research centre," she added.



**Pert Džubák** I've always enjoyed inventing new things

Petr Džubák started his scientific career as a medical student but he has been attracted to discovering new things since childhood and he read textbooks on inorganic chemistry in elementary school. Now he is one of the top researchers at the Institute of Medical Research, which is associated with both CATRIN and the Faculty of Medicine of UP. His work focuses on developing new drugs and early diagnosis of cancer, but as a certified paediatrician he also tries to keep in touch with clinical practice.

"I have been attracted to science and research for as long as I can remember. One of my earliest memories is being given a Young Chemist play set when I was about five years old. My grandfather was a major influence on me. He was not allowed to study by the regime at the time, but he was one of the smartest people I know. I went to the Science Library with him as a boy, he was the one who motivated me the most," Džubák recalled.

While studying at the Faculty of Medicine at UP, he soon discovered that studying alone did not satisfy him. By a happy coincidence, he joined the newly established laboratory of Marian Hajdúch. "There I became involved in the work almost immediately. I was completely hooked, to the point that I even stayed overnight in the laboratory. Once I finished medical school, I started working on a PhD and it was natural for me to pursue research. In addition, I have always worked at the Children's Clinic, and I still perform several shifts there each month. I enjoy being in contact with patients, so I try to keep in touch with real medicine at least a little bit—I would not like to lose that," he added.

His primary focus, however, is on developing anti-cancer drugs and finding biomarkers for early cancer diagnosis.



**Sergii Kalytchuk** I hope that "my" nanomaterials will be useful

Sergii comes from Ukraine, where he graduated from Yuriy Fedkovych Chernivtsi National University. He then received his doctoral degree from the V. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine (Kyiv, Ukraine) and spent some time at the City University of Hong Kong before coming to RCPTM, which is now part of CATRIN. For the last ten years, his research here has focused on the synthesis, characterization, and applications of fluorescent carbon nanoparticles. He hopes that the materials and technologies that he studies will be useful in many areas.

"We started our research on carbon nanoparticles in Hong Kong and knew that RCPTM did work in the same area, so it was a good opportunity for me to continue my research in this direction," he said when asked to describe why he chose to come to Olomouc. Although nanoparticles initially consisted of toxic elements such as cadmium or mercury, these were quickly replaced by non-toxic precursors. It was clear that such non-toxic and biocompatible fluorescent nanoparticles could revolutionize the life sciences and medicine. Studies on nanoparticles of this type led to Sergii's greatest achievement to date-the development of a fluorescent temperature nanosensor based on carbon dots for contactless in vitro monitoring of intracellular temperature.

"In my work, I love the excitement you get when you design a nanomaterial that has never been produced before. The applications of nanomaterials are not limited to biomedicine—they are also useful in photovoltaics, photoelectrochemistry, and anti-counterfeiting technologies. I hope that this list will be extended as more work is done," the scientist explained.

His happiness in Olomouc is not just due to his interesting and diverse work. "I enjoy living here as this place is beautiful and safe at the same time," he explained.

Why Europe must accept new breeding techniques

Jeffrey A. Cole is a microbial physiologist who has devoted a part of his professional career to the European Federation of Biotechnology (EFB), since January 2021 as its President. He considers the application of biotechnology to be crucial for securing sustainable agriculture and biodiversity.

#### Could you please briefly introduce the EFB?

The EFB is Europe's non-profit federation of National Biotechnology Associations, Learned Societies, Universities, Scientific Institutes, Biotech Companies and individual biotechnologists. Our primary task is to promote biotechnology throughout Europe and beyond. As an independent "Voice of Biotechnology in Europe", EFB promotes the safe, sustainable and beneficial use of fundamental research and innovation in life sciences, while providing a forum for interdisciplinary and international cooperation. Key member activities focus on plant, food, agriculture and environmental biotechnology on the green side, and biopharmaceuticals, healthcare, pathogenicity and antibiotic resistance on the red. Physiology and genomics of microorganisms impact many aspects of biotechnology, while white topics include biomaterials, bioengineering, and both systems and synthetic biology.

#### What are the major challenges it is currently addressing?

Major challenges facing the EFB include (i) persuading Europe, not least the European Commission, to base its regulations on scientific evidence rather than prejudice; (ii) persuading the public that technology provides the means to achieve sustainable, regenerative food production that are 100% consistent with aims of the Green and Organic movements and to mitigate loss of biodiversity due to climate change; and (iii) to close the culture gap between academic research and bioprocessing applications. Adequate funding is essential for the EFB to achieve our aim to be an independent voice for biotechnology and to take new initiatives. The federation relies heavily on three major income streams: institutional membership and Regional Branch Office (RBO) contributions; royalty income from our two journals, New Biotechnology and the Bioeconomy Journal; and income generated by providing administrative support for Divisions organising scientific meetings.

## Scientists from CRH, now CATRIN, have been working with EFB for a long time. Ivo Frébort is the Vice-President of the Federation. How do you feel about this cooperation? Is it unique in the Czech Republic?

At one point the EFB was supported to various degrees by 14 national societies that became our RBOs. RBOs in Poland, France and the UK remain active members of the EFB, but cooperation is strongest with RBOs in Spain, France and the Czech Republic. CR Hana, now CATRIN, plays a key role in the growing success of the EFB. Professor Ivo Frébort is one of our Vice-Presidents and Michaela Holecová is a member of the EFB Executive Board. Since the formation of CATRIN, the RBO has become the home of the EFB Plant, Agriculture and Food Division with a gradually increasing range of activities. Examples of new initiatives include a "Healthy soil" meeting to be held in September 2023 in Muttenzi, and seminal contributions to the debate about Europe's use of new genetic technologies for the benefit of Society (see below).

#### Where do you see further possibilities for the development of cooperation and deepening of contacts?

Across Europe, academic microbiologists, chemists and physicists are supported by strong national and international organisations such as the Microbiology Society, FEMS, and the Royal Society of Chemistry. It is surprising that no obvious parallel European organisation serves the similar needs of plant physiologists and geneticists. This gap in provision makes collaboration between academia and industry more difficult and in part explains why Europe lags behind its competitors in the USA and China to embrace new technologies. The EFB is not a national society, but an international Federation dedicated to developing international collaborations across both scientific disciplines and between research and its industrial application. The Czech RBO based in Olomouc offers massive scope to increase these collaborations, especially through the organisation of scientific meetings and the production of evidence-based position papers to guide future European legislation.

## One of the visible outcomes of the cooperation is the biennial G4G conference. The last one took place this year. How did you think the conference went?

The G-4-G meetings always include ground-breaking science from top groups across the world, and the 2022 meeting was no exception. Participants were especially appreciative of the enhanced opportunities to build new collaborations. The introduction of flash poster presentations was undoubtedly an appreciated innovation. Covid has massively depleted participation in all scientific meetings, many of which have been cancelled by other organisations. The G-4-G-6 meeting in 2022 was no exception, attracting only half of the number of paying registrants compared with the previous meeting. Nevertheless, strong financial support recruited by Ivo Frébort and his team by various sponsors enabled income to slightly exceed meeting costs.

#### One important issue for the EFB is changes in European legislation concerning modern methods of plant genome editing. Why are you calling for these changes and do you think they are in sight?

There are many reasons why Europe needs to embrace new plant genetic technologies (NGT). Global warming presents the greatest current threat to civilisation, especially by jeopardising food security. The following examples are just a few of the many ways that NGT can help reverse global warming and its consequences for feeding the World. Significant amounts of carbon dioxide are produced by transporting food across Europe and even across the World. Beans, asparagus and soft fruits are imported by air from Asia, South America and Africa either because they are out of season in Europe, or because our climates are incompatible with their local production. Technology offers ways to produce more crops locally either in the field or in contained environments. Local food production is the friend of the Green movement, not its enemy. The same argument applies to organic farming, which without application of NGT cannot meet the increased food production required to feed a world of 10 billion people. Drought is a major threat to food production: as already demonstrated by new strains of cereals developed by CRH, NGT can provide drought-resistant plant strains that are safe to eat and do not present a threat to the environment. While current regulations in Europe prevent us from reaping the benefits of these plant strains, other nations with greater foresight are attracting large scale food production using plant varieties developed by NGT and then exporting the products long distances to meet the demand in Europe. Not only does this short-sighted European policy exacerbate global warming: it also exports employment from Europe to other continents. Sadly much of Europe remains opposed to the use of scientifically based development of new plant varieties. The battle to persuade the general public to abandon prejudice and fake news is still no closer to success.

#### Prof. Jeffrey A. Cole, Ph.D., (\* 1942)

Professor Cole is a microbial physiologist. He is a Professor Emeritus at University of Birmingham and since 2021 has been the President of European Federation of Biotechnology. In addition, he is a member of CATRIN's Scientific Board. His research has focused on how bacteria adapt to oxygen starvation or excess with >150 papers on bacterial nitrate and nitrite reduction. Recently he has focused on how enteric bacteria protect themselves against nitric oxide generated either by other bacteria, or as a protection mechanism of their mammalian hosts. He currently collaborates with Dr. Amanda Rossiter on projects investigating how bacteria survive the human immune response and their roles in gastric cancer.

#### **CATRIN organized a Czech-French Barrande Conference**



Participants of the 7th Barrande Bioscience Meeting talked about the use of nanoparticles and nanosystems in the diagnosis and treatment of certain diseases. The conference was organized for the first time by CATRIN in collaboration with the Strasbourg Graduate School of Biotechnology, the French National Centre for Scientific Research (CNRS), and the University of Strasbourg under the auspices of the Embassy of France in Prague and the French Institute Prague. It took place at the beginning of October at the Institute of Molecular and Translational Medicine.

"We are pleased that after an almost a three-year break, French and Czech bioscience researchers were able to meet again to discuss the latest results, exchange experiences, and above all, initiate new cooperations across different research disciplines and topics," said the conference organizer Kateřina Poláková, who leads the Nanomaterials in Biomedicine research group at CATRIN. The conference programme focused on five research topics of major current interest in bioscience: nanosystems and drug transport, nanosystems and imaging, drug design and administration, chemistry applied to biological systems, and nanocarriers.

#### The Neuron Prize Goes to Pavel Hobza

The Neuron Prize 2022 in Chemistry was awarded to Professor Pavel Hobza, the discoverer of a new type of hydrogen bond and one of the world's most influential scientists in the field of computational chemistry. The Neuron foundation recognized his life-long contribution to the field of chemistry and the advancement of scientific research worldwide. In addition to his work at the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences, Professor Hobza is a vital part of CATRIN's scientific backbone.

"In general, there are very few awards for science in the Czech Republic. However, each one is significant because it gives the public important information about the state and position of Czech science. While it is very gratifying to be awarded such prizes, their purpose is not to flatter the vanity of the researcher but to publicly recognize scientific achievements," said Hobza, who has been one of the most important Czech scientists in recent decades.

"Pavel Hobza is without a doubt one of the most inspiring scientific personalities and moral authorities I have ever met in my life. I am very proud that he became the first employee of CATRIN in 2020 and I am even



more pleased that he still has the energy and strength to work scientifically," said the CATRIN director, Pavel Banáš.



#### Veronika Šedajová wins the Jean-Marie Lehn Prize for Chemistry

The first place award of the Jean-Marie Lehn Prize for Chemistry 2022 was won by Veronika Šedajová, who works in the Magnetic Nanostructures group at CATRIN. This competition is organized annually by Solvay in collaboration with the French Embassy in the Czech Republic to promote the best doctoral thesis in the field of chemistry. Veronika drew the jury's interest by presenting her research on new graphene-derived materials for storing electrical energy.

"I described the development of a new carbon material—a 2D graphene derivative—and its uses. My presentation outlined the complete journey from the first synthesis of the material to the search for suitable applications, the drafting and award of a patent, the testing phase, and our collaboration with commercial partners to create a prototype supercapacitor for energy storage using the new material. Having initially prepared the material in just milligram quantities, we have developed procedures to reliably produce it on kilogram scales," explained Šedajová. She greatly appreciates having been able to participate in all aspects of this development process during her doctoral studies.

#### The ICN2 and BINA workshops created ample opportunities for cooperation



CATRIN organized two workshops with foreign partners this autumn. On the 17th and 18th of October, we welcomed representatives of the Catalan Institute of Nanosciences and Nanotechnology (ICN2). A week later, a two-day meeting was held with researchers from the Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) at Bar-Ilan University. CATRIN has previously signed memorandums of cooperation with both institutions. "I am glad that, after our visits to Spain and Israel, we were able to welcome our partners to Olomouc and show them the workplaces of all our divisions. We discussed the topics where we see opportunities to cooperate, which include applications of nanomaterials in electrochemistry, environmental applications, molecular farming, and biomedical research," said CATRIN Director, Pavel Banáš.

ICN2 is a non-profit international research institute based in the campus of the Autonomous University of Barcelona (UAB). Its mission is to promote interdisciplinary research in nanoscience and nanotechnology. The collaboration between CATRIN and ICN2 has been ongoing for a long time and developed from joint projects conducted with the research group of Arben Merkoçi, who attended the Olomouc workshop.

"It was a very fruitful event that included tours of the centre's laboratories and the planning of mutual projects," commented Merkoçi. A similar workshop was held with BINA colleagues. BINA is Israel's leading nanotechnology research institute and a world leader in many fields; a Memorandum of Understanding between BINA and CATRIN was signed last October. "The aim of the agreement is to strengthen the ties between the two sides, facilitate the exchange of scientific and technical knowledge, and strengthen the scientific and technical development of both institutions in the field of materials sciences and nanotechnologies. A joint workshop was held to help fulfil these commitments," concluded Banáš.

#### Scientists will create a prototype supercapacitor

In October, a European Innovation Council (EIC) Transition Challenges project with a budget of nearly 2.5 million Euros was launched with an opening ceremony at the Rector's Office of Palacký University and a subsequent kick-off meeting attended by all of the project partners. The task of a research team led by Michal Otyepka from CATRIN is to prepare a prototype supercapacitor for storing electrical energy in cooperation with colleagues from Bar-Ilan University in Israel and the Italian company ITELCOND. They will use nitrogen-enriched graphene developed in Olomouc.

"Our goal is to create a supercapacitor that has a higher capacity and longer lifetime than previously reported systems while also being safer, more environmentally friendly, and cheaper than current batteries. After discovering the new nitrogen-enriched graphene and a way to synthesize it on a laboratory scale, we have been working to create a prototype device as a final step before designing a viable product", said Otyepka, whose work in this area builds on results obtained with the support of two prestigious grants awarded by the European Research Council (ERC)

The researchers aim to create supercapacitors with energy densities above 50 Wh/L, which is about twice the value achieved by the best



existing systems. Their success will enable the widespread use of supercapacitors in electric cars and to support batteries in devices that need large amounts of energy to be supplied in a very short period of time.

#### Nanocon 2022 focused on nanomedicine

Current scientific and technological challenges in nanomedicine were the central theme of Nanocon 2022—the largest international conference of its kind in Central Europe, which took place in October in Brno. As in previous years, Radek Zbořil was the programme's guarantor.

"Thanks to a long-term collaboration with colleagues from the Catalan Institute of Nanoscience and Nanotechnology in Barcelona, one of the world leaders in the field of nanomaterials for biosensors, Arben Merkoçi gave a plenary talk. Another very important guest was Jean Francois Berret from the University of Paris, an expert on nanotechnologies used in medicine, biology and the environment," said Radek Zbořil.

CATRIN was represented by Štěpán Kment. The institute also had strong representation in the programme sections, where Veronika Šedajová received an honorary mention for her poster. Nanocon conferences have been held annually since 2009. Detailed information including programmes is available at https://www.nanocon.eu/cz/.

#### The G4G conference enabled intense interactions between scientists

There is no time to sit back and wait for things to change, we urgently need to implement changes based on the principles of the bioeconomy and circular economy. This was a major conclusion of the Green for Good VI international conference, which was organised in Olomouc by CATRIN in cooperation with the European Biotechnology Federation (EFB) under the auspices of the Minister for Science, Research and Innovation, Helena Langšádlová. Scientists exchanged experiences and new knowledge in the fields of plant genetics, genomics, cell biology, materials chemistry, and bioeconomy. Moreover, they agreed that it is crucial to present research results and new technologies to the public.

Experts from the Czech Republic, Germany, Great Britain, the USA, Finland, and other countries met to discuss sustainable agriculture, circular economy, the fight against climate change, and generating and storing energy in biological systems. The event's speakers included many respected scientists such as Alan Schulman from the University of Helsinki, who is currently President of the European Plant Science Organisation (EPSO), Martin Greimel—Head of the Centre for Bioeconomy at the University of Natural Resources and Life Sciences Vienna (BOKU), and Thomas Brück from the Technical University of Munich.

"The programme was very relevant to my main field of research, which is bioeconomy. I was interested in what is happening here in Olomouc and I was impressed by the scientific infrastructure at CATRIN; the guided tour was very inspiring. I have always believed that European cooperation in research and science policy is extremely important, we need to stay in touch and build links with each other," said Brück shortly after the closing plenary lecture.



Several hundred visitors attended the Researchers' Night event organized by CATRIN on Friday, Sept. 30. Both children and adults seized the opportunity to explore the laboratories, get new insights

## **Researchers' Night Attracted Many Visitors**

into natural sciences, and test their senses in a number of interesting experiments.

"Everything was very interesting and our science popularizers entertained the visitors with great enthusiasm. We managed to show the general public what we do at CATRIN in a way that engaged children's interest," said CATRIN director, Pavel Banáš.

The programme was shaped around this year's motto: 'All the Senses'. Visitors could feel at first hand the heat of a fire and the cold of liquid nitrogen, taste flour worms and other 'insect snacks', test their sense of smell on aromatic essences or herbs, hear the barking of hydrogen, see the larvae of the rose chafer, and learn about natural dyes. They also learned about why it is important to edit the genome of economically important crops using modern targeted methods and how barley can be turned into a 'factory' for antibacterial cathelicidin. In addition, there was a photo corner where children and adults could turn into scientists. Another highlight was a four-meter model of the planet Mars that was borrowed from the Brno Observatory and Planetarium.

#### **CATRIN** participated in the Week of the Academy of Sciences

Guided tours of the laboratories and a lecture at Fort Science for high school students from Příbor, Český Těšín, Vsetín, Uherský Brod, and Olomouc were organized by CATRIN as part of this year's Week of Academy of Sciences, the largest event in the country to promote science.

At CATRIN-CRH, the students learned why research on economically important plants and editing plant genomes is crucial. They also found out how automation helps scientists and why chemical analyses of plants are performed. They looked at fireflies and other insects, and researchers explained how they use state-of-the-art DNA sequencing methods to efficiently map the diversity of insect species. Dominik Kusý and Michal Motyka from the Biodiversity and Molecular Evolution Group delivered a lecture on this topic at Fort Science for students from Olomouc high schools.

Another attraction that drew quite a crowd to CATRIN-RCPTM was an excursion called Exploring a world of small dimensions but large possibilities, which showed what nanoparticles can do and how they can be used. The Week of the Academy of Sciences is a science festival that follows on from the former Week of Science and Technology.







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