



Palacký University
Olomouc



Annual Activity Report

of the Czech Advanced
Technology and Research
Institute for the year 2023



Introductory word of the Director

The year 2023 brought another important milestone for the Czech Advanced Technology and Research Institute CATRIN and at the same time confirmed its position as a fully and professionally functioning research institute. This year, we successfully completed the transition from funding through projects of the Operational Programme Research, Development and Education (OP VVV) to a new funding model that uses support mainly from European grant programmes, namely from the Horizon Europe programme, and projects from the OP JAK Excellent Research Operational Programme. With its grant successes both in Horizon Europe projects and in strategic calls OP JAK, CATRIN ranks unequivocally among the top scientific institutes. This transition, which has been a third fundamental transformation step since the establishment of our research centres, whose integration resulted in CATRIN, confirms not only the Institute's stability, but above all its ability to adapt and excel. As in the past, we have demonstrated that thanks to the high quality of our scientific activities and the professionalism of our employees, we have overcome this significant challenge flawlessly. The achievements of our Institute have again significantly contributed to the development and visibility of Palacký University on the world science scene.

In the area of scientific results, CATRIN has again followed up on the successful year of 2022. Despite a decrease in the overall number of scientific publications, which can be attributed mainly to the research teams' devotion to a great number of new grants proposals in connection with the transition to the new programming period, we have still maintained a high performance in the area of excellent publications, especially in the journals of the first quartile (Q1) or decile (D1), including renowned journals from the Nature Family. Thus, in 2023, our research teams pub-

lished their results in prestigious journals such as Nature Materials, Nature Nanotechnology, Nature Plants, Nature Communications or Chemical Society Reviews. These publications not only demonstrate the high quality of our science, but also our significant contribution to the development of knowledge and innovation on a global scale. In 2023, we also managed to build the Innovative Chemistry group under the leadership of Professor Alexander Dömling, which brings together the potential of CATRIN's all three scientific research units and is a significant scientific asset to our university. This group not only brings innovative approaches and technologies to research, but also creates an important link between academia and industry. Within this group, cooperation with Palacký University's Faculty of Medicine and Dentistry and prime companies in the Czech Republic and the Olomouc region is further developed, which strengthens not only our scientific community, but also our ability to bring real solutions to major societal challenges.

As in the previous year, CATRIN continued to expand its achievements in the field of grant support, especially under Horizon Europe. At the end of 2023, CATRIN was implementing European projects with the total of more than EUR 12 million of funding, which corresponded to approximately 58% of the budget of all parts of the University coming from European sources. CATRIN has thus significantly contributed to consolidating the position of Palacký University on the national map of successful holders of Horizon Europe projects. This significant success confirms CATRIN's international competitiveness in the area of European grants, while also confirming its key role in obtaining significant funding for Palacký University from sources outside the national budget in the field of science and research. In addition, in 2023, Professor Alexander

Dömling received a highly prestigious ERC Advanced project for CATRIN, which represents a fifth ERC project at UP and the first ERC Advanced project that has ever been solved at Palacký University. Winning a ERC Advanced project is generally considered to be an unquestionable sign of excellence in science and research. This success not only highlights the top quality of research conducted at CATRIN, but also strengthens its position in the European research environment. It is worth remembering that all ERC projects that have been implemented at Palacký University so far come exclusively from CATRIN. Another important achievement in the field of grant support is successful participation in the OP JAK Excellent Research call, where CATRIN was the only one to successfully obtain for Palacký University an OP JAK Excellent Research project as principal investigator. The TECHSCALE project, whose principal investigator is Professor Michal Otyepka from CATRIN, was rated as the second-best project in the Czech Republic. This project joins the forces of CATRIN, Charles University and CEITEC-VUT, as well as of five Palacký University's faculties, namely the Faculty of Medicine and Dentistry, the Faculty of Health Sciences, the Faculty of Arts, the Sts Cyril and Methodius Faculty of Theology and the Faculty of Law. This successful cooperation of several UP parts and their involvement in excellent and highly interdisciplinary research is one of the main objectives of CATRIN and unquestionably represents a significant success in the year 2023. In addition to the TECHSCALE project, CATRIN also succeeded as Partner in another two OP JAK Excellent research projects, namely the EXREGMED project, which was rated as the best in the Czech Republic, and in the TANGENC project, where CATRIN cooperates among others with colleagues from the UP Faculty of Science. These achievements in the field of grant support not only confirm the important contribution of CATRIN to sci-

entific research and innovation, but also highlight its key role in strengthening the scientific prestige and international influence of Palacký University.

In 2023, CATRIN clearly demonstrated success in its research activities. With its scientific and grant achievements, CATRIN continues to fulfil all the ambitious objectives for which Palacký University decided to integrate the research capacities of part of its research centres into a higher education institute. CATRIN is now a fully established institute on the European and world scientific map, which significantly increases Palacký University's reputation in the field of science and research. It is therefore an honour for me to present this annual report on CATRIN's activities as well as all the success achieved by CATRIN in 2023, the third year of its full operation. As in previous years, I would like to take this opportunity to thank all CATRIN's employees who have always been and continue to be the most valuable aspect of our institute. It is only thanks to their work that CATRIN is a successful research institute on the European and world level, which contributes significantly to spreading the reputation of Palacký University Olomouc. I extend my thanks and appreciation to all CATRIN's employees, and I wish them remarkable accomplishments in the years to come.

Pavel Banáš, Director

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4. Staff

- 4.1. Age and qualification structure
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5. Major Events

- 5.1. British Ambassador to the Czech Republic Matt Field: CATRIN is a symbol of top Czech science
- 5.2. The SAN4FUEL workshop brought new ideas for deepening cooperation
- 5.3. CATRIN discussed fostering collaboration with Israel
- 5.4. Scientists evaluated the progress on a device to help treat neuroblastoma
- 5.5. Supercapacitor must be not only powerful but also environmentally friendly
- 5.6. CATRIN looked for opportunities to expand cooperation with Spanish scientists
- 5.7. CATRIN's scientists contributed to the debate on antibiotic resistance

6. Internationalization

- 6.1. European Federation of Biotechnology (EFB)
- 6.2. Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) at Bar-Ilan University
- 6.3. Catalan Institute of Nanoscience and Nanotechnology (ICN2)
- 6.4. Leibniz Institute for Catalysis (LIKAT Rostock)



1

Organizational Structure and Development

1.1. CATRIN's Management



doc. Mgr. Pavel Banáš, Ph.D.
General Director



prof. RNDr. Ivo Frébort, CSc., Ph.D.
Head of CATRIN-CRH
Statutory Deputy Director



prof. RNDr. Michal Otyepka, Ph.D.
Head of CATRIN-RCPTM



doc. MUDr. Marián Hajdúch, Ph.D.
Head of CATRIN-IMTM



Mgr. Dalibor Jančík, Ph.D.
Secretary

1.2. CATRIN's Scientific Board

Chair: **doc. Mgr. Pavel Banáš, Ph.D.**

Members: **prof. Ing. Ladislav Bocák, Ph.D.**
prof. Jeffrey Cole, Ph.D.

prof. Ing. Jiří Čejka, DrSc.

Ing. Nuria De Diego, Ph.D.
prof. Ing. Jaroslav Doležel, DrSc.

MUDr. Petr Džubák, Ph.D.
prof. Paolo Fornasiero, Ph.D.

prof. Dr. rer. nat. Roland A. Fischer,
dr.h.c.phil.
doc. MUDr. Marián Hajdúch, Ph.D.
Priv. Doz. DI Dr. Klaus Kratochwill

doc. Ing. Pavel Jelinek, Ph.D.
doc. Ing. Jiří Krechl, CSc.

prof. Arben Merkoçi, Ph.D.
Mgr. Martin Mistrík, Ph.D.
prof. Javier Pozueta-Romero, Ph.D.

prof. RNDr. Michal Otyepka, Ph.D.
prof. RNDr. Martin Pumera, Ph.D.

doc. RNDr. Pavel Saska, Ph.D.

1.3. CATRIN's Supervisory Board

Chair: **Mgr. Petra Jungová, LL.M.**

Members: **doc. Mgr. Michal Botur, Ph.D.**
Mgr. Jakub Doležel, Th.D.
JUDr. Ondřej Hamulák, Ph.D.
Mgr. František Chmelík, Ph.D.
prof. MUDr. Martin Doležel, Ph.D.
doc. RNDr. Martin Kubala, Ph.D.
doc. PhDr. Vojtěch Regec, Ph.D.
Mgr. Ondřej Kučera, Ph.D.
Mgr. Jiří Vévoda, Ph.D.

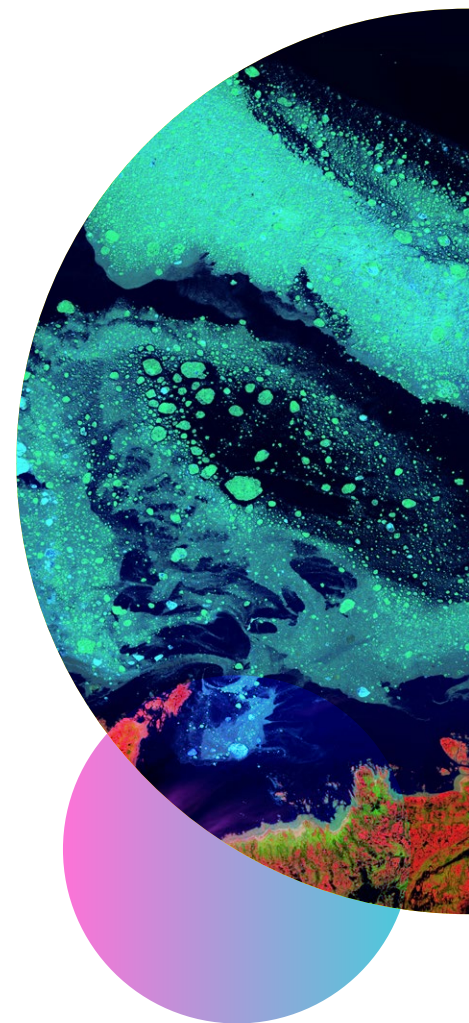
1.4. Scientific research divisions and teams

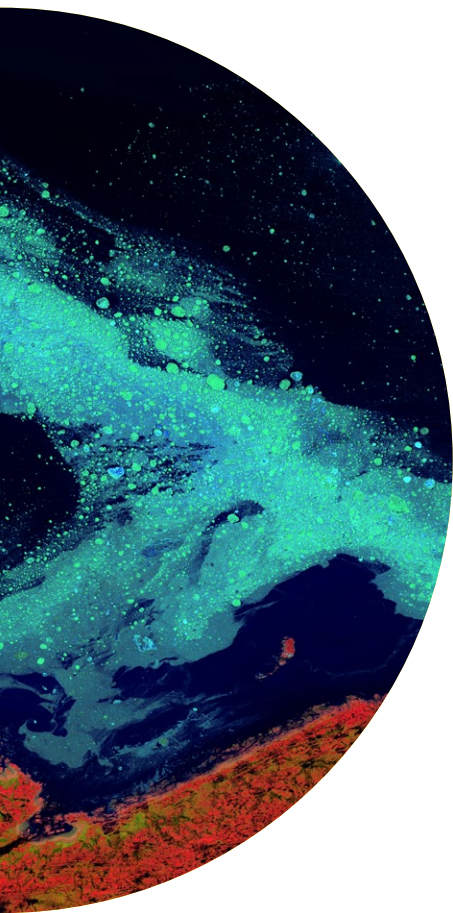
There are three scientific and research divisions at CATRIN, which are the basic organisational units of CATRIN in addition to the Technical-Administrative Division:

HEAD OF THE DIVISION	
CATRIN-CRH	prof. RNDr. Ivo Frébort, CSc., Ph.D.
CATRIN-RCPTM	prof. RNDr. Michal Otyepka, Ph.D.
CATRIN-IMTM	doc. MUDr. Marián Hajdúch, Ph.D.

Within the scientific research divisions, project-driven scientific research teams are established:

	Scientific Research Groups	Group Leaders
CATRIN-CRH	Recombinant Protein Engineering	prof. RNDr. Ivo Frébort, CSc., Ph.D.
	Biodiversity and Molecular Evolution	prof. Ing. Ladislav Bocák, Ph.D.
	Plant Genetics and Engineering	Véronique Bergougnoux-Fojtik, Ph.D.
	Phytochemistry	doc. RNDr. Petr Tarkowski, Ph.D.
	Phenotyping	Mgr. Lukáš Spíchal, Ph.D.
	Innovative Chemistry	Prof. Alexander Dömling, Ph.D.
CATRIN-RCPTM	Magnetic Nanostructures	Aristeides Bakandritsos, Ph.D.
	Carbon Nanostructures, Biomacromolecules and Simulations	prof. RNDr. Michal Otyepka, Ph.D.
	Biologically Active Complexes and Molecular Magnets	prof. RNDr. Zdeněk Trávníček, Ph.D.





	Nanomaterials in Biomedicine	Mgr. Kateřina Poláková, Ph.D.
	Environmental Nanotechnologies	Mgr. Jan Filip, Ph.D.
	Molecular Nanostructures on Surfaces	Bruno de la Torre, Ph.D.
	Photoelectrochemistry	prof. Patrik Schmuki/Ing. Štěpán Kment, Ph.D.
CATRIN-IMTM	Laboratory of Experimental Medicine	doc. MUDr. Marián Hajdúch, Ph.D.
	Laboratory of Genome Integrity	Mgr. Martin Mistrík, Ph.D.

1.5. Directives and Regulations

Number	Name	Effect
CAT-B-23/01	Data Management Policy at the Czech Advanced Technology and Research Institute of Palacký University Olomouc	1/3/2023
CAT-B-23/02	Regulations on spending annual leave for employees of the Czech Advanced Technology and Research Institute of Palacký University Olomouc in the year 2023	21/7/2023
CAT-B-23/03	Directive on determining the level of indirect costs of CATRIN for the purpose of submitting projects under the institutional support and under the earmarked project support	15/9/2023
CAT-B-23/04	Granting a day off on December 21, 2023, at the Czech Advanced Technology and Research Institute	9/11/2023
CAT-B-23/05	Rules for awarding special bonuses at the Czech Advanced Technology and Research Institute of Palacký University Olomouc	1/1/2024



2

Educational Activity

The Higher Education Institute can participate in educational activities carried out within study programmes accredited at individual faculties on the basis of provisions in Section 34 (1) of Act No. 111/1998 Sb., the Higher Education Act. CATRIN's employees participate in teaching activities at UP and are supervisors of students' final theses.

2.1. Overview of CATRIN employee's involvement in teaching activities at faculties

In 2023, 15 employees of the Institute taught at one of the faculties and 27 CATRIN employees supervised bachelor's, master's or doctoral theses.

Guarantor UP Faculty	Number of CATRIN Employees Involved in Teaching	Number of CATRIN Employees Involved in Teaching
PfF/KFC UP	8	15
PfF/KEF UP	2	2
PfF/KBC UP	4	7
PfF/LRR UP	2	1
PfF/KCB UP	1	0
PfF/ZOO UP	0	1
PfF/KBB UP	0	3
Comenius University Bratislava, SK*	0	1
Universitat Rovira i Virgili, Tarragona, ESP*	0	1
Total**	15	28

*Students are involved in research at CATRIN and trained by CATRIN staff

**Number of CATRIN employees involved in teaching or supervising final theses regardless of the guaranteeing workplace



2.2. Involvement of students in research carried out at CATRIN

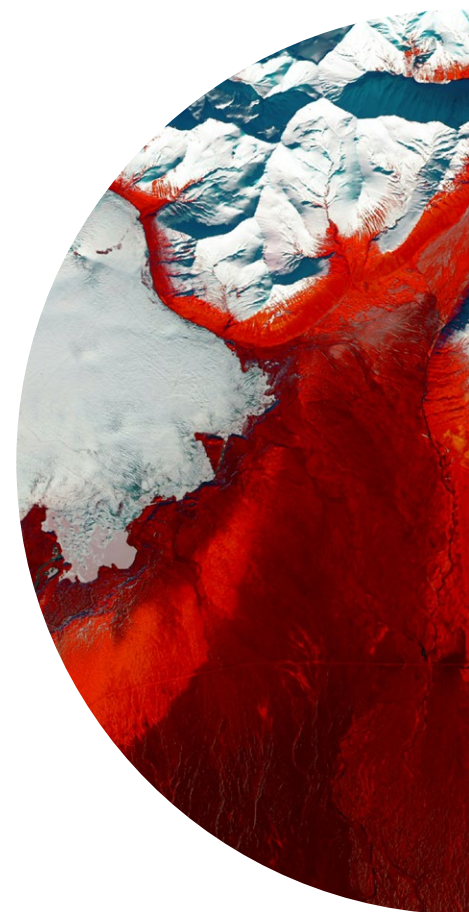
Of the total of 42 students, 23 students are supported by CATRIN in the form of an employment contract at CATRIN, within which they conduct scientific-research activities in areas related to the topic of their final thesis.

Students of Bc., Mgr. and Ph.D. programmes of UP supervised by our employees

Bachelor students	7
Master's students	13
Doctoral students	24
Total number	44

Defended dissertations supervised by CATRIN employees:

Student	Supervisor	Title	Defended
Mahdi Shahrezaei	doc. Štěpán Kment	Hybrid nanostructures for photo-electrochemical water splitting	14/12/2023
Benjamin Mallada Faes	doc. Pavel Jelínek	Chemical and physical properties of molecular nanostructures on surfaces investigated by means of scanning	29/8/2023
Edalatmanesh Shayen	doc. Pavel Jelínek	Theoretical study of charge transport in nanostructures	29/5/2023



2.3. Significant achievements of students involved in CATRIN's research

Doctoral students that are led by supervisors from CATRIN are involved in research projects or internships at foreign universities. Such knowledge and experience can subsequently be used not only in publications, but also at conferences, scientific competitions or in other activities.

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

2.4. Mobility and career growth of students involved in CATRIN's research

In 2023, students led by supervisors from CATRIN were sent, as part of their scientific research activities carried out at CATRIN, to internships at prestigious foreign scientific research institutes with which CATRIN cooperates.

Students	Foreign Workplace	Date of the Internship
Jan Belza	Maynooth University, Ireland	1/2 - 31/3/2023
Rémi Coulon	Ludwig-Maximilians-Universität München, Germany	14/4 - 30/6/2023

Ivan Dědek	Johannes Kepler University Linz, Austria	3/4 - 2/6/2023
Jana Dzibelová	University of Vienna, Austria	8/1 - 14/4/2023
Dominik Kusý	Research stations in Cosanga and Toachi, Ecuador	27/3 - 25/4/2023
David Řepka	CNR-ISTEC Istituto di Scienza e Tecnologia dei Materiali Ceramici, Faenza, Italy	8/10 - 16/11/2023
Veronika Šedajová	CIRIMAT Toulouse, France	15/1 - 15/2/2023
Viktorie Vichová	International Centre for Diffraction Data, Philadelphia, USA	2/6 - 17/6/2023

A number of PhD students who defended their dissertation at CATRIN gained positions at prestigious world institutes. Their involvement in CATRIN research and research projects as well as the experience gained in the teams of their supervisors at CATRIN and within the framework of scientific research internships at CATRIN's partner institutions contributed significantly to the career development of these graduates.

- Benjamin Mallada Faes obtained a research position at the prestigious University of Oxford in the group of Prof. Stephan Rauschenbach's at the Department of Chemistry.





CATRIN

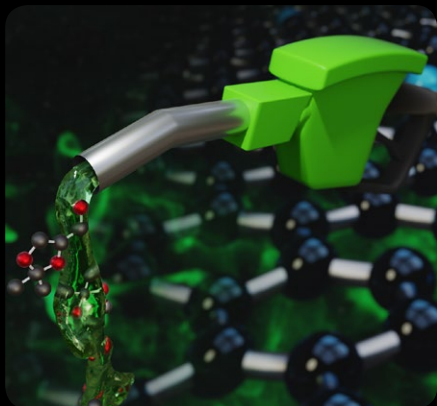
Czech Advanced
Technology and Research
Institute

A circular graphic on a dark background. Inside the circle, a blue hand is shown from the side, with the index and thumb fingers extended. A glowing, golden-yellow molecular structure, resembling a chain of hexagons, is positioned between the fingers. The background of the circle is a soft, warm gradient from light blue to orange. Outside the circle, the background is dark with scattered, colorful bokeh lights.

3

Research and Development

3.1. Significant discoveries of CATRIN in the field of science and research in 2023



Scientists from CATRIN and research centres CEET and IT4Innovations VSB – Technical University of Ostrava have developed a unique technology that will make it possible to turn waste from biodiesel production—glycerol—into a useful product and thus increase the efficiency of existing biofuels. The proposed biomaterial based on graphene will replace the acids that have been used so far for glycerol conversion. However, unlike them, it is non-toxic and fully recyclable. The discovery, which was made in cooperation between Czech scientists and Indian colleagues, was published in the journal *Nature Communications*.

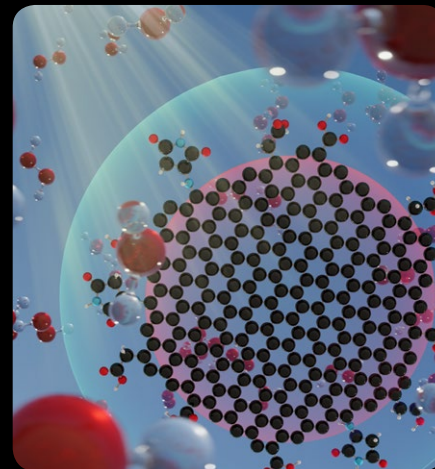
Cheruvathoor Poullose A., Medved' M., Bakuru V. R., Sharma A., Singh D., Kalidindi S. B., Bares H., Otyepka M., Jayaramulu K., Bakandritsos A., Zbořil R.: Acidic graphene organocatalyst for the superior transformation of wastes into high-added-value chemicals. *Nature Communications* 2023, 14 (1), 1373. IF = 14.6



A small box connected to a mobile phone—this is what the new biosensor looks like. It can instantly detect even very small remnants of antibiotics, namely ampicillin, in water or dairy products. It is based on a tailor-made nanomaterial derived from fluorographene, developed by scientists at CATRIN and the UP Faculty of Science. They used the “click chemistry” method, which was awarded the Nobel Prize in Chemistry. The development of the biosensor was presented in the journal *Small*.

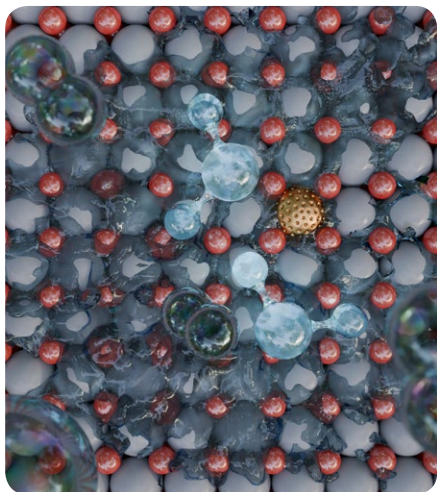
Flauzino J. M. R., Nalepa M., Chronopoulos D. D., Šedajová V., Panáček D., Jakubec P., Kůhrová P., Pykal M., Banáš P., Panáček A., Bakandritsos A., Otyepka M.: Click and Detect: Versatile Ampicillin Aptasensor Enabled by Click Chemistry on a Graphene-Alkyne Derivative. *Small* 2023, 19 (51), 2207216. IF = 13.3

New possibilities in the field of sustainable energy have been opened by a breakthrough discovery concerning the photoluminescent properties of carbon dots made by scientists from CATRIN in cooperation with VSB – Technical University of Ostrava. Researchers found that after exposure to light, magnetically active polarons are formed in carbon dots, which can then be used for the light-activated production of hydrogen peroxide. Thus, a pure carbon



nanomaterial can transform the energy of solar radiation into chemical bonds. The research results were published by the prestigious journal *Small*.

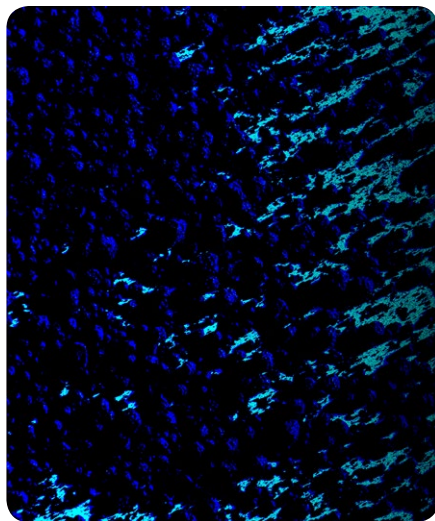
Zdražil L., Baďura Z., Langer M., Kalytchuk S., Panáček D., Scheibe M., Kment Š., Kmentová H., Thottappali M. A., Mohammadi E., Medved' M., Bakandritsos A., Zoppellaro G., Zbořil R., Otyepka M.: Magnetic Polaron States in Photoluminescent Carbon Dots Enable Hydrogen Peroxide Photoproduction. *Small* 2023, 19 (32), 2206587. IF = 13.3



The combination of photocatalytically active metal oxides with platinum (Pt) in the form of single atoms as co-catalysts significantly increases the efficiency of hydrogen production by solar water splitting. The surfaces of photocatalysts are traditionally decorated with Pt atoms by strong electrostatic adsorption (SEA) of Pt complexes such as $[(\text{NH}_3)_4\text{Pt}]^{2+}$, followed by heat treatment. CATRIN scientists and other colleagues have demonstrated that direct reactive binding of Pt atoms from H_2PtCl_6 leads to significantly higher specific activity without the need for heat treatment. This approach offers electronically well-connected SA-anchoring that provides highly photocatalytically active single-atomic reaction sites.

Wang Y., Qin S., Denisov N., Kim H., Bad'ura Z., Sharma B. B., Schmuki P.: Reactive Deposition Versus Strong Electrostatic Adsorption (SEA): A Key to Highly Active Single Atom Co-Catalysts in Photocatalytic H_2 Generation. *Advanced Materials* 2023, 35 [32], 2211814. IF = 29.4

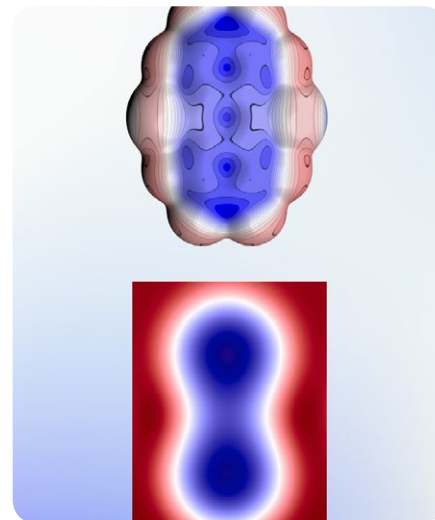
Scientists from CATRIN, in close collaboration with two workplaces in Vienna, have discovered and described the high efficiency of iron nitride nanoparticles for the chemical degradation of chlorinated hydrocarbons. They published the results of this meticulous research in *Journal of Hazardous Materials*. In the study, they showed a much higher reactivity and selectivity of iron nitride nanoparti-



cles compared to iron nanoparticles, which are routinely used for reductive groundwater purification. This type of nanoparticles is thus a highly promising material for real water and soil remediation technologies.

Brumovský M., Micić V., Oborná J., Filip J., Hofmann T., Tunega D.: Iron nitride nanoparticles for rapid dechlorination of mixed chlorinated ethene contamination. *Journal of Hazardous Materials* 2023, 442, 129988. IF = 13.6

Researchers from Palacký University, the Institute of Organic Chemistry and Biochemistry and the Institute of Physics of the CAS have again successfully uncovered the secrets of the world of molecules and atoms. The experiment confirmed the validity of a decades-old theory that assumed an uneven distribution of electron density in aromatic molecules. This phenomenon significantly influences the physico-chemical properties of molecules as well as their interactions. The research expands the possibilities of designing new nanomaterials. A paper presenting the result was published in the scientific journal *Nature Communications*.



Mallada B., Ondráček M., Lamanec M., Gallardo A., Jiménez-Martín A., de la Torre B., Hobza P., Jelinek P.: Visualization of n-hole in molecules by means of Kelvin probe force microscopy. *Nature Communications* 2023, 14 [1], 4954. IF = 16.6



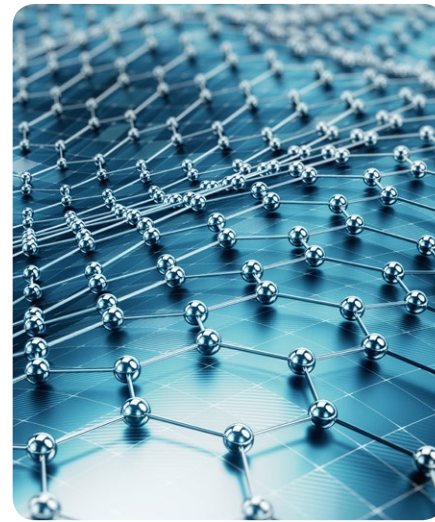
New possibilities for the design of new amides, substances ubiquitous in the world of organic compounds, have been proposed by scientists from CATRIN and the Institute of Molecular and Translational Medicine of Palacký University in collaboration with colleagues from the University of Groningen and the 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*.

Patil P., Zheng Q., Kurpiewska K., Dömling A.: The isocyanide SN2 reaction. *Nature Communications* 2023, 14 (1), 5807. IF = 16.6

A new diagnostic tool for the detection of infections caused by bacteria of the *Burkholderia cepacia* complex was designed by researchers from Palacký University and the Czech Academy of Sciences in a study published in the *Journal of Medicinal Chemistry*. They used a radiolabelled siderophore to identify infections by positron emission tomography. Experiments in animal models showed that the tested radiopharmaceutical reliably localizes infections and has the potential to be an effective tool for diagnosis and treatment monitoring.

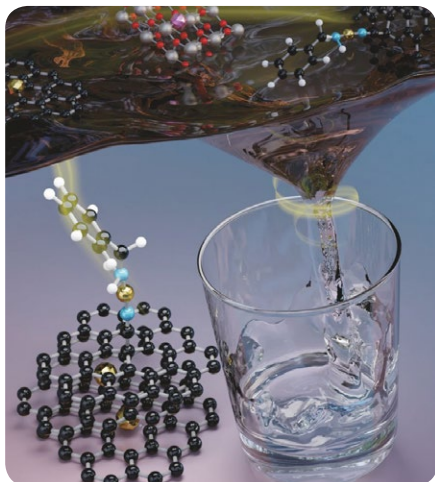


Bendova K., Raclavsky V., Novotny R., Luptakova D., Popper M., Novy Z., Hajduch M., Petrik M.: [^{68}Ga]Ga-Oribactin for *Burkholderia cepacia* complex infection imaging using positron emission tomography. *Journal of Medicinal Chemistry* 2023, 66 (11), 7584-7593. IF = 7.3



The work in *ACS Catalysis* describes a new strategy for the preparation of atomic gold catalysts anchored to a two-dimensional graphene matrix. Gold ions in the low oxidation stage and in the linear arrangement of their surroundings show high efficiency and selectivity in the processes of catalytic activation of the Si-H bond and preparation of the so-called alkoxy-silanes. These are organic silicon compounds with great application potential in chemistry, biomedicine, but also in the production of protective layers, adhesive and structural materials and waterproof coatings.

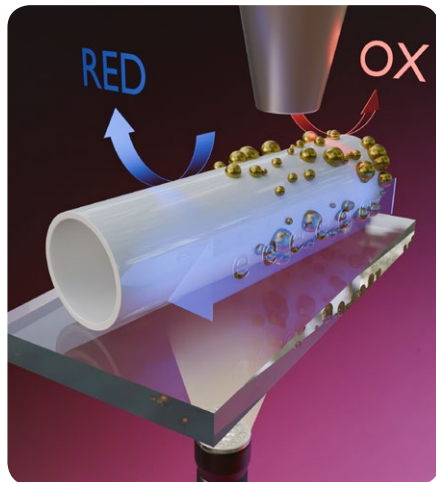
Kadam R. G., Medved' M., Kumar S., Zaoralová D., Zoppellaro G., Bađura Z., Montini T., Bakandritsos A., Fonda E., Tomanec O., Otyepka M., Varma R. S., Gawande M.B., Fornasiero P., Zbořil R.: Linear-Structure Single-Atom Gold(I) Catalyst for Dehydrogenative Coupling of Organosilanes with Alcohols. *ACS Catalysis* 2023, 13 (24), 16067-16077. IF = 12.9



New perspectives in water treatment with an emphasis on environmental sustainability were presented by authors from CATRIN, the Centre for Energy and Environmental Technologies at VSB-TUO and Texas A&M University in a review article published in the prestigious journal *Chemical Society Reviews*, which draws attention to it also graphically on its cover. The main attention of the researchers focused on the use of the method of single-atom engineering and its comparison with traditional technologies of water treatment. According to the authors, it turns out that the use of suitable single-atom catalysts represents a fundamental change in removing trace amounts of toxic substances with high efficiency.

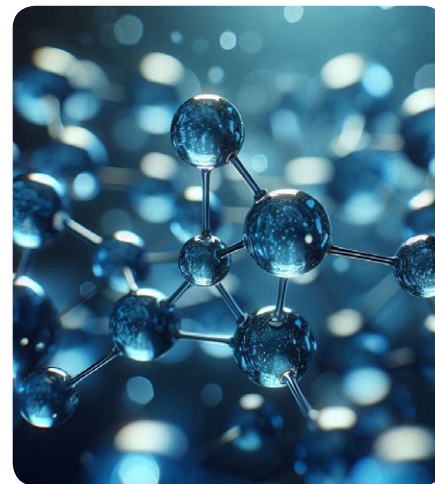
Sharma V. K., Ma X., Zboril R.: Single atom catalyst-mediated generation of reactive species in water treatment. *Chemical Society Reviews* 2023, 52 (22), 7673-7686. IF = 46.2

A description of the reactivity of photocatalysts at the nanoscale is crucial for their basic understanding and improvement of their efficiency. CATRIN scientists have introduced a photochemical 2D mapping technique that allows local detection of molecular products during plasmonic photocatalytic reactions at nano-resolution. This method offers a deeper understanding of the mechanism of plasmonic reactions through a direct correlation between the morphology of the materials and the kinetics of the chemical reaction under study.



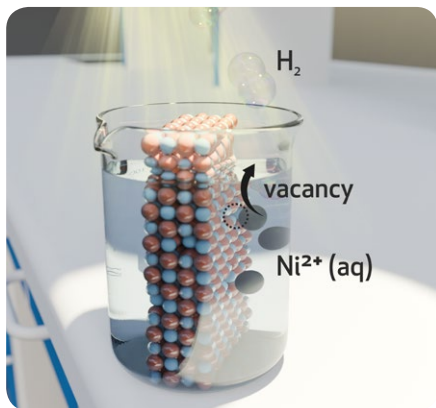
Henrotte O., Santiago E.Y., Movsesyan A., Mascaretti L., Afshar M., Minguzzi A., Vertova A., Wang Z. M., Zboril R., Kment Š., Govorov A. O., Naldoni A.: Local Photochemical Nanoscopy of Hot-Carrier-Driven Catalytic Reactions Using Plasmonic Nanosystems. *ACS Nano* 2023, 17 (12), 11427-11438. IF = 17.1

Collaboration with top foreign teams, including that of the Nobel laureate Professor Feringa in the field of photoswitches, has borne fruit. Computational chemists at CATRIN have contributed to elucidating the photochromic behaviour of another important class of molecular photoswitches. This time round, they focused on azonium ions that photoisomerize, that is, transform their structure be-



tween two isomers, with red light under physiological conditions. This property makes them attractive as molecular components for photocontrol of physiological processes. The details were explained in an article published in the *Journal of American Chemical Society*.

Medved' 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 = 15.0



The article "Metastable Ni(I)-TiO₂-x Photocatalysts: Self-Amplifying H₂ Evolution from Plain Water without Noble Metal Co-Catalyst and Sacrificial Agent" published in the Journal of the American Chemical Society, brings an innovative approach to ecological and sustainable hydrogen production using a photocatalyst, i.e., energy from light. The developed photocatalyst is produced directly on the surface by illuminating reduced anatase TiO₂ particles in an aqueous solution of Ni²⁺. UV radiation thus creates a Ni⁺/TiO₂/Ti³⁺ photocatalyst that activates itself and accelerates hydrogen production. An important element of this process is the light-induced formation of defects in the semiconductor, which allows the formation of nickel [Ni⁺] surface states. These states serve as an electron carrier for hydrogen formation from water, without the need for other harmful substances or noble metal

Altomare M., Qin S., Saveleva V. A., Badura Z., Tomanec O., Mazare A., Zoppellaro G., Vertova A., Taglietti A., Minguzzi A., Ghigna P., Schmuki P.: Metastable Ni(I)-TiO₂-x Photocatalysts: Self-Amplifying H₂ Evolution from Plain Water without Noble Metal Co-Catalyst and Sacrificial Agent. Journal of the American Chemical Society 2023, 145 [48], 26122-26132. IF = 15.0

co-catalyzers, which are expensive and not easily accessible. This discovery opens new possibilities for ecological and sustainable hydrogen production from renewable energy sources.

A recent paper published in the journal Nature Communications presents an innovative approach to the rapid identification of potent "molecular glues" targeting can-



cer proteins via a cereblon (CRBN) E3 ligase. Through automated high throughput synthesis at the nanoscale and rapid phenotypic screening, the proposed platform enables the effective identification of molecular glues and generates promising candidates such as E14, which shows significant anticancer activity by targeting key proteins. This synergy of automated synthesis with phe-

Wang Z., Shaabani S., Gao X., Ng Y. L. D., Sapozhnikova V., Mertins P., Krönke J., Dömling A.: Direct-to-biology, automated, nano-scale synthesis, and phenotypic screening-enabled E3 ligase modulator discovery. Nature Communications 2023, 14 [1], 8437. IF = 16.6

notypic tests has enormous potential to accelerate the discovery of molecular glues.



In collaboration with colleagues from the United States, CATRIN scientists made new discoveries in the field of bioluminescence among click beetles. Genomic data showed close relationships between previously unrelated groups of the Gondwanan lines, leading to the redefinition of several subfamilies. The authors found that *Campyloxenus* represents the youngest ever bioluminescence formation, no older than 53 million years. These findings point to a fourth or fifth independent bioluminescence formation within the group.

Motyka M., Kusý D., Arias-Bohart E. T., Bybee S. M., Bocák L.: Enigmatic *Campyloxenus*: Shedding light on the delayed origin of bioluminescence in ancient Gondwanan click beetles. iScience 2023, 26 [12], 108440. IF = 5.8

3.2. Publication Activity

CATRIN researchers published a total of 172 scientific publications in 2023. Most of them were published in journals with an impact factor higher than 5 (62.22% in total), while 38 publications accounting for a significant share of CATRIN's production were published in prestigious journals with an impact factor higher than 10. Of the 172 publications published in 2023, the majority had a corresponding author from CATRIN, a significant part of the works also had a first author from CATRIN.

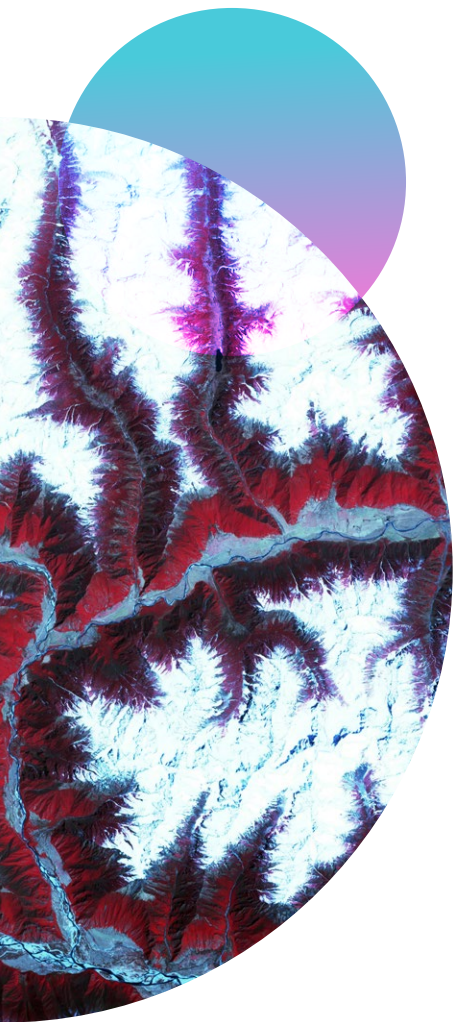
Number of IF < 5 publications	Number of IF 5–10 publications	Number of IF >10 publications	IF N/A	Number of Publications with First Author	Number of Publications with Corresponding Author
65 [37,57%]	69 [39,88%]	38 [21,97%]	1 [0,58%]	48 [27,75%]	92 [53,18%]

The distribution of CATRIN's publications published in 2023 by quartile shows the dominance of publications in the 1st quartile with a significant proportion of publications in the 1st decile. The fact that about 30% of CATRIN's works are published in the first field decile confirms the CATRIN team's extraordinary potential to achieve top results comparable to prestigious European science centres.

Below is a list of publications published in the most prestigious journals with an impact factor above 15:

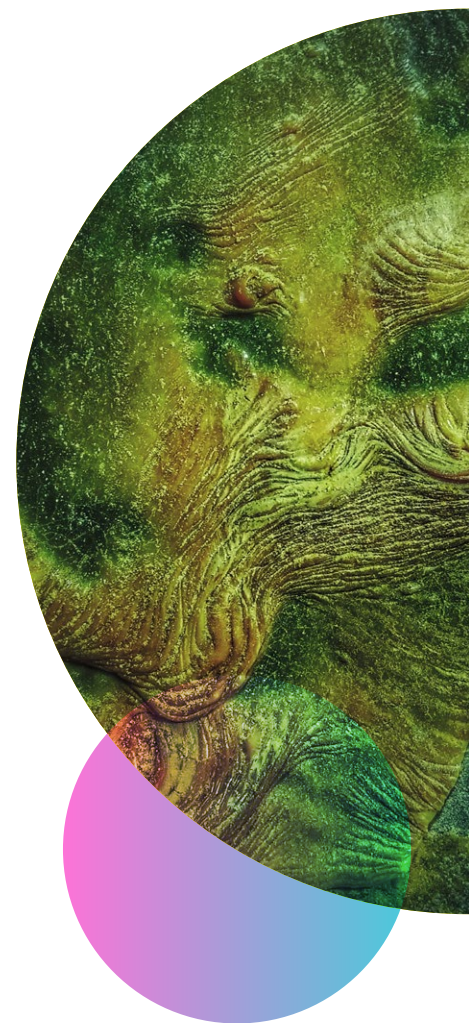
D1	Q1	Q2	Q3	Q4	N/A
52	119	38	15	3	1





Authors	Publication Title	Name of the Journal	IF
Sharma V.K., Ma X., Zbořil R.	Single atom catalyst-mediated generation of reactive species in water treatment	Chemical Society Reviews	46.2
Tesler A.B., Kolle S., Prado L.H., Thievessen I., Böhringer D., Backholm M., Karunakaran B., Nurmi H.A., Latikka M., Fischer L., Stafslin S., Cenev Z.M., Timonen J.V.I., Bruns M., Mazare A., Lohbauer U., Virtanen S., Faibry B., Schmuki P., Ras R.H.A., Aizenberg J., Goldmann W.H.	Long-term stability of aerophilic metallic surfaces underwater	Nature Materials	41.2
Poulose A.Ch., Zoppellaro G., Konidakis I., Serpetzoglou E., Stratakis E., Tomanec O., Beller M., Bakandritsos A., Zbořil R.	Reply to: Primary Role of Photothermal Heating in Light-Driven Reduction of Nitroarenes	Nature Nanotechnology	38.3
Wang Y., Qin S., Denisov N., Kim H., Bad'ura Z., Sarma B.B., Schmuki P.	Reactive Deposition Versus Strong Electrostatic Adsorption (SEA): A Key to Highly Active Single Atom Co-Catalysts in Photocatalytic H ₂ Generation	Advanced Materials	29.4
Vaghasiya J.V., Mayorga-Martinez C.C., Sonigara K.K., Lazar P., Pumera M.	Multi-Sensing Platform Based on 2D Mono-element Germanane	Advanced Materials	29.4
Denisov N., Qin S., Will J., Vasiljevic B.N., Skorodumova N.V., Pašti I.A., Sarma B.B., Osuagwu B., Yokosawa T., Voss J., Wirth J., Spiecker E., Schmuki P.	Light-Induced Agglomeration of Single-Atom Platinum in Photocatalysis	Advanced Materials	29.4

Qin S., Will J., Kim H., Denisov N., Carl S., Spiecker E., Schmukl P.	Single Atoms in Photocatalysis: Low Loading Is Good Enough!	ACS Energy Letters	22
Gulati S., Vijayan S., Mansi, Kumar S., Harikumar B., Trivedi M., Varma R.S.	Recent advances in the application of metal-organic frameworks (MOFs)-based nanocatalysts for direct conversion of carbon dioxide (CO ₂) to value-added chemicals	Coordination Chemistry Reviews	20.6
Tantis I., Talande S., Tzitzios V., Basina G., Shrivastav V., Bakandritsos A., Zboril R.	Non-van Der Waals 2D Materials for Electrochemical Energy Storage	Advanced Functional Materials	19.0
Opatíková M., Semchonok D.A., Kopečný D., Ilik P., Pospíšil P., Iliková I., Roudnický P., Zeljković S.Č., Tarkowski P., Kyriilis F.L., Hamdi F., Kastritis P.L., Kouřil R.	Cryo-EM structure of a plant photosystem II supercomplex with light-harvesting protein Lhcb8 and α -tocopherol	Nature Plants	18.0
Deshmukh S., Ghosh K., Pykal M., Otyepka M., Pumera M.	Laser-Induced MXene-Functionalized Graphene Nanoarchitectonics-Based Microsupercapacitor for Health Monitoring Application	ACS Nano	17.1
Henrotte O., Santiago E.Y., Movsesyan A., Mascaretti L., Afshar M., Minguzzi A., Vertova A., Wang Z.M., Zbořil R., Kment S., Govorov A.O., Naldoni A.	Local Photochemical Nanoscopy of Hot-Carrier-Driven Catalytic Reactions Using Plasmonic Nanosystems	ACS Nano	17.1
Xie M., Gao M., Yun Y., Malmsten M., Rotello V. M., Zbořil R., Akhavan O., Kraskouski A., Amalraj J., Cai X., Lu J., Zheng H., Li R.	Antibacterial Nanomaterials: Mechanisms, Impacts on Antimicrobial Resistance and Design Principles	Angewandte Chemie - International Edition	16.6
Cheruvathoor A. P., Medved' M., Bakuru V. R., Sharma A., Singh D., Kalidindi S. B., Bares H., Otyepka M., Jayaramulu K., Bakandritsos A., Zbořil R.	Acidic Graphene Organocatalyst for the Superior Transformation of Wastes into High-Added-Value Chemicals	Nature Communications	16.6





Mallada Faes B. J., Ondráček M., Lamanec M., Gallardo A., Jiménez Martín A., De La Torre B., Hobza	Visualization of n-hole in molecules by means of Kelvin probe force microscopy	Nature Communications	16.6
Patil P.H., Zheng Q., Kurpiewska K., Dömling A.	The isocyanide SN2 reaction	Nature Communications	16.6
Wang Z., Shaabani S., Gao X., Ng Y. L. D., Sapozhnikova V., Mertins P., Krönke J., Dömling A.	Direct-to-biology, automated, nano-scale synthesis, and phenotypic screening-enabled E3 ligase modulator discovery	Nature Communications	16.6
Shrivastav V., Mansi S., Gupta B., Dubey P., Deep A., Nogala W., Shrivastav V., Sundriyal S.	Recent Advances on Surface Mounted Metal-Organic Frameworks for Energy Storage and Conversion Applications: Trends, Challenges, and Opportunities	Advances in Colloid and Interface Science	15.6
Malaki M., Jiang X., Wang H., Podila R., Zhang H., Samori P., Varma R.S.	MXenes: from past to future perspectives	Chemical Engineering Journal	15.1
González-Sánchez M., Mayoral M.J., Vázquez-González V., Paloncýová M., Sancho-Casado I., Aparicio F., De Juan A., Longhi G., Norman P., Linares M., González-Rodríguez D.	Stacked or Folded? Impact of Chelate Cooperativity on the Self-Assembly Pathway to Helical Nanotubes from Dinucleobase Monomers	Journal of the American Chemical Society	15.0
Medved' 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	15.0
Biswas K., Soler D., Mishra S., Chen Q., Yao X., Sánchez-Grande A., Eimre K., Mutombo P., Martín-Fuentes C., Lauwaet K., Gallego J. M., Ruffieux P., Pignedoli C. A., Müllen K., Miranda R., Urgel J. I.,	Steering Large Magnetic Exchange Coupling in Nanographenes near the Closed-Shell to Open-Shell Transition	Journal of the American Chemical Society	15.0

Altomare M., Qin S., Saveleva V. A., Badura Z., Tomanec O., Mazare A., Zoppellaro G., Vertova A.,

Metastable Ni(II)-TiO₂-x Photocatalysts: Self-Amplifying H₂ Evolution from Plain Water without Noble Metal Co-Catalyst and Sacrificial Agent

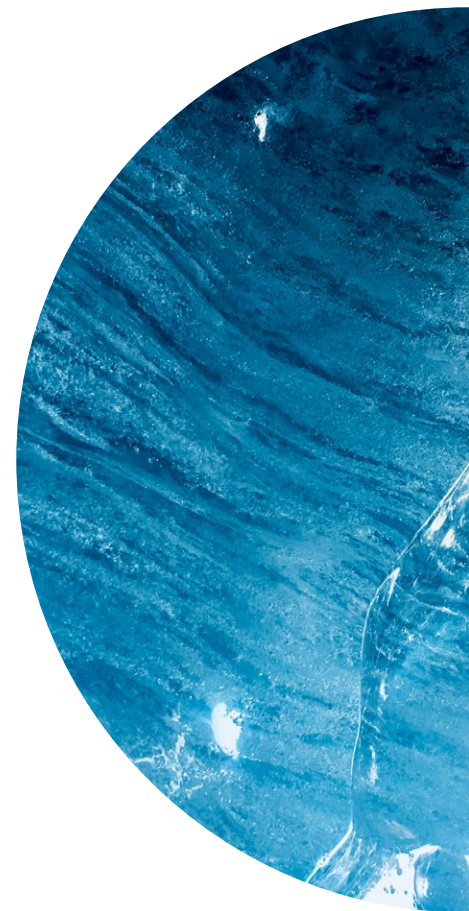
Journal of the American Chemical Society

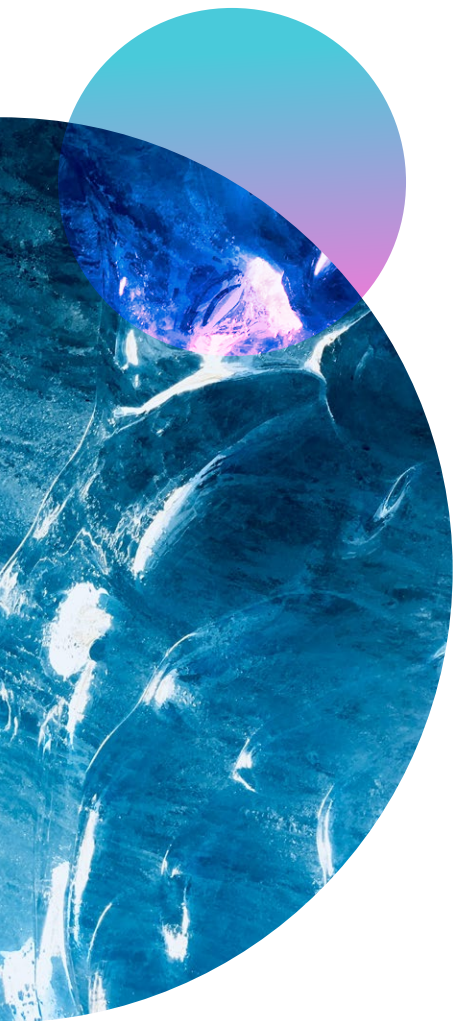
15.0

3.3. Science and research projects implemented at CATRIN

Scientific research activities of CATRIN's staff are supported by a wide range of project grants that were received over the past few years. This funding is obtained from both national and international programmes to support basic and applied research and development, including the most prestigious awarded by the European Research Council (ERC) or the European Innovation Council (EIC). Below is a list of all projects implemented during the course of 2023:

Project Title	ID number	Provider
NANO4TARMED: Advanced hybrid theranostic nanoplatforms for an active drug delivery in the cancer treatment	952063	Horizon 2020 - Twinning
TRANS2DCHEM: Transition of 2D-chemistry based supercapacitor electrode material from proof of concept to applications	101057616	Horizon Europe - EIC
FunGrab: Functionalized Graphene Based Electrode Material for Lithium Sulfur Batteries	101069293	Horizon Europe - ERC
SUSNANO: Twinning to boost the scientific and innovation capacity of the Universiteti i Tiranës to develop	101059266	Horizon Europe - WIDERA
SAN4Fuel: Single atom based nano-hybrid photocatalysts for green fuels	101079384	Horizon Europe - WIDERA





Z-ION: Teaming conductivity and chemical functionality in metal-organic frameworks for zinc-ion batteries	101065296	Horizon Europe – MSCA-PF
ACCELERATOR: ERA Chair for Accelerated Synthetic Chemistry Technologies at Palacký University Olomouc	101087318	Horizon Europe – WIDERA
Chrystals4Skin: Rational development of nanocrystalline drugs for skin administration	101090272	Horizon Europe – WIDERA
PATAFEST: Potato crop effective management strategies to tackle future pest threats	101084284	Horizon Europe – RIA CL6
BEST-CROP: Boosting photosynthesIs To deliver novel CROPs for the circular bioeconomy	101082091	Horizon Europe – RIA CL6
APPROACH: Advanced Photonic Processes for novel solar energy harvesting technologies	101120397	Horizon Europe – WIDERA
2D-BioPAD: Supple Graphene Bio-Platform for point-of-care early detection and monitoring of Alzheimer's Disease	101120706	Horizon Europe – RIA CL4
MINIGRAPH: Minimally Invasive Neuromodulation Implant and implantation procedure based on groundbreaking GRAPHene technology for treating brain disorders	101070865	Horizon Europe – EIC Pathfinder

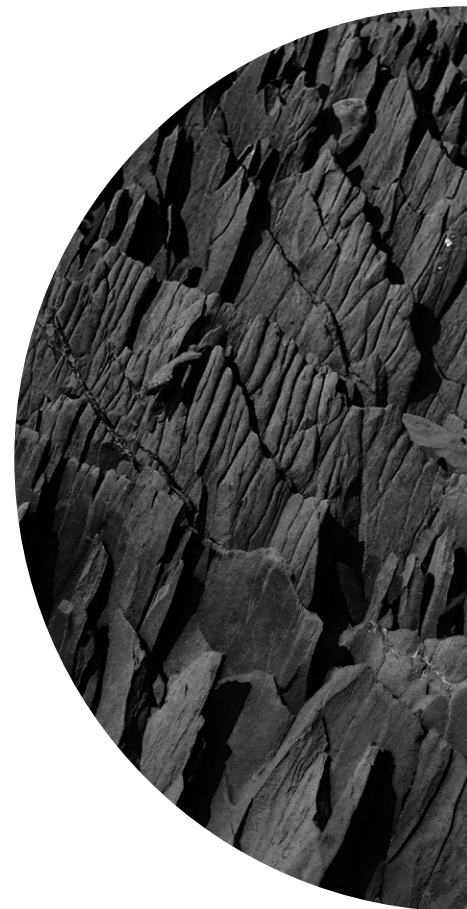
AMADEUS: Automated, miniaturized and accelerated drug discovery	101098001	Horizon Europe – ERC Adv
MESTUM: Machine learning-based prediction and evaluation of supercapacitor performance of transition metal carbide developed by using waste surgical masks during COVID-19	101130854	Horizon Europe – WIDERA
Visualizing Death Inducing Protein Complexes	872195	H2020 - MSCA Staff Exchanges
Laser Engineered Surfaces/Interfaces for Advanced Batteries	101131106	HEU - MSCA Staff Exchanges
Functionalized graphenes for ink technologies	101137959	Horizon Europe - ERC
Making CDK inhibitors work for pediatric cancer	2022-3 DEV/ 14712	KWF Kankerbestrijding
Nanomaterials and Nanotechnologies for Environment Protection and Sustainable Future (NanoEnvicZ III)–infrastructure	LM2023066	MEYS
Nanomaterials and Nanotechnologies for Environment Protection and Sustainable Future (NanoEnvicZ II)–infrastructure	LM2018124	MEYS

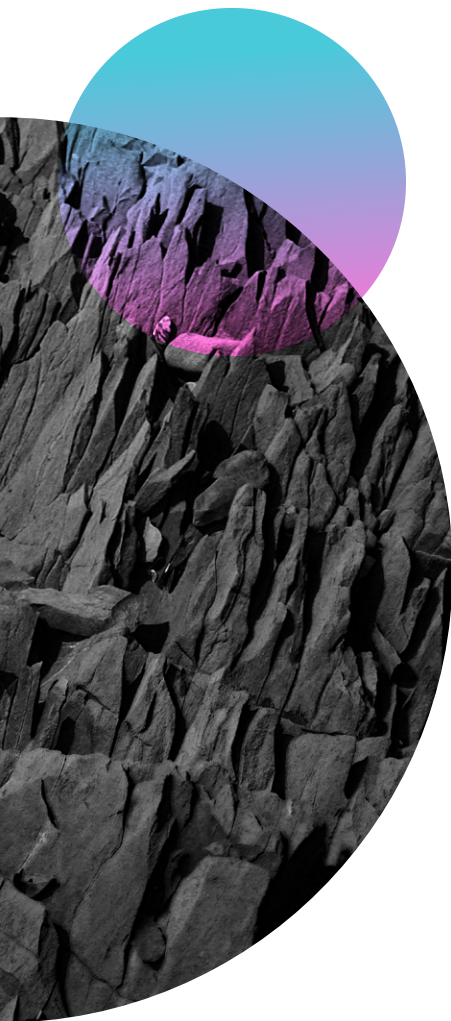




Nanotechnologies for Future (Excellent research)	CZ.02.1.01/0.0/0.0/16_019/754	MEYS
Plants as a tool for sustainable global development	CZ.02.1.01/0.0/0.0/16_019/827	MEYS
Advanced Hybrid Nanostructures for Renewable Energy Applications	CZ.02.1.01/0.0/0.0/15_003/416	MEYS
Technology beyond nanoscale	CZ.02.01.01/00/22_008/0004587	MEYS
Center of Excellence in Regenerative Medicine	CZ.02.01.01/00/22_008/0004562	MEYS
TowArds Next GENeration Crops	CZ.02.01.01/00/22_008/0004581	MEYS
The influence of organic matter on the efficiency of iron nanoparticles in the removal of pharmaceuticals in wet-lands	8J22FR015	MEYS
National Institute for Cancer Research – NICR	LX22NP05102	MEYS
Structural and Physical Aspects of Inverse Heusler Alloys Mn₂FeZ, Z = Si, Al, Sn	21-05339S	GAČR STD

Anticancer active coordination compounds with multimodal effect	21-19060S	GAČR STD
Complexes of selected transition metals with plant-derived compounds with anti-NF-kappa B and pro-PPAR dual	21-38204L	GAČR LA
Solvent mediated photoexcitation of spin-active species in fluorographene	22-33284S	GAČR STD
Nanoscale mapping of chemical reactions driven by multi-metallic plasmonic nanostructures	22-26416S	GAČR STD
Elateriform beetles as a model for studying the evolution of neoteny	22-35327	GAČR STD
Graphene acid heterostructures with MXenes for lithium and sodium ion batteries	22-27973K	GAČR LA
Single-Atom-based 2D-Photocatalysts	23-08019X	GAČR EXPRO
Atomic-scale control and visualization of charge delocalization in light-harvesting molecular nanomodels	23-06781M	GAČR JS
Lead-Free Double Perovskite Nanocrystals for Photocatalytic CO₂ Reduction	23-07971S	GAČR STD





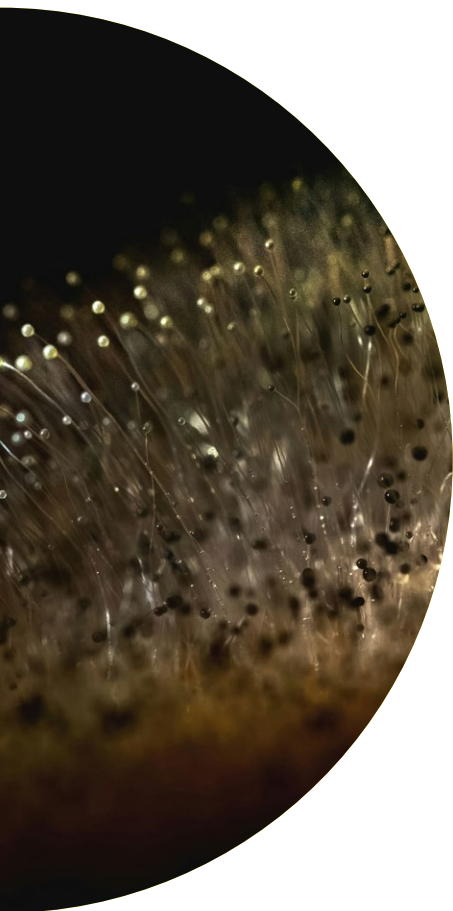
On-surface synthesis and characterization of polyradical molecules	23-05486S	GAČR STD
Development of a hybrid magnetic component based on iron oxide nanoparticles to replace solid permanent magnets used in magnetic closures	FW01010267	TAČR
Next Generation of Integrated Atomic Force and Scanning Electron Microscopy	FW01010183	TAČR
GLEBioassay: Nano-Monitoring of Cancer Immunotherapy Efficiency: The Graphene Lateral Electrophoretic Bioassay platform	TH78020001	TAČR
Genebank 5.0: Gene bank – the cornerstone for biodiversity conservation: development of new technologies for digitalization and process automation in storing plant genetic resources	SS06020208	TAČR
Conditional automation for the RECLIME recycling unit	FW06010765	TAČR
National Centre of Competence–Polymer Materials and Technologies for the 21st Century	TN02000051	TAČR
Elimination of micropollutants in drinking water by sorption followed by UV photocatalysis	SS06020124	TAČR

Development and construction of the Mössbauer spectrometer for industrial and field applications	FW09020048	TAČR
Automated system for growing vegetables using optical phenotyping and artificial intelligence on the principle of circular economy	CZ.01.1.02/0.0/0.0/21_374/27107	MPO
Insight into cellular proteotoxic stress response using a new microthermal protein damage methodology	JG_2023_033	UP – Junior Grants

In the course of 2023, the following projects were obtained, the running of which will start in 2024:

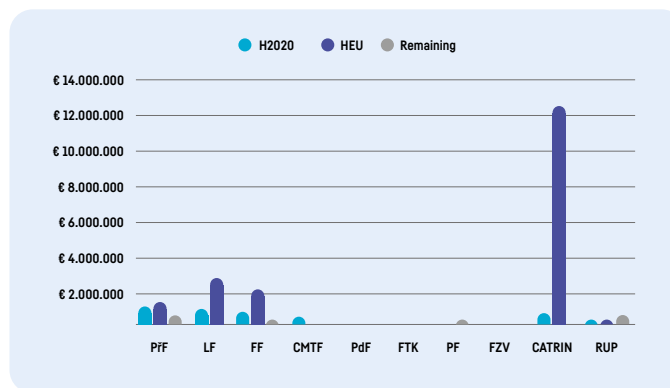
Project Title	Project ID	Provider
Janus Graphene supported Single atom catalysts for ultrasensitive cytokine point of care sensors	101180565	HEU – MSCA-PF
Potassium-Ion electrochemical energy storage in metal-organic hybrid frameworks doped with redox and electron transport boosters	101130867	HEU - ERA Fellowships
Antimicrobial peptide produced by molecular farming in barley and its use in the formation of carriers applicable to the skin	TQ03000264	TAČR
Unraveling the role of polyamines metabolism and its impact on plant-pathogen interaction	JG_2024_036	UP – Juniorské granty





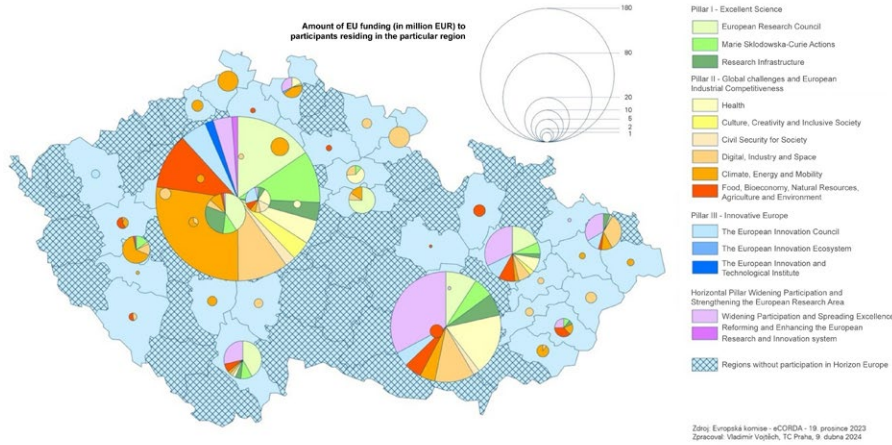
The above-mentioned list of new projects clearly demonstrates CATRIN's high success rate in obtaining research projects, especially European projects from Horizon Europe. CATRIN remains the only UP's part whose employees have successfully obtained and are implementing prestigious European ERC research projects. In 2023, Prof. Alexander Dömling added to this list another project—AMADEUS—awarded in the highest ERC Advanced category. The following chart shows the volume of Palacký University's funding, and its distribution among individual units, coming from European project grants from the expiring H2020 programme and the incoming Horizon Europe, which were being implemented at the end of 2023 or were newly awarded and will start in 2024.

H2020 and H EU projects – UP budget



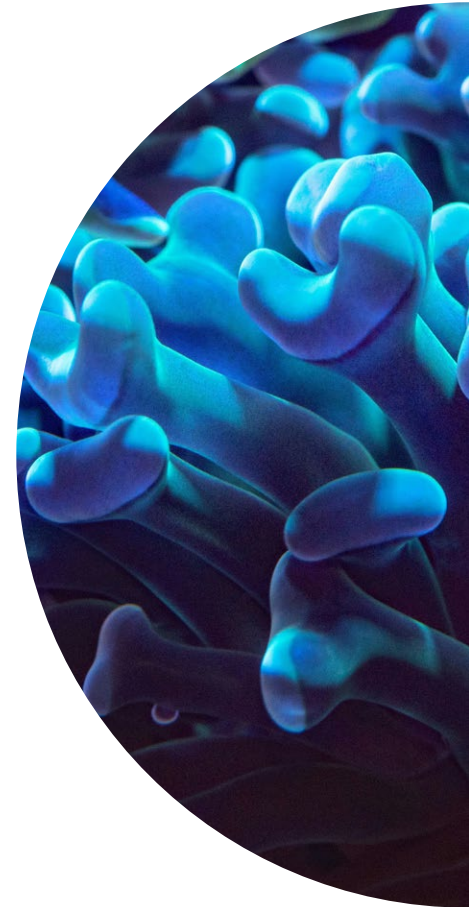
At the end of 2023, CATRIN was implementing or launching European projects covering 57.5% of the total allocation of funding for these types of projects at Palacký University. Thanks to the significant success of CATRIN in winning new European research projects, Palacký University made it onto the map of funding allocated from the Horizon Europe programme.

Distribution of EU Funding to Participants in the Horizon Europe Programme in the Czech Republic according to regions, residence, priorities and clusters (19 December 2023)



In 2023, CATRIN won for UP the OP JAK project from the Excellent Research call. Specifically, it is the TECHSCALE project—Technology Beyond Nanoscale—whose principal investigator is Prof. Michal Otyepka. This project is the only one from this particular call, where UP is the principal investigator, with the total budget of 481 mil. CZK [of which 298 mil. CZK goes to UP]. Its goal is research and development of new materials and technologies using atomic engineering methods. In this project, CATRIN cooperates with Charles University in Prague, CEITEC-VUT in Brno and five UP faculties, namely the Faculty of Medicine and Dentistry, the Faculty of Health Sciences, the Faculty of Arts, the Sts Cyril and Methodius Faculty of Theology and the Faculty of Law. The total budget of the UP faculties coming from the project is 66 mil. CZK.

In addition to the TECHSCALE project, CATRIN has also succeeded in another two OP JAK projects from the Excellent Research call, in which UP is a Partner. The first one is the EXREGMED project: Center of Excellence in Regenerative Medicine, whose main investigator is the Institute of Experimental Medicine of the CAS (total CATRIN's budget 22 mil. CZK), and the second one is the TANGENC project: TowArds Next GENeration Crops (total CATRIN's budget 32 mil. CZK), whose main investigator is the Institute of Experimental Botany of the CAS and in which the Faculty of Science of UP is also involved.





3.4. Technology transfer

3.4.1 Licence agreements

In 2023, one contract was signed with a foreign partner with an option for a license. Licence fees totalling 410,000 CZK were paid to CATRIN from licensing agreements concluded in previous years.

3.4.2 Contractual research

In 2023, contract research was carried out at CATRIN with 16 Czech and 11 foreign commercial companies and with four research institutes in the Czech Republic in a total volume of 5.19 million CZK. Contractual research at CATRIN-RCPTM consisted mainly of specialized analyses of nanomaterials and iron containing samples and development and preparation of nano Ag dispersions. CATRIN-CRH was mainly concerned with expert activities, consultancy and analyses for companies in the field of agrochemistry and plant physiology.

3.4.3. Patents

In 2023, CATRIN filed a total of four patent applications for the European patent and for the territories of the USA and Japan and obtained two new patents, one European and one for the territory of the Czech Republic.

3.5. International Collaboration

Of the total 172 articles published by CATRIN employees in 2023, a total of 136 articles (79.07%) were created together with collaborating teams from foreign universities and research institutes. Below are examples of collaboration on joint, highly impacted works.

Partner Institution	Examples of Joint Publications	IF
Friedrich-Alexander-Universität Erlangen-Nürnberg	Nature Materials, 2023, 22, 1548-1555	41,2
	Advanced Materials, 2023, 35(22), 2211814	29,4
	Advanced Materials, 2023, 35 (5), 2206569	29,4
	ACS Energy Lett. 2023, 8(2), 1209-1214	22,0
	J. Am. Chem. Soc. 2023, 145, 48, 26122-26132	15,0
Leibniz Institute for Catalysis	Nature Nanotechnology, 2023, 18, 327-328	38,3
University of Turin	ACS Nano, 2023, 17(12), 11427-11438	17,1
University of Groningen, Netherlands	Nature Communication, 2023, 14, 5807	16,6
	Nature Communications, 2023, 14, 8437	16,6
	Am. Chem. Soc. 2023, 145 (36), 19894-19902	15,0





3.6. Scientific Conferences Organized by CATRIN

- **NANOCON:** Nanotechnologies for Sustainable Energy and the Environment were the central theme of the 15th annual international conference NANOCON, which took place in Brno from 18 to 20 October 2023. The main expert guarantor of the conference was again the Scientific Director of CATRIN-RCPTM, Radek Zbořil.

- **NanoOstrava 2023:** With the organizational support of CATRIN, the SAN4Fuel project, the NanoOstrava2023 conference with the subtitle Energy and Environment took place from 15 to 18 May. More than 100 participants focused on the issues of nanotechnology, nano- and advanced materials and their applications, ranging from medicine to the environment to industry.

- **Inaugural Tri-University Symposium: Palacký University Olomouc – University of Florida – University of Naples Federico II:** Head of CATRIN-CRH Ivo Frébort was involved in the organization of a conference that was hosted by the University of Florida on April 18–21, 2023. The aim of the conference was to create a scientific bridge between the participating institutions, promote knowledge exchange and develop collaborative projects between scientists from the involved universities.

3.7. Promotion and popularization of science and research

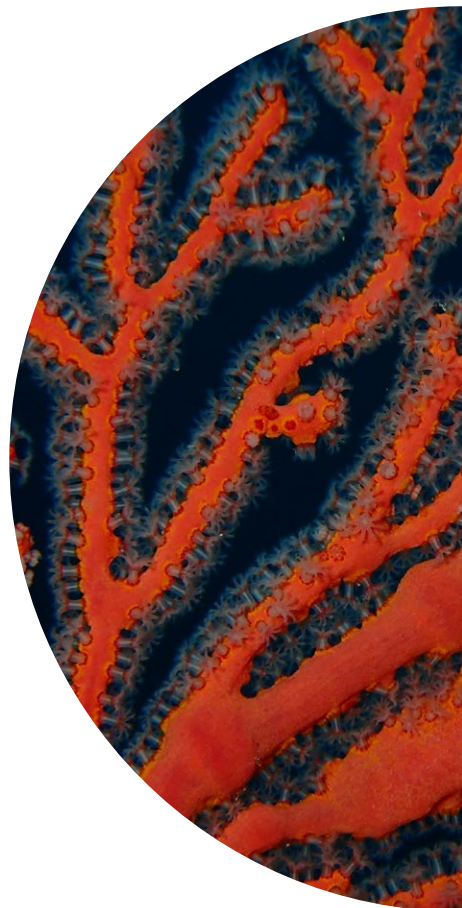
Presentation of the research results as well as informing about what is happening in the institute are among CATRIN's regular activities, which go both direction—inside the academic community of Palacký University and to the general public. For internal communication, CATRIN uses the communication channels of Palacký University. In 2023, CATRIN contributed to the creation of almost 60 articles in *Žurnál Online* and regularly contributes to the printed version *Žurnál UP*.

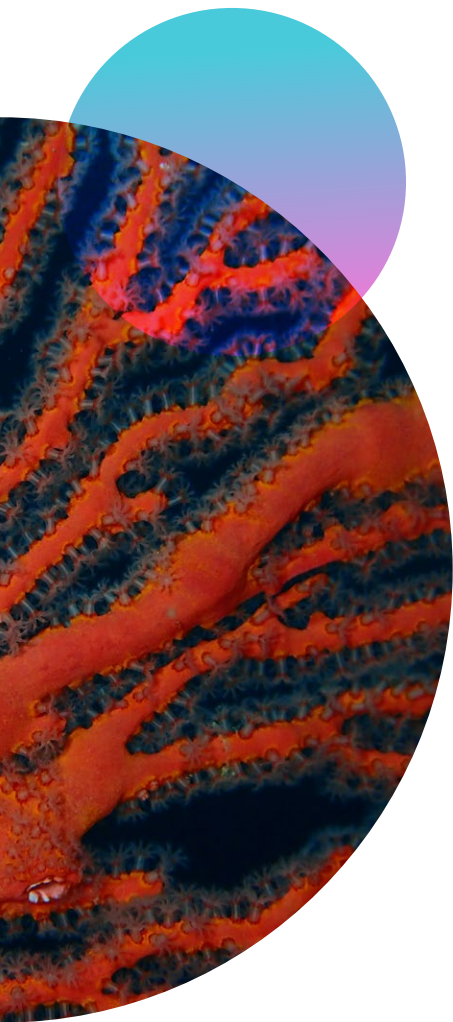
Regular information about CATRIN's activities and results can also be found on CATRIN's website and social networks (Facebook, Twitter, Instagram, LinkedIn and YouTube). CATRIN's newsletter is another effective communication tool, which is published primarily in an electronic form. In 2023, two issues were distributed in this way (see <https://www.catrin.com/en/media/newsletter/>).

In cooperation with the UP Communication Department, CATRIN also provides the most important information to the media. Publication of research results is carried out mainly through press releases; in 2023 CATRIN contributed to 14 UP press releases. CATRIN also provides information to the media outside press releases, through interviews or expert opinions. In total, CATRIN had at least 130 outputs in media in 2023 (<https://www.catrin.com/en/media/publicity/>). Further, the General Director of CATRIN, Pavel Banáš, featured in the podcast *Deník s nadhledem*, in which he explained, among other things, how research teams work and why the interconnection of natural and social sciences is important.

An important part of scientific work is the popularization of science. In 2023, CATRIN employees engaged in the following activities:

- On November 22, another year of the “Cannabis without prejudice” event took place in the Fort Science, which, as in previous years, was moderated by the leader of the Phytochemistry research group, Petr Tarkowski. The discussion focused on the possibilities of cannabis use in agriculture as well as in various industrial sectors, the issue of CBD products and related legislation, the perspectives of cannabis products in human and veterinary medicine and last but not least the regulation of the use of cannabis for recreational purposes. One of the important topics was the research of cannabis for therapeutic purposes.
- CATRIN researchers joined the Children’s University Olomouc event. In November, Petr Tarkowski and Dominika Kaczorová from the CATRIN Phytochemistry research group introduced their research through special activities for children; in May, Michal Motyka and Dominik Kusý from the Biodiversity and Molecular Evolution research group introduced the life of beetles to children through the eyes of scientists. A total of 100 children participated in both events.
- As part of the Academy of Sciences Week festival in November, CATRIN offered laboratory excursions as well as a lecture in the Fort Science entitled “Cannabis, a Threat or a Challenge”, delivered by the leader of the Phytochemistry research group, Petr Tarkowski. Around 100 visitors took advantage of the offer. In an interactive programme titled “Exploring a World of Small Dimensions but Big Possibilities”, the researchers introduced the students to CATRIN’s materials research in particular. They explained the advantages of nanomaterials and nanotechnologies as well as the possibilities of their application in practice.
- On Friday, October 7, several hundred visitors visited the CATRIN-RCPTM building as part of the Researchers’ Night event. The central theme of this popularization event was “The Secret”. Traditionally, guided tours of the Centre’s laboratories aroused great interest, during which the main directions of CATRIN’s research were introduced. Thanks to the experiments, both small and adult visitors got into the secrets of nanomaterials and modern methods of plant breeding, learned about catalysis and radioactivity and saw a levitating magnet or the habitat of pollinators.
- Under the umbrella of the Researchers’ Night, experts from CATRIN prepared also the exhibition called “Journey to the Inside of Matter”, which was on display in the UPoint university shop and the Information Centre on Horní Náměstí until October 20.
- In August, CATRIN prepared two excursions for teachers of chemistry and biology and mathematics and physics, as part of the course of the Academy of Sciences of the Czech Republic. The aim was to introduce new directions and possibilities of research.
- CATRIN participated for the first time in the programme of one of the most important Czech festivals “Colours





of Ostrava” and in the largest European discussion forum “Meltingpot”. On Saturday, July 22, Štěpán Kment from the Photoelectrochemistry research group presented new technologies for green energy.

CATRIN’s scientists prepared an entertaining and interactive programme for the participants of the Science Camp, which was organized by the Fort Science Olomouc and done in two shifts. The children tried working in the laboratory and watched a number of experiments.

- A week-long internship at CATRIN-CRH was completed in June by two students of Biskupské Gymnázium in Žďár nad Sázavou. The school awarded Vanessa Vernerová and Daniela Sobotková not only for their interest in biology, but also for their activity in organizing school events. The girls, who are deciding between the career of a scientist or a doctor, appreciated that they had the opportunity to get more familiar with the work of researchers. They would like to use the visit for preparing a seminar work.

- The Medialogue company prepared a third part of the series of authorial exhibitions by the Egyptologist Miroslav Bárta, called “Sustainability and Civilization”, which was launched on May 12 in Kampa, Prague. Authors of the 39 panels focused on the concepts of sustainability, the role of natural materials and the acquisition of clean energy. Seven panels were prepared in cooperation with scientists from CATRIN, namely Veronika Veselská, Michal Otyepka, Ivo Frébort, Jan Filip and Vojtěch Kupka. They contributed to, for example, the panels entitled “How to Feed Humanity”, “Recycling of Plastics”, “Energy in the Pocket” or “Carbon on the Stage”.

- CATRIN, as in the previous year, became one of the main partners of the international film festival Academia film Olomouc and was also involved in the programme of this 58th edition. The development of genetics, but also the possibilities of contemporary science, for example in the treatment of rare genetic diseases or in the field of editing the genome of plants, was debated by the audience after the screening of the film “The Confidential History of Gene”. Partners in the discussion were the President of the European Biotechnology Federation (EFB) and a member of CATRIN’s Scientific Board Jeff Cole and the Vice-President of EFB and the Head of CATRIN-CRH Ivo Frébort. The panel Talent in Science, which focused on the importance of leaders in scientific work, was joined by former CATRIN’s scientist Veronika Šedajová, who shortly before went to gain further scientific experience at the prestigious University of Cambridge. CATRIN was also visible in the accompanying programme Science in the Streets. Scientists presented their research to passers-by through graphic presentations and experiments in Horní Náměstí Olomouc.

- CATRIN observes growing interest in excursions from both elementary and upper-secondary schools in the region. In 2023, it offered tours of its laboratories and prepared an interactive programme, for example, for Olomouc Gymnasium – Hejčín, the elementary school Hálkova Olomouc, the elementary school Horka nad Moravou and others.

4

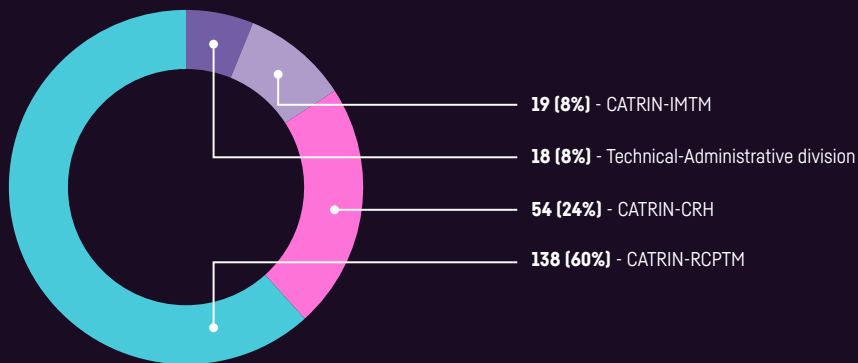
Staff



4.1. Age and Qualification Structure

During 2023, there were no major changes in the staffing of CATRIN. In 2023, a total of 229 employees worked at CATRIN. Of this number, 19 employees from IMTM straddled IMTM-LF and CATRIN-IMTM, of which 16 were based at the Faculty of Medicine and Dentistry and 3 at CATRIN. Most of the 229 employees were employees of CATRIN-RCPTM, CATRIN-CRH and CATRIN-IMTM Divisions (92% in total), who were further divided into individual research groups. The Technical-Administrative Division, responsible for the management of the Institute, made up 7.86% of the total number of employees.

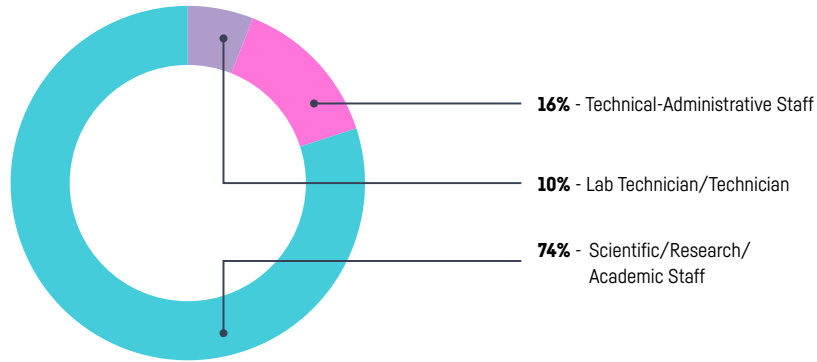
The Number of CATRIN's Employees in 2023



The entire CATRIN team comprised 44.1% of women and 55.9% of men. The share of foreign workers with respect to the Czech environment was very high and reached 34.9% (41.6% in the category of researchers, lab technicians and technicians). CATRIN also reached above-average figures in the percentage of women in scientific positions. While the worldwide share of women in science is over 33%, according to the UN, and only 27% in the Czech Republic, CATRIN has approximately 42.0% women of the total number of scientists.



The Structure of CATRIN's Employees



Staff Category	Number	FTE
Lab technician/technician	23	15,0
Technical-administrative staff	37	25,1
Technical-administrative staff	169	130,0
Total	229	170,1

The average age of CATRIN employees is 39.3 years, so it is a very young and progressive team. Absolutely and relatively the most represented is the age category 31–40. Age categories 21–30 and 41–50 are significantly represented, from which it can be concluded that the team of the Institute is well-proportioned and has high potential for further development.





Age Category	Number	Share [%]
21 - 30	23	10,0
31 - 40	105	45,8
41 - 50	64	28,0
51 - 60	27	11,8
61 - 70	7	3,1
71 - 80	3	1,3
Total	229	100,0

4.2. Significant Awards

Also in 2023, CATRIN researchers achieved success and received prestigious awards.

Patrik Schmuki, a world-renowned electrochemistry expert and one of CATRIN's scientific mainstays, received the prestigious Heinz Gerischer Award. Since 2001, the Electrochemical Society has awarded it to scientists who have made important contributions to the science of semiconductor electrochemistry and photoelectrochemistry, including related areas of physical and materials chemistry. The award to Schmuki is in recognition of his lifetime contribution to electrochemistry and photoelectrochemistry, ranging from his work on the preparation of titanium dioxide nanotubes and their use in photocatalysis to the use of single-atom engineering.

The Miloš Hudlický Prize for significant contribution published within the Chemistry Europe consortium was awarded to the physical chemist Radek Zbořil from CATRIN on May 30 during the meeting of the Executive Board of the Czech Chemical Society (CChS). One of the most prominent Czech chemists and materials scientists was the corresponding author of a paper which reported on the development of a simple electrochemical nanosensor for the detection of the broad-spectrum antibiotic chloramphenicol. The author team also included Petr Jakubec, Veronika Urbanová and Zdenka Medříková.

A number of researchers from CATRIN featured in the international Research.com ranking. The Scientific Director of CATRIN-RCPTM, Radek Zbořil, ranked highest in the field of materials sciences in the national ranking, being 471st in the world comparison. The first position in the field of chemistry belonged to Pavel Hobza, who ranked 223rd in the world ranking. Research.com rates scientists in more than 20 areas, from natural sciences to medicine to social sciences, for example.

CATRIN won an honorary mention for the 4th generation Mössbauer spectrometer in the Innovation of the Year competition. The Association of Innovative Entrepreneurship of the Czech Republic, which hosts the competition, awarded a total of 10 of the 134 innovative products assessed. The aim of the competition is to evaluate and award the best innovative products in the Czech Republic in all fields.

4.3. Invited Lectures and Membership in Major Bodies

CATRIN is represented in the major bodies of research institutions and editorial boards of scientific journals. Its employees are also invited as speakers to major international conferences:

- Professor Radek Zbořil is a member of the Editorial Board of Applied Materials Today and external evaluator of ERC Advanced and ERC Consolidator panels. He is a member of the Scientific Board of VSB-TUO.
- Professor Michal Otyepka is a member of the Scientific Advisory Body of the Czech Science Foundation for Non-Living Nature Sciences and the Scientific Board of Palacký University Olomouc. He is also a representative of the Czech Republic in the Division of Computational and Theoretical Chemistry (DCTC) of the European Association for Chemical and Molecular Sciences EuCheMS.
- Professor Ivo Frébort is the Vice-President of the European Federation of Biotechnology (EFB) and Head of the Division of Plant, Food and Agriculture.
- Michaela Holecová is the Vice-Chair of the Platform for Bioeconomics of the Czech Republic and a member of the Executive Board of the EFB.

Major Events

5



5.1 British Ambassador to the Czech Republic Matt Field: CATRIN is a symbol of top Czech science

During his visit to the Olomouc Region and Palacký University, the British Ambassador to the Czech Republic Matt Field seized the opportunity to see the Czech Advanced Technology and Research Institute (CATRIN UP). 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 also made a tour of CATRIN's laboratories for materials and plant research and addressed CATRIN as one of the symbols of top Czech science. The British Embassy's scientific attaché in Prague, Otakar Fojt, also attended the visit along with the ambassador.



5.2 The SAN4FUEL workshop brought new ideas for deepening cooperation

The possibilities of using computational methodologies in the design of advanced materials and the analysis of their effect in catalytic applications for energy, biomedicine or the environment were discussed at a workshop of the SAN4Fuel project in Ostrava on 19 September. This meeting was a result of the synergistic partnership between the Nanotechnology Centre VSB-TUO's Materials-Envi Lab and the SAN4Fuel project, which boasts, alongside Ostrava, other prestigious partners—the University of Tri-



este and the University of Erlangen–Nuremberg, Germany. The European project SAN4Fuel aims to develop new materials for sustainable energy and environmental chemistry applications using single-atom catalysts.

5.3 CATRIN discussed fostering collaboration with Israel

Nanotechnologies for sustainable energy were presented by CATRIN's representatives on a joint mission of Czech research institutions to Israel, which was organized by the Ministry of Foreign Affairs of the Czech Republic in May. In addition to a visit to Bar-Ilan University (BIU) in Tel Aviv, with which CATRIN collaborates, the programme included, for example, tours of



Israeli companies GenCell, Electreon and Israeli Electric Company in Hadera. Subsequently, CATRIN representatives also attended the Czech-Israeli University Conference in the Chamber of Deputies of the Parliament of the Czech Republic.

5.4 Scientists evaluated the progress in neuroblastoma treatment

The results of the first year of the international GLEBBIOASSAY project, which aims to develop a biosensor to monitor the effectiveness of treatment for the children's cancer–neuroblastoma, were evaluated by researchers from CATRIN, the Catalan Institute for Nanoscience and Nanotechnology (ICN2) and the Spanish organization Fundació Sant Joan de Déu



[FSJD] at a meeting in Olomouc. They set out a research strategy for the next period of the three-year project, which was supported by the Technology Agency of the Czech Republic under the international call EuroNanoMed2021. The aim of the meeting was to inform one another about what each partner is working on and to show the success and problems so far and find solutions.

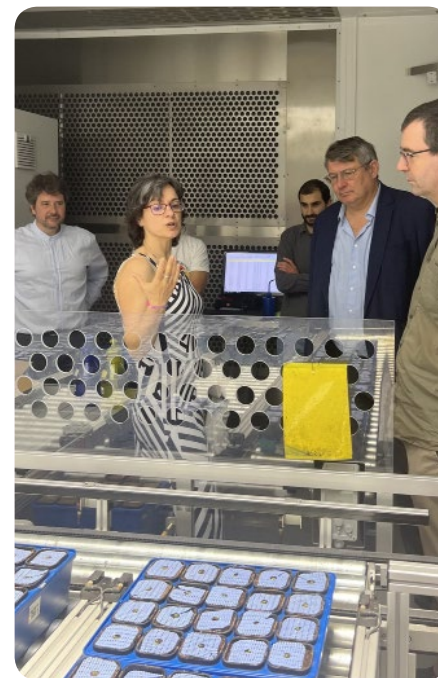
5.5 Supercapacitor must be not only powerful but also environmentally friendly



After the Olomouc kick-off meeting, another crucial meeting of partners of the European Innovation Council (EIC) TRANS-2DCHEM project took place in mid-June in Italy. The participants evaluated the progress in the preparation of a prototype supercapacitor with nitrogen-doped graphene derivative at the Italian company Itelcond and at the Giulio Natta Institute of Polytechnic University of Milan. In addition to production technology, one of the dominant topics was the issue of environmental friendliness of the device being developed. Scientists from CATRIN, in collaboration with colleagues from Bar-Ilan University in Israel and the Italian company ITELCOND, aim to develop a high-capacity, safe and environmentally friendly supercapacitor, i.e., a device for storing electrical energy. To this end, they use a graphene-derived material developed and patented in Olomouc.

5.6 CATRIN looked for opportunities to expand cooperation with Spanish scientists

A lecture by Dimas G. de Oteyza from the Research Centre for Nanomaterials and Nanotechnologies (CINN), who was accompanied by Bernardo Lopez Lopez-Rios, repre-



representative of the Embassy of Spain in Prague, helped to enhance cooperation with Spanish partners. Both guests visited the laboratories of the Centre and were introduced to, for example, the Phenotyping group's research or advanced microscopic methods for materials research. Professor Dimas G. de Oteyza presented the latest achievements and advances in the design of functional materials based on molecular composites and talked about possible practical applications of these materials in various fields.



5.7 CATRIN's scientists contributed to the debate on antibiotic resistance

The issue of antibiotic resistance was discussed on 11 April by participants of a professional roundtable that took place in the Chamber of Deputies of the Parliament of the Czech Republic. Representatives of CATRIN Radek Zbořil and David Panáček, who are engaged in research in this area, were also invited to the meeting. Scientific Director of CATRIN-RCPTM Radek Zbořil had a presentation entitled "The use of nanomaterials in antibacterial applications and their modification for the prevention of antimicrobial resistance". Among other things, he presented the results of research on which CATRIN cooperates with colleagues from the UP Faculty of Medicine and Dentistry and the University Hospital Olomouc.



6

Internationalization



CATRIN is a research institute with a rate of internationalisation reaching almost 35% in 2023, i.e., there was an increase in foreign workers from the original 30% share compared to year 2022. The largest number of foreign employees come from India (21), Italy (8), Slovakia (7), Spain (6), France (5), Iran (5), Greece (5) and Ukraine (5). In 2023, CATRIN had two employees from each of the following countries: Brazil, Germany, Poland and Vietnam. CATRIN also employs scientists from Belgium, China, Egypt, Japan, Colombia, Korea, Hungary, Mexico, Nigeria and Switzerland.

As part of the development of its internationalisation and the systematic building of an environment friendly to foreign employees and students doing their internship at CATRIN, we built the CATRIN Welcome-Point in 2023, which follows the activities of the UP Welcome Office. CATRIN's Welcome-Point is a contact point where we systematically deal with the obstacles that new foreign colleagues need to face while integrating into CATRIN. CATRIN also focuses on the systematic building of strategic partnerships with major global research institutions. In the next year of its full operation, CATRIN thus put emphasis on building and strengthening these links.

6.1. European Federation of Biotechnology (EFB)

CATRIN is the Regional Branch Office (RBO) of the European Federation of Biotechnology—a non-profit organisation bringing together national biotechnology companies, scientific societies and institutes, universities, biotechnology companies and individuals. The EFB promotes safe, sustainable and beneficial use of basic research and innovation in life sciences and provides space for interdisciplinary and international cooperation. The Head of CATRIN-CRH, Ivo Frébort, is the Vice-President of the EFB and manages one of its divisions called Plants, Agriculture and Food.

International contacts within EFB help CATRIN to engage in international consortia and research projects. In cooperation with partners in EFB, CATRIN is part of the consortium of the European project BEST-CROP.

6.2. Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) at Bar-Ilan University

BINA is a leading research institute in the field of nanotechnology in Israel and ranks among the world leaders in many fields. It connects scientists from the fields of technical sciences, life sciences, physics, chemistry and informatics. The institute's laboratories are among the most modern in the world and offer the highest standards of scientific performance. The instrumentation includes devices for charged particle microscopy, surface analysis and nanotechnological production.

CATRIN concluded a Memorandum of Understanding with BINA in 2021. CATRIN is cooperating with BINA colleagues on



a joint European research project grant of the European Innovation Council EIC Transition Challenges, whose principal investigator is Prof. Michal Otyepka. In 2023, a joint mission of Czech research institutions to Israel took place, within which the mutual cooperation with BINA colleagues was further deepened.

6.3. Catalan Institute of Nanoscience and Nanotechnology (ICN2)

ICN2 is a prestigious international research institute based in Barcelona. Its mission is to promote interdisciplinary research in the field of nanoscience and nanotechnology. ICN2 is part of the Catalan Government's organisation for research centres (CERCA), which aims to encourage and maximise synergies and strategic collaboration between research centres in Catalonia. The institute is also a founding member of the Barcelona Institute of Science and Technology, which was established in cooperation with another six research centres in Catalonia to achieve greater international competitiveness by promoting multidisciplinary scientific cooperation in the fields of genome regulation, chemical research, nanoscience and nanotechnology, photonic science or biomedicine.

Representatives of CATRIN and the Catalan Institute of Nanoscience and Nanotechnology (ICN2) signed a Memorandum of Understanding in 2022. CATRIN has obtained three European projects with ICN2 colleagues so far: SUSNANO, GLEBi-oassay and 2D-BioPAD. The collaboration with ICN2 colleagues has also resulted in several successful publications in the field of biosensory science, and a number of mobility activities took place in 2023 with a focus on deepening mutual collaboration.

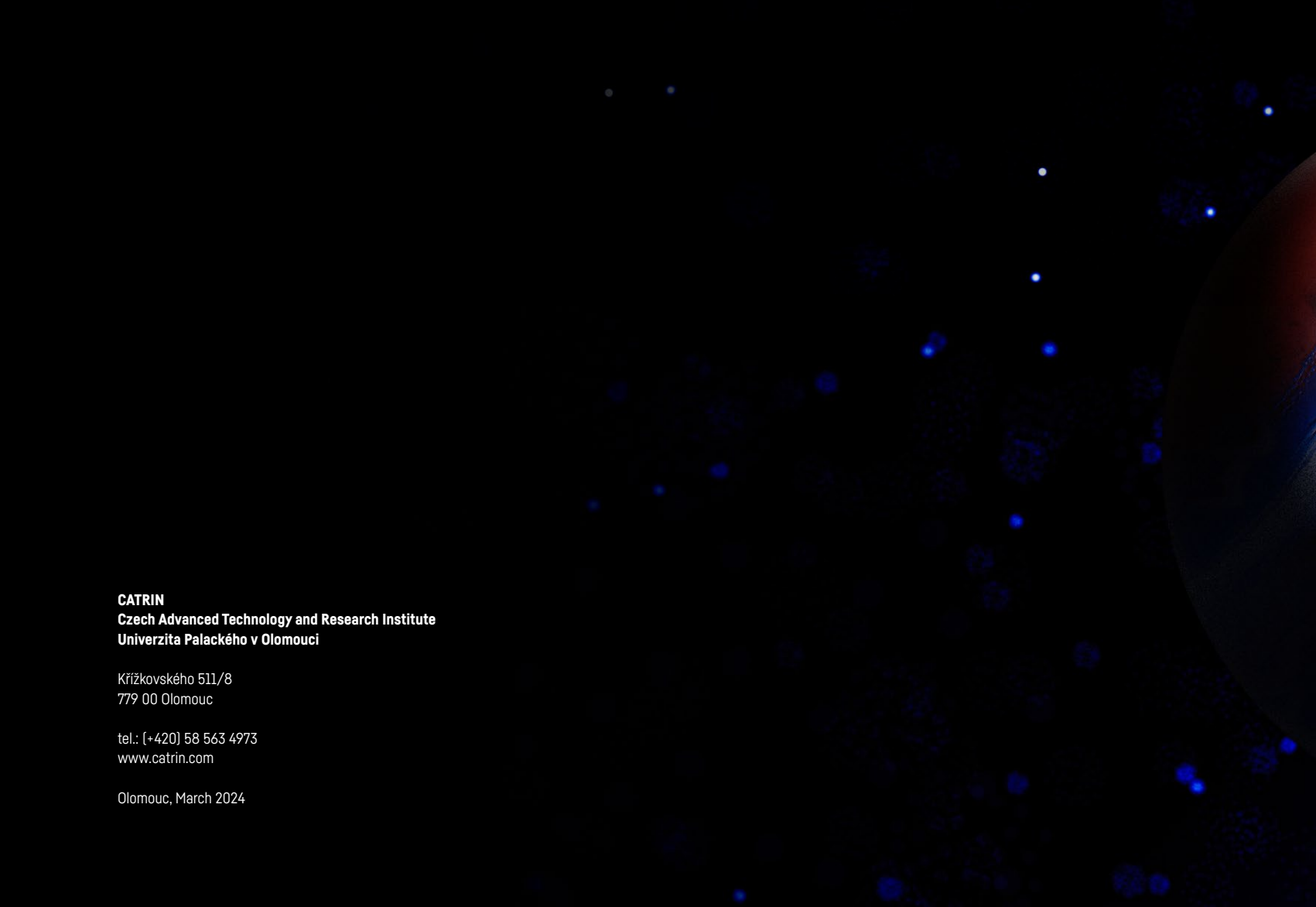
6.4. Leibniz Institute for Catalysis (LIKAT Rostock)

The Leibniz Institute for Catalysis LIKAT, based in Rostock, Germany, is the first and one of the largest publicly funded research institutes in the field of applied catalysis in Europe. LIKAT focuses on research and development of high-performance catalysts for chemical reactions. It focuses on the development of technologies that save resources in a significant way while increasing the yield of the reaction, avoiding by-products and reducing specific energy requirements.

Representatives of CATRIN and the Leibniz Institute for Catalysis LIKAT signed a Memorandum of Understanding in 2022. The collaboration with LIKAT is focused on, among other things, the so-called single-atom catalysis, one of the key areas covered by the OP JAK Excellent Research project– TECHSCALE, which CATRIN successfully obtained in 2023.







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Olomouc, March 2024