



CATRIN
Czech Advanced
Technology and Research
Institute



Palacký University
Olomouc

Annual Activity Report

of the
Czech Advanced Technology and
Research Institute
for the year 2022



Introductory word of the Director

The year 2022 was the first year of full operation for the Czech Advanced Technology and Research Institute (CATRIN) with fully integrated and established research and administrative teams. At the same time, it was a year rich in new challenges, especially in the grant scheme area. In 2022, many of us devoted considerable effort to the demanding preparation of strategic OP JAK projects as part of the Excellent Research call. At the same time, we were unusually successful in winning European grant projects from the Horizon Europe programme and the research teams put in a strong scientific performance. However, none of these many accomplishments came of their own accord. Behind each of them was genuine effort of individuals as well as great team work. I have always perceived that the human potential of CATRIN employees, alongside their enthusiasm, talent and willingness to work hard, is the very essence of the functioning of a top scientific institute that CATRIN has clearly become. I am very pleased and extremely proud that we have continuously managed to show that CATRIN makes a significant contribution to the development and visibility of Palacký University on the world scientific scene.

CATRIN in 2022 continued to be as successful in the field

of science and research as in the year 2021. CATRIN research teams continued publishing their superior results in a number of prestigious and highly impacted journals such as Nature Catalysis (IF 41,813), Nature Nanotechnology (IF 39,213), Nature Chemistry (IF 24,427) or Chemical Reviews (IF 72,087). Significant part of our research is focused on the development of new technologies and materials responding to the current societal crises. Examples include photocatalysts and plasmonic catalysts, which our colleagues developed in 2022. These new materials significantly reduce both the financial and mainly energy costs of industrial production and can find applications especially in the pharmaceutical industry. In doing so, we make the most of new green technologies and materials, which will release us from dependence on energy and raw materials. These materials have been reported on in prestigious journals Nature Catalysis and Nature Nanotechnology. CATRIN thus continues to strengthen the scientific reputation of our university and contributes to the search for solutions to societal crises.

CATRIN achieved unprecedented success in the field of grant support in 2022. Thanks to the building of a highly professional Grants Office team and also thanks to the hard work of many key scientists at CATRIN, it was possible to obtain a large number of research grants especially from the Horizon Europe programme. CATRIN was able to obtain a highly prestigious ERA Chair ACCELERATOR grant during the course of 2022, within which a new research group focused on innovative and synthetic chemistry will be assembled, further interconnecting all the three CATRIN divisions and their research directions. At the same time, it is the largest European grant that the University has been awarded in its entire history. Thanks to these and other projects, CATRIN was implementing or prepared

the launching of a number of European projects from the H2020 and Horizon Europe programmes towards the end of 2022, whose total budget for UP amounted to almost half of all European projects at our University. Palacký University has thus appeared on the map of EU financial contributions to participants of the Horizon Europe programme in the Czech Republic and has clearly consolidated its position there. The creation of another research group, this time junior, was possible thanks to the GACR Junior Star project. In 2022, many CATRIN researchers and administrative staff were also involved in the preparation of strategic OP JAK projects from the Excellent Research call. CATRIN participated in the preparation of several of these projects, with one being the Coordinator of. This project was submitted by Palacký University together with Charles University and CEITEC-VUT. Within UP, five faculties were involved in the preparation of this project: Faculty of Medicine and Dentistry, Faculty of Health Sciences, Faculty of Arts, Faculty of Theology and Faculty of Law. The final evaluation of these projects will take place in 2023. CATRIN is therefore fulfilling one of its missions, which is to proactively search for common scientific-research opportunities in cooperation with individual faculties across Palacký University. The year 2022 also brought the conclusion of another two strategic partnerships. With our colleagues from the Catalan Institute of Nanoscience and Nanotechnology in Barcelona, we are establishing a very fruitful collaboration in the field of sensorics and nanotechnology. With our colleagues at the Leibniz Institute for Catalysis in Rostock, we are consolidating our cooperation in the field of heterogeneous catalysis. These strategic partnerships are crucial both in joint research and in the submission of joint research projects.

CATRIN has thus clearly continued its successful oper-

ation in 2022. With its scientific and grant accomplishments, it continues to fulfil all the ambitious objectives for which Palacký University has decided to integrate its research centres into a University Institute. CATRIN is now a well-established institute on the European and world scientific map, which significantly increases the reputation of Palacký University in the field of science and research. At the same time, CATRIN plays an important role in fostering mutual cooperation in the field of science and research within Palacký University.

It is therefore an honour for me to present this Annual Report on CATRIN's activities as well as all the successes achieved in 2022—the second year of full operation. My big thanks go especially to those who contributed to this, but I would like to thank all the employees who contribute to the running of CATRIN through their day-to-day work. It is only thanks to the enthusiasm, talent and, above all, hard work of all our employees that CATRIN has become a successful research institution on a European and world level. Together we all contribute to spreading the good name of Palacký University Olomouc. I would like to express my appreciation to all CATRIN's employees, alongside wishing them zeal and success in the upcoming years.

Pavel Banáš, Director

Contents

1. Organizational Structure and Development

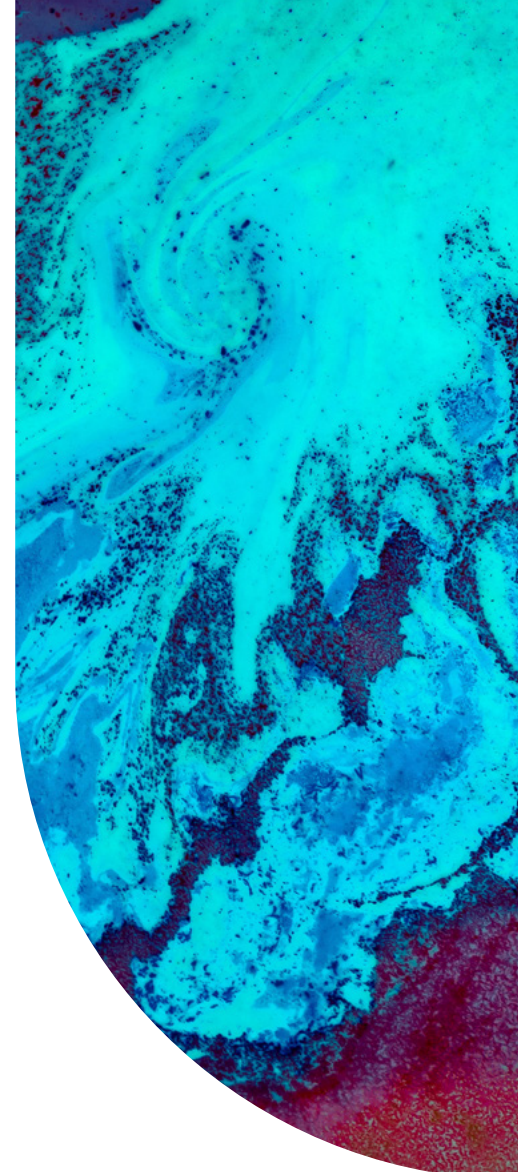
- 1.1. CATRIN's Management
- 1.2. CATRIN's Scientific Board
- 1.3. CATRIN's Supervisory Board
- 1.4. Scientific research divisions and teams
- 1.5. Directives and Regulations

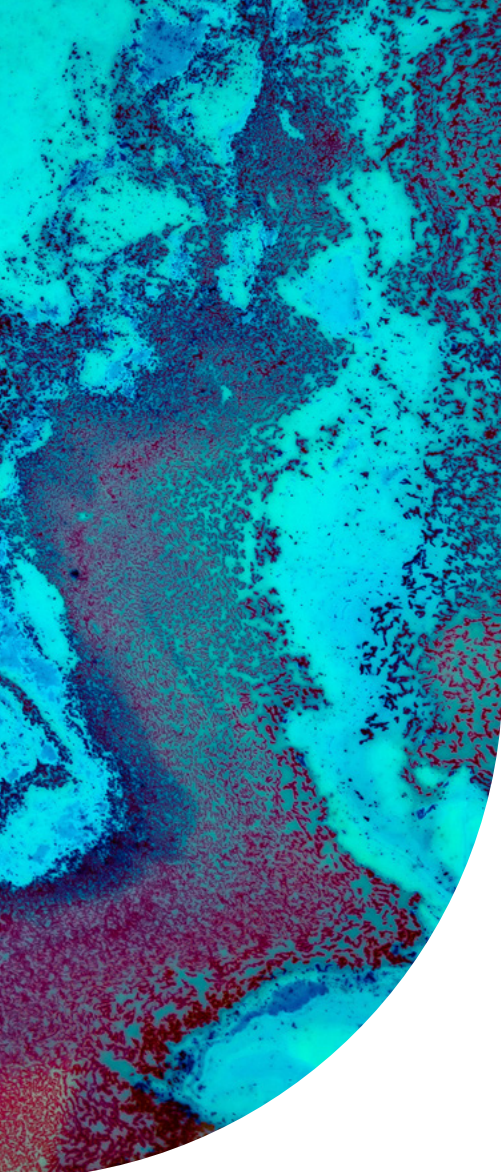
2. Vzdělávací činnost

- 2.1. Overview of CATRIN employee's involvement in teaching at faculties
- 2.2. Involvement of students in research carried out at CATRIN
- 2.3. Significant achievements of students involved in CATRIN's research
- 2.4. Mobility and career growth of students involved in research at CATRIN

3. Research and Development

- 3.1. Significant discoveries of CATRIN in the field of science and research in 2022
- 3.2. Publication activity
- 3.3. Science and research projects implemented at CATRIN
- 3.4. Technology transfer
 - 3.4.1. Licence agreements
 - 3.4.2. Contractual research
 - 3.4.3. Patents
- 3.5. International collaboration
- 3.6. Scientific conferences organized by CATRIN
- 3.7. Promotion and popularization of science and research





4. Staff

- 4.1. Age and qualification structure
- 4.2. Significant awards
- 4.3. Invited lectures and membership in major bodies

5. Major Events

- 5.1. Kick-off meeting of European Innovation Council (EIC) project
- 5.2. Interest in collaboration between CATRIN and LIKAT resulted in the signing of a Memorandum
- 5.3. CATRIN a ICN2 formally confirmed their collaboration
- 5.4. CATRIN management made contacts in Benelux
- 5.5. Workshop Nanotechnologies in HealthTech
- 5.6. Workshop with SUSNANO project partners
- 5.7. CATRIN-BINA Workshop

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.
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.**
(University of Birmingham, GB)
• **prof. Ing. Jiří Cejka, DrSc.**
(Charles University, CZ)
• **Ing. Nuria De Diego, Ph.D.**
• **prof. Ing. Jaroslav Doležel, DrSc.**
(Institute of Experimental Botany of CAS, CZ)
• **MUDr. Petr Džubák, Ph.D.**
• **prof. Paolo Fornasiero, Ph.D.**
(University of Trieste, IT)
• **prof. Dr. rer. nat. Roland A. Fischer, dr.h.c.phil.** (TUM, DE)
• **doc. MUDr. Marián Hajdúch, Ph.D.**
• **Priv. Doz. DI Dr. Klaus Kratochwill**
(Medical University of Vienna, AT)
• **doc. Ing. Pavel Jelínek, Ph.D.**
• **doc. Ing. Jiří Krechl, CSc.**
(CzechInvest Prague, CZ)
• **prof. Arben Merkoçi, Ph.D.** (ICN2 BIST, ES)
• **Mgr. Martin Mistrík, Ph.D.**
• **prof. Javier Pozueta-Romero, Ph.D.**
(IHSM-UMA-CSIC, ES)
• **prof. RNDr. Michal Otyepka, Ph.D.**
• **prof. RNDr. Martin Pumera, Ph.D.**
(CEITEC-VUT, CZ)

doc. RNDr. Pavel Saska, Ph.D. (ÚRV, CZ)

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. Petr Kaňovský, CSc., FEAN**
• **doc. RNDr. Martin Kubala, Ph.D.**
• **doc. PhDr. Vojtěch Regec, Ph.D.**
• **doc. Mgr. Jan Stejskal, M.A., Ph.D.**
• **Mgr. Jiří Vévoda, Ph.D.**

1.4. Scientific research divisions and teams

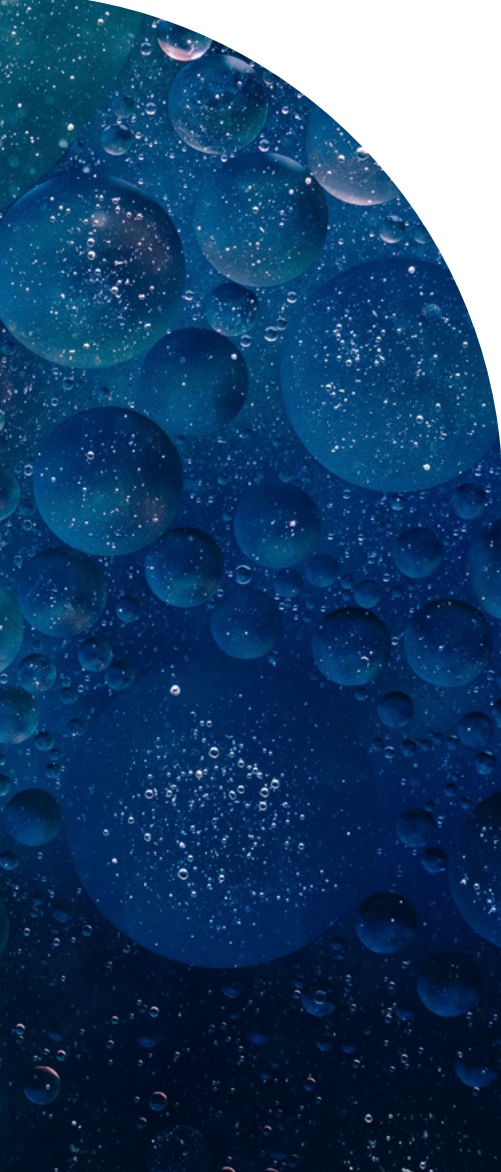
There are three scientific and research divisions at CATRIN, which are the basic organisational units of CATRIN in addition to the Technical-Administrative Division:

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 Špichal, 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.
	Photoelectrochemistry	prof. Patrik Schmuki/Ing. Štěpán Křent, 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

The following Directives were issued in CATRIN in 2022:

Number	Name	Effect
CAT-B-22/01	Order to take leave for employees of the Czech Advanced Technology and Research Institute of Palacký University Olomouc in the calendar year 2022	1. 7. 2022
CAT-B-22/02	Guidance on determining the level of indirect costs of the Czech Advanced Technology and Research Institute (hereinafter CATRIN) for the purpose of submitting projects within the framework of institutional support and within the framework of submitting projects for earmarked support	1. 8. 2022

2

Educational Activity



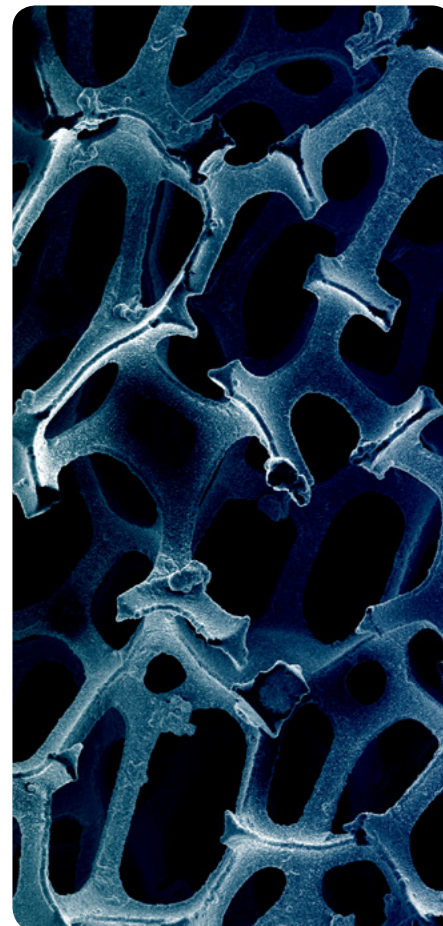
The Higher Education Institute may participate in educational activities carried out within study programmes accredited at individual faculties on the basis of provisions in Section 34 (1) of Act No. 111/1998 Sb., the Higher Education Act. Employees of the CATRIN Higher Education Institute are involved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

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

In 2022, 20 employees of the Institute taught at one of the faculties and 34 CATRIN employees supervised bachelor's, master's or doctoral theses.

Guarantor Faculty	Number of CATRIN Employees Involved in Teaching	Number of CATRIN Employees Supervising Final Theses
PfF/KFC	12	18
PfF/KEF	2	2
PfF/KBC	6	8
PfF/LRR	2	4
PfF/KCB	1	0
PfF/ZOO	0	1
PfF/KBI	0	1
PfF/KBB	0	2
Total*	20	34

* 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

Out of a total of 57 students, 34 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	13
Master's students	11
Doctoral students	33
Total number	57

Defended dissertations supervised by CATRIN employees:

Student	Supervisor	Title	Defended
Alba Estaban Hernandiz	Dr. Nuria De Diego Sanchez	Characterizing the mode of action of small molecule-based biostimulants	29.8.2022
Yunpeng Zuo	doc. Štěpán Kment	Pyrite Transition Metal Dichalcogenides for Oxygen Evolution	1.9.2022
Veronika Šedajová	Dr. Aristeides Bakandritsos	Chemical functionalization of graphene	16.12.2022





Lukáš Zdražil	prof. Radek Zbořil	Luminescent zero-dimensional nano-materials for optoelectronic applications	16.12.2022
Rostislav Langer	doc. Piotr Blonski	Structural, electronic, and magnetic properties of nanomaterials for potential magnetics, energy storage, and catalytic applications	1.12.2022
Carlos Díaz	Prof. Ivo Frébort	Production of recombinant proteins for veterinary use	12.12.2022
David Panáček	Dr. Aristeides Bakandritsos	Use of graphene derivatives for biological and catalytic applications	1.12.2022

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

Doctoral students led by supervisors from CATRIN can capitalize on their knowledge and experience gained through their involvement in research projects or during study stays at prestigious international universities. The result is not only quality publications, but also, for example, success at conferences and in scientific competitions.

• **First place in the competition for the Jean-Marie Lehn Prize**, which the French Embassy along with Solvay awards young scientists in the field of chemistry, went to the PhD student Veronika Šedajová. In the competition, she attracted interest by her research into new materials derived from graphene for the storage of electrical energy. As part of the award, Veronika Šedajová worked for a month in the laboratory of Prof. P. Simon in Toulouse.

• **The Werner von Siemens Award for the year 2021** in the Most Important Result of Basic Research category, handed out in the spring of 2022, went to a team of authors led by Dr. Bruno De La Torre. The prize was awarded for the discovery of a ground-breaking imaging method that enabled, as the first in the world, to observe the inhomogeneous distribution of electron charge around a halogen atom, the so-called sigma hole. This discovery

was published in the prestigious journal Science. The award-winning team includes the PhD student Benjamin Mallada Faes, who is the first author of the award-winning work. Within Palacký University, this is the first and only first-author work in the prestigious journal Science, which is also the first and only corresponding work in this journal.

• **The Talent of the Year**, which is awarded by the City of Ostrava to students with permanent residence in Ostrava studying at universities in the Czech Republic and abroad for their excellent results, went to PhD students Michal and Rostislav Langer.

• **The “Young Researcher Award in recognition of best poster presentation in ISSON22”** was handed out within the conference ISSON22–International Summer Schools On Nanotechnologies, organic Electronics & Nanomedicine to the doctoral student Klára Gajdošová, who is working on her dissertation under doc. Václav Ranc from CATRIN.

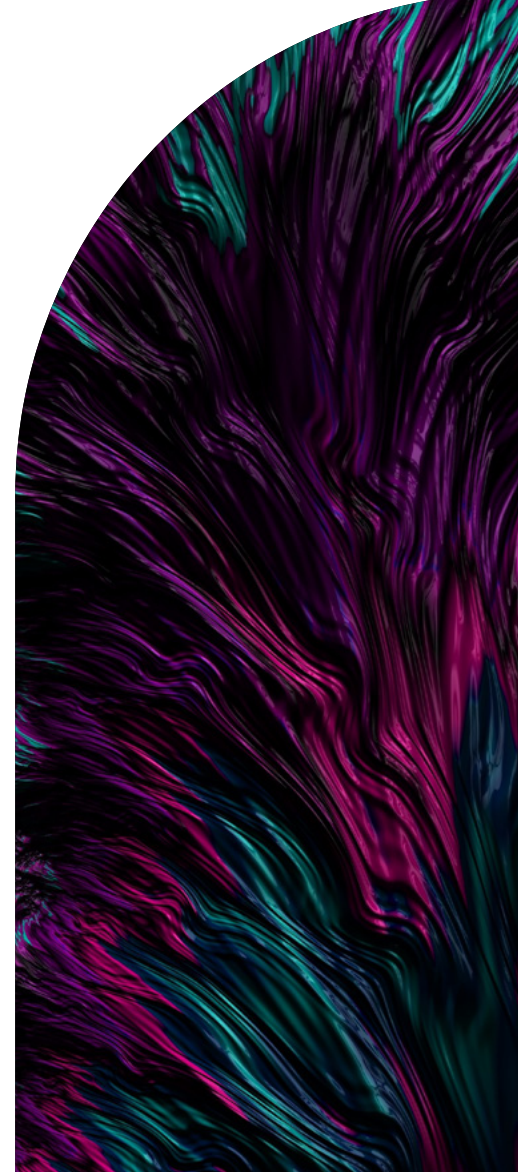
• PhD students Nikola Kořínková and Alexie Techer, who are working on their dissertation at CATRIN under the supervision of Dr. Veronique Bergougnoux Fojtik, and the PhD student Jan Belza, who is working on his dissertation under Prof. Radek Zbořil, **received an annual research grant within the Igráček student competition.**

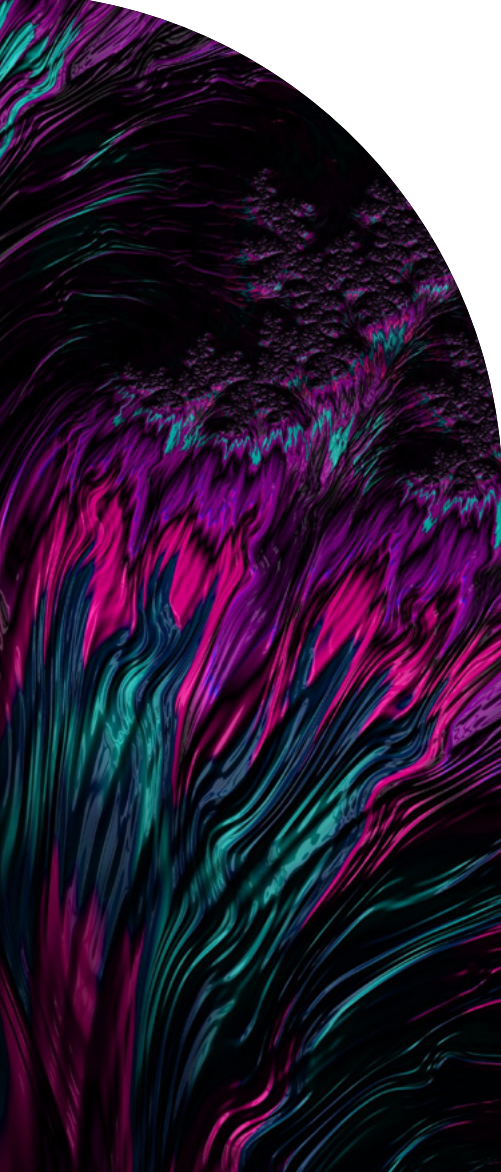
2.4. Mobility and career growth of students involved in research at CATRIN

In 2022, students led by supervisors from CATRIN were sent as part of their scientific research activities carried out at CATRIN to internships at important foreign scientific research institutes with which CATRIN cooperates.

Students	Foreign Workplace	Date of the Internship
Morteza Afshar	University of Trieste, Italy	1/4–30/6 2022
Carlos Díaz	UPJŠ Košice, Slovakia	1/4–30/4 2022
David Panáček	ICN2 Barcelona, Spain	2/5–29/5 2022

PhD students who defended their dissertation at CATRIN gained positions at prestigious world institutions in 2022. 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.

- **Veronika Šedajová** obtained a research position at the prestigious **Cambridge University** in the group of Prof. Clare Gray at the Yusuf Hamied Department of Chemistry, where she will continue to pursue material research in close contact with industry.

- **Lukáš Zdražil** obtained a research position at the **Friedrich-Alexander-Universität in Erlangen** in the laboratory of Prof. Dirk Guldi, where he will focus on fluorescence properties of nanomaterials.

- **Michal Langer** obtained a research position at the **University of Warsaw** in the group of Prof. Silvio Osello, where he will devote himself to computer modelling of new materials.

In addition, our postdocs **José M. R. Flauzino** and **Iosif Tantis** gained new positions for their career growth at Imperial College of London and Cornell University USA thanks to their research and experience obtained at CATRIN. Congratulations on their success.

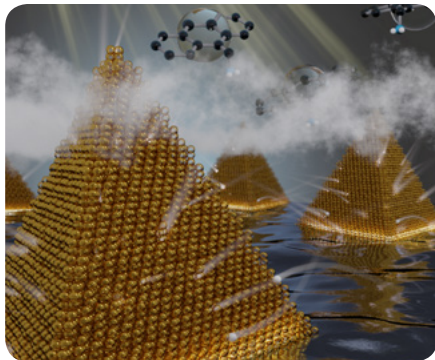


3

Research and Development

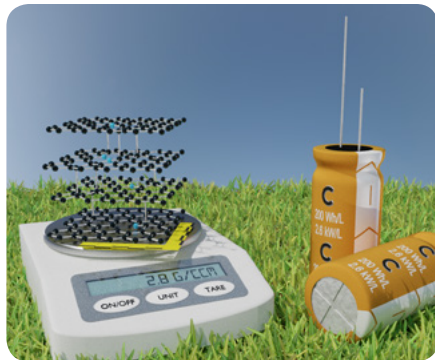
3.1. Significant discoveries of CATRIN in the field of science and research in 2022

Significant discoveries were published by authors from CATRIN in prestigious journals. Many of them were made in collaboration with foreign colleagues. The list includes works in which the first or corresponding author works at CATRIN.



Instead of electric furnaces, the sun, instead of gold, a cheap nanomaterial. This is a brief description of a new process that can accelerate and make cheaper the production of a range of pharmaceuticals, chemicals, plastics or dyes. The basis of the technology is a nanomaterial developed by scientists from CATRIN and the Centre for Energy and Environmental Technologies–VSB-TUO in collaboration with foreign colleagues. Its composition corresponds to common minerals occurring in nature, but it can replace precious metals, which have been used so far. The discovery was published in the journal *Nature Nanotechnology*.

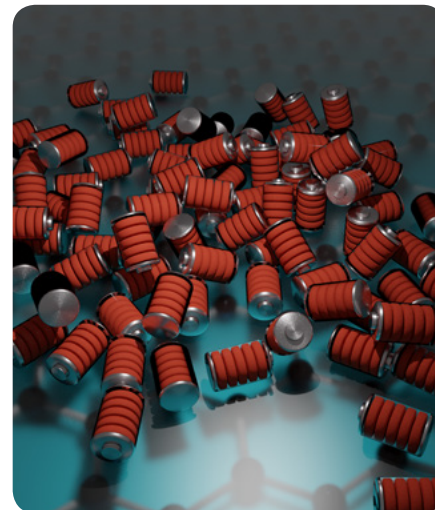
Poulose A.Ch., Zoppellaro G., Konidakis I., Serpetzoglou E., Stratakis E., Tomanec O., Beller M., Bakandritsos A., Zbořil R.: Fast and selective reduction of nitroarenes under visible light with an earth-abundant plasmonic photocatalyst, *Nature Nanotechnology* 2022, 17 (5), 485-492. IF = 39.21



Nitrogen-enriched graphene, developed by CATRIN scientists, is proving to be a very promising electrode material for use in supercapacitors. It is another example of results responding to the global demand for electrochemical energy storage devices with better performance, higher safety, lower costs and environmental impacts. The benefits of the new material were reported on in the journal *Energy & Environmental Science*.

Šedajová V., Bakandritsos A., Břošský P., Medved' M., Langer R., Zaoralová D., Ugolotti J., Džibelová J., Jakubec P., Kupka V., Otyepka M.: Nitrogen doped graphene with diamond-like bonds achieves unprecedented energy density at high power in a symmetric sustainable supercapacitor, *Energy & Environmental Science* 2022, 15 (2), 740-748. IF = 38.532

Scientists from CATRIN, in collaboration with VSB-Technical University of Ostrava and Saarland University in Saarbrücken, Germany, have developed a new anode for lithium-ion batteries based on graphene acid—a densely carboxylated graphene derivative. The new anode surpasses the previously reported similar anode materials and enables the storage of electric charge significantly better than high-quality single-layer graphene. The results were published in the prestigious journal for energy research *Advanced Energy Materials*.



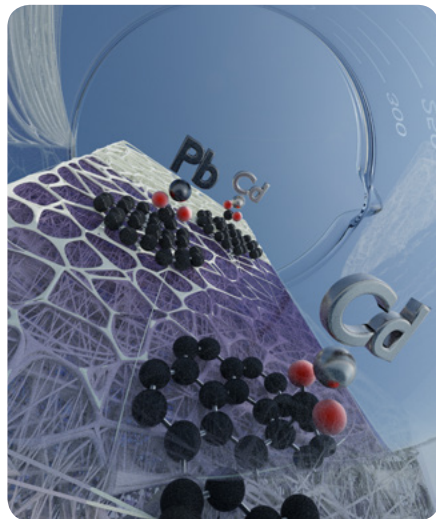
Obraztsov I., Bakandritsos A., Šedajová V., Langer R., Jakubec P., Zoppellaro G., Pykal M., Presser V., Otyepka M., Zbořil R.: Graphene Acid for Lithium-Ion Batteries—Carboxylation Boosts Storage Capacity in Graphene. *Advanced Energy Materials* 2022,12 (5), 2103010. IF = 29.368



An international team of scientists, including CATRIN researchers, has solved one of the fundamental obstacles to the use of nanographene as a successor to silicon components in electronics—the lack of chemical stability of graphene ribbons. A multidisciplinary team of physicists and chemists has succeeded in developing a method for the preparation of a chemically modified form of graphene nanoribbons that is stable in the atmosphere. An innovative solution for the surface treatment of graphene nanoribbons was published in the journal *Nature Chemistry*.

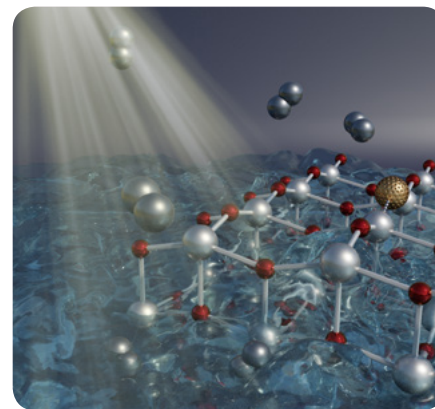
Lawrence J., Berdonces-Layunta A., Edalatmanesh S., Castro-Esteban J., Wang T., Jimenez-Martin A., de la Torre B., Castrillo-Bodero R., Angulo-Portugal P., Mohammed S. G. M., Matěj A., Vilas-Varela M., Schiller F., Corso M., Jelínek P., Peña D., de Oteyza D. G.: Circumventing the stability problems of graphene nanoribbon zigzag edges. *Nature Chemistry* 2022, 14 (12), 1451-1458. IF = 24.427

A cheap, efficient and recyclable nanomaterial that can not only detect but also remove heavy metals, especially cadmium and lead, from water—this is the result of collaboration between scientists from CATRIN, VSB-TUO and the Catalan Institute of Nanoscience and Nanotechnology (ICN2) in Barcelona. The so-called graphene dots derived from the Nobel material graphene have already been used by CATRIN researchers to prepare a paper detector. A simple test will prove the presence of dangerous heavy metals without costly devices within about 30 minutes.



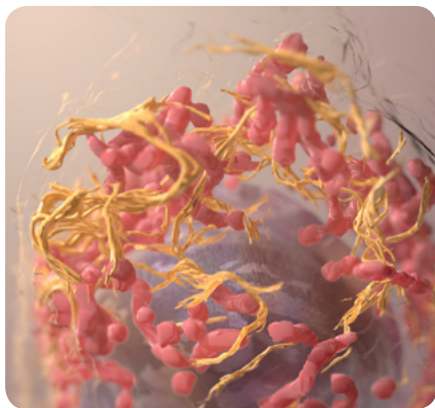
Panáček D., Zdražil L., Langer M., Šedajová V., Baďura Z., Zoppellaro G., Yang Q., Nguyen E. P., Álvarez-Diduk R., Hrubý V., Kolařík J., Chalmpes N., Bourlinos A. B., Zbořil R., Merkoči A., Bakandritsos A., Otyepka M.: Graphene Nanobeacons with High-Affinity Pockets for Combined, Selective, and Effective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

Single-atom catalysis represents one of the most fascinating areas of current research, similarly to the advent of nanotechnology in the 1990s. A research team of scientists from CATRIN and the University of Trieste developed a method of depositing individual platinum atoms on the surface of 2D TiO₂ nanosheets, with a very unique crystal structure of bronze, using ethylene glycol, which creates



chemical traps on the surface of TiO₂ for their covalent anchoring and for preventing their agglomeration into nanoparticles. This resulted in an almost 100-fold increase in the efficiency of hydrogen production by solar water splitting compared to TiO₂ nanosheets not containing platinum atoms.

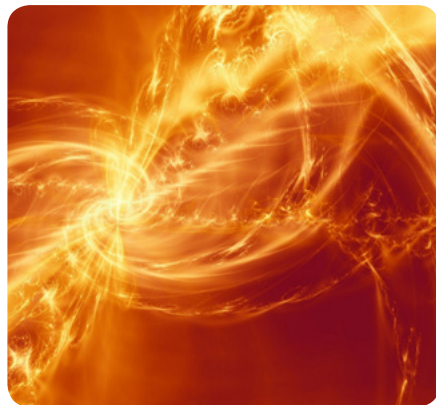
Rej S., Hejazi S. M. H., Baďura Z., Zoppellaro G., Kalytchuk S., Krment Š., Fornasiero P., Naldoni A.: Light-Induced Defect Formation and Pt Single Atoms Synergistically Boost Photocatalytic H₂ Production in 2D TiO₂-Bronze Nanosheets. *ACS Sustainable Chemistry & Engineering* 2022, 10 (51), 17286-17296. IF = 9.224



Scientists from CATRIN and the Faculty of Medicine and Dentistry of Palacký University together with colleagues from the Institute of Organic Chemistry and Biochemistry and First Faculty of Medicine Charles University has developed a new method of imaging sentinel lymph nodes that drain tumours using ultrabright 200nm fluorescent nanodiamonds (FNDs). FNDs are modified by a polyvalent mannose field and show *in vitro* increased binding to mannose receptor CD206. *In vivo* experiments in mice also confirmed increased retention of FND-p-Man in sentinel lymph nodes. This new method has the potential for imaging affected lymph nodes in perioperative cancer diagnosis and as a tool for fluorescence and robotic controlled surgery.

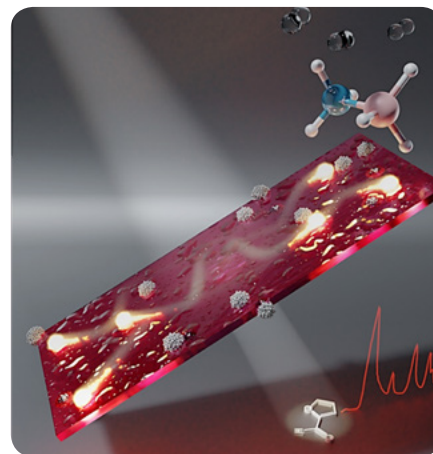
Kvakova K., Ondra M., Schimer J., Petrik M., Novy Z., Raabova H., Hajduch M., Cigler P.: Visualization of Sentinel Lymph Nodes with Mannosylated Fluorescent Nanodiamonds. *Advanced Functional Materials* 2022, 32 (23), 2109960. IF = 19.924

Experimentally distinguishing between thermal and electronic effects in photothermal catalytic processes remains an unsolved scientific problem and is an effort of many research teams around the world. An international team of scientists from CATRIN, VSB-TUO, Italy and the USA in their work discusses the distinction between thermal and electronic effects in photocatalysts through accurate temperature measurements, taking into account various experimental conditions and the choice of instrumentation.



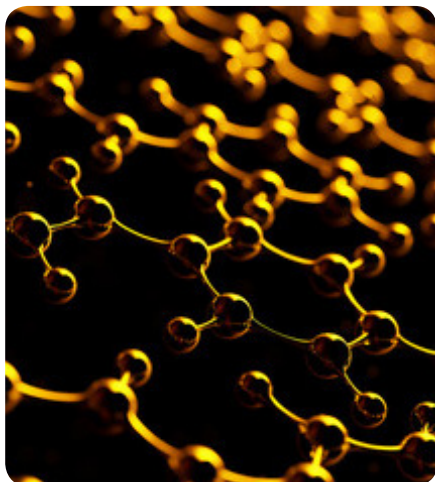
Furthermore, they also developed a universal method for isolating the pure thermal mechanism in thin-layer photocatalysts by applying an atomic layer of a broadband semiconductor (Al₂O₃ or MgO) between the layer of the photothermal material and the nanoparticles of the catalyst. In this way, electronic transmissions are prevented, but light-initiated thermal changes remain.

Mascaretti L., Schirato A., Montini T., Alabastri A., Naldoni A., Fornasiero P.: Challenges in temperature measurements in gas-phase photothermal catalysis. *Joule* 2022, 6 (8), 1727-1732. IF = 46, 048



An international team of scientists from CATRIN, the US, and Germany studied how to increase the photocatalytic efficiency of low-cost metal nitride plasmonic materials in the Visible Light Spectrum (VIS) and Near Infrared Region (NIR). Due to the high presence of NIR photons in the solar radiation spectrum, their effective use in solar conversion technologies to green fuels is highly sought after. The team prepared a new titanium-nitride-based plasmonic material with a unique nanobar morphology that provided the required shift of the absorption spectrum to the NIR region (500–2500 nm). This greatly increased the rate of hydrogen evolution by direct solar water splitting due to plasmonic excitation in the NIR region.

Rej S., Yazmin Santiago E., Baturina O., Zhang Y., Burger S., Kment S., Govorov A. O., Naldoni A.: Colloidal Titanium Nitride Nanobars for Broadband Inexpensive Plasmonics and Photochemistry from Visible to Mid-IR Wavelengths. *Nano Energy* 2022, 104, 107989. IF=19,069



A unique mechanism for the scaffold rearrangement of polyaromatic hydrocarbon molecules with an unusual C-C bond cleavage driven by the concerted action of single AuO gold atoms on an Au(111) surface has been discovered by researchers from CATRIN, Charles University, and the Czech Academy of Sciences. This discovery shows the importance of single-atom catalysis in surface synthesis. The findings provide new insight into the catalytic activity of individual AuO atoms in the cleavage of covalent carbon bonds and are relevant for the field of organic synthesis. The results were published in the prestigious journal *Angewandte Chemie*.

Mendieta-Moreno J. I., Mallada B., de la Torre B., Cadart T., Kotora M., Jeřábek P.: Unusual Scaffold Rearrangement in Polyaromatic Hydrocarbons Driven by Concerted Action of Single Gold Atoms on a Gold Surface, *Angewandte Chemie* 2022, 61 (50). IF = 16, 823

In the field of optimizing nanomaterials for environmental applications, CATRIN scientists, in collaboration with the University of Ostrava, the University of Vienna, and the University of Natural Resources and Life Sciences, Vienna, have developed iron nitride nanoparticles, tested their effects for removing pollutants from aqueous environments and described in detail the mechanisms of the reactions. Unlike traditional iron nanoparticles, iron nitrides are much more effective for the elimination of trichloroethylene. The results were published in the prestigious journal for environmental research *Environmental Science & Technology*.



Brumovský M., Oborná J., Micić V., Malina O., Kašík J., Tunega D., Kolos M., Hofmann T., Karlický F., Filip J.: Iron Nitride Nanoparticles for Enhanced Reductive Dechlorination of Trichloroethylene. *Environmental Science & Technology* 2022, 56 (7) 4425–4436. IF = 11,357

Higher resistance of agricultural crops against drought and heat, better absorption of fertilizers and higher yields—these results can be achieved by application of new growth regulators (biostimulants) developed by scientists from CATRIN and the Institute of Experimental Botany of the CAS. These are simple substances based on urea, which regulate the content of plant hormones



cytokinins in plants. The first agrochemical company is already starting to test the new biostimulants. The scientists reported on their results in the *Journal of Experimental Botany*.

Nisler J., Pěkná Z., Končítiková R., Klimeš P., Kadlecová A., Murvanidze N., Werbrück S. P. O., Plačková L., Kopečný D., Zalabák D., Spichal L., Strnad M.: Cytokinin oxidase/dehydrogenase inhibitors: outlook for selectivity and high efficiency. *Journal of Experimental Botany* 2022, 73 (14), 4806–4817. IF = 7,38

3.2. Publication activity

CATRIN researchers published a total of 270 scientific publications in 2022. Most of them were published in journals with an impact factor higher than 5 (61.85% in total), while 45 publications, accounting for a significant share of CATRIN's production, were published in prestigious journals with an impact factor higher than 10.

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
100 [37,04%]	120 [44,44%]	45 [16,67%]	5 [1,85%]	49 [18,15%]	149 [55,19%]

Of the 270 publications published in 2022, the majority had a correspondent author from CATRIN, a significant part of the works also had a first author from CATRIN.

The distribution of CATRIN publications published in 2022 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 a quarter 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.

D1	Q1	Q2	Q3	Q4	N/A
67	134	94	31	8	3

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



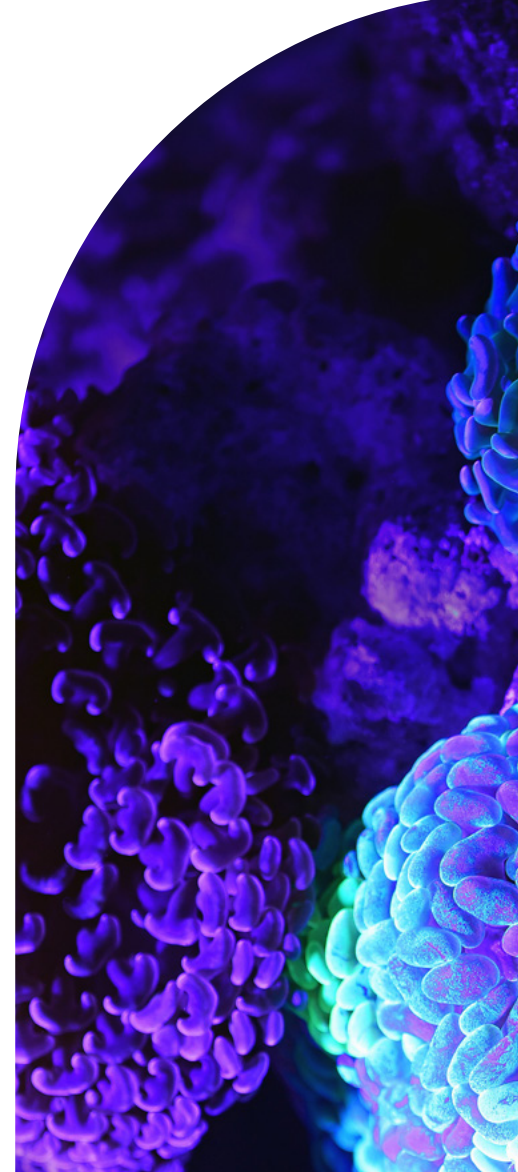
Authors	Publication Title	Name of the Journal	IF
Jayaramulu K., Mukherjee S., Morales D.M., Dubal D.P., Nandandan A.K., Schneemann A., Masa J., Kment S., Schuhmann W., Otyepka M., Zbořil R.	Graphene-Based Metal-Organic Framework Hybrids for Applications in Catalysis, Environmental, and Energy Technologies	Chemical Reviews	72.087
Mascaretti L., Schirato A., Montini T., Alabastri A., Naldoni A., Fornasiero P.	Challenges in temperature measurements in gas-phase photothermal catalysis	Joule	46.048
Chandrashekar V.G., Senthamarai T., Kadam R.G., Malina O., Kašlík J., Zbořil R., Gawande M.B., Jagadeesh R.V., Beller M.	Silica-supported Fe/Fe-O nanoparticles for the catalytic hydrogenation of nitriles to amines in the presence of aluminium additives	Nature Catalysis	40.706
Cheruvathoor Poulouse A., Zoppellaro G., Konidakis I., Serpetzoglou E., Stratakis E., Tomanec O., Beller M., Bakandritsos A., Zbořil R.	Fast and selective reduction of nitroarenes under visible light with an earth-abundant plasmonic photocatalyst	Nature Nanotechnology	40.523
Šedajová V., Bakandritsos A., Blonski P., Medved' M., Langer R., Zaoralová D., Ugolotti J., Džibelová J., Jakubec P., Kupka V., Otyepka M.	Nitrogen doped graphene with diamond-like bonds achieves unprecedented energy density at high power in a symmetric sustainable supercapacitor	Energy & Environmental Science	39.714
Denisov N., Qin S., Will J., Vasiljevic B. N., Skorodumova N. V., Pašti I. A., ... & Schmukí P.	Light-Induced Agglomeration of Single-Atom Platinum in Photocatalysis	Advanced Materials	32.086

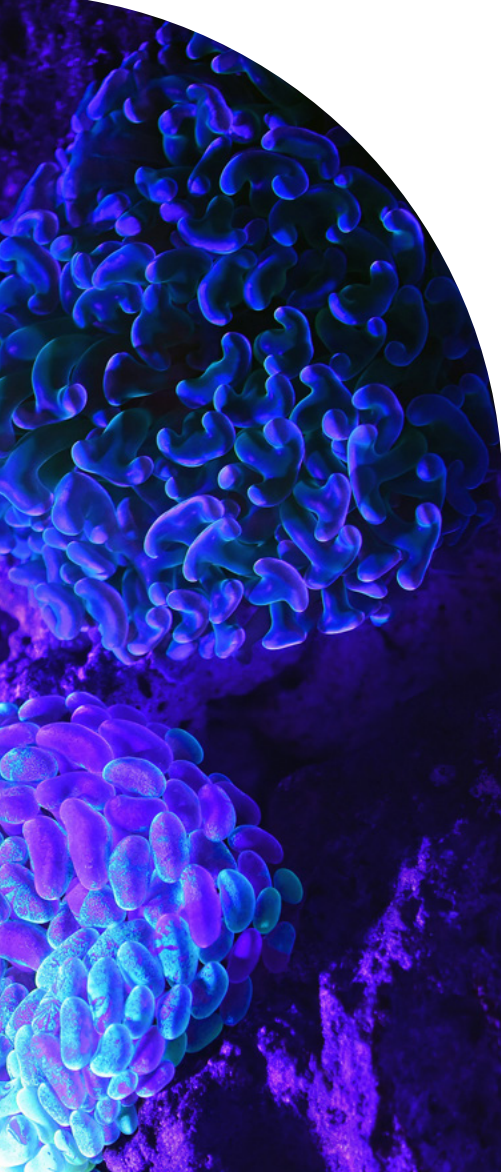




Oroojalian F., Karimzadeh S., Javanbakht S., Hejazi M., Baradaran B., Webster T. J., Mokhtarzadeh A., Varma R.S., Kesharwani P., Sahebkar A.	Current trends in stimuli-responsive nanotheranostics based on metal-organic frameworks for cancer therapy	Materials Today	26.943
Gupta R.K., Riaz M., Ashafaq M., Gao Z.Y., Varma R.S., Li D.C., Cui P., Tung C.H., Sun D.	Adenine-incorporated metal-organic frameworks	Coordination Chemistry Reviews	24.833
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 M.S.G., Matěj A., Vilas-Varela M., Schiller F., Corso M., Jelinek P., Pena D., de Oteyza D. G.	Circumventing the stability problems of graphene nanoribbon zigzag edges	Nature Chemistry	24.274
Iravani S., Varma R.S.	MXene-Based Composites as Nanozymes in Biomedicine: A Perspective	Nano-Micro Letters	23.655
Iravani S., Varma R.S.	Nature-inspired MXene nanocomposites with unique properties and multifunctional potentials	Matter	19.967
Kvaková K., Ondra M., Schimer J., Petřík M., Nový Z., Raabová H., Hajdúch M., Cígler P.	Visualization of Sentinel Lymph Nodes with Mannosylated Fluorescent Nanodiamonds	Advanced Functional Materials	19.924
Hwang I., Mazare A., Will J., Yokosawa T., Spiecker E., Schmuki P.	Inhibition of H ₂ and O ₂ Recombination: The Key to a Most Efficient Single-Atom Co-Catalyst for Photocatalytic H ₂ Evolution from Plain Water	Advanced Functional Materials	19.924

Rej S., Santiago E. Y., Baturina O., Zhang Y., Burger S., Kment S., Govorov A.O., Naldoni A.	Colloidal titanium nitride nanobars for broadband inexpensive plasmonics and photochemistry from visible to mid-IR wavelengths	Nano Energy	19.069
Li Y., Zhang P., Tang W., McHugh K.J., Kershaw S.V., Jiao M., Huang X., Kalychuk S., Perkinson C.F., Yue S., Qiao Y.	Bright, Magnetic NIR-II Quantum Dot Probe for Sensitive Dual-Modality Imaging and Intensive Combination Therapy of Cancer	ACS Nano	18.027
Simmons C.R., MacCulloch T., Krepl M., Matthies M., Buchberger A., Crawford I., Šponer J., Šulc P., Stephanopoulos N., Yan H.	The influence of Holliday junction sequence and dynamics on DNA crystal self-assembly	Nature Communications	17.694
Lo R., Manna D., Lamanec M., Dračinský M., Bouř P., Wu T., Bastien G., Kaleta J., Miriyala V.M., Spirko V., Masinova A., Nachtigallova D., Hobza P.	The stability of covalent dative bond significantly increases with increasing solvent polarity	Nature Communications	17.694
Mirzaee M., Osmani Z., Frébertová J., Frébert I.	Recent advances in molecular farming using monocot plants	Biotechnology Advances	17.681
Mendieta-Moreno J., Mallada Faes B.J., De La Torre B., Cadart T., Kotora M., Jelínek P.	Unusual Scaffold Rearrangement in Polyaromatic Hydrocarbons Driven by Concerted Action of Single Gold Atoms on a Gold Surface	Angewandte Chemie - International Edition	16.823
Biswas K., Edalatmanesh S., Jelínek P.	Synthesis and Characterization of peri-Heptacene on a Metallic Surface	Angewandte Chemie - International Edition	16.823



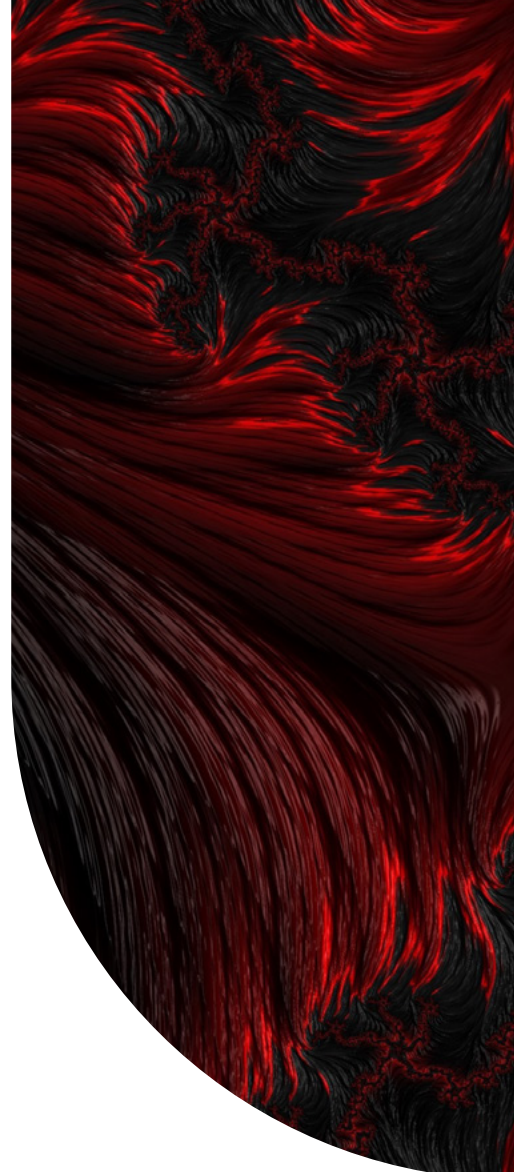


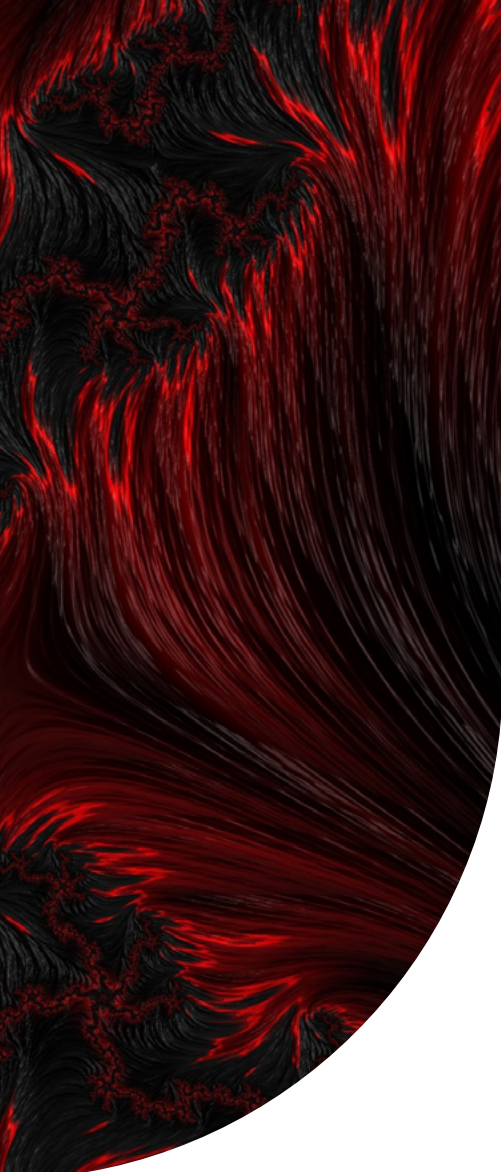
Zhou Z., Zhang J., Mukherjee S., Hou S., Khare R., Döblinger M., Tomanec O., Otyepka M., Koch M., Gao P. Zhou L., Li W., Fischer R.A.	Porphyrinic MOF derived Single-atom electrocatalyst enables methanol oxidation	Chemical Engineering Journal	16.744
Lowe B., Hellerstedt J., Matěj A., Mutombo P., Kumar D., Ondráček M., Jelinek P., Schiffrin A.	Selective Activation of Aromatic C-H Bonds Catalyzed by Single Gold Atoms at Room Temperature	Journal of the American Chemical Society	16.383
Yang Ch., Slavětinská Poštová L., Fleutí M., Klepetářová B., Tichý M., Gurská S., Pavliš P., Džubák P., Hajdúch M., Hocek M.	Synthesis of Polycyclic Hetero-Fused 7-Deazapurine Heterocycles and Nucleosides through C-H Dibenzothiophenation and Negishi Coupling	Journal of the American Chemical Society	16.383
Ussia M., Urso M., Kment S., Fialova T., Klíma K., Dolezelikova K., Pumera M.	Light-Propelled Nanorobots for Facial Titanium Implants Biofilms Removal	Small	15.153
Panáček D., Zdražil L., Langer M., Šedajová V., Baďura Z., Zoppellaro G., Hrubý V., Zbořil R., Bakandritsos A., Otyepka M.	Graphene Nanobeacons with High-Affinity Pockets for Combined, Selective, and Effective Decontamination and Reagentless Detection of Heavy Metals	Small	15.153
Paloncýová M., Pykal M., Kuhrová P., Banáš P., Šponer J., Otyepka M.	Computer Aided Development of Nucleic Acid Applications in Nanotechnologies	Small	15.153
Kadam R.G., Zaoralová D., Medved' M., Sharma P., Zoppellaro G., Tomanec O., Otyepka M., Zbořil R., Gawande M.B.	Intermetallic Copper-Based Electride Catalyst with High Activity for C-H Oxidation and Cycloaddition of CO ₂ into Epoxides	Small	15.135

3.3. Science and research projects implemented at CATRIN

Scientific research activities of CATRIN's staff are supported by a wide range of grant projects that were obtained over the past few years. These are funds from national and international programmes to support basic and applied research and development, including the most prestigious ones awarded by the European Research Council (ERC) or the European Innovation Council (EIC). Below is a list of all projects implemented at the end of 2022:

Project Title	ID number	Provider
2D-CHEM: Two-dimensional Chemistry towards Graphene Derivatives	683024	Horizon 2020 – ERC
NANO4TARMED: Advanced hybrid theranostic nanoplatfor- ms for an active drug delivery in the cancer treatment	952063	Horizon 2020 – Twinning
TRANS2DCHEM: Transition of 2D-chemistry based superca- pacitor electrode material from proof of concept to applications	101057616	Horizon Europe – EIC
FunGrab: Functionalized Gra- phene Based Electrode Material for Lithium Sulfur Batteries	101069293	Horizon Europe – ERC
SAN4Fuel: Single atom based nanohybrid photocatalysts for green fuels	101079384	Horizon Europe – WIDERA
Nanotechnologies for Future (Excellent research)	CZ.02.1.01/0.0/0.0/16_019/0000754	MEYS





NanoEnvicZ II: Nanomaterials and nanotechnologies for environment protection and sustainable future	LM2018124	MEYS
Pro-NanoEnvicZ II: Modernization and upgrade of large research infrastructure Nanomaterials and nanotechnologies for protection of the environment and sustainable future	CZ.02.1.01/0.0/0.0/18_046/0015586	MEYS
Nanotechnologies for Future (Excellent research)	CZ.02.1.01/0.0/0.0/16_019/0000754	MEYS
Plants as a tool for sustainable global development	CZ.02.1.01/0.0/0.0/16_019/0000827	MEYS
Advanced Hybrid Nanostructures for Renewable Energy Applications	CZ.02.1.01/0.0/0.0/15_003/0000416	MEYS
Support for international mobility of researchers – MSCA-IF at Palacký University Olomouc III	CZ.02.2.69/0.0/0.0/18_070/0018294	MEYS
The influence of organic matter on the efficiency of iron nanoparticles in the removal of pharmaceuticals in wetlands	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 activities	21-38204L	GAČR LA
Plasmonic catalysis with titanium nitride nanocrystals for sustainable chemical reactions	20-17636S	GAČR STD
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
Next Generation of Integrated Atomic Force and Scanning Electron Microscopy	FW01010183	TAČR

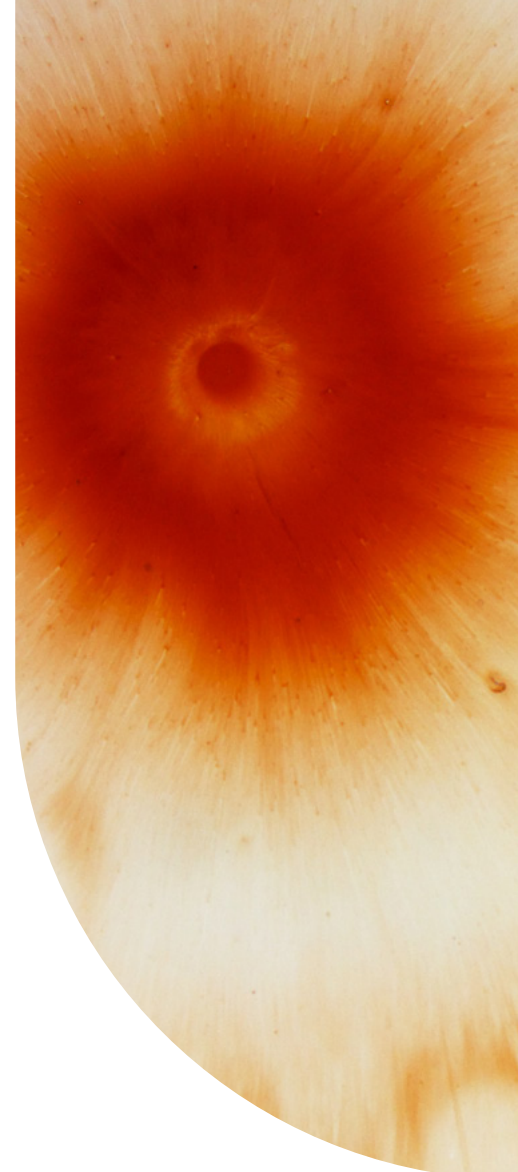




Development of a hybrid magnetic component based on iron oxide nanoparticles to replace solid permanent magnets used in magnetic closures	FW01010267	TAČR
Personalized Medicine – Diagnostics and Therapy	TN01000013	TAČR
GLEBioassay: Nano-Monitoring of Cancer Immunotherapy Efficiency: The Graphene Lateral Electrophoretic Bioassay platform	TH78020001	TAČR
Development of a new generation of RECLIME recycling units for calcium [Ca⁺⁺] recycling used to clean raw sugars and sugar cane	CZ.01.1.02/0.0/0.0/17_176/0015758	MPO
Research and development of optimization of energy intake at metabolic stress states for standardization of glycemic regulation	CZ.01.1.02/0.0/0.0/20_321/0024452	MPO
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_374/0027107	MPO

In the course of 2022, the following projects were awarded, the implementation of which starts in 2023:

Project Title	Number	Provider
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 ground-breaking 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	101130854	Horizon Europe – WIDERA
Nanomaterials and Nanotechnologies for Environment Protection and Sustainable Future	LM2023066	MEYS
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
National Centre of Competence–Polymer Materials and Technologies for the 21st Century	TN02000051	TAČR
Gene bank–the cornerstone for saving biodiversity: development of new technologies for digitization and automation of plant genetic resource storage	SS06020208	TAČR
Conditional automation for the RECLIME recycling unit	FW06010765	TAČR
Insight into cellular proteotoxic stress response using a new microthermal protein damage	JG_2023_033	UP–Young Researcher Grant Competition

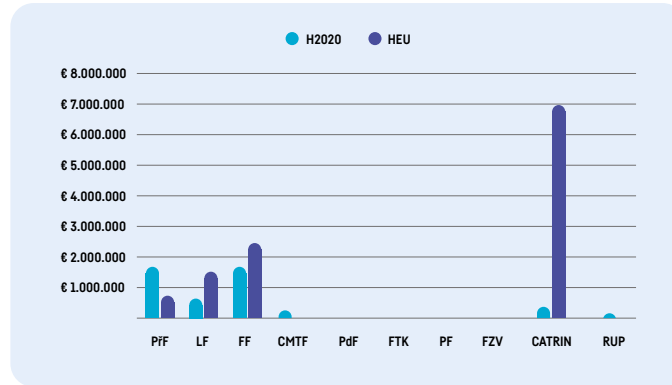
The above-mentioned list of new grants clearly documents the high success rate of CATRIN in winning research projects, especially European projects from the Horizon Europe programme. The following graph shows the volume of Palacký University funding and its distribution among individual units in European grant projects from the expiring H2020 and the incoming Horizon Europe, which were awarded at the end of 2022 or were newly awarded and starts in 2023.

At the end of 2022, CATRIN was implementing or launching European projects covering 47.5% 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.

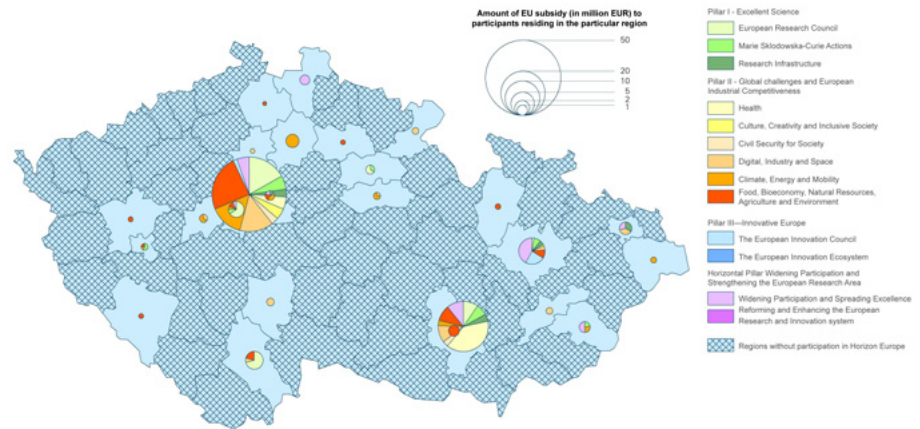
In 2022, the CATRIN teams continued to prepare other projects that will be submitted and evaluated in the course of 2023. In particular, they participated in the preparation of the OP JAK projects from the Excellent Research call, where CATRIN coordinated the preparation of one UP project with the involvement of UP's Faculty of Medicine and Dentistry, Faculty of Health Sciences, Faculty of Arts, Sts Cyril and Methodius Faculty of Theology and Faculty of Law, with Charles University and CEITEC-VUT joining as Co-Investigators. CATRIN participated in other OP JAK project proposals as a Partner.



H2020 and HEU projects—UP budget



Distribution of EU Funding to Participants in the Horizon Europe Programme in CZ according to Regions (27 July 2022)



Zdroj: Evropská komise - eCORDA - 27. července 2022
Zpracoval: Vladimír Vojtěch, TC AV ČR, 24. srpna 2022

3.4. Technology transfer

3.4.1 Licence agreements

No new licence contracts were signed in 2022. Licence fees totalling CZK 1.4 million were paid for CATRIN from licence contracts concluded in 2021 and 2022.

3.4.2 Contractual research

In 2022, contract research was carried out at CATRIN with 11 Czech and 5 foreign commercial companies and 2 research institutes in the Czech Republic in a total volume of 4.6 million CZK. Contractual research at the RCPTM consisted mainly of specific analyses for pharmaceutical companies and deliveries of functionalized magnetic particles for diagnosis of viral diseases, including COVID-19. CRH was mainly involved in expert activities, consultancy and analyses for companies in the field of agrochemistry and plant physiology.

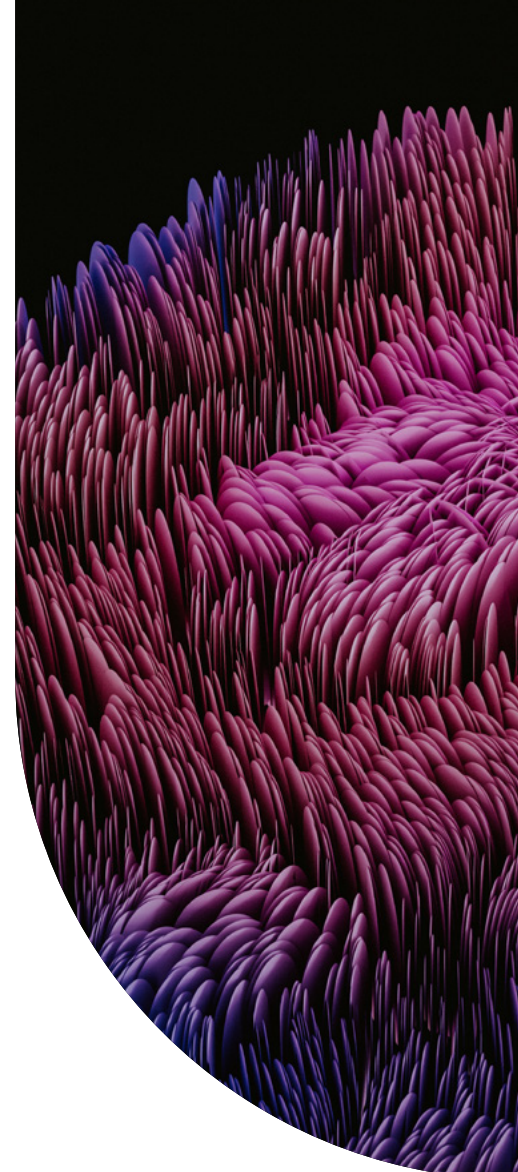
3.4.3. Patents

CATRIN filed a total of 12 patent applications in 2022—3 PCT applications, 4 European Patent applications and 1 each in Canada, USA, Israel, Japan and India. No patents were granted for CATRIN in 2022 as individual patent proceedings are still ongoing. CATRIN employees, in cooperation with LF UP, succeeded in being granted another four patents (in Canada, Korea, Japan and Mexico).

3.5. International collaboration

CATRIN is a Partner of an international COST project CA21101—CONFINED MOLECULAR SYSTEMS: FROM A NEW GENERATION OF MATERIALS TO THE STARS (COSY), whose implementation is shared among researchers from more than 30 countries.

Of the total 270 scientific papers published by CATRIN staff in 2022, a total of 230 articles (85.19%) were produced together with 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	Advanced Materials, 2022, 30 [5]	32.086
	Advanced Functional Materials, 2022, 83, 105828	17.881
	Advanced Functional Materials, 2022, 32 [44]	19.924
	Advanced Materials, 2022, 35 [5]	32.086
Technische Universität München	Chemical Reviews, 2022, 122 [24], pp. 17241-17338	72.087
	Chemical engineering journal, 2022, 449, 137888	16.744
Leibniz Institute for Catalysis	Nature Catalysis, 2022, 5 [1], pp.20-29	40.766
	Nature Nanotechnology, 2022, 17 [5]	40.523
University of Trieste	Joule, 2022, 6 [8], pp. 1727-1732	46.048
Technische Universität Dresden	Angewandte Chemie-International Edition, 2022, 61 [23]	12.732
University of Turin	Nano Energy, 2022, 104 [B]	19.069
Tokyo Institute of Technology, Japan	Small, 2022, 18 [38]	15.135

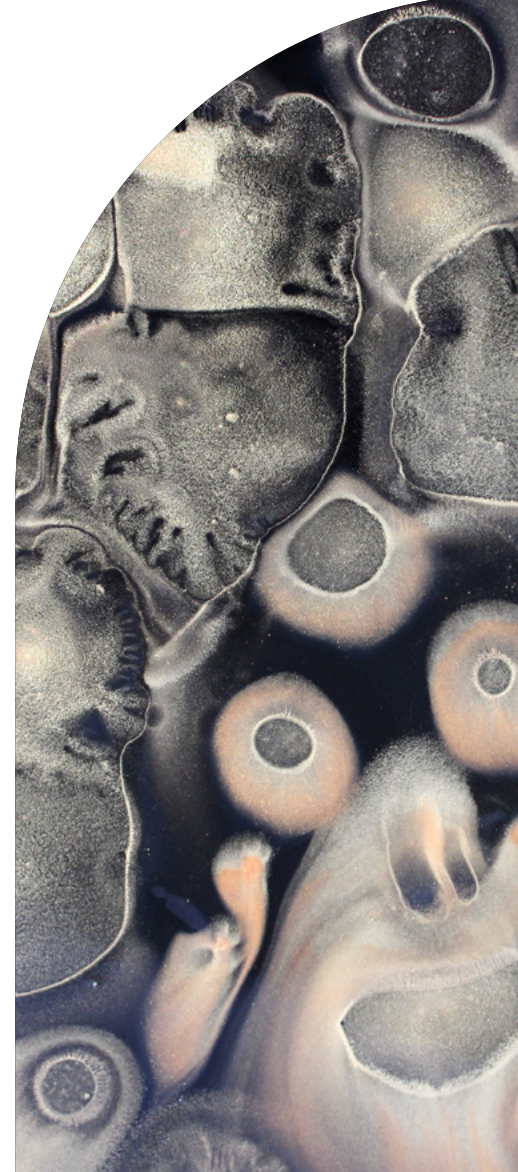
Arizona State University	Nature Communications, 2022, 13 [1]	17,694
Univ Santiago de Compostela	Nature Chemistry, 2022, 14[12]	24,274
Chinese Academy Science, Beijing	ACS Nano, 2022, 16 [5], pp. 8076-8094	18,027
Yonsei University, South Korea	Small, 2022, 18 [22]	15,123
Monash University, Australia	Journal of the American Chemical Society, 2022, 144 [46], pp. 21389-21397	16,383
Catalan Inst Nanoscience & Nanotechnology, Spain	Small, 2022, 18 [23].	15,153

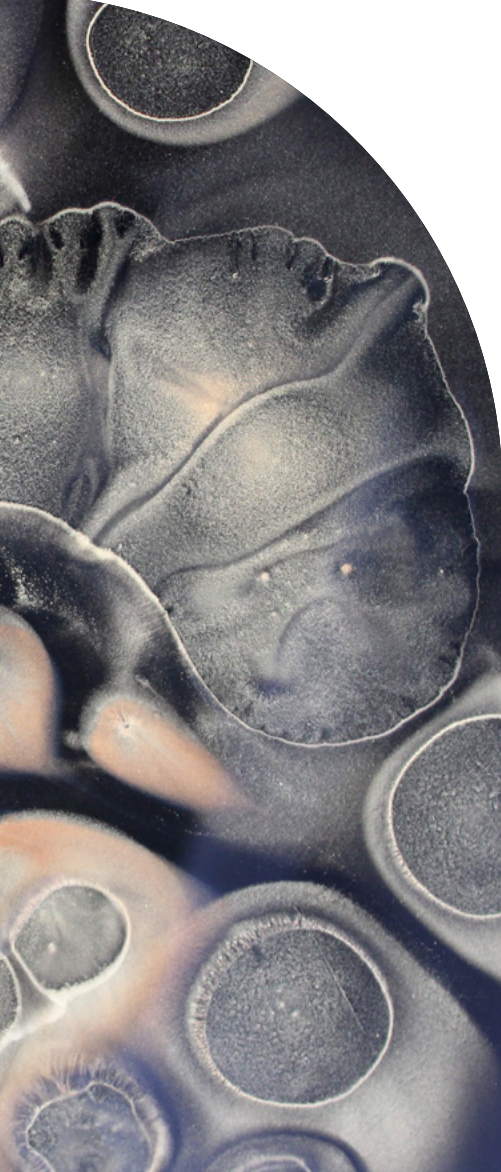
3.6. Scientific conferences organized by CATRIN

Green for Good – Global Challenges: The sixth year of the conference of the Green for Good series, this time round subtitled Global Challenges, took place from 12 to 15 September 2022 in Olomouc. CATRIN organizes this event biannually in collaboration with the European Federation of Biotechnology. The conference has traditionally brought together experts on plant biotechnology or genome editing of economically important crops; however, in accordance with the subtitle of the event, new issues of bioeconomy and circular economy, energy generation and storage in biological systems, a European Green Deal, climate change combat, and other topics were added.

NANOCON: The 14th year of the annual international conference took place from 19 to 21 October 2022 in Brno. 67 lectures and an exhibition of 128 posters were prepared for 232 participants from 19 countries. The central theme was the latest scientific and technological challenges in nanomedicine. As in previous years, Radek Zbořil was the expert guarantor of the programme, which included talks by CATRIN scientists. In the Czech Republic, it is the largest event of its kind and ranks among the largest in the Central European region.

Barrande Bioscience Meeting: CATRIN held the Barrande Bioscience Meeting for the first time in collaboration with the Strasbourg Graduate School of Biotechnology, the French National Centre for Scientific Research (CNRS), and the University of Strasbourg. The conference took place from 9 to 11 October 2022 at the Institute of Molecular





and Translational Medicine LF UP. Experts talked about the use of nanoparticles and nanosystems in the diagnosis and treatment of certain diseases.

- EFB Spring Congress 2022: CATRIN, in particular thanks to Jitka Frébortová, participated in the organization of the virtual conference EFB Spring Congress 2022, which took place from 10 to 13 May 2022

3.7. Promotion and popularization of science and research

CATRIN regularly informs the academic community of Palacký University and the general public about its scientific work, research results, awards, distinguished figures and other interesting topics. For internal communication within Palacký University, the Journal Online is used, as well as the printed Journal UP (e.g., in 2022, CATRIN contributed or co-contributed to about 50 articles in the Journal Online).

Regular information about events in CATRIN is also published on the CATRIN website and also on social networks. CATRIN has its profiles on Facebook, Twitter, Instagram, LinkedIn and YouTube. The primarily electronic version of the CATRIN newsletter is also an important communication tool. In 2022, two issues were published [viz <https://www.catrin.com/cs/media/newsletter/>].

In coordination with the UP Communication Department, CATRIN is involved in the media coverage of science at UP. In 2022, CATRIN prepared (or participated in the preparation of) a total of 14 press releases [see <https://www.catrin.com/en/media/press-releases/#>], which had a significant response in the media, including public media. In total, CATRIN featured in at least 170 media outputs in 2022 [see <https://www.catrin.com/en/media/publicity/>]. In the public space, scientists also respond to important social topics, current events, or try to stimulate public discussion on some topics (for example, European legislation related to new genome editing techniques or the cultivation and use of cannabis).

An important part of scientific work is the popularization of science. In 2022, CATRIN employees engaged in the following events:

- On December 12, a discussion called **About Cannabis, Without Prejudices** was held in the Fort Science, moderated by the Leader of the CATRIN Phytochemistry research group, Petr Tarkowski. The main topic was the legalization of cannabis use for recreational purposes, which was also commented by the national drug coordinator Jindřich Vobořil.
- Leader of the Plant Genetics and Engineering research group, Véronique Bergougnoux-Fojtik discussed with other Czech and Belgian scientists the issue of gene editing and GMO at the **Science Café** in Brussels. The event organized by CZELO, alongside the Representation of the South Moravian Region in Brussels and the Czech Centre

Brussels, on the premises of the Permanent Representation of the Czech Republic to the EU, attracted nearly 70 participants.

- In November, CATRIN participated in the science festival **Week of the Czech Academy of Sciences**. For high school students, CATRIN prepared excursions called **We Explore a World of Small Dimensions but Big Possibilities** and **We Look for Ways to Benefit Plants and Humans**. The issue of mapping insect species diversity thanks to the use of the most modern DNA sequencing methods was addressed by Dominik Kusý and Michal Motyka from the Biodiversity and Molecular Evolution research group in a lecture held in the Fort Science with the participation of grammar school students from Olomouc.

- Several hundred visitors participated in **Researchers' Night** on Friday, September 30, which was organized by CATRIN on its premises. Both children and adults took advantage of the opportunity to explore the laboratories, gain new knowledge on natural sciences and test their senses in a number of interesting experiments. A key attraction was a four-meter large model of the planet Mars, which CATRIN borrowed for this event from Observatory and Planetarium Brno.

- The biochemist and Head of CATRIN-CRH, Ivo Frébort, spoke about new breeding techniques and the upcoming change of EU regulatory rules at the seminar **Trends and New Technologies of Sustainable Agriculture**, organized in Zábřeh on 10 August by the Innovation Centre of the Olomouc Region ICOK.

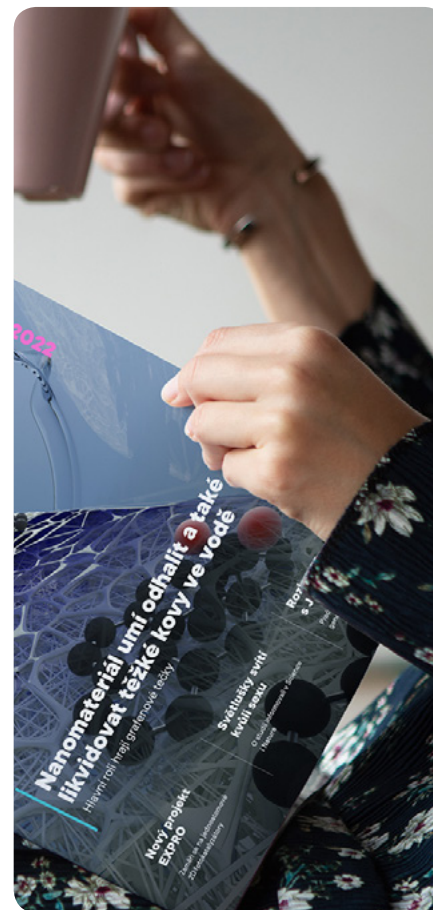
- Especially junior scientists from CATRIN prepared a **day-long programme for children from the city camp**, which was organized by the Fort Science Olomouc. The participants could see microscopes, experiments with liquid nitrogen, including the popular experiment “rocket”, and prepared their own lava lamps or nanoparticles of sulfur.

- CATRIN organizes excursions for **secondary and elementary schools** during the school year. For example, on June 17, it welcomed students of the 9th grade from FZŠ Stupkova in Olomouc, who learned about the preparation of nanomaterials as well as about their applications. A week earlier, children from Horní Moštěnice elementary school and students from SPŠE Mohelnice got the opportunity to watch CATRIN scientists in labs. In April, students from Gymnázium Čajkovského Olomouc and Cirkevní gymnázium Německého řádu Olomouc visited the Institute.

- CATRIN participated for the first time in the largest educational event in the Czech Republic—the **Science Fair of the Czech Academy of Sciences**, which took place on June 2–4 in Prague's Letňany region. CATRIN researchers presented plant and material researchers to the public in an interactive and entertaining way.

- CATRIN presented itself as a partner of the international festival **Academia film Olomouc 2022**. Among other things, CATRIN introduced a new spot to the audience and visitors. Within the programme section Young Scientists at UP, Lukáš Zdražil presented his research focused on the development of nanomaterials for luminescent solar concentrators.

- Entomological collections focused mainly on the species diversity of beetles could be seen at the event **Odpudiví nebo kouzelní (Repulsive or Magical)**, which took place in the Fort Science on 26 and 27 March. They were presented by researchers from the CATRIN group Biodiversity and Molecular Evolution. A big attraction was also breeding colonies of fireflies, on which scientists are conducting research. Dominik Kusý and Michal Motyka also presented their research from the perspective of entomologists at the lecture Island of New Guinea.



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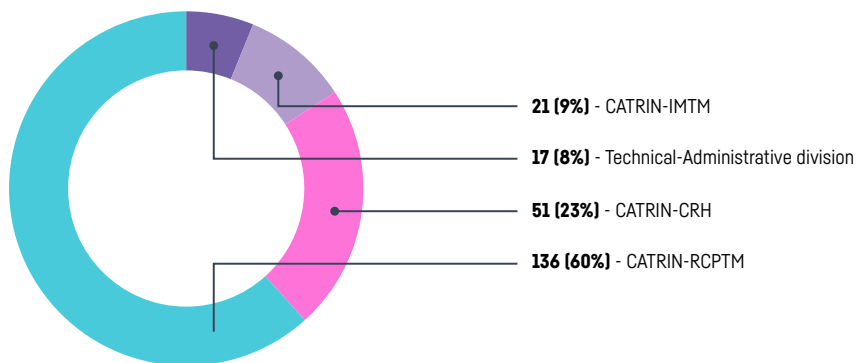
Staff



4.1. Age and qualification structure

During 2022, there were no major changes in the staffing of CATRIN. In 2022, a total of 225 employees worked at CATRIN. Of this number, 21 employees straddle the IMTM, the IMTM-LF and CATRIN-IMTM, of which 18 are part of the Faculty of Medicine and Dentistry, 3 are based at CATRIN. The majority of the 225 employees are employees of CATRIN-RCPTM, CATRIN-CRH and CATRIN-IMTM divisions (92% in total), which are further divided into individual research groups. The Technical-Administrative Division is responsible for the management of the Institute, with employees accounting for 7.56% of the total number of staff.

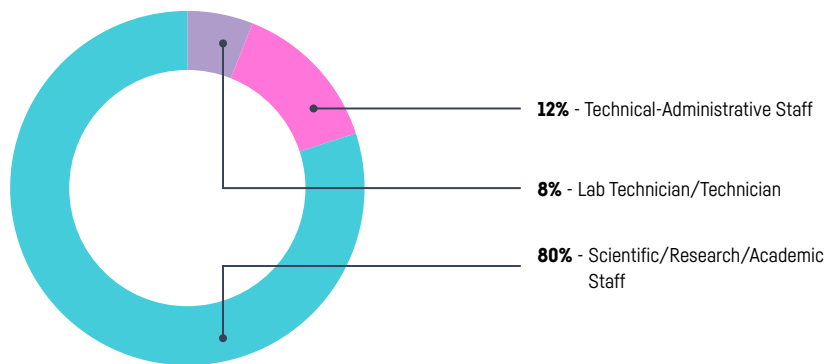
The Number of CATRIN's Employees in 2022



The entire CATRIN team consists of 46.2% women and 53.8% men. The share of foreign workers within the Czech environment is very high and reaches 29.8% (33.67% in the category of researchers, lab technicians and technicians). CATRIN also reaches above-average figures in the percentage of women in scientific positions. According to the UN, if the share of women in science is over 33% worldwide and only 27% in the Czech Republic, CATRIN has approximately 34.8% women of the total number of scientists.



The Structure of CATRIN's Employees in 2022



Staff Category	Number	FTE
Lab Technician/Technician	18	15.0
Technical-Administrative Staff	26	22.7
Technical Administrative Staff	181	131.7
Scientific Research Staff	225	169.4

The average age of CATRIN employees is 39.77 years, so it is a very young and progressive team. Absolutely and relatively the most represented is the age category 31-40 years. Very balanced are the categories 21-30 and 41-50 years, from which it can be concluded that the team of the Institute is well-proportioned and has a high potential for further development.

Age Category	Number	Share [%]
21 - 30	33	14.7
31 - 40	106	47.1
41 - 50	53	23.5
51 - 60	25	11.1
61 - 70	6	2.7
71 - 80	2	0.9
Total	225	100.0

4.2. Significant awards

CATRIN employees have achieved significant successes and won prestigious awards

The **Neuron Prize 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 endowment fund appreciated his lifelong work in the field of chemistry, which has enriched the world's research. In addition to his work at the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences, Professor Hobza is also one of the scientific backers of CATRIN.

The **Werner von Siemens Prize** in the Most Important Result of Basic Research category was awarded to a group of authors led by Bruno de la Torre. Junior scientists based at CATRIN of Palacký University and the Czech Academy of Sciences were awarded for a breakthrough imaging method, thanks to which they were the first in the world to observe the inhomogeneous distribution of electron charge around a halogen atom, the so-called sigma hole. They thus definitively confirmed its existence, which was theoretically predicted 30 years ago.





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 the VIEW journal. The interdisciplinary journal published by Wiley is focused on in vitro and in vivo biodiagnostics using biomaterials. 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 its 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.

Head of CATRIN-RCPTM, Michal Otyepka, attended The Graphene Flagship Annual Meeting held in Dublin in April 2022. The topic of his talk was 2D chemistry.

5

Major Events



5.1. Kick-off meeting of European Innovation Council (EIC) project

A Kick-off meeting with the participation of all partners launched a unique project in the Czech republic funded by the European Innovation Council (EIC) Transition Challenges with a budget of nearly 62.5 million Czech koruna, at the end of which is to be a prototype of a supercapacitor for storing electrical energy with a nanomaterial developed by scientists from CATRIN. They are collaborating with colleagues from Bar-Ilan University in Israel and the Italian company ITELCOND with the aim to bring the discovery closer to practice. Compared to batteries, the new device will be safer, more environmentally friendly, cheaper and, above all, will have a high capacity and a long service life.



5.2. Interest in collaboration between CATRIN and LIKAT resulted in the signing of a Memorandum

Representatives of the Czech Advanced Technology and Research Institute (CATRIN) of Palacký University and the Leibniz Institute for Catalysis in Rostock, Germany, have committed themselves to research cooperation, implementation of joint research projects, including doctoral theses, exchange of know-how or, for example, organisation of joint conferences, workshops or seminars by signing a Memorandum of Understanding. Both institutions have thus confirmed their interest in deepening existing collaboration in the fields of catalysis, nanotechnology, sustainable reactions and new materials.



5.3. CATRIN a ICN2 formally confirmed their collaboration

A Memorandum of Understanding was signed on 10 May by the Directors of CATRIN and the Catalan Institute of Nanoscience and Nanotechnology (ICN2). They have committed themselves to scientific cooperation, exchange of knowledge and researchers. The signing of the document was preceded by a two-day workshop focused on a number of topics in the field of nanoscience and nanotechnology. The two institutes will create joint projects, identify suitable funding opportunities, facilitate the mobility of visiting scientists and students, and jointly organize scientific seminars and conferences. In October, a joint two-day workshop was held in Olomouc.



5.4. CATRIN management made contacts in Benelux

Presentation of research results as well as discussions on the possibilities of cooperation with academic and commercial partners were part of a “nano tour” in Benelux made by representatives of the CATRIN management during the last week of March. In addition to meetings and seminars at Embassies in Luxembourg, Brussels and The Hague, they also visited the IMEC research institute in Leuven, which is active in the field of nanoelectronics and digital technologies.



5.5. Workshop Nanotechnologies in HealthTech

The CATRIN management presented the results of research in the field of nanotechnology application in biomedicine and participated in the debate on possibilities of cooperation with academic and commercial partners within the workshop Nanotechnology in HealthTech. The workshop took place in May 2022 at the Czech Embassy in Helsinki and focused mainly on deepening mutual Czech-Finnish cooperation.



5.6. Workshop with SUSNANO project partners

CATRIN welcomed researchers from the University of Tirana, with which it collaborates, alongside ICN2 in Barcelona and Intelligentsia Consultants Sarl, as part of the international SUSNANO project. In addition to exchanging experience and knowledge, the main objective of this Horizon Europe project is the development of an electrochemical sensor for water quality control.

5.7. CATRIN-BINA workshop

A tour of the laboratories, presentation of the work of the CATRIN research groups and discussions on possible collaboration were the topics of a two-day meeting with the Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) researchers at Bar-Ilan University. In the past, both institutions signed a memorandum of cooperation.



6

Internationalization



CATRIN is a research institute with a rate of internationalisation reaching almost 30%. The largest number of foreign employees come from India (13), Slovakia (9), Greece (5), Iran (6), France (5), Spain (5), Italy (5) and Ukraine (4). Two employees each are from Poland and Vietnam. In addition, CATRIN employs scientists from Belgium, Brazil, USA, Croatia, Germany, Japan, Mexico, Colombia, Vietnam, Congo and China.

As part of its internationalisation, CATRIN focuses on systematically building strategic partnerships with major global research institutions. In the second year of its full operation, CATRIN thus put emphasis on building and strengthening these links.

6.1. European Federation of Biotechnology (EFB)

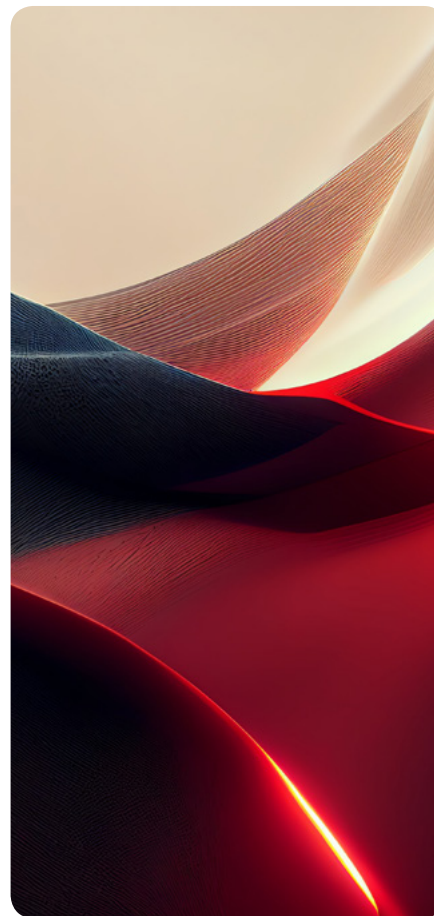
CATRIN is the Regional Branch Office (RBO) of the European Federation of Biotechnology—a non-profit organisation bringing together national biotechnology companies, scientific societies and institutes, universities, biotechnology companies and individuals. The EFB promotes safe, sustainable and beneficial 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.

In 2022, CATRIN co-hosted with the EFB the international conference Green for Good on Plant Biotechnology. The conference is held once every two years in Olomouc. The most important guests of this year's event included, for example, the President of the European Plant Science Organisation (EPSO), Alan Schulman, from the University of Helsinki, a leading expert on the diagnosis and treatment of diseases in vegetables, Gary Vallad from the University of Florida, or Jeff Cole, the president of the EFB.

International contacts within the EFB help CATRIN to engage in international consortia and research projects. In 2022, mutual cooperation within the EFB contributed to winning the European BEST-CROP project.

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. In 2022, CATRIN and BINA colleagues launched a



joint European research grant of the European Innovation Council EIC Transition Challenges, whose principal investigator is Prof. Michal Otyepka. Furthermore, a joint workshop with BINA colleagues aimed at deepening mutual cooperation was held in Olomouc.

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 six other 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 on 10 May 2022. The agreement aims to promote collaboration and knowledge exchange between the two institutions. The two institutes will create joint projects, identify suitable funding opportunities, facilitate the mobility of visiting scientists and students and jointly organize scientific seminars and conferences. CATRIN has so far obtained three European projects with colleagues from ICN2: SUSNANO, GLEBioassay and 2D-BioPAD. Collaboration with colleagues from ICN2 resulted in several successful publications in the field of biosensors and in 2022 a joint workshop focused on deepening mutual cooperation was held in Olomouc.

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 and committed themselves to research cooperation, the implementation of joint research projects including doctoral theses, exchange of know-how or, for example, the organisation of joint conferences, workshops or seminars. In 2022, mutual collaboration resulted in the publication of several research studies that were published in prestigious journals such as Nature Catalysis or Nature Nanotechnology.





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