CATRIN

Czech Advanced Technology and Research Institute

Palacký University Olomouc

Annual Activity Report

of the Czech Advanced Technology and Research Institute
for the year 2021

Introductory word of the Director

The year 2021 was not only a great challenge for the newly established Czech Advanced Technology and Research Institute (CATRIN) but also a demanding test of the abilities and skills of all its employees. We faced difficult tasks consisting in building and bringing to life a completely new part of Palacký University Olomouc. It was necessary to create and start standard administrative operations, covering both Finance and HR Offices, as well as the administrative background of the Director and the Secretary's agenda. It was also necessary to integrate the key sections of grant support and technology transfer and to systematize their use across the whole Institute. All this happened under non-standard conditions influenced by the Covid-19 pandemic and the current need to maintain the full scientific performance of the teams that were integrated into CATRIN from three research centres– RCPTM, CRH, and IMTM. None of this would have been possible without the enthusiasm and dedicated work of CATRIN's employees. I am very proud that our Institute rose up to these formidable challenges, and I am espe-

cially proud of every single staff member who has chosen to be part of our joint team and contributes to securing CATRIN's place, and thus Palacký University's, on the world's scientific map.

In the field of science and research, the past year has been very successful for CATRIN. CATRIN research teams have maintained their high performance and published their results in a number of prestigious and highly impacted journals such as Nature Catalysis (IF 41,813), Advanced Materials (IF 30,849), or Chemical Reviews (IF 60,622). In 2021, colleagues from CATRIN-RCPTM achieved significant success by dramatically increasing the resolution capabilities of scanning microscopy and were the first in the world to directly observe the so-called sigma hole, the subatomic details of the inhomogeneous electron charge distribution around a halogen atom. They literally looked where no one has ever looked before. This success was crowned with the first-ever first-authored article in the prestigious journal Science, by which CATRIN contributed to strengthening the scientific reputation of our university. Also in the area of grant support, the past year has been extraordinary. Thanks to sharing experience, integration, and systematization in the area of grant support at CATRIN, we were able to create and submit an unprecedented number of grant applications. The effort put in this work starts to gradually bear its fruit in the form of awarded research projects. At the end of 2021, for example, a highly prestigious grant of the European Innovation Council (EIC Transition Challenges), which is the first project of its kind in the Czech Republic, was approved for funding. Another of CATRIN's missions, which is to proactively search for joint scientific-research opportunities in cooperation with individual faculties across Palacký University, has been successfully fulfilled. In 2021, for example, a joint project with colleagues from the UP Faculty of Health Sciences within the Horizon Europe programme was successfully submitted.

In the field of technology transfer, CATRIN contributed significantly to further commercialization of a whey protein separation technology, in particular lactoferin and lactoperoxidase, from a milk medium. CATRIN also created a spin-off company involved in the design and sale of Mössbauer spectrometers.
The year 2021 also brought the conclusion of a new strategic partnership with colleagues from Bar-Ilan Institute of Nanotechnology and Advanced Materials at Bar-Ilan University in Israel. Further negotiations on a number of new strategic partnerships, whether in the framework of international cooperation or at the national level, were launched.

CATRIN has thus started to fulfil the objectives for which it was founded and for which Palacký University decided to integrate the research capacities of part of its research centres into a university institute. In a number of cases, the goals planned for the several-year integration period were already achieved in the first year. CATRIN is now a well-established institute on the European and world's scientific map, is able to demonstrate its ability to succeed in challenging and prestigious international grant competitions, enhances the reputation of Palacký University in the field of science and research, and proactively seeks and builds both strategic partnerships in the international environment and opportunities for mutual cooperation within the university.

It is therefore an honour for me to present this annual report on the activities of CATRIN as well as all the accomplishments that CATRIN achieved in just one year of its full operation. I extend my gratitude to all who are involved in the construction and operation of CATRIN. It is only thanks to the coherent team of talented and enthusiastic scientists and dedicated administrative staff members that we are able to build together this research institute, which has the ambition to be one of the strongest research institutions at European and world level and thus significantly contribute to spreading the reputation of Palacký University Olomouc. I extend my deep appreciation and thanks to all CATRIN employees, as well as wishing them continued enthusiasm and further success in the coming years.

Pavel Banáš, Director

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4. Staff

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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 Čejka, DrSc.** (Univerzita Karlova, CZ)
- **Ing. Nuria De Diego, Ph.D.**
- **prof. Ing. Jaroslav Doležel, DrSc.** (Institute of Experimental Botany of the 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 Praha, 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. (VÚRV, CZ)

1.3. CATRIN's Supervisory Board

Chair:
- **Ing. Jiří Přidal** (do 10/2021),
- **Mgr. Petra Jungová, LL.M.** (od 11/2021)

Members:
- **doc. Mgr. Michal Botur, Ph.D.**
- **Mgr. Jakub Doležel, Th.D.**
- **JUDr. Ondrej Hamuľák, 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	Head of the Group
CATRIN-CRH	Protein Biochemistry and Proteomics	prof. Mgr. Marek Šebela, Dr.
	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-Fojtík, Ph.D.
	Phytochemistry	doc. RNDr. Petr Tarkowski, Ph.D.
	Phenotyping	Mgr. Lukáš Spíchal, 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 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. Issued Standards and Regulations

The CATRIN Director issued the following standards and regulations in 2021

Number	Title	From
CAT-A-21/02	Rules of Procedure of CATRIN Scientific Board	23. 4. 2021
CAT-A-21/03	Rules of Procedure of CATRIN Supervisory Board	5. 6. 2021
CAT-B-21/01	Rules for withdrawing social funds	1. 4. 2021
CAT-B-21/02	Rules for spending annual leave	28. 6. 2021
CAT-B-21/03	Granting a day off on December 23 and 30 at CATRIN	10. 12. 2021

2

Educational Activity

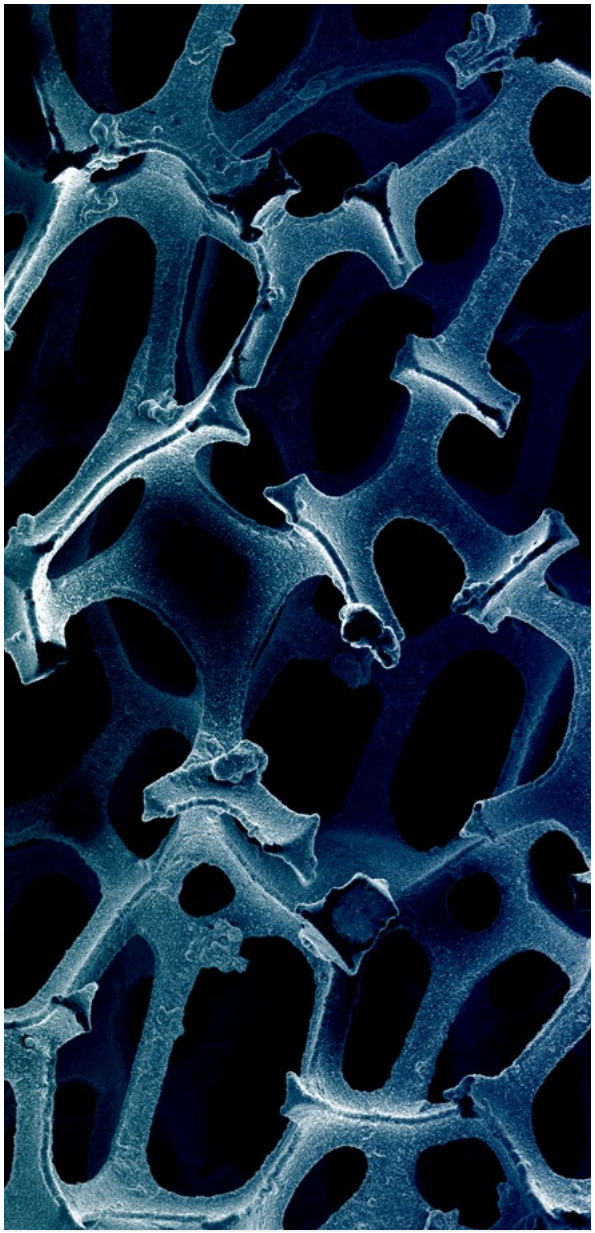
The Higher Education Institute may participate in educational activities carried out within study programmes accredited at individual faculties on the basis of provisions in Section 34 (1) of Act No. 111/1998 Sb., the Higher Education Act. Employees of the CATRIN Higher Education Institute are involved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

2.1. Overview of CATRIN employees' involvement in teaching at faculties

In 2021, 35 employees of the institute taught at one of the faculties and 27 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
PřF/KFC	24	17
PřF/KEF	4	1
PřF/SLO	1	0
PřF/KBC	8	6
PřF/LRR	3	3
PřF/KCB	1	0
PřF/ZOO	1	1
PřF/BOT	1	0
PřF/KBB	0	1
total*	**35**	**27**

**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, 31 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	6
Master's students	5
Doctoral students	46
Total number	**57**

Defended dissertations supervised by CATRIN employees:

Students	Supervisors	Title	Defended
Tomáš Malina	prof. Radek Zbořil	Toxicity of carbon-based nanomaterials	15.11.2021
Petra Skácelová	prof. Radek Zbořil	Reactivity and migration of nZVI in groundwater remediation technologie	25.10.2021
Eyrilmez Saltuk Mustafa	prof. Pavel Hobza	Quantum Mechanical Investigation of Non-Covalent Interaction in Protein-Ligand and Nanomaterial Complexes	30.6.2021
Santhini Vijai Meena	doc. Pavel Jelínek	Chemical and Physical Properties of Nanostructures on Surface Investigated by Scanning Probe Microscopy	15.10.2021

Talande Smita	Dr. Aristeides Bakandritsos	Composites of two-dimensional materials for energy storage	16.2.2021
Michaela Králová	Prof. Ivo Frébort	Genetic transformation of fungi from the order Hypocreales	21.6.2021

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.

- **Third place in the Jean-Marie Lehn Prize for Chemistry 2021**, which the French Embassy along with Solvay honours young scientists in the field of chemistry, goes to the PhD student Michal Langer. In the competition he presented the possibilities of modelling nanoparticles using computational chemistry, including research focused on carbon dots. Along with Michal Langer, his supervisor Michal Otyepka from CATRIN received the award as well.

- **Veronika Šedajová took the honourable mention** for the poster titled Nitrogen Doped Graphene in Symmetrical Sustainable Supercapacitor with Record Energy Density from the 13th year of the international Nanocon conference in Brno. The young scientist was also awarded at the School of Catalysis conference in Liblice for the best presentation.

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

In 2021, students led by supervisors from CATRIN were sent, as part of their scientific research activities carried out at CATRIN, to internships in important foreign scientific research institutes with which CATRIN cooperates.

Students	Institute	Duration
Veronika Šedajová	Drexel University, Philadelphia USA	10.1 - 31.5 2021
Jan Belza	National University of Ireland Maynooth, Ireland	29.9. - 1.11. 2021
Ludmila Žárská	Institute of Science and Technology for Ceramics CNR, Italy	17.9. - 18.10. 2021
Mahdi Shahrezaei	University of Trieste, Italy	1.9. - 2.12. 2021

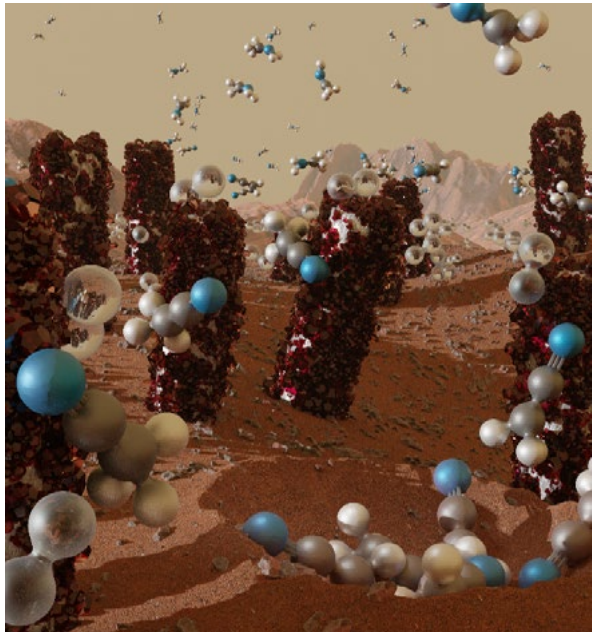
Tomáš Malina from CATRIN, who defended his dissertation in November, will be working at the prestigious Karolinska Institute in Sweden from February 2022. He succeeded in a competition of more than 30 candidates for a postdoc position at this prestigious institute. He will be on the team of Professor Fadeel's, one of the world's best groups in the field of nanotoxicity, to implement a new scientific project.

3

Research and Development

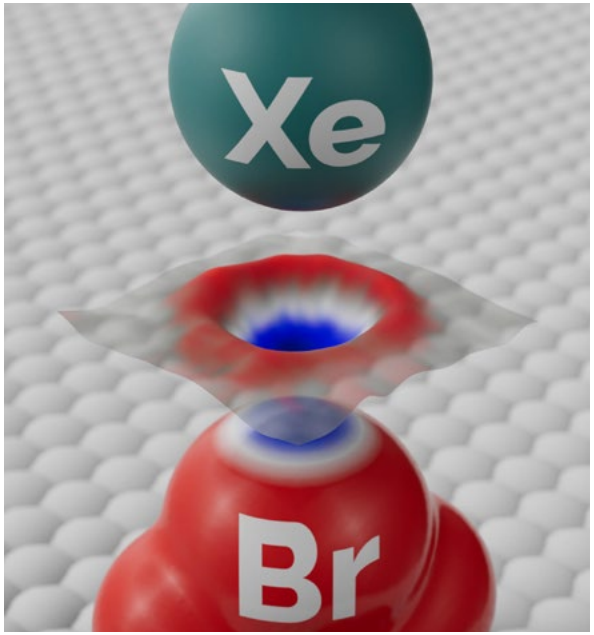
3.1. Significant discoveries of CATRIN in the field of science and research in 2021

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



Scientists from CATRIN and VSB-TUO have developed, in collaboration with colleagues from the Leibniz Institute for Catalysis in Rostock, Germany, a unique eco-friendly nanomaterial that can enable cheaper and more effective production of many important pharmaceuticals and chemicals. The results of this Czech–German research were published at the end of the year in the prestigious journal Nature Catalysis.

Chandrashekhar 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 2021, 5, 20-29. IF = 41,813 https://doi.org/10.1038/s41929-021-00722-x

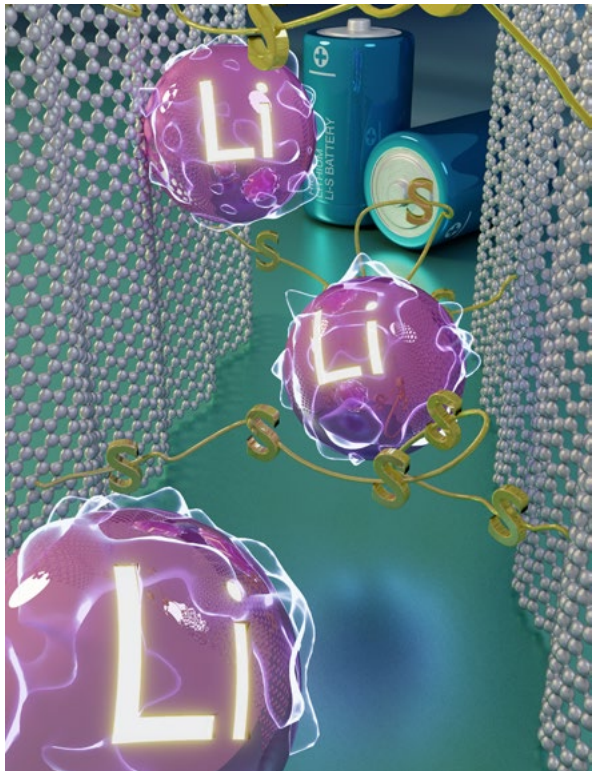


Czech scientists, including CATRIN workers, presented a method by which they were the first in the world to observe the inhomogeneous distribution of electron charge around a halogen atom. They confirmed the existence of a phenomenon that was theoretically predicted but not directly observed. The discovery was published in the journal Science.

Mallada B., Gallardo A., Lamanec M., de la Torre B., Špirko V., Hobza P., Jelínek P.: Real-space imaging of anisotropic charge of σ-hole by means of Kelvin probe force microscopy. Science 2021, 374 (6569), 863-867 IF= 47, 728

A total of 11 biostimulants obtained by hydrolysis of plant waste material and their effect on the model plant Arabidopsis thaliana were studied by researchers from CATRIN, Palacký University, PSI and Italian universities. By combining automated large-scale plant phenotyping with non-targeted metabolomics, they not only described the functions of individual biostimulants but also revealed their mechanisms of action. The work was published in Frontiers in Plant Science.

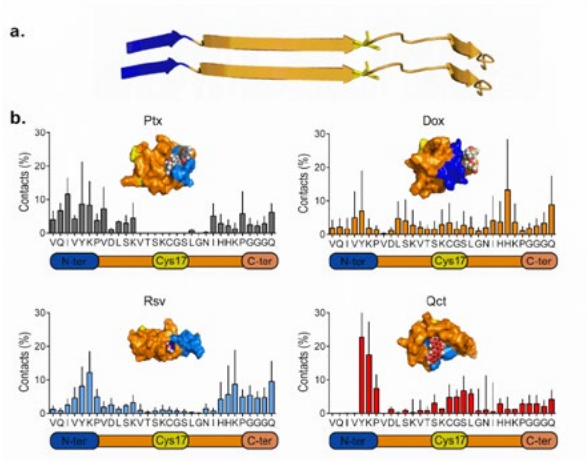
Sorrentino M., De Diego N., Ugena L., Spíchal L., Lucini L., Miras-Moreno B., Zhang L., Rouphael Y., Colla G., Panzarová K.: Seed Priming With Protein Hydrolysates Improves Arabidopsis Growth and Stress Tolerance to Abiotic Stresses. Frontiers in Plant Science 2021, 12:626301. IF=5,753



Favourable price, high performance as well as stability and long life–these are the advantages of the new material designed for lithium battery cathodes developed by CATRIN scientists. The composite, which has great potential for practical application, was created by combining the properties of modified fluorographene and sodium polysulfide. The material has already been submitted to the European Patent Office.

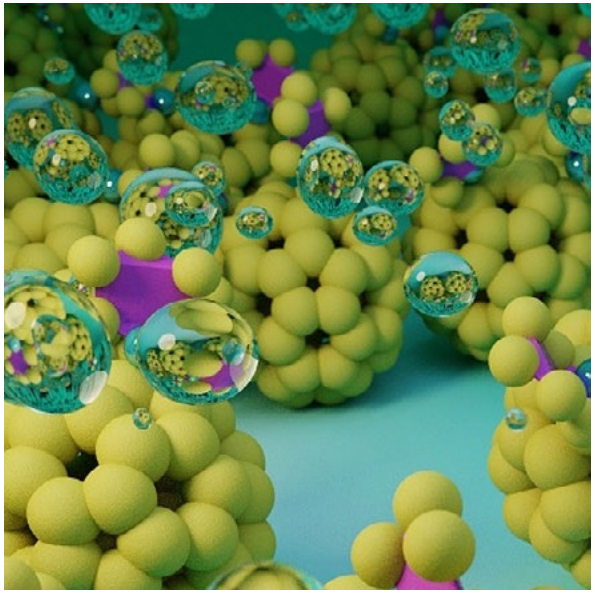
Tantis I., Bakandritsos A., Zaoralová D., Medveď M., Jakubec P., Havláková J., Zbořil R., Otyepka M.: Covalently Interlinked Graphene Sheets with Sulfur-Chains Enable Superior Lithium–Sulfur Battery Cathodes at Full-Mass Level. Advanced Functional Materials 2021, 31 (30), 2101326. IF = 18,808

The potential use of some commonly available and experimental anti-cancer drugs in the fight against Alzheimer's disease was explored by scientists from CATRIN together with colleagues from IMTM and other departments of Palacký University, Italy's Mario Negri Institute for Pharmacological Research, and Ostrava's IT4Innovations VŠB-TUO. In a study published in the FEBS Journal they confirmed that some anti-cancer agents are able to effectively block, at an early stage, formation of aggregates of so-called TAU proteins, which are present in brain tissues of patients with Alzheimer's disease.



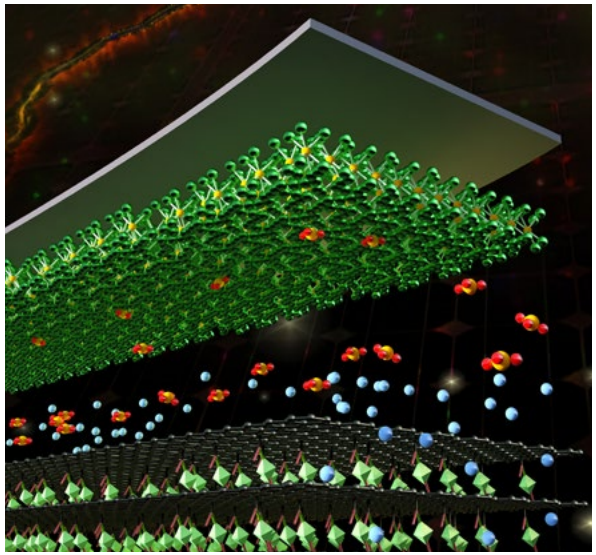
Annadurai N., Malina L., Salmona M., Diomede L., Bastone A., Cagnotto A., Romeo M., Šrejber M., Berka K., Otyepka M., Hajdúch M., Das V.: Antitumour drugs targeting tau R3 VQIVYK and Cys322 prevent seeding of endogenous tau aggregates by exogenous seeds. The FEBS Journal 2021, in press. IF = 5,542

Scientists from CATRIN, IOCB, and VSB-TUO described the reaction of fullerene and piperidine, in which this nanomaterial dissolves. In two studies, published by prestigious journals JACS and Angewandte Chemie, they scrutinized reactions between secondary amines (piperidine) and fullerene consisting of 60 carbon atoms on the basis of theoretical calculations as well as experiments. These findings can contribute to further application of this nanomaterial, for example, in energy storage.



Lo R., Manna D., Lamanec M., Wang W., Bakandritsos A., Dračínský M., Zbořil R., Nachtigallová D., Hobza P.: Addition Reaction between Piperidine and C60 to Form 1,4-Disubstituted C60 Proceeds through van der Waals and Dative Bond Complexes: Theoretical and Experimental Study. Journal of the American Chemical Society 2021, 143 (29), 10930-10939. IF = 15, 419

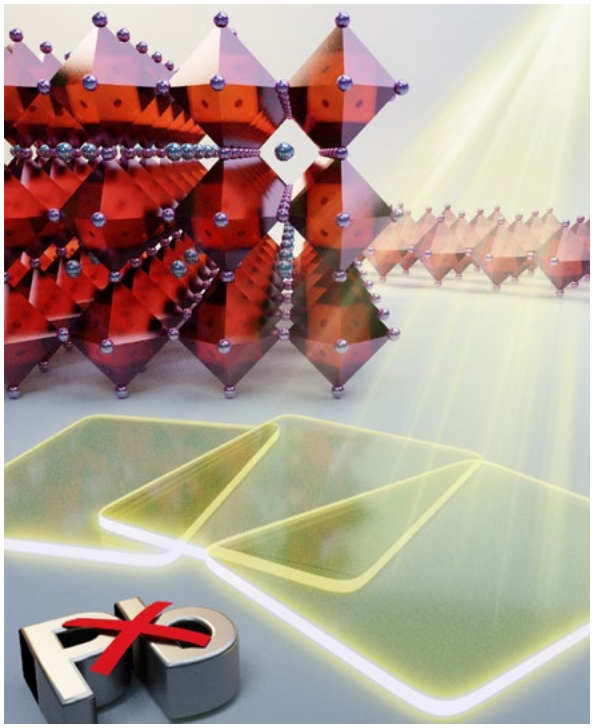
Lamanec M., Lo R., Nachtigallová D., Bakandritsos A., Mohammadi E., Dračínský M., Zbořil R., Hobza P., Wang W.: The Existence of a N→C Dative Bond in the C60–Piperidine Complex. Angewandte Chemie 2021, 60 (4), 1942-1950. IF = 15, 336



Two unique classes of carbon materials are graphene derivatives and metal organic frameworks (MOFs). Linking their properties to develop new technologies has long been the focus of CATRIN scientific teams in collaboration with colleagues from the Technical University of Munich. Now they have prepared a material that exhibits excellent properties for use in so-called supercapacitors.

Jayaramulu K., Horn M., Schneemann A., Saini H., Bakandritsos A., Ranc V., Petr M., Stavila V., Narayana C., Scheibe B., Kment Š., Otyepka M., Motta N., Dubal D., Zbořil R., Fischer R. A.: Covalent Graphene-MOF Hybrids for High-Performance Asymmetric Supercapacitors. Advanced Materials 2021, 33 (4), 2004560. IF = 30, 849

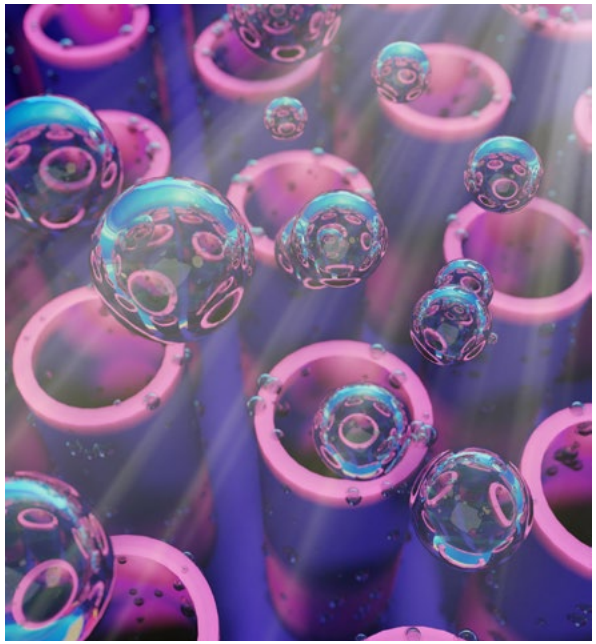
The first transparent luminescent solar concentrator (LSC) based on lead-free perovskite nanocrystals was developed by scientists from CATRIN in collaboration with colleagues from University of Erlangen–Nuremberg, Germany; Brno University of Technology; and VSB – Technical University of Ostrava. The unique solution overcomes the disadvantages of the existing perovskite solar energy devices, namely the presence of lead and low stability.



Zdražil L., Kalytchuk S., Langer M., Ahmad R., Pospíšil J., Zmeškal O., Altomare M., Osvet A., Zbořil R., Schmuki P., Brabec Ch. J., Ozyepka M., Kment Š.: Transparent and Low-Loss Luminescent Solar Concentrators Based on Self-Trapped Exciton Emission in Lead-Free Double Perovskite Nanocrystals. ACS Appl. Energy Mater. 2021, 4 (7), 6445-6453. IF = 6, 024

Scientists from Palacký University developed a new way to overcome bacteria's resistance to silver nanoparticles, which are commonly used in medicine for their antimicrobial effect. This method has great potential in fighting harmful pathogens, particularly in local disinfection and antibacterial therapy. This work was published in Advanced Science, and made it to the cover.

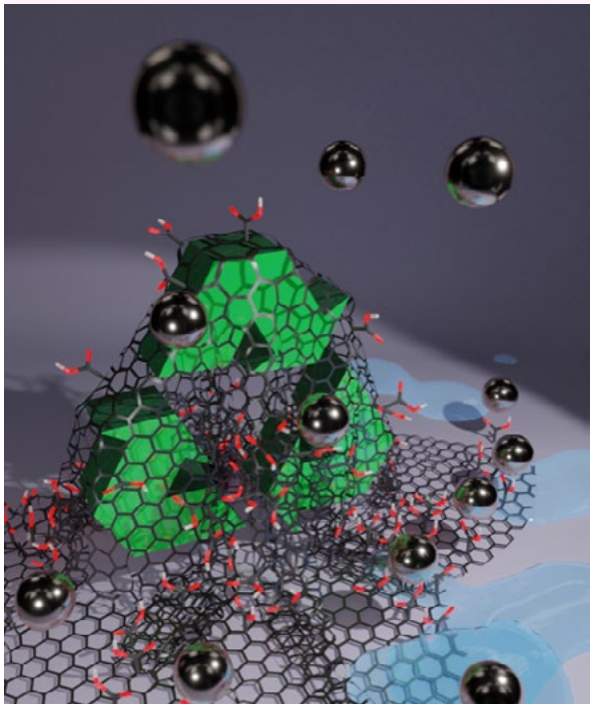
Panáček D., Hochvaldová L., Bakandritsos A., Malina T., Langer M., Belza J., Martincová J., Večeřová R., Lazar P., Poláková K., Kolařík J., Válková L., Kolář M., Otyepka M., Panáček A., Zbořil R.: Silver Covalently Bound to Cyanographene Overcomes Bacterial Resistance to Silver Nanoparticles and Antibiotics. Adv. Sci. 2021, 2003090. IF = 16, 806



An international team of scientists led by researchers from CATRIN has developed, in collaboration with American, German and Italian colleagues, ultra-small and highly efficient solar furnaces used for removing toxic gases, desalination, or as steam generators and chemical reactors for the production of nanomaterials. These nanofurnaces feature a size of several tens of nanometres in diameter and can be made in the form of thin films or panels transforming the solar energy into heat, thus reaching temperatures of up to 600 degrees Celsius. The results of the unique technology, which the author team protects with an international patent application, were published in Nano Letters and Nano Energy.

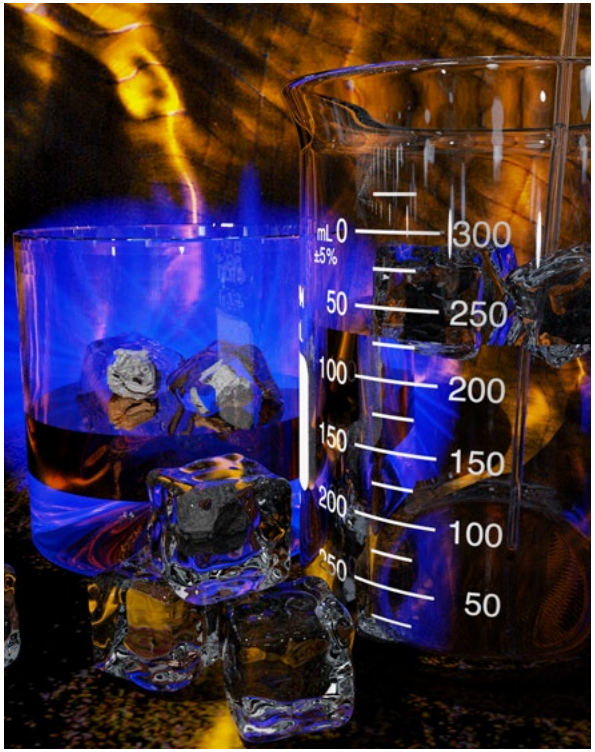
Mascaretti L., Schirato A., Zbořil R., Kment Š., Schmuki P., Alabastri A., Naldoni A.: Solar steam generation on scalable ultrathin thermoplasmonic TiN nanocavity arrays. Nano Energy 2021, 83, 105828. IF = 17, 881

A new type of graphene acid-based sorbent, which can remove heavy metals from contaminated waters but can also serve to extract noble metals from aqueous environments, was developed by a team of scientists from CATRIN, VŠB–TUO, and the Institute of Organic Chemistry and Biochemistry of the Czech Academy of Sciences. Graphene acid is a two-dimensional organic acid which has been developed in Olomouc for several years, also thanks to a grant funded by the European Research Council.



Kolařík J., Bakandritsos A., Bad'ura Z., Lo R., Zoppellaro G., Kment Š., Naldoni A., Zhang Y., Petr M., Tomanec O., Filip J., Otyepka M., Hobza P., Zbořil R.: Carboxylated Graphene for Radical-Assisted Ultra-Trace-Level Water Treatment and Noble Metal Recovery. ACS Nano 2021, 15, 3349-3358. IF = 15, 881

The mechanism behind quenching the fluorescence of carbon dots during the water–ice phase transition was unveiled by scientists from CATRIN in collaboration with colleagues from the City University of Hong Kong. The discovery was capitalized on by designing a method that has the chance to become a cheap and non-invasive diagnostic tool in screening for early-stage lung cancer.



Kalytchuk S., Zdražil L., Bad'ura Z., Medveď M., Langer M., Paloncýová M., Zoppellaro G., Kershaw S. V., Rogach A.L., Otyepka M., Zbořil R.: Carbon Dots Detect Water-to-Ice Phase Transition and Act as Alcohol Sensors via Fluorescence Turn-Off/On Mechanism, ACS Nano 2021, 15 (4), 6582–6593. IF = 14,58

3.2. Publication activity

CATRIN researchers published a total of 260 scientific publications in 2021. Most of the publications were published in journals with an impact factor above 5 (total 65.76%), while 68 publications, accounting for over one quarter of CATRIN's production, were published in prestigious journals with an impact factor above 10.

Number of Publications with IF < 5	Number of Publications with IF 5-10	Number of Publications with IF >10	IF N/A	Number of Publications with First Author	Number of Publications with Corresponding Author
85 (32,57%)	103 (39,46%)	69 (26,44%)	4 (1,53%)	56 (21,54%)	158 (60,54%)

Of the 260 professional publications published in 2021, the majority had a corresponding author from CATRIN, a significant part of the works also had a first author from CATRIN.

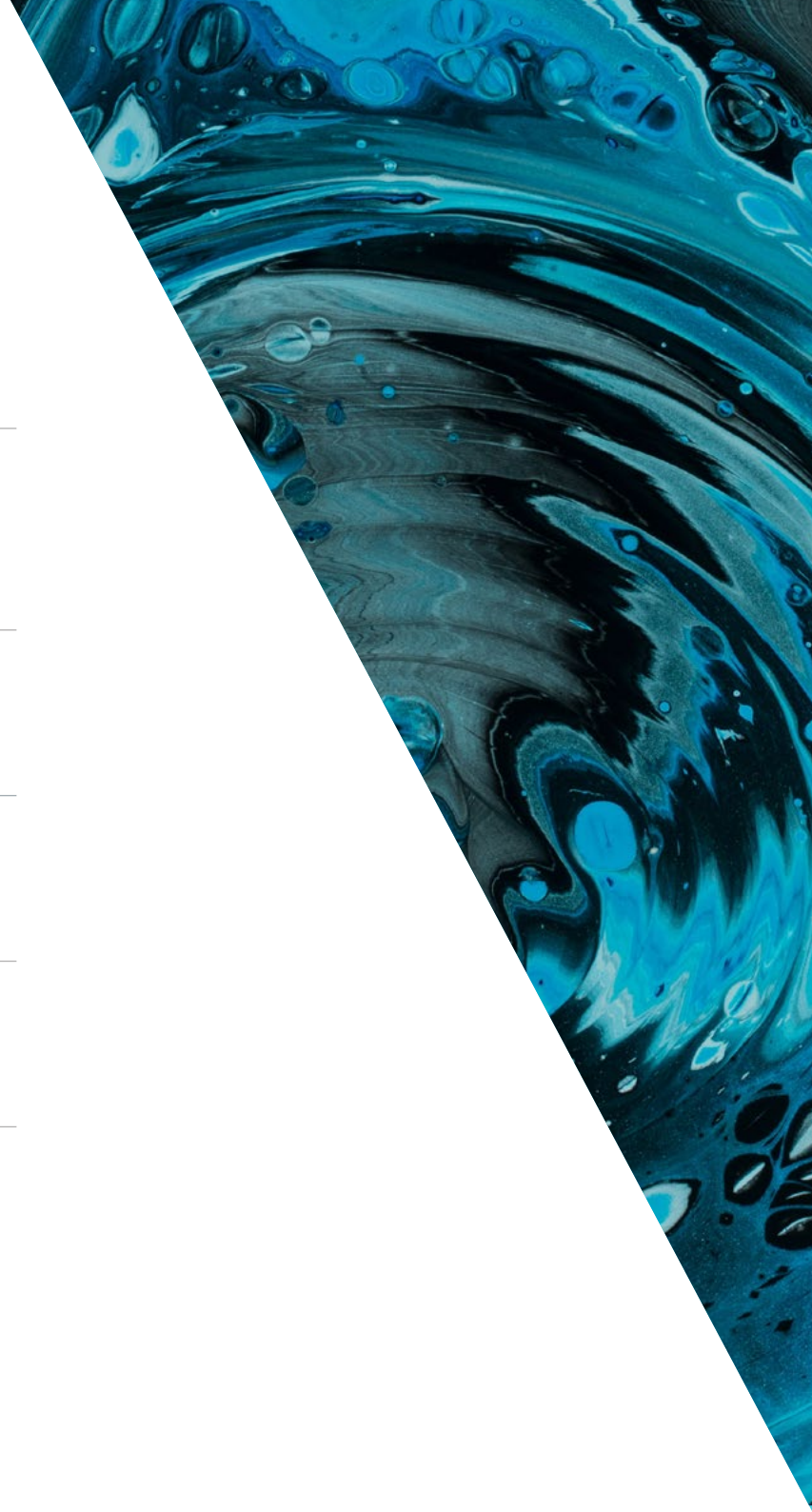
The distribution of CATRIN papers published in 2021 by quartile shows the dominance of publications in the 1st quartile with a significant proportion of publications in the 1st decile. The fact that more than a quarter of CATRIN's works are published in the first decile shows the extraordinary potential of the CATRIN team to achieve top results comparable to prestigious European science centres.

D1	Q1	Q2	Q3	Q4	N/A
72	167	61	19	3	11

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

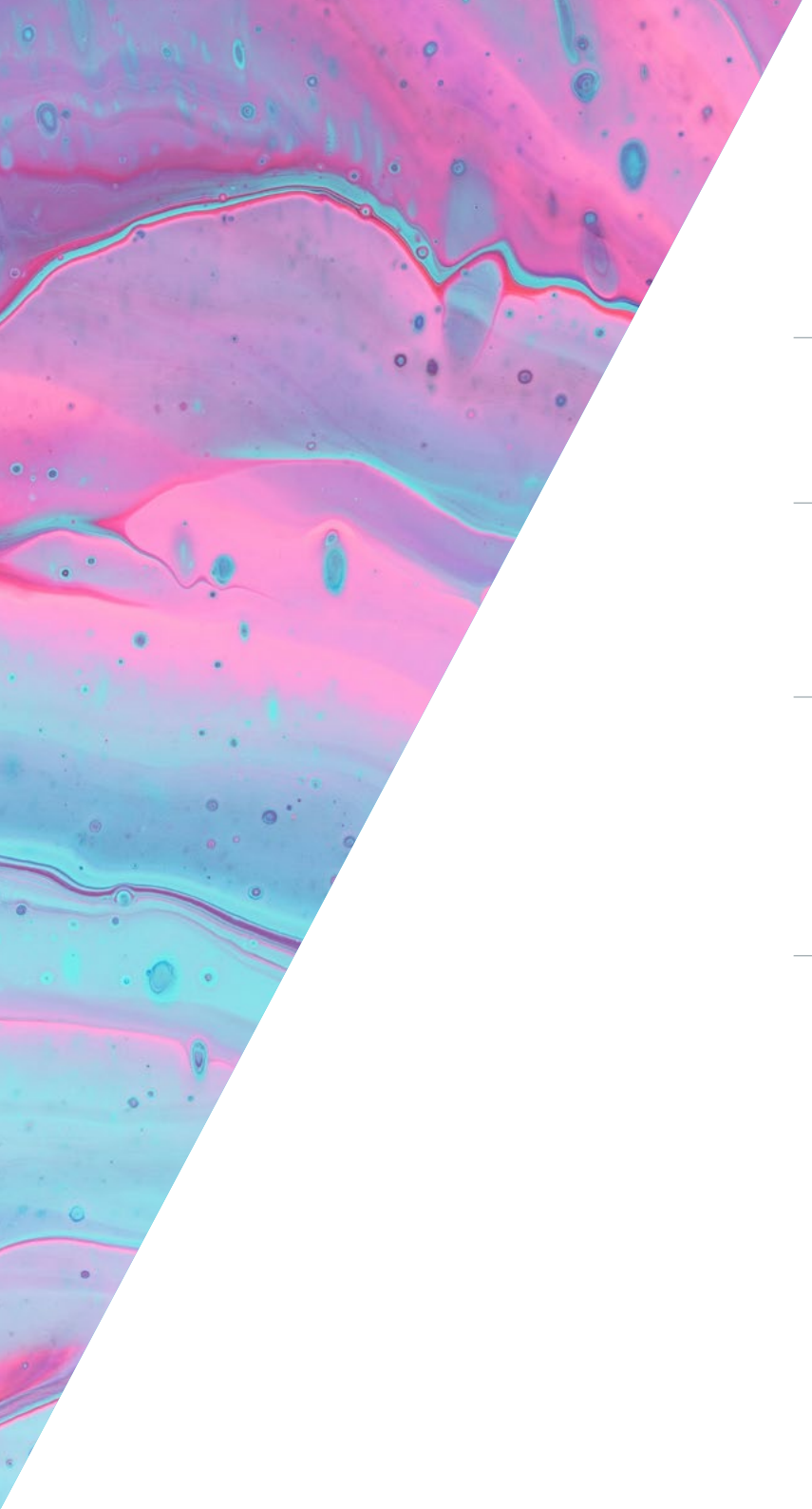
Authors	Publication Title	Journal Name	IF
Singh B., Gawande M.B., Kute A.D., Varma R.S., Fornasiero P., McNeice P., Jagadeesh R.V., Beller M., Zbořil R.	Single-Atom (Iron-Based) Catalysts: Synthesis and Applications	Chemical Reviews	60,622
Sharma R.K., Yadav S., Dutta S., Kale H.B., Warkad I.R., Zboril R., Varma R.S., Gawande M.B.	Silver nanomaterials: Synthesis and (electro/photo) catalytic applications	Chemical Society Reviews	54,564
Mallada B., Gallardo A., Lamanec M., de la Torre B., Špirko V., Hobza P., Jelinek P.	Real-space imaging of anisotropic charge of σ-hole by means of Kelvin probe force microscopy	Science	47,728
Sievers G.W., Jensen A.W., Quinson J., Zana A., Bizzotto F., Oezaslan M., Dworzak A., Kirkensgaard J.J.K., Smitshuysen T.E.L., Kadkhodazadeh S., Juelsholt M., Jensen K.M.Ø., Anklam K., Wan H., Schäfer J., Čépe K., Escudero-Escribano M., Rossmeis J., Quade A., Brüser V., Arenz M.	Self-supported Pt–CoO networks combining high specific activity with high surface area for oxygen reduction	Nature Materials	43,841
Chandrashekhar V. G., Senthamarai T., Kadam R. G., Malina O., Kašlik 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	41,813
González-Herrero H., Mendieta-Moreno J.I., Edalatmanesh S., Santos J., Martín N., Écija D., de la Torre B., Jelinek P.	Atomic Scale Control and Visualization of Topological Quantum Phase Transition in π-Conjugated Polymers Driven by Their Length	Advanced Materials	30,849

Jayaramulu K., Horn M., Schneemann A., Saini H., Bakandritsos A., Ranc V., Petr M., Stavila V., Narayana C., Scheibe B., Kment Š., Otyepka M., Motta N., Dubal D., Zbořil R., Fischer R.A.	Covalent Graphene-MOF Hybrids for High-Performance Asymmetric Supercapacitors	Advanced Materials	30,849
Delfi M., Sartorius R., Ashrafizadeh M., Sharifi E., Zhang Y., De Berardinis P., Zarrabi A., Varma R.S., Tay F.R., Smith B.R., Makvandi P.	Self-assembled peptide and protein nanostructures for anti-cancer therapy: Targeted delivery, stimuli-responsive devices and immunotherapy	Nano Today	20,722
Zhou X., Hwang I., Tomanec O., Fehn D., Mazare A., Zboril R., Meyer K., Schmuki P.	Advanced Photocatalysts: Pinning Single Atom Co-Catalysts on Titania Nanotubes	Advanced Functional Materials	18,808
Tantis I., Bakandritsos A., Zaoralová D., Medveď M., Jakubec P., Havláková J., Zbořil R., Otyepka M.	Covalently Interlinked Graphene Sheets with Sulfur-Chains Enable Superior Lithium–Sulfur Battery Cathodes at Full-Mass Level	Advanced Functional Materials	18,808
Chia H.L., Mayorga-Martinez C.C., Sofer Z., Lazar P., Webster R.D., Pumera M.	Vanadium Dopants: A Boon or a Bane for Molybdenum Dichalcogenides-Based Electrocatalysis Applications	Advanced Functional Materials	18,808
Santhini V.M., Stetsovych O., Ondráček M., Mendieta Moreno J.I., Mutombo P., de la Torre B., Švec M., Klívar J., Stará I.G., Vázquez H., Starý I., Jelínek P.	On-Surface Synthesis of Polyferrocenylene and its Single-Chain Conformational and Electrical Transport Properties	Advanced Functional Materials	18,808



Tesler A.B., Sannomiya T., Hejazi S., Mohammadi R., Vogel N., Altomare M., Schmuki P.	Metallic nanoparticle-on-mirror: Multiple-band light harvesting and efficient photocurrent	Nano Energy	17,881
Mascaretti L., Schirato A., Zbořil R., Kment Š, Schmuki P., Alabastri A., Naldoni A.	Solar steam generation on scalable ultrathin thermo-plasmonic TiN nanocavity arrays	Nano Energy	17,881
Niraula G., Coaquira J.A.H., Aragon F.H., Bakuzis A.F., Villar B.M.G., Garcia F., Muraca D., Zoppellaro G., Ayesh A.I., Sharma S.K.	Stoichiometry and Orientation- And Shape-Mediated Switching Field Enhancement of the Heating Properties of Fe3 O4 Circular Nanodiscs	Physical Review Applied	17,881
Chen J., Cheng M., Salgado G.F., Stadlbauer P., Zhang X., Amrane S., Guédin A., He F., Šponer J., Ju H., Mergny J.-L., Zhou J.	The beginning and the end: Flanking nucleotides induce a parallel G-quadruplex topology	Nucleic Acids Research	16,971
Panáček D., Hochvaldová L., Bakandritsos A., Malina T., Langer M., Belza J., Martincová J., Večeřová R., Lazar P., Poláková K., Kolařík J., Válková L., Kolář M., Otyepka M., Panáček A., Zbořil R.	Silver Covalently Bound to Cyanographene Overcomes Bacterial Resistance to Silver Nanoparticles and Antibiotics	Advanced Science	16,806
Qin T., Wang Z., Wang Y., Besenbacher F., Otyepka M., Dong M.	Recent Progress in Emerging Two-Dimensional Transition Metal Carbides	Nano-Micro Letters	16,419
Rahimnejad M., Nasrollahi Boroujeni N., Jahangiri S., Rabiee N., Rabiee M., Makvandi P., Akhavan O., Varma R.S.	Prevascularized Micro-/Nano-Sized Spheroid/Bead Aggregates for Vascular Tissue Engineering	Nano-Micro Letters	16,419

Iravani S., Varma R.S.	Plant Pollen Grains: A Move Towards Green Drug and Vaccine Delivery Systems	Nano-Micro Letters	16,419
Saini H., Srinivasan N., Šedajová V., Majumder M., Dubal D.P., Otyepka M., Zbořil R., Kurra N., Fischer R.A., Jayaramulu K.	Emerging MXene@Metal-Organic Framework Hybrids: Design Strategies toward Versatile Applications	ACS Nano	15,881
Majumder M., Saini H., Dědek I., Schneemann A., Chodankar N.R., Ramarao V., Santosh M.S., Nanjundan A.K., Kment Š., Dubal D., Otyepka M., Zbořil R., Jayaramulu K.	Rational Design of Graphene Derivatives for Electrochemical Reduction of Nitrogen to Ammonia	ACS Nano	15,881
Ng S., Sturala J., Vyskocil J., Lazar P., Martincova J., Plutnar J., Pumera M.	Two-Dimensional Functionalized Germananes as Photoelectrocatalysts	ACS Nano	15,881
Mayorga-Burrezo P., Muñoz J., Zaoralová D., Otyepka M., Pumera M.	Multiresponsive 2D Ti3C2TxMXene via Implanting Molecular Properties	ACS Nano	15,881
Cahlík A., Hellerstedt J., Mendieta-Moreno J.I., Švec M., Santhini V.M., Pascal S., Soler-Polo D., Erlingsson S.I., Výborný K., Mutombo P., Marsalek O., Siri O., Jelínek P.	Significance of Nuclear Quantum Effects in Hydrogen Bonded Molecular Chains	ACS Nano	15,881



Zuo Y., Li T., Zhang N., Jing T., Rao D., Schmuki P., Kment Š., Zbořil R., Chai Y.	Spatially Confined Formation of Single Atoms in Highly Porous Carbon Nitride Nanoreactors	ACS Nano	15,881
Doležal J., Canola S., Merino P., Švec M.	Exciton-Trion Conversion Dynamics in a Single Molecule	ACS Nano	15,881
Kalytchuk S., Zdražil L., Bad'ura Z., Medved' M., Langer M., Paloncýová M., Zoppellaro G., Kershaw S.V., Rogach A.L., Otyepka M., Zbořil R.	Carbon Dots Detect Water-to-Ice Phase Transition and Act as Alcohol Sensors via Fluorescence Turn -Off/On Mechanism	ACS Nano	15,881
Urbanová V., Antonatos N., Plutnar J., Lazar P., Michalička J., Otyepka M., Sofer Z., Pumera M.	Rhenium Doping of Layered Transition-Metal Diselenides Triggers Enhancement of Photoelectrochemical Activity	ACS Nano	15,881
Bakandritsos A., Hobza P., Zbořil R., Kolařík J., Bad'ura Z., Lo R., Zoppellaro G., Kment Š., Naldoni A., Zhang Y., Petr M., Tomanec O., Filip J., Otyepka M.	Carboxylated graphene for radical-assisted ultra-trace-level water treatment and noble metal recovery	ACS Nano	15,881

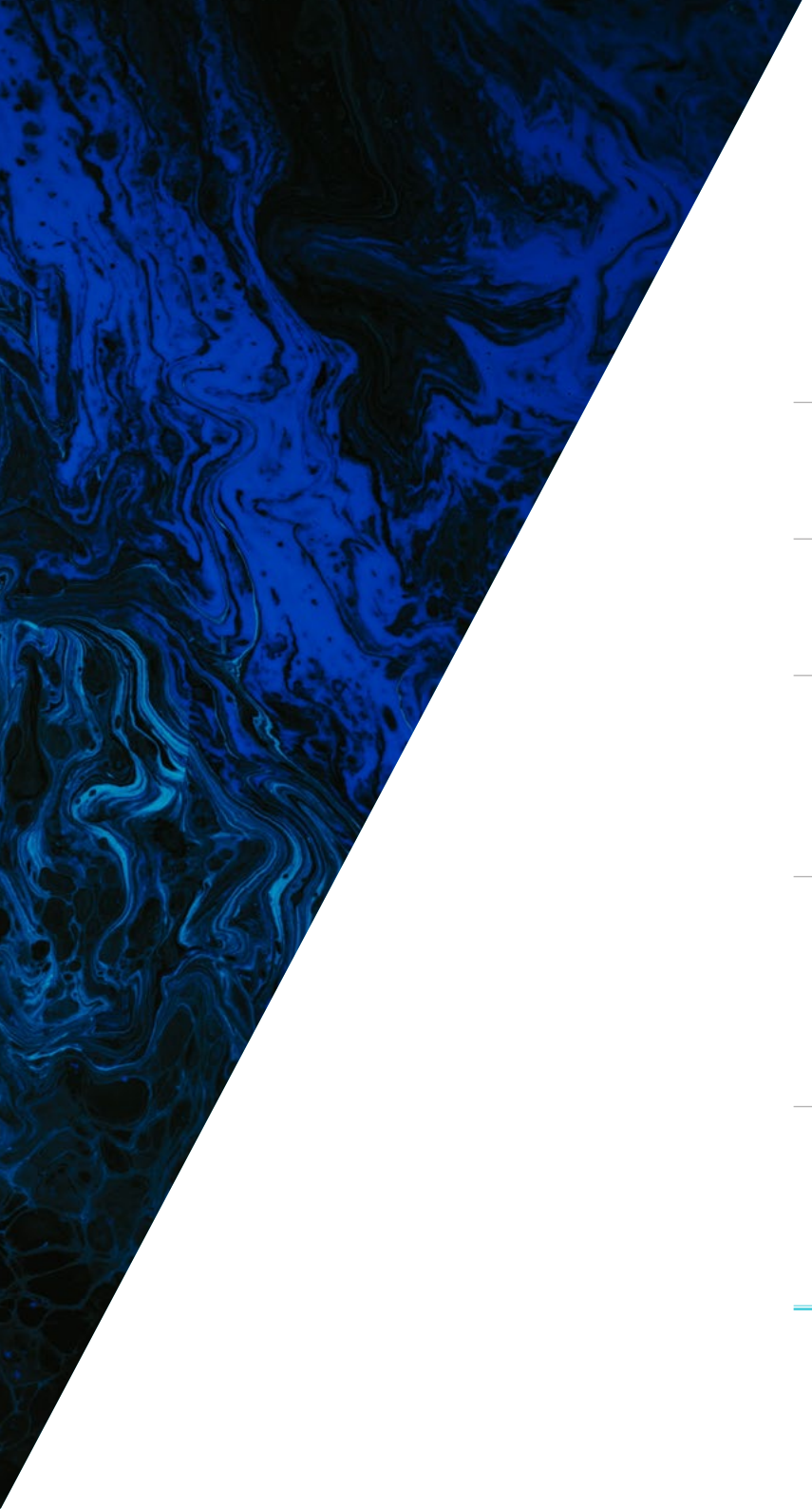
Biswas K., Urgel J.I., Xu K., Ma J., Sánchez-Grande A., Mutombo P., Gallardo A., Lauwaet K., Mallada B., de la Torre B., Matěj A., Gallego J.M., Miranda R., Jelínek P., Feng X., Écija D.	On-Surface Synthesis of a Dicationic Diazahexabenzocoronene Derivative on the Au(111) Surface	Angewandte Chemie - International Edition	15.336
Lamanec M., Lo R., Nachtigallová D., Bakandritsos A., Mohammadi E., Dračínský M., Zbořil R., Hobza P., Wang W.	The Existence of a N→C Dative Bond in the C60–Piperidine Complex	Angewandte Chemie - International Edition	15.336
Santhini V.M., Wäckerlin C., Cahlík A., Ondráček M., Pascal S., Matěj A., Stetsovych O., Mutombo P., Lazar P., Siri O., Jelínek P.	1D Coordination π–d Conjugated Polymers with Distinct Structures Defined by the Choice of the Transition Metal: Towards a New Class of Antiaromatic Macrocycles	Angewandte Chemie - International Edition	15.336

3.3. Science and research projects implemented at CATRIN

The scientific research activities of CATRIN's staff are supported by a wide range of grant projects that were obtained in previous 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). Below is a list of all projects implemented by the end of the year 2021.

Project Title	ID Number	Provider
2D-CHEM: Two-dimensional Chemistry towards Graphene Derivatives	ERC-2015-CoG - 683024_2D-CHEM	Horizon 2020 ERC
UP2DCHEM: Upscaling of fluorographene chemistry for supercapacitor electrode material	ERC-2019-PoC: 899245	Horizon 2020 ERC
NANO4TARMED: Advanced hybrid theranostic nanoplatfor-ms for an active drug delivery in the cancer treatment	H2020-WIDESPREAD-2020-5: 952063	Horizon 2020 REA
META-CAT: A light-driven biorefinery using metacatalysts	LL1903	MŠMT
NanoEnviCZ II: Nanomaterials and nanotechnologies for environment protection and sustainable future	LM2018124	MŠMT
Pro-NanoEnviCz II: Moderniza-tion and upgrade of large rese-arch infrastructure Nanomate-rials and nanotechnologies for protection of the environment and sustainable future	CZ.02.1.01/0.0/0.0/18_046/0015586	MŠMT
Nanotechnologies for Future	CZ.02.1.01/0.0/0.0/16_019/0000754	MŠMT

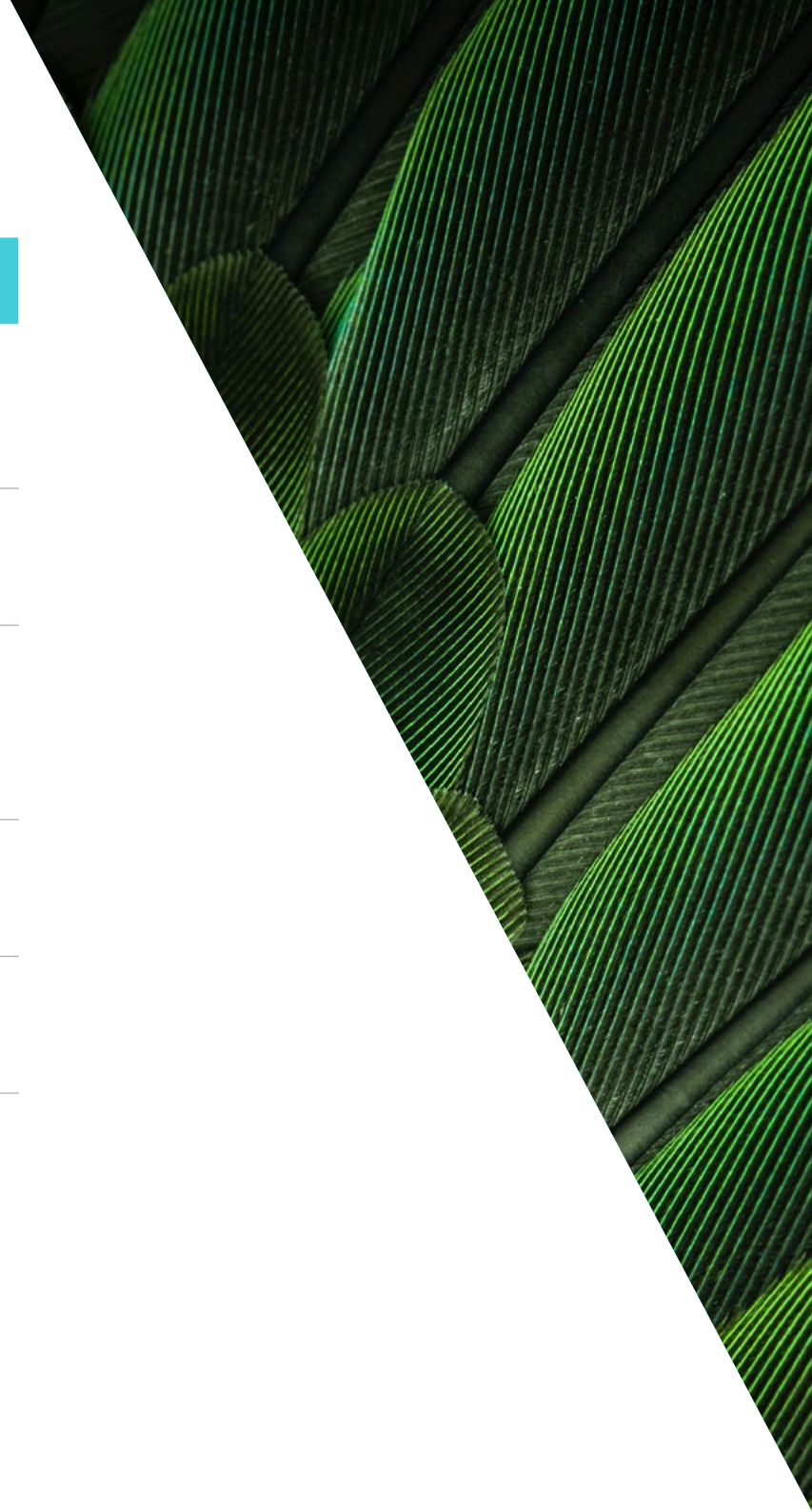
Plants as a tool for sustainable global development	CZ.02.1.01/0.0/0.0/16_019/0000827	MŠMT
Advanced Hybrid Nanostructures for Renewable Energy Applications	CZ.02.1.01/0.0/0.0/15_003/0000416	MŠMT
Support for international mobility of researchers – MSCA-IF at Palacký University Olomouc II	CZ.02.2.69/0.0/0.0/19_074/0016220	MŠMT
Support for international mobility of researchers – MSCA-IF at Palacký University Olomouc III	CZ.02.2.69/0.0/0.0/18_070/0018294	MŠMT
Structural and Physical Aspects of Inverse Heusler Alloys Mn2FeZ, Z = Si, Al, Sn	21-05339S	GAČR
Anticancer active coordination compounds with multimodal effect	21-19060S	GAČR
Complexes of selected transition metals with plant-derived compounds with anti-NF-kappa B and pro-PPAR dual activities	21-38204L	GAČR
Plasmonic catalysis with titanium nitride nanocrystals for sustainable chemical reactions	20-17636S	GAČR



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
Personalized Medicine – Diagnostics and Therapy	TN01000013	TAČR
Reaching of low phosphorus effluent concentrations at wastewater treatment plants by using nanoparticle modified materials	FV30034	MPO
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 energy intake optimization in metabolic stress conditions for standardization of glycemic control	CZ.01.1.02/0.0/0.0/20_321/0024452	MPO

The following projects were awarded in the course of 2021, the implementation of which will start in 2022:

Project Title	ID Number	Provider
Transition of 2D-chemistry based supercapacitor electrode material from proof of concept to applications	HORIZON-EIC-2021-TRANSITION-CHALLENGES-01: 101057616	Horizon Europe EIC
Functionalized Graphene Based Electrode Material for Lithium Sulfur Batteries	ERC-2022-POC1: 101069293	Horizon Europe ERC
Twinning to boost the scientific and innovation capacity of the Universiteti i Tiranes to develop sustainable nanosensors for water pollution detection	HORIZON-WIDERA-2021-ACCESS-02: 101059266	Horizon Europe
Elateriform beetles as a model for studying the evolution of neoteny	22-35327S	GAČR
Solvent mediated photoexcitation of spin-active species in fluorographene	22-26416S	GAČR
Nanoscale mapping of chemical reactions driven by multi-metallic plasmonic nanostructures	22-33284S	GAČR



Nano-Monitoring of Cancer Immunotherapy Efficiency: The Graphene Lateral Electrophoretic Bioassay platform	JTC2021	TAČR
Effect of organic matter on the removal efficiency of Fe-nanoparticles towards pharmaceuticals in wetlands	8J22FR015	MŠMT

In 2021, CATRIN's research teams continued to prepare other projects that will be submitted in the course of 2022, both in the Horizon Europe programme, e.g., a joint project with the UP Faculty of Health Sciences, as well as in national calls, including projects of the National Recovery and Resilience Plan prepared in cooperation with the UP Faculty of Medicine and Dentistry, as part of cooperation with IMTM (IMTM-LF and CATRIN-IMTM) or within the AURORA consortium.

3.4. Technology Transfer

3.4.1 Licence agreements

Lactoferin separation from milk and whey

In February 2021, a second licensing agreement for the patented lactoferin separation technology was signed with the Polish company FERILAC sp. z o.o., established by two large Polish companies Lactopol and Geo Poland, for the production and sale of lactoferin. (The first licensing agreement was concluded with the Czech company Lactofirm s.r.o. in 2018, which has introduced its product on the market, but has not yet started mass production of lactoferin). FERILAC sp. z o.o. plans to start mass production of lactoferin in the summer of 2022 at Lactopol's milk processing plant in Suwalki. CATRIN employees participate in the launch and optimization of this technology on site in FERILAC sp. z o.o., based on the concluded licensing agreement.

At the end of 2021, negotiations for a third potential license for this technology were launched with the Czech company Brazzale Moravia a.s. Negotiations have not been concluded yet.

Production of the 4th generation Mössbauer spectrometers

In July 2021, a license agreement was concluded for classified know-how for the production of the 4th generation Mössbauer spectrometers. The license was purchased by the spin-off company Iron Analytics, s.r.o., founded by CATRIN employees with the intention to maximize the potential of the current market for commercialization of Mössbauer spectrometers.

3.4.2 Contractual research

In 2021, CATRIN carried out contractual research with several commercial companies and research institutes in the Czech Republic and abroad, including deliveries of special particles and devices in a total volume of 8.28 mil. CZK. Below is a list of contractual research items by individual scientific research divisions that carried out this research:

- CATRIN-IMTM: Cooperation on development and analysis of anticancer agents in the volume of 2.55 mil. CZK
- CATRIN-CRH: Expert activities, consultancy, and analyses in the field of agrochemical and plant physiology, in the total volume of 830 thousand CZK.
- CATRIN-RCPTM: Contractual research and analyses for domestic and foreign partners in the pharmaceutical and chemical industry. Supplies of functionalized magnetic particles for the diagnosis of COVID-19 and production of spectrometers for foreign universities (Poland, China) in the total volume of 4.9 million CZK.

3.4.3. Patents

In 2021, CATRIN filed a total of 6 applications for inventions and technical solutions for industrial-legal protection, including 4 PCT applications and 2 utility models. In 2021, a total of 4 patents and registered utility models were granted, including one European patent, one Czech patent and two utility models.

3.5. International collaboration

Of the total 260 papers written by CATRIN employees in 2021, 220 articles (84.62%) were produced in collaboration with cooperating teams from foreign universities and research institutes. Below are examples of cooperation on joint, highly impacted works.

Partner Institutes	Examples of Joint Publications	IF
Friedrich-Alexander-Universität Erlangen-Nürnberg	Nano Energy, 2021, 90, Part B, 106609.	17,881
	Nano Energy, 2021, 83, 105828.	17,881
	Advanced Functional Materials, 2021, 31 (30).	18,808
Technische Universität München	Journal of Materials Chemistry A, 2021, 9 (41),pp.23651-23659.	12,732
	Advanced Materials, 2021, 33 (4), 2004560.	30,849
	ACS Nano, 2021, 15 (12), pp. 18742-18776.	15,881
Leibniz Institute for Catalysis	Chemical Reviews, 2021, 121 (21), pp. 13620-13697.	60,622
	Nature Catalysis 2021, 5, pp. 20-29.	41,813
University of Trieste	Small, 2021, 17 (16), 2006473.	13,281
	Journal of Materials Chemistry A, 2021, 9 (10), pp. 5915-5951.	12,732
	Chemical Reviews, 2021, 121 (21), pp. 13620-13697.	60,622
City University of Hongkong	ACS Nano, 2021, 15 (4), pp. 6582-6593.	15,881

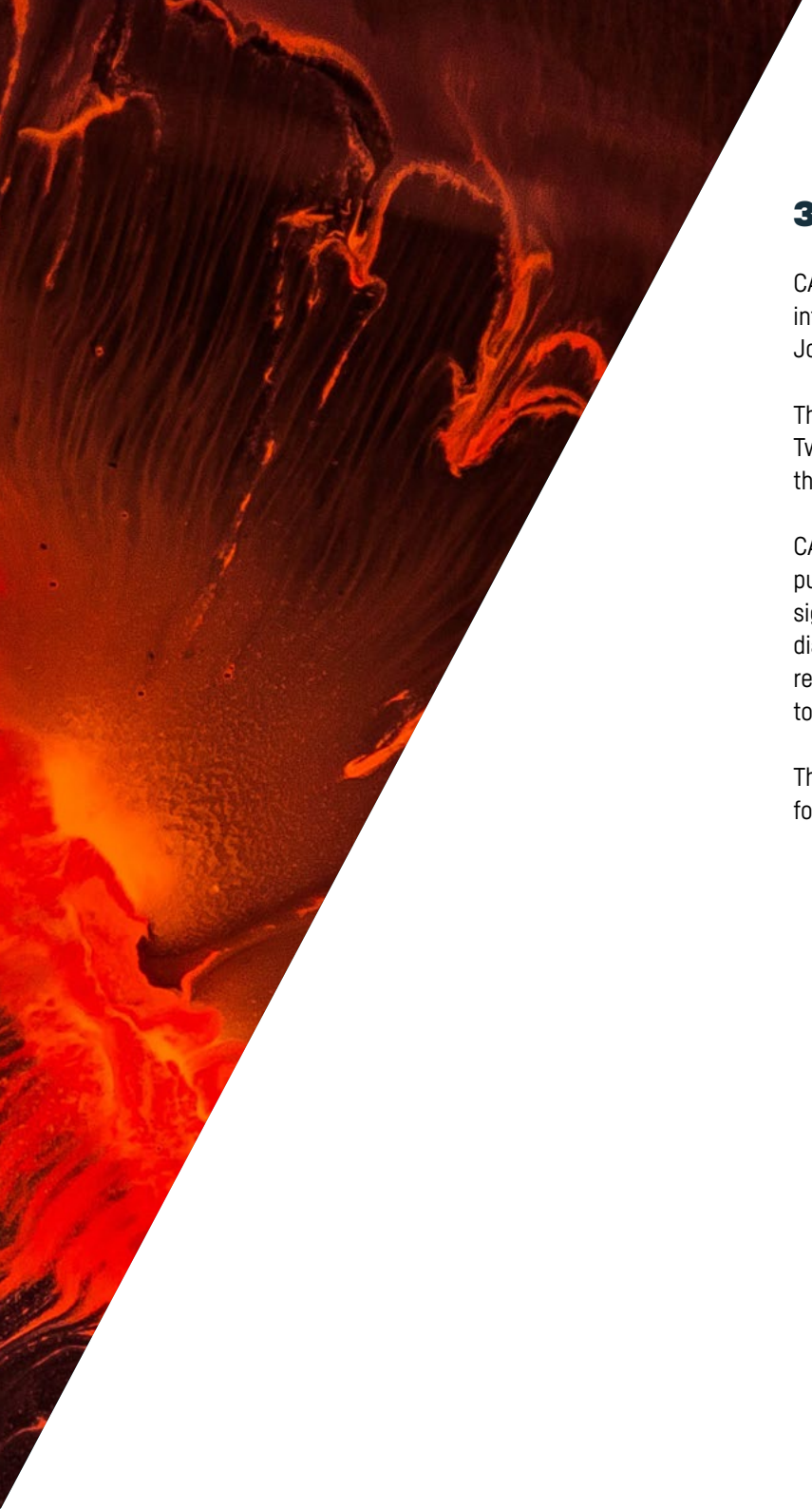
Nanyang Technological University	Advanced Functional Materials, 2021, 31 (8), 2009083.	18,808
US EPA	Chemical Society Reviews, 2021, 50 (20), pp. 11293-11380.	54,564
National Research Council CNR	Nano Today, 2021, 38, 101119.	20,722
IMDEA-Nanociencia	ACS Nano, 2021, 15 (11), pp. 17275-17298.	15,881
	Advanced Materials, 2021, 33 (44), 2104495.	30,849
	Chemical engineering journal, 2021, 426, 131315.	13,273

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, will take place from 12 to 15 September 2022 in Olomouc. This series has been held in Olomouc since 2011. Green for Good VI was originally scheduled to take place in 2021, but was postponed due to the covid-19 pandemic. However, preparations started already in 2021. CATRIN cooperates with the European Federation of Biotechnology (EFB) and the Institute of Experimental Botany of the Academy of Sciences of the Czech Republic to prepare it. The organizers are already promising to introduce some innovations.

· NANOCON: CATRIN is significantly involved in the organization of the international conference on nanomaterials–NANOCON–focused on their research and applications. The 13th year of this conference was held in October 2021 in Brno with the participation of 280 scientists from 19 countries worldwide. Radek Zbořil has been the Chair of the NANOCON Scientific Board for several years.

· EFB 2021: CATRIN, through Michaela Holecová, participated in the organization of the EFB 2021 virtual conference, which took place in May 2021.



3.7. Promotion and popularization of science and research

CATRIN regularly reports on scientific works, research results, interesting topics, and important personalities through internal and external communication channels. For internal communication within Palacký University, Journal Online or Journal UP is used (e.g., in 2021 CATRIN participated or co-participated in about 35 articles in Journal Online).

The CATRIN website is also an important information source, and the institute is also active on social networks (Facebook, Twitter, Instagram, LinkedIn, YouTube). The CATRIN newsletter informs closer about events happening inside and outside of the university. In 2021, two issues of the newsletter were published (see https://www.catrin.com/en/media/newsletter/)

CATRIN is involved in the medialization of science at UP, in coordination with the UP Communication Department. For this purpose, it has prepared seven press releases (see https://www.catrin.com/en/media/press-releases/), which have significantly resonated in the media, including the public media. In total, CATRIN recorded at least 120 outputs in the media environment in 2021 (see https://www.catrin.com/en/media/publicity/). In the public space, the scientists are also responding to important social issues or trying to stimulate discussion on them (for example, European legislation related to new genome editing techniques).

The CATRIN staff consider the popularization of science an important part of scientific work. In 2021, they engaged in the following events:

- With two lectures for high school students in early November, CATRIN joined the Week of the Academy of Sciences of the Czech Republic. In the Fort Science, Lukáš Spíchal spoke about the role of automatic systems and robots in plant research and Jana Soukupová introduced the possibilities of using nanomaterials in medicine. The Week of the Academy of Sciences of the Czech Republic was a continuous follow-up to the Week of Science and Technology of the Academy of Sciences of the Czech Republic, the largest scientific festival in the Czech Republic.

- CATRIN welcomed the Children's University, organized by the Fort Science Olomouc, for the first time in November. During *Nanohrátky*, children found out what silver or graphene nanoparticles looked like, about a hydrogen explosion, or how magnets work.

- The Researchers' Night was met with great interest of visitors and was joined by CATRIN for the first time on Friday, 24 September. The rich programme attracted about 500 visitors to the Holice campus. A great attraction was also a five-meter luminous model of the Earth borrowed from Academia film Olomouc. A large part of the

visitors seized the opportunity to see some of the laboratories as part of guided tours. In cooperation with the UP Communication Department, five promotional videos from the field of chemistry or physics were created (https://www.catrin.com/en/video/).

• CATRIN scientists joined the programme of U3A. The topics of the lectures were nanotechnology and its application in everyday life or plant research and development of plant biotechnology.

• CATRIN staff participated in the preparation of a touring exhibition called Water and Civilization, which people could see in Horní náměstí Olomouc in July. On large panels, they found not only photographs from Australia, Greenland or America, but also texts from a number of internationally recognized scientists. Among them were also Jan Filip, Michal Otyepka, and Radek Zbořil.

• 'On cannabis without prejudice' – that was the name of the public debate taking place on November 23 in the Fort Science. Researchers and experts on cannabis discussed the possibilities of using this plant in agriculture, industry, and health care. Petr Tarkowski from CATRIN took on the role of the host.

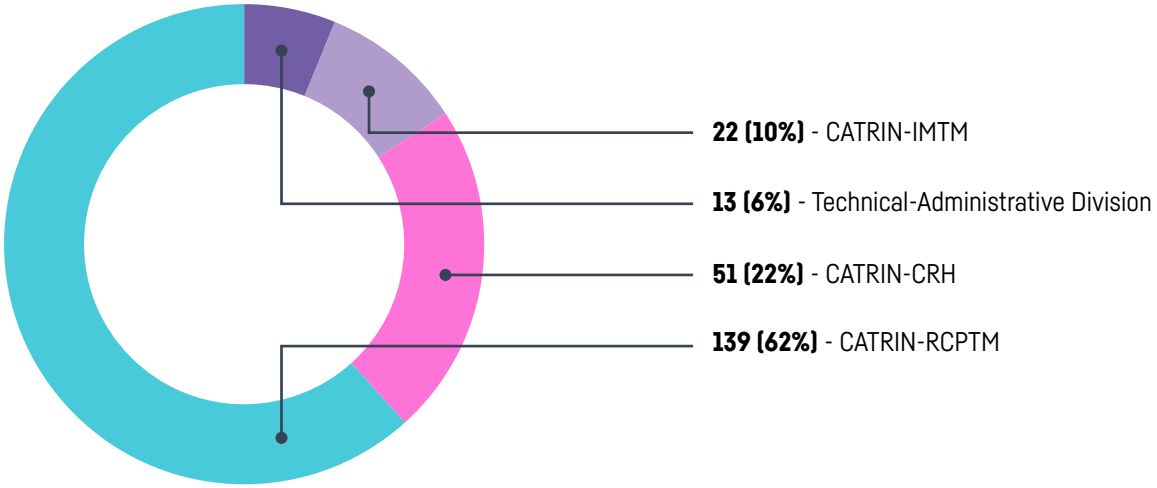
4

Staff

4.1. Age and qualification structure

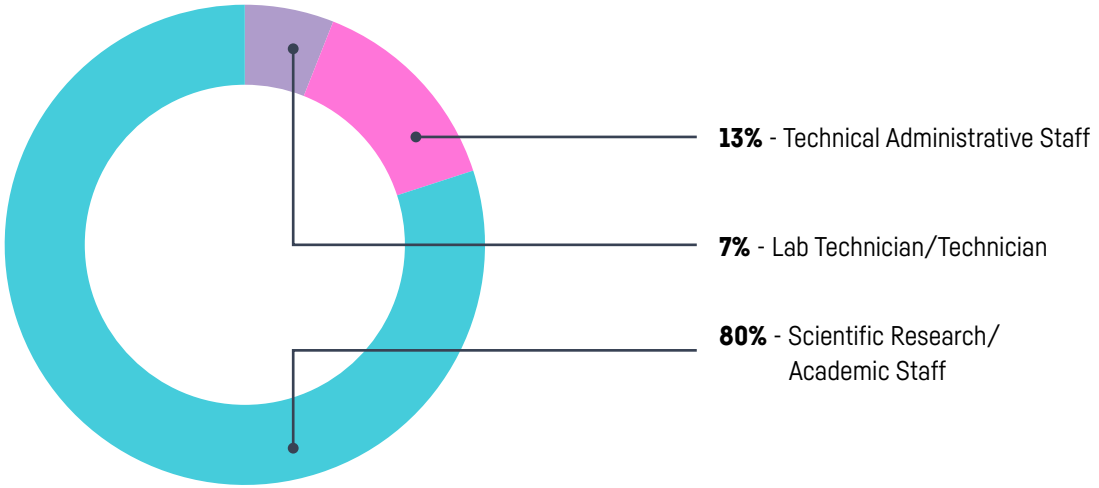
In 2021, CATRIN's staffing was significantly stabilised. By 31 December 2021, CATRIN reached a total of 225 employees. Within IMTM, 22 employees straddle both IMTM-LF and CATRIN-IMTM, 20 are affiliated to the Faculty of Medicine and Dentistry and 2 to CATRIN. The majority of staff are employees of CATRIN-RCPTM, CATRIN-CRH, and CATRIN-IMTM (94% in total), and are further divided into individual research groups. In order to manage the institute efficiently, a Technical-Administrative Division was established, comprising 6% of the employees.

The Number of CATRIN's Employees by 31 December 2021



The team consists of 41.8% women and 58.2% men. The share of foreign workers is very high, compared to a common Czech workplace environment, and reaches 30.2% (34.9% in the category of scientists, lab technicians, and technicians). CATRIN also reaches above-average figures in the percentage of women in scientific positions. According to the UN, the share of women in science is over 33% worldwide, with the Czech Republic reaching only 27%; however, the total number of female scientific research workers at CATRIN is 34.27%.

The Structure of CATRIN's Employees by 31 December 2021



Staff Category	Number	FTE
Lab Technician/Technician	16	14,7
Technical Administrative Staff	28	24,7
Scientific Research Staff	181	128,9
Total Number	**225**	**168,3**

The average age of employees is 39.3 years, meaning CATRIN has a very young and progressive team. The age category 31–40 years is both absolutely and relatively most represented. Categories 21–30 and 41–50 years are very evenly represented, from which it can be concluded that the team is well-balanced in terms of age and therefore has high potential for further development.

Age Category	Number	Share [%]
21 - 30	41	18,2
31 - 40	103	45,8
41 - 50	49	21,8
51 - 60	24	10,6
61 - 70	6	2,7
71 - 80	2	0,9
Total Number	**225**	**100,0**

4.2. Significant awards

CATRIN employees received several awards for their significant achievements in the field of science and research:

- World renowned electrochemistry expert Patrik Schmuki from Friedrich–Alexander University Erlangen–Nürnberg, Germany, who is also on CATRIN's scientific team, received the **Natta Award 2020**. This prize is annually awarded by the Department of Chemistry, Materials and Chemical Engineering "Giulio Natta" of the Polytechnic University of Milan for remarkable accomplishments in fields that fall into the department's scientific interests. The award ceremony took place on 12 November 2021.

- The chemists Radek Zbořil and Rajender Varma appeared again on the **Highly Cited Researchers 2021** which is published annually by Clarivate Analytics. The list comprises about 6600 scientists from 70 countries, including 24 Nobel laureates. There are also ten scientists in this elite group who affiliate to domestic institutions or universities.

- **An honorary mention in the Vizionáři 2021 competition** goes to RCPTM, now part of CATRIN, for NANOBIOWAT, a system for subsurface groundwater treatment, and its contribution to the protection of water

resources and the environment. The Vizionáři project, organised for the 11th year by CzechInno, aims to award innovative projects and help commercialise innovative ideas.

- Effervescent cleaning tablets developed by scientists from CATRIN were awarded first prize at the national **Transfera Technology Day** competition. The winning tablets, which contain iron nanoparticles for purifying contaminated water, beat another 12 projects from domestic universities and research institutes. The aim of this event, in general, is to join together business and science in order to obtain feedback on the participating projects' commercial readiness and, in the future, provide funding for the particularly promising research results.

- One of the most highly cited Czech scientists, computational chemist Pavel Hobza, who is based at Charles University and CATRIN, alongside the Institute of Organic Chemistry and Biochemistry of CAS (IOCB), obtained a **Gold Medal of Remembrance** awarded by Charles University..

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 at 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. In 2021, he represented CATRIN in the form of an invited plenary lecture at the international conference Global Summit and Expo on Graphene and 2D Materials (2DMAT2021) held in August 2021 in Paris, where among other renowned scientists the Nobel Prize laureate for physics K. Novoselov delivered a talk.

Professor Michal Otyepka is a member of the Scientific Board of the Grant Agency of the Czech Republic (GACR) for Non-Living Nature Sciences and of 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 Molecuar 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-President of the Platform for Bioeconomics of the Czech Republic and Member of the EFB Executive Board.

5

Major Events

5.1. Kick-off CATRIN

By cutting the ribbon in the presence of a number of distinguished guests, Palacký University inaugurated CATRIN on 4 October 2021. The ceremony at the Rector's Office was followed by tours of the laboratories of the Institute.

"It is a great honour for me to witness the opening of such an important institution. As Mayor, who represents the city at various levels, I always very much appreciate when I hear that it is the two basic pillars people admire about Olomouc–the history we have inherited and education, research and development. I hope CATRIN will be successful, will pass down its legacy to the future generations, and will be the fuel for the further development of the city," said Mayor Žbánek during the formal meeting.

5.2. Visit of the British Ambassador

In September, the British ambassador to the Czech Republic, Nicholas Archer, discussed the possibilities of cooperation with the CATRIN management. During his visit to the Institute, he saw the laboratories and was introduced to the main fields of research.

5.3. Cooperation agreement with Bar-Ilan Institute of Nanotechnology & Advanced Materials

A memorandum of mutual cooperation was signed in Israel by representatives of CATRIN, Palacký University, and the Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) of Bar-Ilan University. Both sides in the document declare their interest in pursuing joint research activities and sharing knowledge to contribute to the development of research in materials science and nanotechnology.

5.4. CATRIN and IT4Innovations join forces

Presenting research activities, alongside discussing the possibilities for cooperation, was the main goal of the joint workshop of IT4Innovations National Supercomputing Centre at VSB – Technical University of Ostrava and CATRIN of Palacký University, which took place in Ostrava on 4 November. About thirty scientists focused on, in particular, seeking synergies in the areas of high-performance computing (HPC) and artificial intelligence.

6

Internationalization

CATRIN is a research institute with an internationalisation rate higher than 30%. In 2021, a large number of foreign employees were from India (14), Slovakia (8), Greece (6), Iran (6), France (5), Spain (5), Germany, (3) and Italy (3). In 2021, CATRIN employed workers from Brazil, Poland, and the Ukraine–two per each country. In addition, CATRIN employs scientists from Ecuador, Slovenia, Belgium, Austria, Japan, Mexico, Argentina, Vietnam, Congo, Venezuela, the USA, and China.

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

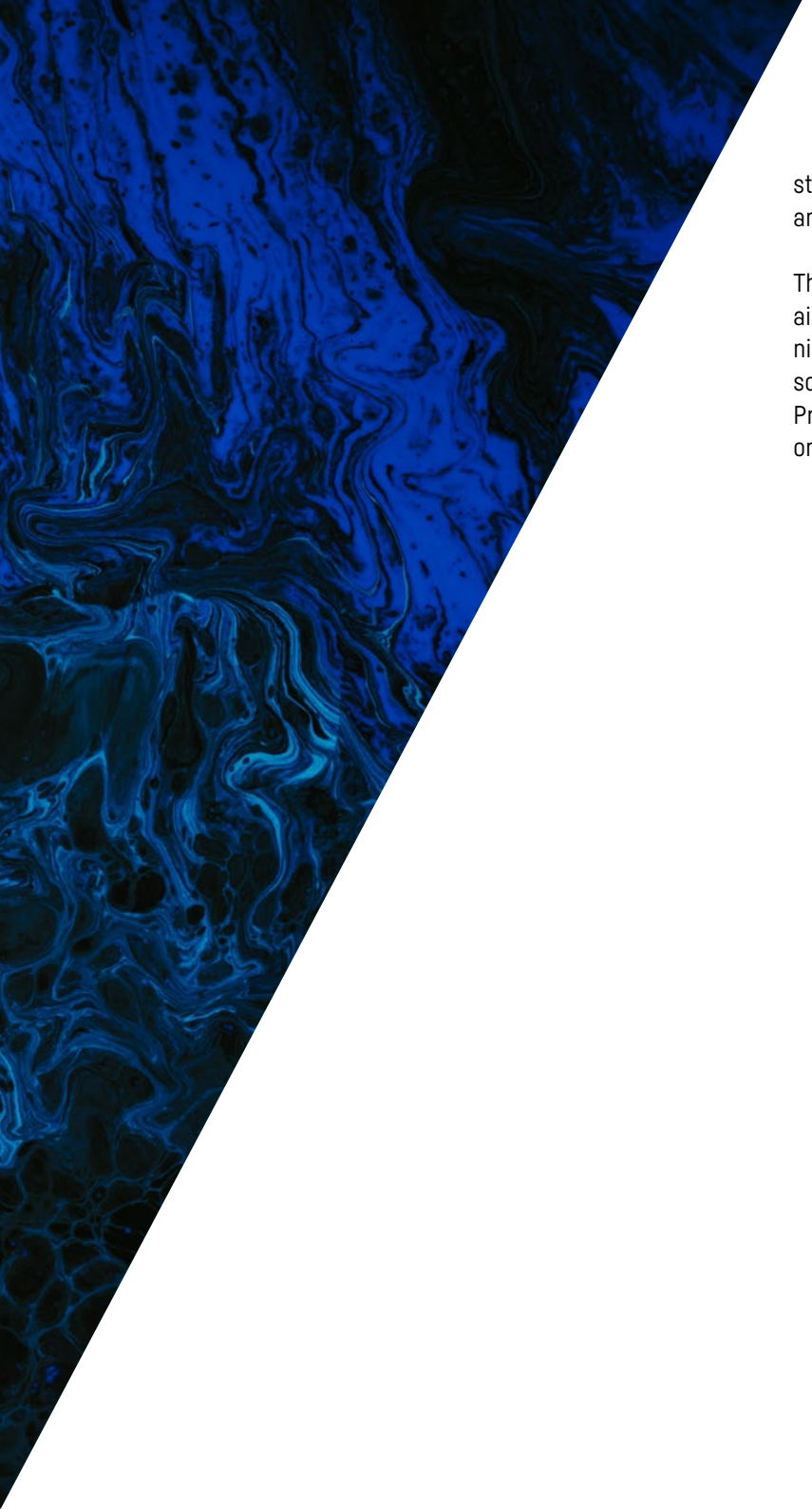
6.1. European Federation of Biotechnology (EFB)

CATRIN is the Regional Branch Office (RBO) of the European Federation of Biotechnology–a non-profit organisation bringing together national biotechnology companies, scientific companies and institutes, universities, biotechnology companies, and individuals. The EFB promotes safe, sustainable, and beneficial use of fundamental research and innovation in life sciences and creates space for interdisciplinary and international cooperation. One such platform is the Green for Good conference on plant biotechnologies, which takes place every two years in Olomouc. The most important guests included the world's leading expert on chemical ecology, John Pickett from Great Britain, or the winner of the World Food Prize, Marc van Montagu. The head of CATRIN-CRH, Ivo Frébort, is the Vice-President of EFB and manages one of its divisions called Plants, Agriculture and Food.

CATRIN, through EFB and Prof. Ivo Frébort, participated in the preparation of an expert opinion as part of the questionnaire commissioned by the Directorate-General for Health and Food Safety–DG SANTE concerning GMO legislation in relation to new genome editing techniques (NGT) in 2021. Joint effort led to publishing a ground-breaking study on NGT by the European Commission, which states, among other things, that the use of new techniques of mutagenesis and cisgenosis in plants within NGT is as safe as traditional breeding techniques, and, therefore, it is appropriate to adapt the existing European legislation to the latest scientific knowledge and technological progress.

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

In October 2021, CATRIN signed a Memorandum of Cooperation with the Bar-Ilan Institute of Nanotechnology & Advanced Materials (BINA) at Bar-Ilan University in Israel. BINA is the leading nanotechnology research institute 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 IT. The institute's laboratories are among the most modern in the world and offer the highest



standards of scientific performance. The instrumentation includes equipment for charged particle microscopy, surface analysis, and nanotechnology production.

The representatives of BINA and CATRIN management signed a Memorandum of Cooperation on 11 October 2021. The aim of the agreement is to strengthen the ties between the two parties, facilitate the exchange of scientific and technical knowledge, and strengthen the scientific and technical development of both institutions in the field of materials sciences and nanotechnologies. The Memorandum is concluded for five years, after which it can be extended. In 2021, Prof. Michal Otyepka and his colleagues from BINA succeeded in winning a research grant from the European Innovation Council EIC Transition Challenges, which is the first grant of this kind within the Czech Republic.

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