

REGISTRATION FORM FOR CZECH SCIENTIFIC INSTITUTION

1. Research institution data (name and address):

Palacký University Olomouc
Czech Advanced Technology and Research Institute (CATRIN)
Křížkovského 511/8
779 00 Olomouc

2. Type of research institution: Public university (veřejná vysoká škola)

3. Head of the institution: doc. Mgr. Pavel Banáš, Ph.D. – director of CATRIN

4. Contact information of designated person(s) for applicants:

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5. Research discipline in which the strong international position of the institution ensures establishing a Dioscuri Centre:

Natural Sciences and Technology: *Materials and synthesis* - materials synthesis, structure-properties relations, advanced and functional materials with designed properties, (macro)molecular architecture, material engineering

6. Description of important research achievements from the selected discipline from the last 5 years including a list of the most important publications, patents, or other results:

CATRIN scientists were behind the discovery of fluorographene in 2010 ([Small](#)). This thinnest insulator paved the way for developing other graphene-derived ultra-thin materials, the properties of which can be tailored to specific applications in medicine, environmental protection, or high-efficiency catalysts or electronics. Researchers have already confirmed their use for energy storage ([AdvFunctMater](#)) as the developed derivatives are light, conductive and allow large amounts of electrical charge to accumulate. They can also serve as singleatom catalysts ([AdvMater](#)), assist in the treatment of water contaminated with heavy metals, or, conversely, in the extraction of noble metals such as palladium, gallium or indium from the aqueous environment ([ACS Nano](#)). The development of the first graphene-based non-metallic magnet was also one of the crucial results in this area ([NatComm](#)). The so-called [2D chemistry](#) and development of new carbon materials is also the subject of prestigious European Research Council grants in the category of [Consolidator](#) and two [Proof of Concept](#) projects and [European Innovation Council Transition](#).

The researchers of CATRIN together with colleagues from the Institute of Physics of CAS, the Institute of Organic Chemistry and Biochemistry of CAS, and the IT4Innovations Ostrava centre have managed to dramatically increase the resolution capabilities of scanning microscopy— from atomic level to subatomic phenomena. They were the first in the world to observe the asymmetric distribution of electron density on single atoms of halogen elements (sigma-hole). The discovery was published by the journal Science.

During the first wave of covid-19 pandemic, CATRIN researchers have developed magnetic nanoballs for testing with the PCR method in a matter of days. Miniature particles with a magnetic core and a thin quartz shell on the surface that can bind viral RNA molecules have become an important part of the new covid-19 testing technology.

List of significant publications in the last 5 years:

- A unique combination of silica supported Fe/Fe-O nanoparticles and aluminum additives for catalytic hydrogenation of all kinds of nitriles to amines. G. Vishwas, T. Senthamarai, R. Kadam, O. Malina, J. Kašík, R. Zbořil, M. B. Gawande, R. V. Jagadeesh, M. Beller, *Nat. Catal.* Article ASAP. DOI 10.1038/s41929-021-03535-3 (*Nat. Catal.* is #1 of 60 (Top 1%) in the SJR category Catalysis in 2020).
- Single-atom (iron-based) catalysts: synthesis and applications. B. Singh, M. B. Gawande, A. D. Kute, R. S. Varma, P. Fornasiero, P. McNeice, R. V. Jagadeesh, M. Beller, R. Zboril, *Chem. Rev.* Article ASAP. DOI: 10.1021/acs.chemrev.1c00158 (*Chem. Rev.* is #1 of 742 (Top 1%) in the SJR category Chemistry in 2020).
- Tailoring topological order and π -conjugation to engineer quasi-metallic polymers. B. Cirera, A. Sánchez Grande, B. de la Torre, J. Santos, S. Edalatmanesh, E. Rodriguez-Sánchez, K. Lauwaet, B. Mallada, R. Zbořil, R. Miranda, O. Gröning, P. Jelinek, N. Martin, D. Ecija, *Nat. Nanotech.* 2020, 15, 437–443 (*Nat. Nanotech.* is #4 of 959 (Top 1%) in the SJR category Materials Science in 2020).
- On the controlled loading of single platinum atoms as a co-catalyst on TiO₂ anatase for optimized photocatalytic H₂ generation. S. Hejazi, S. Mohajernia, B. Osuagwu, G. Zoppellaro, P. Andryskova, O. Tomanec, Š. Kment, R. Zbořil, P. Schmuki, *Adv. Mater.* 2020, 32, 1908505 (*Adv. Mater.* is #6 of 959 (Top 1%) in the SJR category Materials Science in 2020).

- Mixed-valence single-atom catalyst derived from functionalized graphene. A. Bakandritsos, R. G. Kadam, P. Kumar, G. Zoppellaro, M. Medved', J. Tuček, T. Montini, O. Tomanec, P. Andrýsková, B. Drahoš, R. S. Varma, M. Otyepka, M. B. Gawande, P. Fornasiero, R. Zbořil, Adv. Mater. 2019, 31, 1900323 (Adv. Mater. is #6 of 961 (Top 1%) in the SJR category Materials Science in 2019).

7. List of no more than 3 important research projects in the selected discipline awarded in national and international calls to the institution in the last 5 years:

Horizon Europe – ERC

2D-CHEM: Two-Dimensional Chemistry towards New Graphene Derivatives

Project number: ERC-2015-CoG: 683024

Principal investigator: Prof. Dr. Michal Otyepka, Ph.D.

Funding: 1.8 million EUR

Duration: 06/2016-06/2022

Horizon Europe – EIC

Transition of 2D-chemistry based supercapacitor electrode material from proof of concept to applications

Project number: HORIZON-EIC-2021-TRANSITION-CHALLENGES-01: 101057616

Principal investigator: Prof. RNDr. Michal Otyepka, Ph.D.

Funding: ~2.5 million EUR

Duration: 01/2022-12/2024

MEYS - Operational Programme Research, Development and Education

Nanotechnologies for Future

Project number: CZ.02.1.01/0.0/0.0/16_019/0000754

Project director: Prof. RNDr. Michal Otyepka, Ph.D.

Funding: ~13 million EUR

Duration: 01/2018-12/2022

8. Description of the available laboratory and office space for a Dioscuri Centre:

The Dioscuri Centre will have at its disposal sufficient laboratory space at Palacký University Olomouc, namely in the Regional Centre of Advanced Technologies and Materials (RCPTM) under the Czech Advanced Technology and Research Institute (CATRIN). Thus, the potential applicant together with his/her research group will have access to fully equipped laboratories as well as offices to carry out administrative tasks, group meetings, and joint events with the partner from Germany. CATRIN disposes of several buildings at the University campus and enjoys the practicality of many other laboratories from different fields of natural as well as life sciences being nearby, which allows for interdisciplinary research. There is also a library and a cafeteria on campus.

9. List of the available research equipment for a Dioscuri Centre:

CATRIN - RCPTM is equipped with state-of-the-art laboratories for materials/nanotechnology research enabling the comprehensive characterization of developed supports/Single Atom Catalysts including the description of their chemistry, structure, valence states of TMs, coordination environment, loading, etc.

Microscopic Laboratory: High-resolution transmission electron microscope (resolution 0.08nm) capable of measurements at low temperatures (cryoHRTEM) and allowing chemical mapping technology such as EDX and EELS is present. This microscopic technique is further complemented by a standard transmission electron microscope (TEM). A high-resolution scanning electron microscope (HRSEM) equipped with a focused ion beam (FIB) system and utilizing the EDX modeHRSEM-FIB technique will be used for the preparation of thin lamellas for a HRTEM analysis of the developed SAC films. An atomic force microscope (AFM) as well as a scanning tunnelling microscope (UHV STM) is also available.

X-Ray Laboratory: X-ray powder diffractometer enabling phase analysis and the processing of samples at high temperatures (XRD) in different atmospheres, an X-ray single crystal diffractometer, and an X-ray fluorescence spectrometer (XRF) capable of analysing solid and liquid samples composed of elements in the range from sodium to uranium are at the researchers' disposal.

Spectroscopic Laboratory: An inductively coupled plasma mass spectrometer (ICP-MS) with laser ablation is present in the laboratory. Other spectroscopic techniques that may be used for the SAC characterization include IR/Raman spectroscopy, a Raman scattering microscope, micro-Raman spectroscopy, and electron paramagnetic resonance (EPR). Other techniques accessible for the advanced characterization of SACs are NMR with a solid-state probe and a physical property measurement system (PPMS) allowing the description of the chemical and transport properties of the samples, respectively.

Surface Properties Laboratory: A BET analyser for the measurement of the surface area and material porosity, facilities for measuring chemisorption and specific surface area with the ability to perform analyses up to 450°C, dynamic light scattering (DLS) analyser for measuring the distribution of particle sizes and zeta potential, and surface energy analyser (SEA) facilities for measuring surface energy using the inverse gas chromatography method are present. These techniques will be used to provide important information about the surface area, porosity, surface energy, and surface charge of the developed supports/SACs.

It is worth mentioning that there are many other facilities available at Palacký University Olomouc (<https://www.rcptm.com/business/analytic-services/>), which will be fully accessible to the potential Dioscuri program applicant.

10. List of the additional benefits (other than listed in the conditions for hosting a DC, see invitation) that the Institution declares to provide for a Dioscuri Centre (i.e.: additional funds, personal benefits, dual career options, relocation support or other):

Apart from state-of-the-art equipment in the laboratories of our research institute we are willing to offer sophisticated support from our administrative staff who are continuously encouraged to improve their communication skills in English. We offer relocation support in the form of a Welcome office which is in charge of integrating foreign employees as well as their family members should that be necessary into the local environment. There are possibilities to maintain career options at other institutes within the Czech Republic as well as abroad. The Palacký University offers a variety of employee benefits from accommodation in University-owned apartments, convenient prices in University dining facilities, wide selection of sports and leisure activities in University facilities, University kindergarten, science museum Fort Science, University language school etc.

11. Other information about the internationalization of the research institution, international researchers employed at the institution, the availability of English language seminars etc.:

As it is one of the goals stipulated in the Strategic objectives of CATRIN, the internationalization of the research institute is of utmost importance. It is developed especially through a higher degree of involvement of foreign research workers in the scientific activities of the centre as well as an increasing number of study and research stays abroad.

The ratio of foreign workers employed at CATRIN reaches impressive 32 %, which is quite unique within the Czech Republic. A great attention is devoted to the participation at international conferences, establishing new international research collaborations, and development of international strategic partnerships. The international approach applied at all levels of CATRIN's activities is essential for securing an open and welcoming environment as well as for overcoming barriers while establishing and developing international scientific, research, and creative activities.

CATRIN supports the internationalization of the scientific research environment. Given its short history, it currently has only three cooperation agreements: the European Federation of Biotechnology, Bar-Ilan University and Bar-Ilan's Institute for Nanotechnology and Advanced Materials. We are aware of the importance of the University's involvement in the Alliance of European Universities AURORA and are looking for opportunities to expand cooperation with its members.

Our goal is to keep creating conditions for full integration of foreign research workers, thus enhancing the high internationalization ratio. Through our scientific research activities and a greater involvement in international grant project consortia we shall strengthen ties with international scientific as well as industrial area.