REGISTRATION FORM FOR CZECH SCIENTIFIC INSTITUTION

1. Research institution data (name and address):

Brno University of Technology (BUT)
Central European Institute of Technology (CEITEC BUT – university institute)
Purkyňova 656/123, 612 00 Brno, Czech Republic

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

3. Head of the institution: prof. Ing. Radimír Vrba, CSc. – Director of CEITEC BUT

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

Dr. Ing. Jan Macák - Coordinator of the research programme „Advanced Materials“
e-mail jan.macak@ceitec.vutbr.cz, tel. +420 54114 9726, mobile +420777268358

Ing. Jan Bogdan – Project Support at the CEITEC BUT Grant Office
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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:

CEITEC BUT publishes high-profile publications on the synthesis and characterization of nanomaterials and their application in various fields described below. We provide several publication examples for each field:

Catalysis including electrocatalysis and photocatalysis

R. Zazpe, H. Sopha, J. Charvot, R. Krumpolec, J. R. Pereira, J. Michalicka, J. Mistrik, D. Baca, M. Motola, F. Bures, J.M. Macak, *2D MoTe2 nanosheets by atomic layer deposition: Excellent photo-electrocatalytic properties*, Applied Materials Today, 23 (101017) 2021. DOI: 10.1016/j.apmt.2021.101017, **IF: 10.041**

S. Ng, R. Zazpe, J. Rodriguez-Pereira, K. Michalicka, J.M. Macak, M. Pumera, *Atomic layer deposition of photoelectrocatalytic material on 3D-printed nanocarbon structures*, Journal of Materials Chemistry A, 9(18) (11405-11414) 2021. DOI: 10.1039/d1ta01467f, **IF: 12.732**

R. Zazpe, R. Krumpolec, H. Sopha, J. Rodriguez-Pereira, J. Charvot, L. Hromadko, E. Kolibalova, J. Michalicka, D. Pavlinak, M. Motola, J. Prikryl, M. Krbal, F. Bures, J. M. Macak, *Atomic Layer Deposition of $MoSe_2$ Nanosheets on TiO_2 Nanotube Arrays for Photocatalytic Dye Degradation and Electrocatalytic Hydrogen Evolution*, ACS Applied Nanomaterials, 3(12) (12034-12045) 2020. DOI: 10.1021/acsanm.0c02553, **IF 5.09**

H. Sopha, A. Kashimbetova, L. Hromadko, I. Saldan, L. Celko, E.B. Montufar, J.M. Macak, *Anodic TiO_2 Nanotubes on 3D-Printed Titanium Meshes for Photocatalytic Applications*, Nano Letters, 21(20) (8701-8706) 2021. DOI: 10.1021/acs.nanolett.1c02815, **IF: 11.189**

Sensors for various gases and lights

S. Ng, J. Prasek, R. Zazpe, Z. Pytlicek, Z. Spotz, J.R. Pereira, J. Michalicka, J. Prikryl, M. Krbal, H. Sopha, J. Hubalek, J.M. Macak, *Atomic layer deposition of SnO_2-coated anodic one-dimensional TiO2 nanotube layers for low concentration NO_2 sensing*, ACS Applied Materials & Interfaces, 12(29) (33386-33396) 2020, DOI: 10.1021/acsami.0c07791, **IF: 9.220**

B. Wiltshire, M. Alijani, S. Mohammadi, A. Hosseinni, J.M. Macak, M.H. Zarifi, *High-Frequency TiO2 Nanotube-Adapted Microwave Coplanar Waveguide Resonator for High-Sensitivity Ultraviolet Detection,* ACS Applied Materials & Interfaces, 14(22) (6203-6211) 2022, DOI: 10.1021/acsami.1c21741, **IF: 9.220**

Solar Cells

Zazpe, R., Sopha, H., Prikryl, J., Krbal, M., Mistrik, J., Dvorak, F., Hromadko, L., & Macak, J. M. (2018). *A 1D conical nanotubular TiO2/CdS heterostructure with superior photon-to-electron conversion*. *Nanoscale, 10*(35), 16601-1661, DOI:10.1039/c8nr02418a, **IF: 7.790**

Ng, S., Krbal, M., Zazpe, R., Prikryl, J., Charvot, J., Dvořák, F., Strizik, L., Slang, S., Sopha, H., Kosto, Y., Matolin, V., Yam, F. K., Bures, F., & Macak, J. M. (2018). *MoSexOy-coated 1D TiO2Nanotube layers: Efficient interface for light-driven applications*. Advanced Materials Interfaces, 5(3), DOI:10.1002/admi.201701146, **IF: 6.147**

Nanorobots

USSIA, M.; URSO, M.; DOLEŽELÍKOVÁ, K.; MICHÁLKOVÁ, H.; ADAM, V.; PUMERA, M., 2021: *Active Light-powered antibiofilm ZnO micromotors with chemically programmable properties.* Advanced Funct. Mater*, 31(27)*, p. 1 - 10, DOI: 10.1002/adfm.202101178; **IF: 18.808**

KOCHERGIN, Y.; VILLA, K.; NOVOTNÝ, F.; PLUTNAR, J.; BOJDYS, M.; PUMERA, M., 2020: *Multifunctional Visible-Light Powered Micromotors Based on Semiconducting Sulfur- and Nitrogen-Containing Donor-Acceptor Polymer.* Advanced Funct. Mater *30(38)*, p. 2002701-1 - 9, DOI: 10.1002/adfm.202002701; **IF: 18.808**

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:

Breakthrough zero-emissions heat generation with hydrogen-metal systems (HERMES): Dr. Ing. Jan Macák, H2020 FET Proactive, 2020-2024, € 3 999 870

The project was proposed to study hydrogen (and deuterium) evolution in unconventional conditions, i.e. on metal-hydrides and the main motivation for this work is based on the recent Nature perspective "Revisiting the cold case of cold fusion". When loading deuterium into the Pd lattice, there is a chance that something very interesting will happen, resulting in production of excess heat. The first report of such reaction was published 30 years ago, but quickly dismissed by the scientific community. But what if there is really something? Can we afford to not to investigate this further, considering the current climate crisis? This is a high risk/high reward project, but with aid of all the improved techniques and tools developed in the last 30 years, we believe that it is worth revisiting the topic.

2D Nanomaterials Electrochemistry: prof. RNDr. Martin Pumera, Ph.D., GAČR EXPRO, 2019-2023, CZK 49 451 000 (~ € 1 901 961)

The overall aim of this project is to develop fundamental understating of the electrochemistry of the layered and 2D materials. These materials include monoelemental materials, such as layered pnictogens (black phosphorus, layered arsenic, antimony and bismuth); binary materials such as layered transition metal dichalcogenides, MXenes, and ternary materials such as metal phosphorus chalcogenides and their monolayer (2D) counterparts.
The answers will be found to profound basic electrochemical questions regarding layered and 2D materials, such as:
A) What is the edge vs. basal plane electroactivity? What are general underlying rules?
B) What is the influence of crystal structures on the electroactivity? Why?
C) What is the size confinement effect on electrocatalysis?
D) What is the influence of atomic composition variation of the materials on the electrochemistry?
E) What is the role of heteroatom dopants, impurities and vacancies in the lattice of 2D materials on their electrochemistry and electrocatalysis?
F) What is the influence of materials curvature on electrochemistry?

Autonomous Smart Swarming Microswimmers: prof. RNDr. Martin Pumera, Ph.D., ERC-CZ, 2020-2022, CZK 21 136 000 CZK (~ € 812 923)

The project focuses on the cutting edge research and the development of artificial functional self-propelled microscopic devices – microswimmers, which respond to external stimuli and are capable of autonomous behavior in a complex system, mutual communication, swarming, similar to primitive organisms and which are able to perform "detect and act" tasks. Research studies on the use of microswimmers in biomedical applications are currently progressing at an incredibly fast pace. We want to develop artificial autonomous smart swarming microswimmers capable of chemotaxis, magnetotaxy and phototaxis.

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

The CEITEC Nano Research Infrastructure (https://nano.ceitec.cz/) provides complex equipment, expertise and methods for nanotechnology and advanced materials R&D in open access mode. The CEITEC Nano facilities for nanofabrication, nanocharacterization, structural analysis and X-ray tomography enable to carry out complete fabrication of nanostructures and nanodevices and their characterization down to the sub-nanometre level in an entirely clean environment. The chemical laboratories are intended to serve users interested in chemical processes and samples preparation. Some additional equipment needed for the foreseen research agenda is also available and accessible among individual research groups. For the Dioscouri Centre we will offer:

a) Open-space laboratories dedicated for establishing new research groups.

b) Modern, fully furnished office ranging from 15 to 90 m2.

c) Fully equipped, specialized laboratories, dedicated for organic and inorganic synthesis and analysis, clean synthesis and characterisation of novel materials with special properties.

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

Nanofabrication cleanroom laboratories (ISO 5): size 350 m2

- Photolithography lab
- Maskless lithography (EBL, UV, DWL)
- Depositions (PVD, CVD, PECVD) and Etching (RIE, IBE)

Nanocharacterization cleanroon laboratories (ISO 8): size 1300 m2

- FIB/SEM lab
- SPM lab
- Optical lab Low temperature measurement lab
- Electrical lab
- UHV lab

Structural analysis cleanroom laboraties (ISO 8) size 300 m2

- FIB/SEM lab
- TEM lab
- XRD lab
- Sample preparation labs

Chemical laboratories

- Benchtop NMR system (Magritec)
- Microwave Synthesis reactor (Anton Paar)
- Surface area and pore Size Analyzer
- Vacuum FTIR Vertex70v + microscope Hyperion 3000
- DHR2 Rheometer
- Gas Chromatography (GC) with TurboMarix Headspace (HS) (Perkin Elmer Clarus 680)
- Gel Permeation Chromatography (GPC)/Size Exclusion Chromatography (SEC)
- Smaller laboratory items suitable for synthesis of organic and inorganic compounds

Furthermore, in other labs of the hosting institution (among individual research groups), additional accessible instruments for the development and testing of solar cells are available, including various 3D-, inkjet- and screen-printing setups, gloveboxes with spin coaters, AM 1.5 Solar simulator, etc.

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):

CEITEC has at its disposal state-of-the-art research infrastructure unique within the Czech Republic and the whole Central Europe. Our long-term focus is to maintain this unique position and its full utilization in high-quality research and its impact on society. Our aim is to provide seamless support and operations for the researchers to minimize their exposure to operational tasks.

We value autonomy of our research groups and professional research support. We offer fully English-speaking highly motivating environment with wide local and international network of collaborators from academia and industry. We provide professional growth and further education possibilities through workshops, trainings, seminars, invited lectures, and conferences.

Our Welcome Office provides practical support for researchers and their family members before, during and after relocation to Brno. Specifically, we assist in obtaining employment and residence permit, finding suitable accommodation, organising the arrival, moving around the city and other matters related to the life in Brno.

Work-life balance is facilitated by 8 weeks of paid holidays, flexible working hours, home-office or a university kindergarten. Furthermore, we offer pension savings/life insurance contribution, meal vouchers and preferential tariffs with a mobile operator. We also establish regular opportunities for social and scientific interactions.

The Brno City Municipality will provide additional funding for the DC leader and support his or her relocation to Brno, including help in finding a suitable position for the partner of the DC leader.

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

CEITEC BUT is a leader when it comes to obtaining international research grants namely Horizon 2020 and Horizon Europe.

We offer a welcoming environment for talented and motivated people from all over the world. Almost 25% of our about 400 employees and 50% of our 150 doctoral students are foreigners and around 30 nationalities are represented.

English language is therefore our standard of communication, including the administration and support staff. Our International Scientific Board, regular meetings of Research Group Leaders held in English or our Seminar Series aimed at Advanced Materials and Nanotechnology delivered by top-scientists from renowned institutions worldwide are just a few examples of our international dimension.

To promote the existing international environment, we offer our employees a variety of language courses such as English, German, French or Czech for foreigners on different levels of proficiency.