## CEITEC BUT – overview of the topics

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2 |
| 2 | NAME OF THE RESEARCH GROUP |
| 3 | TOPIC/TOPICS |
| 4 | SHORT SUMMARY |
| 5 | WEBPAGE OF THE GROUP/CONTACT |

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2: advanced biomaterials |
| 2 | NÁZEV VÝZKUMNÉ SKUPINY: **Advanced Biomaterials (L. Vojtová)** |
| 3 | TÉMA/TÉMATA:<br>**Radical-free photocrosslinkable hydrogels for 3D bioprinting of advanced cartilage constructs** |
| 4 | ANOTACE K TÉMATU/TÉMATŮM:<br>3D bioprinting is rapidly emerging as a transformative technology in regenerative medicine, enabling the fabrication of complex, patient-specific tissue constructs with unprecedented spatial precision. Among the strategies employed in this field, photocrosslinking has gained particular attention due to its ability to provide spatiotemporal control over the biochemical and mechanical properties of biomaterials. Hydrogels represent the principal class of bioinks for such applications; however, conventional photocrosslinking methods often rely on photoinitiators that generate free radicals, which may compromise cell viability and hinder clinical translation.<br>This project seeks to advance the field by developing a new generation of radical-free, photocrosslinkable hydrogels specifically designed for 3D bioprinting applications. The research will focus on engineering dynamic polymeric networks that can be rapidly stabilized under cytocompatible light conditions, thereby ensuring precise spatiotemporal gelation without the limitations of radical-mediated chemistry. The resulting materials are expected to combine high printability, mechanical robustness, and biocompatibility, establishing an advanced platform for biofabrication and regenerative medicine of cartilage tissue. |
| 5 | WEBPAGE VÝZKUMNÉ SKUPINY/KONTAKT: https://biomaterials.ceitec.cz/ |

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2: advanced instrumentation and methods for materials characterization |
| 2 | NÁZEV VÝZKUMNÉ SKUPINY: **Advanced Instrumentation and Methods for Materials Characterization (J. Kaiser)** |
| 3 | TÉMA/TÉMATA<br>A) **Unravelling microplastic fate and transport using combined advanced imaging and chemical characterization methods**<br>B) **Advancing coral biomineralization studies: Real-time imaging of coral skeletogenesis using 4D X-ray microcomputed tomography** |
| 4 | ANOTACE K TÉMATU/TÉMATŮM<br>A) This project aims to driving forward microplastic research by developing a novel, multi-instrumental approach that combines high-resolution X-ray computed |

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| | tomography (CT) with SEM, FTIR, Raman spectroscopy and LIBS. Using a dynamic, environmentally realistic model system, simulating natural processes such as UV degradation, organisms' activity, and biofilm formation, we will track microplastic movement and transformation in complex matrices like soil and sediment. This multi-modal methodology will expand detection capabilities and provide new insights into microplastic fate, informing improved environmental monitoring and mitigation strategies.<br>B) The project will advance our understanding of coral biomineralization by developing a novel, non-invasive method for real-time imaging of skeletal formation in live reef-building corals using 4D X-ray microcomputed tomography. By capturing high-resolution structural changes over time, we seek to uncover the dynamic processes behind coral skeletogenesis and how they are influenced by environmental stressors such as ocean acidification. The methodology developed will provide a powerful platform for interdisciplinary research at the intersection of marine biology, imaging science, and environmental change. |
| 5 | WEBPAGE VÝZKUMNÉ SKUPINY/KONTAKT: https://www.ceitec.eu/advanced-instrumentation-and-methods-for-materials-characterization/rg6 |

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2: future energy |
| 2 | NÁZEV VÝZKUMNÉ SKUPINY: Future Energy and Innovation Lab (M. Pumera) |
| 3 | TÉMA/TÉMATA<br>**Topic A: Nanorobots for Biomedical and Environmental Applications**<br>**Topic B: Next Generation Materials for Flexible Wearable Sensors and Energy Storage**<br>**Topic C: Atomically Engineered Materials for Sustainable Carbon-Free Fuels** |
| 4 | ANOTACE K TÉMATU/TÉMATŮM<br>Annotation A: Microrobots are at the forefront of next-generation solutions in healthcare and environmental technologies. They are designed to:<br>• Remove nanoplastics from aquatic environments<br>• Eradicate biofilms that obstruct medical treatments and device performance<br>Our group explores the innovative designs and mechanisms of nano- and microrobots, with emphasis on:<br>• Targeted biomedical therapies and improved antibiotic efficacy<br>• Environmental remediation through micro- and nanoplastic adsorption<br>• Advanced single atom engineering strategies for precise functionality<br>We seek motivated candidates interested in pioneering microrobotics research, contributing to sustainable technologies, and addressing pressing biomedical and environmental challenges.<br>Key References:<br>• Urso, Ussia & Pumera, Smart micro- and nanorobots for water purification, Nat. Rev. Bioeng. 2023.<br>• Mayorga-Martinez, Zhang & Pumera, Chemical multiscale robotics for bacterial biofilm treatment, Chem. Soc. Rev. 2024.<br>• Urso, Ussia, Novotný & Pumera, Trapping and detecting nanoplastics by MXene-derived oxide microrobots, Nat. Commun. 2022.<br>• Pumera et al., Technology Roadmap of Micro/Nanorobots, ACS Nano 2025. |

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| | Annotation B: The transition to flexible and wearable electronics demands advanced energy storage and sensing materials. Our group pioneers the development of next-generation systems that integrate:<br>• Flexible and stretchable batteries and supercapacitors with high energy density<br>• Wearable sensors for real-time health and environmental monitoring<br>• 2D and MXene-based nanomaterials, conductive polymers, and hybrid architectures<br>• 3D printing for batteries and sensors<br>This research bridges materials science, nanotechnology, and device engineering, addressing key challenges in:<br>• Mechanical flexibility and stability of energy storage devices<br>• Biocompatibility and integration into wearable platforms<br>• High sensitivity, selectivity, and durability of flexible sensors<br>We seek motivated postdoctoral researchers eager to shape the future of smart energy and sensing technologies through materials innovation and device engineering.<br><br>Annotation C: This project focuses on the design and development of next-generation electrocatalysts for the sustainable production of carbon-free fuels such as hydrogen and ammonia. By applying single-atom engineering and atomic-scale tailoring of catalyst surfaces, we aim to significantly enhance catalytic efficiency, selectivity, and stability. The electrocatalytic processes will be ultimately powered by renewable green energy sources, ensuring a closed, environmentally friendly fuel cycle. The research will establish a fundamental understanding of structure–property relationships at the atomic level, enabling breakthroughs in scalable, sustainable fuel generation technologies crucial for the energy transition. |
| 5 | WEBPAGE VÝZKUMNÉ SKUPINY/KONTAKT: https://www.ceitec.eu/future-energy-and-innovation/rg322 |

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2: bioelectronics materials and devices |
| 2 | NÁZEV VÝZKUMNÉ SKUPINY: Bioelectronics Materials and Devices (E. Glowacki) |
| 3 | TÉMA/TÉMATA<br>Exploring High-Frequency Electrical Neurostimulation Beyond Classical Mechanisms |
| 4 | ANOTACE K TÉMATU/TÉMATŮM<br>We are seeking a motivated postdoctoral researcher to join our interdisciplinary team at the Bioelectronics Materials and Devices Laboratory, Brno University of Technology. Our research focuses on high-frequency electrical neurostimulation, specifically using unconventional waveforms in the kilohertz-to-megahertz (kHz–MHz) range. The central goal is to investigate how these atypical frequencies can influence neuronal function through non-classical biophysical mechanisms, potentially operating beyond standard membrane depolarization. This is a fundamental scientific question with significant implications for future bioelectronic therapies and neural interfacing technologies. We offer a flexible and multidisciplinary research environment, with opportunities to work across several experimental and theoretical platforms: Computational modeling of neuronal responses to high-frequency fields; In vitro electrophysiology, including patch clamp and multielectrode arrays; Experiments on model organisms (e.g. invertebrate nervous systems); Noninvasive human studies, |

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| | with access to stimulation and recording equipment. The project benefits from strong collaborative ties with neuroscience groups at the CEITEC campus of Masaryk University (MUNI), enabling joint experiments and access to complementary infrastructure across Brno's leading research institutions. A successful fellowship project may thus span both campuses. |
| 5 | WEBPAGE VÝZKUMNÉ SKUPINY/KONTAKT: https://www.ceitec.eu/bioelectronics-materials-and-devices/rg375 |

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2: advanced ceramic materials, polymers & composites |
| 2 | NÁZEV VÝZKUMNÉ SKUPINY: Advanced Ceramic Materials (M. Trunec) |
| 3 | TÉMA/TÉMATA<br>Development of multimaterial 3D printing using the digital light processing method |
| 4 | ANOTACE K TÉMATU/TÉMATŮM<br>The aim of the project is to develop an innovative technology for 3D printing ceramic–metal components using the digital light processing (DLP) method. The project will focus not only on developing novel materials and manufacturing processes, but also on supporting a long-term research platform for technology transfer. This platform will provide regional companies with sustainable collaboration opportunities and access to advanced 3D printing technologies under development. The developed method will be demonstrated through the preparation of prototype composite components, designed in cooperation with regional companies (e.g., Roplass s.r.o.) and validated in industrial practice.<br><br>Leading CEITEC Institution and PI: CEITEC BUT, Prof. Martin Trunec, RG201<br>Cooperating CEITEC Institution and PI: CEITEC IPM, Dr. Zdenek Chlup |
| 5 | WEBPAGE VÝZKUMNÉ SKUPINY/KONTAKT: https://www.ceitec.eu/advanced-ceramic-materials/rg12 |

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| 1 | CEIPEX RESEARCH TOPIC LEVEL2: nanomagnetism & spintronics |
| 2 | NÁZEV VÝZKUMNÉ SKUPINY: Nanomagnetism and Spintronics (V. Uhlíř) |
| 3 | TÉMA/TÉMATA<br>A) In situ magneto-ionic control of antiferromagnetic/ferromagnetic interfaces<br>B) Magnetic actuation platforms for biological environments |
| 4 | ANOTACE K TÉMATU/TÉMATŮM<br>A) Study how electric fields or ion migration reshape magnetic order in thin films, using advanced electron microscopy. The goal is to directly watch magnetic domain walls and/or phase changes as they happen, linking atomic-scale mechanisms to device-scale functionality.<br>B) Design magnetic micro- and nanostructures that can be remotely controlled by external magnetic fields to actively influence biological systems. These platforms would deliver mechanical forces or trigger local electrical responses inside cells or tissues, enabling new modes of stimulation and therapeutic intervention. |
| 5 | WEBPAGE VÝZKUMNÉ SKUPINY/KONTAKT: https://www.ceitec.eu/nanomagnetism-and-spintronics/rg261 |