



XIX. Call for the Junior Fund, 2026

Proposal for a research project

Faculty/institute/unit of CU:	Faculty of Science
Department:	Department of Physical and Macromolecular Chemistry
Research project title:	Low Potential Aldehyde Oxidation Reaction-Assisted Bipolar Hydrogen Production: Overcoming Mechanistic, Materials, and Scale-up Challenges
Project description:	<p>The coupling of electrosynthesis oxidation reactions to the hydrogen evolution reaction is more advanced, sustainable, and economically viable strategy for hybrid water electrolysis. This not only lowers the overall voltage required for hydrogen production and omits H₂/O₂ explosion hazards but also generates chemical feedstocks with commercial value. However, these systems still need more than 1 volt to operate, which means they end up using a lot of electricity. Among electrosynthesis oxidation reactions, the low-potential oxidation of aldehydes has recently attracted considerable research interest because it can offer a more energy-efficient bipolar hydrogen production system.</p> <p>Low potential aldehyde oxidation assisted bi-polar hydrogen production systems is emerging as promising alternative to conventional water electrolysis. Despite the promise, state of art copper-based catalysts suffers with limited selectivity and working potential window due to surface passivation. These challenges restrict their application, especially at industrially relevant high current densities. Importantly, the dynamic roles of Cu(0) and Cu(+1) species during the reaction remains unclear, preventing rational catalyst design.</p> <p>This project aims to establish a structure-activity correlation between copper oxidation state dynamics and catalytic performance by using detailed studies by operando techniques. Further, establish a mechanistic foundation that quantitatively links operando Cu(0)/Cu(+1) dynamics to catalytic performance in LPAOR, thereby guiding the design of Cu-rich high-entropy electrode materials based on the Cu-Ni-Fe-Co-Zn system with optimized high-entropy alloy (HEA)/ high-entropy oxides (HEO) interface for LPAOR-assisted bipolar H₂ production at industrially relevant current densities (300-500 mA/cm²) for at least 100-200 h.</p> <p>Publications of research group related to this topic:</p> <ol style="list-style-type: none">1. Gao, R.#; Dai, Q.#; Du, F.; Yan, D.; Dai, L. C60-Adsorbed Single-Walled Carbon Nanotubes as Metal-Free, pH-Universal, and



	<p>Multifunctional Catalysts for Oxygen Reduction, Oxygen Evolution, and Hydrogen Evolution. <i>Journal of the American Chemical Society</i> 2019, 141, 11658–11666. https://doi.org/10.1021/jacs.9b05006</p> <p>2. Gao, R.; Yan, D. Fast Formation of Single-Unit-Cell-Thick and Defect-Rich Layered Double Hydroxide Nanosheets with Highly Enhanced Oxygen Evolution Reaction for Water Splitting. <i>Nano Research</i> 2018, 11, 1883–1894. https://doi.org/10.1007/s12274-017-1806-x (Nano Research Top Papers Award in 2020)</p> <p>3. Gao, R.; Yan, D. Recent Development of Nickel/Iron-Based Micro/Nanostructures toward Photo-/Electrochemical Water Oxidation. <i>Advanced Energy Materials</i> 2020, 10, 1900954. https://doi.org/10.1002/aenm.201900954 (Wiley Top Cited Article 2020-2021)</p> <p>4. Gao, R.; Zhang, H.; Yan, D. Iron Diselenide Nanoplatelets: Stable and Efficient Water-Electrolysis Catalysts. <i>Nano Energy</i> 2017, 31, 90–95. https://doi.org/10.1016/j.nanoen.2016.11.021</p> <p>5. Kodaimati, M. S.#; Gao, R.#; Root, S. E.; Whitesides, G. M. Magnetic Fields Enhance Mass Transport During Electrocatalytic Reduction of Carbon Dioxide. <i>Chem Catalysis</i> 2022, 2, 797–815. https://doi.org/10.1016/j.checat.2022.01.023</p>
What do we offer?	Two-year fixed-term position which can be further extended if additional funds become available.
Profile of an ideal candidate:	PhD in Chemistry or a related field, with strong expertise in electrocatalysis, hybrid water splitting, transition-metal catalyst design, and electrochemical characterization. Experience in organic molecule oxidation would be an advantage, while structure-activity correlation using advance characterization technique is highly desirable
Position available from:	October 1, 2026
Workplace location:	Department of Physical and Macromolecular Chemistry, Faculty of Science, Charles University, Hlavova 8, 120 00 Prague 2, Czechia www.physchem.cz
Supervisor(s):	Dr Rui Gao, Ph.D.
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Application deadline:	May 15, 2026
Applicants must submit required documents to:	(Rui Gao) gaoru@natur.cuni.cz