

## Low-dimensional Materials in Advanced Catalytic Applications

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Low-dimensional chemistry represents an emerging field of materials science allowing to entrap single metal species in suitable supports thus achieving unprecedented properties in various applications including catalysis, energy, medicine or environmental technologies. In the talk, the specific aspects of 2D graphene chemistry starting from fluorographene and enabling to prepare a broad portfolio of 2D materials will be introduced. Among others, we will demonstrate the unique applicability of well-defined graphene derivatives, graphene acid and cyanographene [1], for the development of advanced single-atom materials. We will report cyanographene-supported linear structure single-atom gold(I) catalyst for dehydrogenative coupling of organosilanes with alcohols [2], and mixed valence Cu(I)/Cu(II) single atom catalyst for the oxidative coupling of amines and the oxidation of benzylic C-H bonds toward high-value pharmaceutical synthons [3]. Also, the use of amino-acid functionalized graphene organocatalyst for the superior transformation of wastes into high-added-value chemicals will be discussed [4].

Among other low-dimensional systems, the use of various cheap Cu/Fe based catalysts for sustainable chemical technologies will be shown. Thus, the unique properties of pyramidal 0D plasmonic CuFeS<sub>2</sub> nanoparticles for fast and selective reduction of nitroarenes under visible light will be introduced [5]. Similarly, the exceptional catalytic properties of 1D Fe/Fe-O nanowires embedded in the silica matrix will be explored through their use for the catalytic hydrogenation of nitriles to amines in the presence of aluminum additives [6].

In the concluding part, we will show the huge potential of low-dimensional chemistry and single atom engineering also in other fields including medicine and environmental technologies [7,8].

### References:

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**Prof. Radek Zbořil** after receiving his PhD degree in 2000, stayed at several universities, e.g., the University of Delaware or the University of Tokyo. Since 2010, he has been a Professor at Palacký University Olomouc. He was a Founding Director (2010–2020) of the Regional Centre of Advanced Technologies and Materials (RCPTM) at Palacký University Olomouc. Since 2018, he has been a guest scientist at Friedrich–Alexander University Erlangen–Nürnberg, Germany. Currently, he acts as the Scientific Director of the RCPTM division of the Czech Advanced Technology and Research Institute (CATRIN). He is also a vice-director of Nanotechnology Centre and leads the Materials-Envi Lab at the Centre for Energy and Environmental Technologies (CEET) at VSB-Technical University Ostrava. Between years 2012 and 2019, prof. Zbořil also acted as the Director of the Competence Centre of the Technology Agency of the Czech Republic. He was a member of the Board of the Technology Agency of the Czech Republic (Alfa programme) and of the Scientific Board for chemistry of the Neuron Endowment Fund. He was or still is a member of the Editorial Boards of several journals published by Elsevier, Wiley or Nature family. Since 2012, he has been the Chairman of Nanocon, one of the largest conferences in the field of nanotechnologies. Since 2014, he has been the Chairman of the prestigious Zahradník lecture series. Prof. Zbořil has received many awards for his research, e.g., the Czech Republic's Minister of Education for extraordinary results achieved in the field of research, experimental development and innovations (2011), the Werner von Siemens Award (2018), the Miloš Hudlický Award given by the Czech Chemical Society (2023).. He also acted as the panel member for the evaluation of ERC Advanced grants (2022) and as the external panel evaluator of ERC Advanced grants (2023). The research of Prof. Zbořil's is focused on advanced nanotechnologies, low-dimensional materials and single-atom engineering towards applications in biomedicine, water treatment, catalysis, energy, and environmental technologies, with other application strategies being developed.

He is an author and co-author of 711 papers and many books/book chapters published by, e.g., American Chemical Society, Wiley, or American Institute of Physics. His publications have received over 73 600 / 55 900 citations (Google Scholar/Web of Science). His H-index is 123/106 (October, 2024). Professor Zbořil has appeared many times on the list of Highly Cited Researchers, published annually by Clarivate Analytics in the USA and on the list of Top 2% Scientists Worldwide by Stanford University. Based on the prestigious research.com) ranking, he is the most cited Czech scientist in the field of materials science (2022, 2023). In the world ranking, he is among the Top 5 most highly cited scientists in Water Treatment, Top 20 in Energy, and Top 50 in Catalysis and Nanotechnology, according to Google Scholar.

Professor Zbořil is the Principal Investigator of many national and international grant projects, with the financial support for Palacký University Olomouc and VSB-Technical University Ostrava totalling more than EUR 80 million.