

Photo(electro)catalysis with single-atom-based co-catalysts for renewably energy applications

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In the face of growing energy demands, dwindling fossil fuel reserves, and the urgent need to reduce carbon emissions, our society is confronted with critical challenges regarding the future of energy sources. Renewable energy alternatives are not only vital for addressing these challenges but also hold the potential to transform our approach to energy generation and sustainability. This seminar will delve into the forefront of semiconductor and carbon-based photo(electro)catalysis, focusing on titanium dioxide (TiO₂) as a benchmark photoactive semiconductor material along with advanced carbon-based photocatalysts such as graphitic carbon nitride (g-C₃N₄) and carbon dots. These materials hold potential for sustainable and renewable energy generation, including hydrogen production through solar-driven water splitting and ammonia decomposition, as well as H₂O₂ production via selective oxidation processes. A key emphasis will be placed on the role of metal-based co-catalysts, where nanoparticles and single-atom co-catalytic sites have been shown to significantly enhance catalytic efficiency and selectivity. These co-catalysts facilitate charge separation and transfer, mitigate recombination losses, and introduce unique active sites that improve the photocatalytic and photoelectrocatalytic performance of the base materials. By examining recent advances in catalyst design and mechanistic understanding, we will explore how these hybrid systems contribute to the generation of clean fuels and chemicals, paving the way toward sustainable energy solutions.



Assoc. Prof. Štěpán Kment is the head of the CATRIN research group on Photochemistry and is also affiliated with VSB – Technical University of Ostrava, Czech Republic. He has been working and collaborating with leading universities and research institutions worldwide, including the University of Nebraska–Lincoln (USA), Friedrich-Alexander University Erlangen (Germany), and the Institute of Physics of the Czech Academy of Sciences (Prague, CZ).

Prof. Kment has authored and co-authored over 140 scientific publications in prestigious journals such as *Chemical Reviews*, *Chemical Society Reviews*, *Advanced Materials*, *Chemical Catalysis*, *ACS Nano*, *Small*, *ACS Catalysis*, and *Advanced Functional Materials*. His work has received more than 6,000 citations, with an h-index of 40 (Google Scholar).

He has been awarded several notable research grants, serving as principal investigator on major projects funded by the Ministry of Education, Youth and Sports (MEYS) - Operational Programme Research, Development, and Education (2017–2022, EUR 5 million) and four GACR projects.

His research focuses on the development and synthesis of diverse 0D–3D nanostructures for renewable energy applications. In recent years, he has concentrated on advancing co-catalysts and hybrid nanostructures in photocatalysts, as well as elucidating the mechanistic functionality of related photocatalytic processes.