LAM SEMINAR SERIES

Laboratory for Advanced Materials (LAM) is inviting you to attend series of lectures organized by the laboratory as part of our outreach program with the goal to communicate to a broader scientific community, students as well as general public significant recent advances in the field of materials science and at the boundaries of materials science, chemistry, physics and biology. The lectures will feature prominent scientists from Slovakia and abroad, from academia and industry, who are performing research at the frontier of these areas. To make the lectures informative and appealing to non-experts, students as well as specialists, the lectures will be typically divided into two parts. In the first part, aimed primarily at non-experts, the presenter will provide a brief tutorial of the basic principles relevant to the research topic discussed and, where applicable, provide an overview of potential practical applications. In the second part, the presenter will discuss recent advances from his/her laboratory. We are looking forward to seeing you!

Lecture 1. August 27, 11:00, Comenius University Science Park, 187

Photocatalysis and photocatalytic reactions

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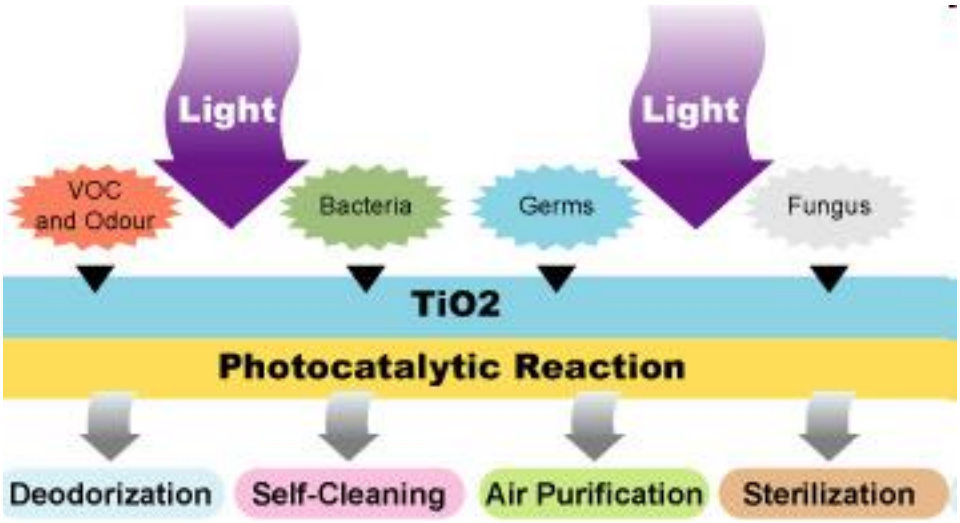
Photocatalytic reactions use the energy of photons from light sources to activate a photocatalyst (semiconductor). Unlike metals, which have a continuum of electronic states, semiconductors exhibit a void energy region, or band gap, that extends from the top of the filled valence band to the bottom of the vacant conduction band. A photocatalytic reaction generally includes the following processes: when photons have a higher energy than the semiconductor band gap, they are absorbed, and electrons in the valence band are promoted to the conduction band, leaving positive holes in the valence band. The excited electron is used to reduce the substance, while the positive hole is used to oxidize substances on the surface of the photocatalyst. Since the discovery of photocatalytic water splitting on TiO_2 electrodes by Fujishima and Honda in 1972, important efforts were made to develop highly active photocatalysts for various photocatalytic reactions, such as CO_2 reduction and water splitting, providing a promising way to mitigate the constantly worsening environmental issues and energy crisis. Moreover, the photocatalytic processes can be used for cleaning of waste air or water. One of the most basic materials in our daily life, titanium dioxide has emerged as an excellent photocatalytic material for environmental purification. Researches on photocatalytic methods, while still in progress, have led to many promising applications for environmental purposes. Still many aspects remain to be solved like: photocatalytic efficiency improvement, increased solar energy utilization, suitable form of catalyst, all in turn influencing the economic aspects of this technique. In our laboratory, we focus on: i) photocatalytic reduction of CO_2, ii) photocatalytic decomposition of N_2O, iii) photocatalytic generation of hydrogen from ammonia and methanol solution, iv) photochemical oxidation of waste air emission. In my presentation, I will first provide an introduction to the basic principles of photocatalysis, photocatalysts and introduce possible applications. In the second part of my talk, I will discuss the research on photocatalytic reactions in our laboratory.



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Prof. Kočí completed her M.S. Degree in Physical Chemistry at Faculty of Chemical Engineering, Institute of Chemical Technology, Prague in 1990. She worked at primary and secondary school and from 2007 at university. She received her PhD at Faculty of Metallurgy and Materials Engineering, VŠB-Technical University of Ostrava (VŠB-TUO) in 2008, where her research focus was on studies of photocatalysis especially CO_2 photocatalytic reduction. Following her PhD, she was as academic staff at the Department of Physical Chemistry and Theory of Technologic Processes, VŠB-TUO, and from 2014 she started to work at Institute of environmental technology, VŠB-TUO. There, her focus was extended to other photocatalytic reactions (photocatalytic decomposition of N_2O, photocatalytic generation of hydrogen). In 2016, she obtained the title professor of Environment Protection. During her fifteen years at VŠB-TUO, Prof. Kočí performed research primarily in the area of heterogeneous photocatalysis in gaseous and liquid phases, physico-chemical properties of nanostructured photocatalysts and chemical engineering. She also served in various leadership roles, including applicant or co-applicant of the project Grant Agency of Czech Republic (GAČR), Ministry of Industry and Trade, member (chairman in 2021) of panel 106 Technical Chemistry of GAČR, chairman of the Ostrava branch of Czech Chemical Society and others. She was a tutor of 5 bachelor works, 11 diploma works and 9 PhD students (6 defended). Prof. Kočí is an author of co-author of 75 research publications (over 2200 citations) and co-inventor of two utility models.

Selected Representative Publications:

1. **K. Kočí**, L. Obalová, L. Matějová, D. Plachá, Z. Lacný, J. Jirkovský, O. Šolcová, Effect of TiO_2 particle size on photocatalytic reduction of CO_2. *Applied Catalysis B: Environmental*, 89 (2009) 494-502.
2. **K. Kočí**, K. Matějů, L. Obalová, S. Krejčíková, Z. Lacný, D. Plachá, L. Čapek, A. Hospodková, O. Šolcová, Effect of silver doping on the TiO_2 for photocatalytic reduction of CO_2. *Applied Catalysis B: Environmental*, 96 (2010) 239-244.
3. L. Matějová, **K. Kočí,** M. Reli, L. Čapek, A. Hospodková, P. Peikertová, Z. Matěj, L. Obalová, A. Wach, P. Kustrowski, A. Kotarba: Preparation, characterization and photocatalytic properties of cerium doped TiO_2: On the effect of Ce loading on the photocatalytic reduction of carbon dioxide. *Applied Catalysis B: Environmental* 152-153 (2014) 172-183.
4. **K. Kočí,** M. Reli, I. Troppová, M. Šihor, J. Kubková, P. Kustrowski, P. Praus, Photocatalytic decomposition of N_2O over TiO_2/g-C_3N_4 photocatalysts heterojunction. *Applied Surface Science*, 396 (2017) 1685-1695.
5. N. Ambrožová, M. Reli, M. Šihor, P. Kustrowski, J.C.S. Wu, **K. Kočí**, Copper and Platinum Doped Titania for Photocatalytic Reduction of Carbon Dioxide, *Applied Surface Science*, 430 (2018) 475-487.
6. **K. Kočí,** M. Reli, I. Troppová, T. Prostějovský, R. Žebrák, Degradation of Styrene from Waste Gas Stream by Advanced Oxidation Processes, CLEAN – Soil, Air, Water, 47 (2019) 1900126.
7. **K. Kočí**, M. Reli, I. Troppová, T. Prostějovský, R. Žebrák, Degradation of ammonia from gas stream by advanced oxidation processes, Journal of Environmental Science and Health, Part A, 55 (2020) 433-437.
8. A.W. Morawski, E. Kusiak-Nejman, A. Wanag, U. Narkiewicz, M. Edelmannová, M. Reli, **K. Kočí**, Influence of the calcination of TiO2-reduced graphite hybrid for the photocatalytic reduction of carbon dioxide, Catal. Today, (2021).
9. T. Prostějovský, M. Reli, R. Žebrák, T. Konečná, F. Salvadores, M.M. Ballari, **K. Kočí**, Advanced oxidation processes for elimination of xylene from waste gases, J. Photochem. Photobiol. A, 407 (2021) 113047.
10. M. Reli, N. Ambrožová, M. Valášková, M. Edelmannová, L. Čapek, C. Schimpf, M. Motylenko, D. Rafaja, **K. Kočí**, Photocatalytic water splitting over CeO2/Fe2O3/Ver photocatalysts, Energy Conversion and Management, 238 (2021) 114156.