CZ-DE PhD in physical chemistry, Prague, Czech Rep.

Self-organized growth of metal-oxide nanostructures for model catalysis

Bi-national Ph.D., Cotutelle schematic

Supervisors:
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Annotation:

Global transformation to a renewable energy economy requires new technologies in chemical production and energy storage. In this context, catalyzed electrochemical reactions represent one of the key technologies [1]. For understanding elementary physicochemical processes on the chemically and structurally complex surfaces of electrocatalysts, we develop so-called model approaches to study electrocatalytic processes on nanostructured surfaces with atomically defined morphology [2].

The proposed Thesis will deal with bottom-up fabrication of atomically defined metal-oxide nanostructures and their characterization in model catalytic experiments. [3]. Atomically defined metal-oxide nanostructures are difficult to prepare using purely electrochemical approaches. On the other hand, such systems are routinely prepared in a surface science approach [4]. It is the key idea of the proposed Thesis to combine surface science and electrochemistry approaches. This approach will make it possible to obtain unique information on the relations between morphology and reactivity of metal-oxide electrocatalysts. The electrocatalytic materials studied will be combinations of Pd, Rh, cerium oxide and cobalt oxide, the targeted reactions will be the electrooxidation of energy-relevant molecules, especially molecules containing C-C bonds.

The proposed Thesis is bi-national (Cotutelle schematic) with the work performed alternately in the Surface Physics Group at the Department of Surface and Plasma Science, Charles University in Prague, Czech Republic (supervision: doc. Josef Mysliveček) [5], [6], and in the group of Interface Research and Catalysis at the Department of Chemistry and Pharmacy of the Friedrich Alexander University Erlangen Nuremberg (Erlangen, Germany, supervision: Prof. Jörg Libuda) [3], [7], [8].

References:

[1] V. R. Stamenkovic et ak., “Energy and fuels from electrochemical interfaces,” *Nat. Mater.*, vol. 16, pp. 57–69, 2017, doi:10.1038/nmat4738.
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[4] H. Kuhlenbeck, S. Shaikhutdinov, and H. Freund, “Well-ordered transition metal oxide layers in model catalysis - a series of case studies,” *Chem. Rev.*, vol. 113, pp. 3986–4034, 2013, doi:10.1021/cr300312n.

[5] F. Dvořák et al., "Creating single-atom Pt-ceria catalysts by surface step decoration," *Nat. Commun.*, vol. 7, p. 10801, 2016, doi:10.1038/ncomms10801.
[6] F. Dvořák et al., "Bulk Hydroxylation and Effective Water Splitting by Highly Reduced Cerium Oxide: The Role of O Vacancy Coordination," *ACS Catal.*, vol. 8, 2018, doi:10.1021/acscatal.7b04409.
[7] G. N. Vayssilov et al., "Support nanostructure boosts oxygen transfer to catalytically active platinum nanoparticles," *Nat. Mater.*, vol. 10, pp. 310–315, 2011, doi:10.1038/nmat2976.
[8] Y. Lykhach et al., "Counting electrons on supported nanoparticles," *Nat. Mater.*, vol. 15, pp. 284–288, 2016, doi:10.1038/nmat4500.

Prerequisites: MSc in physics or chemistry, solid state physics/chemistry of advantage

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Deadlines: Applications till 30th April 2020, exams mid June 2020, please contact me for details ASAP