



Vabilo na predavanje / Invitation to the Lecture

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Importance of Advanced Diagnostics in Designing of Interfaces for Electrocatalytic Water Splitting

Amongst the central challenges for large-scale application of electrochemical energy conversion, employing reactors for water electrolysis and CO₂ reduction, is low efficiency of the anodic oxygen evolution reaction (OER). Despite metal-oxides are representative class of compounds used as electrode materials, after more than 40 years of intensive research on OER, it is still not clear what governs catalytic activity and what assures long-term catalytic performance. At technically relevant current densities, the critical point for obtaining a conclusive picture about the electrode performance is to understand the dynamic behavior of the triple-phase boundary. Fluctuations in the magnitude of the active surface area, due to gas-blockage of active sites, induces great uncertainty in kinetic analysis which is usually based on stationary electrochemical methods. Consequently, the task of the highest merit is to employ advanced analytical tools and create methodologies which allow realistic insight into dynamic behavior of the electrode/electrolyte interface during the gas release. In this work, recently developed approaches for comprehensive activity/stability studies based on scanning electrochemical microscopy (SECM) and scanning flow cell coupled to the inductively coupled mass spectrometer (SFC-ICPMS) will be discussed. Based on the information gathered using SECM and SFC-ICPMS, a perspective for the design of highly active and highly stable catalysts for the OER will be thoroughly analyzed. In the second part of the lecture, it will be discussed can Sabatier principle, as key paradigm of gas-phase heterogeneous catalysis, be transferred to electrocatalysis in straightforward manner, as usually portrayed. While predictive models, based on the optimal adsorption energies of key intermediate(s), so called "volcano" plots, are widely accepted and Sabatier principle as a concept seems to be intuitive, argumentation shown in this work indicates that electrocatalytic reactions encompass level of complexity which still represents challenge for comprehension even in a case of "simple" reaction like hydrogen evolution reaction (HER). Namely, interaction between electrode material and electrolyte could alter electrode surface in a sense that no bulk or surface property of material could be directly linked to the rate of electrocatalytic reaction. This suggests, not only that solvent plays very important role in the kinetics of electrocatalytic reactions, but rather suggests importance of interfacial phenomena, which are strictly result of interaction between electrode material and solvent. Crucial questions are: 1) what is/are the adequate catalytic descriptor/s b) can we confirm it experimentally and 3) what triggers HER. Answers on the posed questions was suggested by careful analysis of key contributions about HER up to date, together with new experimental insights obtained in our lab.

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Vljudno vabljeni / Kindly invited