Invitation to the TACO Colloquium by

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Edvin Lundgren (Lund University):

Surface-Sensitive Studies of the Electrolyte-Electrode Interface

Date: Monday, January 22nd, 2024

Time: 5:00 p.m. CET (s.t.)

Place: Uni Wien, Kolingasse 14-16, Seminar Room 9, and on Zoom

Abstract: The electrified electrode-electrolyte interface is notoriously difficult to study during electrochemical (EC) reactions. Most traditional surface science techniques are disqualified due to using electrons; on the other hand, several new in-situ experimental methods have been developed recently. Examples are Electro Chemical X-ray Photoelectron Spectroscopy (ECXPS), Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), High Energy Surface X-Ray Diffraction (HESXRD) [1], and EC-IRAS [2]. However, each of these methods has limitations in the EC environment. A combination of methods is necessary to understand the electrode surface development and dynamics during EC reactions.

The first part of the talk will address the corrosion of an industrial Ni-based Ni-Cr-Mo alloy. A comprehensive investigation combining several synchrotron-based techniques is used to study the surface region of a Ni-Cr-Mo alloy in NaCl solutions *in situ* during electrochemical polarization. X-Ray Reflectivity (XRR) and ECXPS were used to investigate the thickness and chemistry of the passive film. Grazing Incidence X-ray Diffraction (GIXRD) was used to determine the change in the metal lattice underneath the passive film. X-Ray Fluorescence (XRF) was used to quantify the dissolution of alloying elements. X-ray Absorption Near Edge Structure (XANES) was used to determine the chemical state of the dissolved species in the electrolyte. Combining these techniques allowed us to study the corrosion process, detect the passivity breakdown in situ, and correlate it to the onset of the Oxygen Evolution Reaction (OER) [3].

In the second part, an alternative approach to studying the development of a model electro-catalyst surface is presented. By using a combination of Grazing Incidence X-ray Absorption Spectroscopy (GIXAS) [4], 2D Surface Optical Reflectance (2D-SOR) [5], and Cyclic Voltammetry (CV) and an Au(111) electrode model surface, direct surface information during real-time CV can be obtained. Using H_2SO_4 as an electrolyte, our study demonstrates that a thin, passive Au oxide is formed at potentials corresponding to the oxidation peak in the Au CV. This oxide prevents further surface oxidation, and not until the onset of the OER further oxidation of the Au surface occurs, leading to the formation of a thick Au oxide.

Bio: The research of Prof. Edvin Lundgren is focused on surface structure and applying in-situ synchrotron based techniques to material systems under working conditions. Lundgren and co-workers are responsible for three UHV Scanning Probe Microscopy systems at Lund University, and he performs synchrotron based research around the world. The research has led to the discovery of a new set of ultrathin oxides on late transition metals, atomic scale views on nano structures such as quantum dots and nanowires and pioneering work on in situ studies of catalysts and model electrodes under operating conditions. He has published more than 300 peer reviewed articles cited 13600 times and has an h-index of 67.