

In-situ Near Ambient Pressure X-Ray Photoelectron Spectroscopy (NAP-XPS) Studies of Ir-based Anode/Electrolyte Interface under Water Electrolysis Conditions

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ABSTRACT

Hydrogen produced by electrocatalytic water splitting in proton exchange membrane (PEM) electrolyzers is considered as a promising means for the storage of surplus electricity produced by renewable energy sources such as solar and wind. The significant overpotential arising at the anode side, where the oxygen evolution reaction (OER) takes place, justifies great interest of industry and academia in the development of active and stable OER electrocatalysis [1]. Benchmark anode catalysts for the OER in acid media are iridium-based, whereby metallic Ir has shown much higher activity compared to stoichiometric rutile-type IrO₂ oxide [2]. The behavior of Ir-based anodes during the OER has been studied by various analytical techniques, including synchrotron radiation-based methods [3, 4]. Notwithstanding the great interest to this matter, the active species formed on the Ir-based anodes under the operation conditions are still widely disputed. Recently our group has demonstrated the capability of near-ambient pressure X-ray photoelectron spectroscopy (NAP-XPS) to provide meaningful and reliable information regarding the (Ir,Ru-based) electrode/polymer electrolyte interface under PEM electrolyzer conditions by performing measurements using a water-saturated membrane electrode assemblies (MEA) exposed at 3 mbar water vapor pressure under polarization [5]. In this presentation, we will show the application of in-situ near ambient pressure X-ray photoelectron spectroscopy (NAP-XPS) and soft X-ray absorption near edge structure (XANES) to decipher the surface state of highly active oxide-covered metallic Ir (Ir@IrOx) against to thermally obtained IrO₂ anodes during the OER. The experiments were conducted at the ISS beamline of the BESSY II synchrotron facility (HZB). The potential-induced changes of the Ir 4f XP and O K edge spectra under the operation conditions provide valuable information allowing us to explain the key differences in the performance of IrO₂ and Ir@IrOx anodes during water electrolysis. The authors are indebted to the HZB (Berlin) for the allocation of synchrotron radiation beamtime. The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for Fuel Cell and Hydrogen Joint Technology Initiative under Grant No. 621237 (INSIDE).

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