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## Characterization of nanostructured iridium oxide-based electrocatalysts using advanced x-ray analytics

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Iridium oxide (IrO<sub>2</sub>) has been suggested as a promising candidate for efficient water oxidation, and thus catalyst materials based on nanostructured iridium (hydr)oxide have recently been developed and commercialized. In this work, we present a comprehensive spectroscopic study of commercially available iridium oxide-based electrocatalysts ("nano-IrO<sub>2</sub>" and "IrO<sub>2</sub>@TiO<sub>2</sub>") using advanced x-ray analytics at the synchrotron sources BESSY II and ALS.

The spectroscopic study of these materials at the oxygen K-edge revealed a high-resolution fingerprint related to the reorganization of local electronic states presumably due to a varying degree of crystallinity, as suggested by the comparison with an extensively characterized rutile-like  $IrO_2$  and an amorphous iridium oxide. Furthermore, detailed information about the hybridization of electronic states in the valence band was obtained combining the atom specificity of soft x-ray absorption (XAS) and emission spectroscopy (XES) with the surface sensitivity of x-ray photoelectron spectroscopy (XPS).

The study was completed comparing the spectroscopic results with diffraction and microscopy measurements, in which the heterogeneous nature of the nanostructured iridium oxide-based materials is confirmed, discerning contributions from a rutile-type structure and an amorphous phase. The latter phase has been implicated in the high catalytic activity of these materials in the sluggish oxygen evolution reaction.

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