Fcc Ru Formed in Bimetallic Ir-Ru Alloy Leads to Enhanced Performance: Operando PEM-WE Study Using Synchrotron X-Ray Scattering

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Ir-Ru alloys demonstrate notable stability and exceptional catalytic activity for the oxygen evolution reaction in Proton Exchange Membrane Water Electrolyzers (PEM-WE), facilitating sustained operation with minimal iridium loading (150 μg cm-2). Despite their effectiveness, the precise mechanisms underlying their remarkable stability remain unknown. Using operando wide-angle X-ray scattering, we delve into the structural dynamics of these alloys within a specialized PEM-WE setup. Our investigation unveils the role of mutual strain between iridium and ruthenium in fostering the formation of the ruthenium face-centered cubic (fcc) phase. Moreover, we analyze the operando evolution of these alloys, elucidating the impact of ongoing oxidation processes and ruthenium dissolution. We provide detailed insights into the strained lattice parameters of the active ruthenium phase, offering avenues for future research to engineer ruthenium strain independently of costly iridium. Our comprehensive study sheds light on the intricate mechanisms governing the stability of iridium-ruthenium catalysts, thereby catalyzing the development of more efficient and economically viable catalyst materials for PEM-WE applications.