A Novel Two-Dimensional Cobalt Phosphate Electrocatalysts with Intrinsic CoO_6 Lattice Distortion for High-Performance Water Oxidation

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Abstract

In this study, the two-dimensional cobalt phosphate hydroxides ($Co_5(PO_4)_2(OH)_4$) nanosheets with a unique stacking-disordered phosphate-based inorganic configuration were successfully prepared via a facile and scalable method for the first time to serve as a superior and robust electrocatalyst for water oxidation. Based on the obtained characterization results (e.g., X-ray absorption near-edge structure and X-ray photoelectron spectroscopy), the as-prepared nanosheets comprise special zigzag CoO_6 octahedral chains along with intrinsic lattice distortion and excellent hydrophilicity, in which these factors contribute to the highly efficient performance of prepared electrocatalysts for OER. Specifically, $Co_5(PO_4)_2(OH)_4$ deposited on glassy carbon electrode (loading amount ≈0.553 mg cm^{-2}) can exhibit an unprecedented overpotential of 254 mV to drive a current density of 10 mA cm^{-2} with a small Tafel slope of 57 mV dec^{-1} in alkaline electrolytes, which outperforms the ones of $CO_3(PO_4)_2$ (370 mV) and $Co(OH)_2$ (360 mV) as well as other advanced catalysts. Evidently, this work has opened a new pathway to the rational design of promising metal phosphate hydroxides toward the efficient electrochemical energy conversion.

Keywords - $Co_5(PO_4)_2(OH)_4$, Nanosheet, Lattice Distortion, Electrocatalyst, Oxygen Evolution Reaction