

FUNCTIONALIZATION OF CoP AND CoFeP WITH GOLD NANOPARTICLES VIA GALVANIC DISPLACEMENT FOR ALKALINE WATER SPLITTING

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Hydrogen is a clean and sustainable energy carrier with immense potential to replace fossil fuels. Overall water splitting (OWS), which involves both the hydrogen evolution reaction (HER) and the oxygen evolution reaction (OER), is an efficient method of producing hydrogen. Designing and developing innovative bifunctional electrocatalysts that exhibit both high catalytic activity and enhanced stability for both the HER and the OER is highly desirable and yet challenging. Transition metal phosphides (TMPs) are recognized as highly effective electrocatalysts due to their abundance of active surface sites, excellent electrical conductivity, and strong chemical stability. These characteristics are derived from the intrinsic high electrocatalytic activity of the metal (M) centers and phosphorus (P) sites. In this study, cobalt phosphide (CoP) and cobalt-iron phosphide (CoFeP) were directly deposited on copper (Cu) substrates via electroless deposition. The P source and reducing agent used in this process was sodium hypophosphite (NaH₂PO₂). Gold (Au) nanoparticles were subsequently anchored to the phosphides through a galvanic displacement strategy, thereby creating a composite material with enhanced properties. A comprehensive investigation was conducted to elucidate the morphology, composition, and crystal structure of the catalysts. This investigation utilized a range of analytical techniques, including scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). The electrocatalytic bifunctionality of the materials for overall water splitting (OWS) was evaluated in a two-electrode setup using a 1 M KOH electrolyte.

The Au-CoFeP catalyst exhibited significant bifunctional activity, achieving a low cell voltage of 1.68 V at 10 mA cm⁻². This performance was superior to that of the Au-CoP catalyst, due to the synergistic interaction among the Co, Fe, and Au elements. The combination of Au modification and bimetallic CoFeP composition led to lower overpotentials and enhanced stability, underscoring a practical and effective strategy for designing gold-modified transition metal phosphides as durable, efficient candidates for application in the field of electrocatalysis.

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