

Área: FIS

Electrochemical Synthesis of Mixed Ni, Co, and Cu Oxide Alloys as Efficient and Stable Photoelectrocatalysts for Water Splitting Application.

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Palavras Chave: Water Splitting; Photoelectrocatalysis; Oxygen Evolution Reaction; Mixed Metal Oxides; Pulse Chronoamperometry.

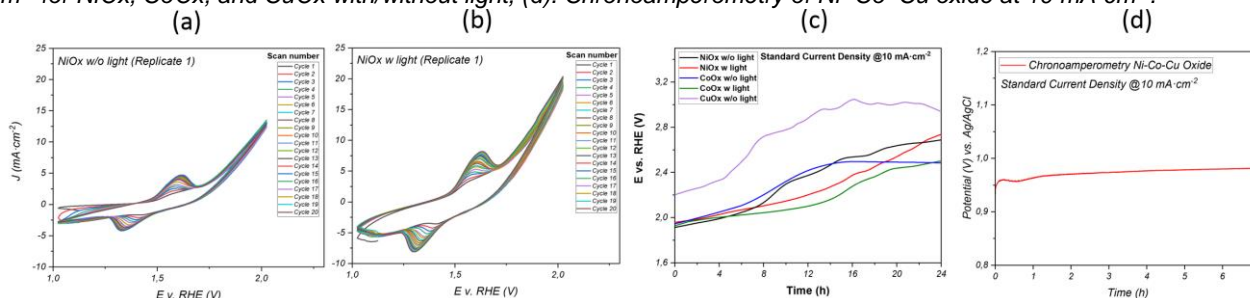
Highlights

The Ni-Co-Cu oxides alloy maintains stable operation at 10 mA·cm⁻² for over 24 hours under continuous light, demonstrating outstanding photoelectrochemical durability.

Abstract

The sustainable production of hydrogen through the photocatalytic splitting of water represents a key strategy toward the development of clean energy technologies and the reduction of carbon emissions. This work reports the synthesis and characterization of individual metal oxides (NiOx, CoOx, and CuOx) and their binary and ternary alloys (CoCuOx, NiCoOx, NiCuOx, and NiCoCuOx) deposited on ITO, prepared via an innovative pulse-current chronoamperometric electrochemical technique that enables controlled, homogeneous, and highly reproducible film deposition in a single synthesis step. The resulting materials were evaluated both electrochemically and optically as photoelectrocatalysts for the oxygen evolution reaction (OER) under dark conditions and continuous illumination of 3.40 eV ($\lambda \cong 365$ nm). Optical characterizations (UV-Vis and photoluminescence), performed in duplicate for each experimental condition, confirmed the influence of metal composition on light absorption and charge-carrier recombination dynamics. Electrochemical analyses revealed that light assistance markedly enhances catalytic performance, as evidenced by a reduction in overpotential, lower Tafel slopes, lower charge-transfer resistance, and improved potential stability at 10 mA·cm⁻² during chronoamperometric testing. Remarkably, the binary and ternary alloy systems, particularly NiCoCuOx, exhibited a strong synergistic effect among transition metals, achieving an ONSET potential of 1.35 V vs. RHE (reversible hydrogen electrode) and maintaining operational stability for over 24 hours under illumination. These findings demonstrate that the integration of optical and electrochemical approaches provides valuable insights into the mechanisms governing enhanced photoelectrocatalytic activity, establishing electrodeposited mixed oxide alloys as highly promising materials for light-assisted water-splitting applications.

Figure 1. (a). Cyclic voltammetry curves of electrodeposited NiOx without light illumination, showing the evolution of current density over 20 consecutive cycles. (b). Cyclic voltammetry curves of electrodeposited NiOx under continuous illumination (3.40 eV, 365 nm), evidencing enhanced anodic current density and improved OER activity compared to the dark condition. (c). Stability at 10 mA·cm⁻² for NiOx, CoOx, and CuOx with/without light, (d). Chronoamperometry of Ni-Co-Cu oxide at 10 mA·cm⁻².



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