ACS APPLIED MATERIALS & INTERFACES

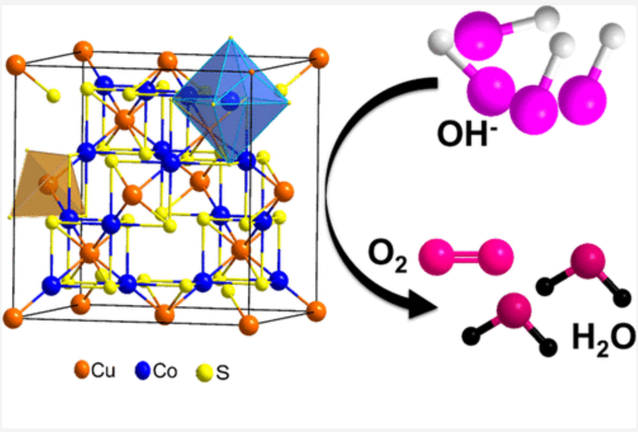
Facile Synthesis of Hierarchical CuS and $CuCo_2S_4$ Structures from an Ionic Liquid Precursor for Electrocatalysis Applications

Ahed Abouserie, Gumaa A. El-Nagar*, Benjamin Heyne, Christina Günter, Uwe Schilde, Matthew T. Mayer, Sasho Stojkovikj, Christina Roth, and Andreas Taubert*

Cite this: *ACS Appl. Mater. Interfaces* 2020, 12, 47, 52560−52570
Publication Date: November 12, 2020
https://doi.org/10.1021/acsami.0c13927

SUBJECTS: Catalysts, Materials, Morphology, Physical and chemical processes, Radiology

Abstract



Covellite-phase CuS and carrollite-phase $CuCo_2S_4$ nano- and microstructures were synthesized from tetrachloridometallate-based ionic liquid precursors using a novel, facile, and highly controllable hot-injection synthesis strategy. The synthesis parameters including reaction time and temperature were first optimized to produce CuS with a well-controlled and unique morphology, providing the best electrocatalytic activity toward the oxygen evolution reaction (OER). In an extension to this approach, the electrocatalytic activity was further improved by incorporating Co into the CuS synthesis method to yield $CuCo_2S_4$ microflowers. Both routes provide high microflower yields of >80 wt %. The $CuCo_2S_4$ microflowers exhibit a superior performance for the OER in alkaline medium compared to CuS. This is demonstrated by a lower onset potential (~1.45 V vs RHE @10 mA/cm^2), better durability, and higher turnover frequencies compared to bare CuS flowers or commercial Pt/C and IrO_2 electrodes. Likely, this effect is associated with the presence of Co^{3+} sites on which a better adsorption of reactive species formed during the OER (e.g., OH, O, OOH, etc.) can be achieved, thus reducing the OER charge-transfer resistance, as indicated by X-ray photoelectron spectroscopy and electrochemical impedance spectroscopy measurements.

KEYWORDS: oxygen evolution reaction, nanoparticles, copper cobalt sulfide, ionic liquid, water splitting