

Synthesis of Copper Sulfide and Hybrid with Molybdenum Disulfide for Hydrogen Evolution Reaction

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Abstract

Much effort has been made to develop cost-effective electrocatalysts for last decades to replace expensive and earth-rare platinum catalysts in hydrogen evolution reaction (HER). Copper sulfide (CuS) has been little used for an electrocatalyst but can have potential as a component of hybrid electrocatalysts. In this study, we demonstrate colloidal syntheses of CuS and its hybrid materials for HER catalysts. The colloidal CuS nanoplatelets showed poor electrocatalytic activity in HER (-526 mV for onset potential and 100 mV/dec for Tafel slope). The low HER performance can be attributed to proton-inaccessibility by hydrophobic ligand, and coverage of active sites by aggregation of nanocrystals. To improve the HER catalytic activity, CuS based hybrid materials with molybdenum disulfide (MoS₂) were synthesized. CuS/MoS₂ hybrid was synthesized by ligand exchange and annealing procedures. Ammonium tetrathiomolybdate ((NH₄)₂MoS₄) was used as a precursor for the ligand exchange. (NH₄)₂MoS₄ was dissolved in *N,N*-dimethylformamide (DMF) and acted as an inorganic ligand (MoS₄²⁻). Simple sonication of a mixture solution consisting of CuS in hexane and (NH₄)₂MoS₄ in DMF exchanged oleylamine ligand of CuS with MoS₄²⁻ to give CuS@MoS_x. During the ligand exchange, stacked CuS nanoplatelets were disassembled by sonication. The HER activity of CuS@MoS_x was improved: -182 mV for onset potential and 88.2 mV/dec for

Tafel slope. The improvement would be due to exposure of more active sites by disassembly of nanoplatelets and enhanced proton accessibility by removing oleylamine ligands attached to CuS.

Figures

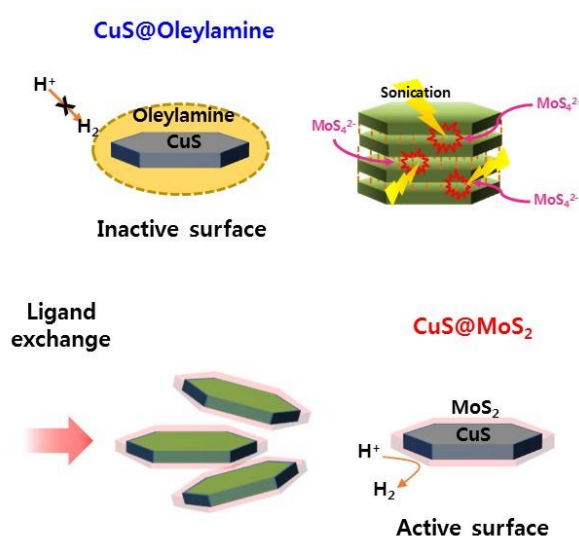


Figure 1: Ligand exchange from CuS@Oleylamine to CuS@MoS_x and disassembly of nanoplatelets.