Boosting the Photoelectrochemical Water Splitting Performance of CuO-Cu2O Heterojunction Thin Films

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Developing active, low-cost, and stable catalysts is a key challenge for efficient hydrogen production. Copper oxide is one of the most effective photocatalysts for water splitting. However, it is known to be unstable in many conditions. In this research, aerosol-assisted chemical vapor deposition was used to deposit copper oxide (Cu2O-CuO) heterojunction thin films over fluorine-doped tin oxide substrate. Copper(II) nitrate hemi(pentahydrate) was used as a precursor. In addition, different quantities of acetic acid were added to the solvent as a novel acid treatment for Cu2O-CuO films. X-ray diffraction and X-ray photoelectron spectroscopy were used for characterizing the four resulting catalysts. Scanning electron microscopy was performed to determine the surface morphology. UV-vis spectra was used to study the optical properties. The catalysts were investigated by linear sweep voltammetry, Mott-Schottky, chronopotentiometry, electrochemical impedance spectra, and gas chromatography in acidic and alkaline conditions in two different photo-electrochemical tests. Mott-Schottky plot confirmed the heterojunction of p-Cu2O and n-CuO. Results showed that acid-treated Cu2O-CuO thin film was an effective cathode in an alkaline medium with a photocurrent of -24mA/cm2, which is a 300% improvement for copper oxide catalysts. In the acidic medium, the Cu2O-CuO thin film showed, for the first time, both hydrogen evolution reaction and oxygen evolution reaction with an onset potential of 0.9V vs RHE at 10mA/cm2, which resulted in an overall water splitting. This catalyst is stable, bifunctional, and three times more efficient in hydrogen production than the previous results for copper oxide, which could make it suitable for many photo-electrochemical applications.

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