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PREPARATION OF $Cu/Cu_2O/CuO/SrTiO_3$ PHOTOCATHODE FOR ENHANCED PHOTOELECTROCHEMICAL WATER SPLITTING

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Photoelectrochemical (PEC) water splitting offers a clean and sustainable approach for solar hydrogen production. However, the development of photocathodes that are simultaneously low-cost, efficient, and stable remains a major challenge. This study presents the fabrication and characterisation of a multilayered $Cu/Cu_2O/CuO/SrTiO_3$ photocathode to address these limitations by enhancing charge separation, light absorption, and interfacial stability. The photocathode was synthesised through sequential anodisation, thermal oxidation, and spin coating techniques. Copper foils were anodised in aqueous NaOH solution to form $Cu(OH)_2$, thermally reduced to Cu_2O under nitrogen, and partially oxidised in air to form CuO. A thin $SrTiO_3$ layer was deposited via spin coating and annealed under nitrogen to promote passivation and minimise interfacial recombination. The material system was strategically selected due to excellent conductivity of Cu acting as a substrate. Moreover, Cu_2O is a visible light absorbing *p*-type semiconductor, while CuO extends absorption deeper into the visible range, forming beneficial heterojunctions. On the other hand, the $SrTiO_3$ layer serves as a wide *n*-type bandgap that passivates the surface and improves charge separation. Stepwise PEC measurements showed negligible photocurrent for bare Cu and Cu/Cu_2O, while introducing CuO improved visible light absorption. Further enhancement was achieved with $SrTiO_3$, which resulted in a photocurrent density of -3.76 mA cm^{-2} at 0.05 V vs. reversible hydrogen electrode (RHE) and an applied bias photon-to-current efficiency (ABPE) of 4.44%. X-ray diffraction confirmed successful phase formation, UV-visible diffuse reflectance spectroscopy demonstrated band gap tuning and enhanced optical absorption, and Mott-Schottky analysis revealed favorable semiconductor properties and improved charge carrier density. The combination of Cu-based oxides and $SrTiO_3$ contributed to significant improvement in photoresponse and stability. This work highlights the novelty of employing a low-cost, multilayered $Cu/Cu_2O/CuO/SrTiO_3$ photocathode architecture to simultaneously improve efficiency and stability, providing a promising pathway for the future development of solar fuel technologies.

Keywords: Band gap tunning, Charge carrier, Cu based photocathode, Photoelectrochemical water splitting