

Geometric Manipulation of Cuprous Oxide Nanocrystal Surface Morphology Enhances Photoelectrochemical Properties and Enables Fabrication of Low-Cost, High Efficiency Photovoltaic Cells

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Delicate manipulation of nanocrystal morphology and surface structure is crucial in order to synthesize particles with specific electrochemical properties. In this study, cuprous oxide (Cu_2O) nanocrystals were fabricated and utilized in the creation of highly stable and efficacious photocathodes for use in solar technologies. The selective surface stabilization of Cu_2O nanocrystals by the capping molecule polyvinylpyrrolidone (PVP) allows for further modification into distinct morphological structures—nanocubes and nanooctahedrons—each with distinct electrochemical properties. The structural stabilities of different Cu_2O nanocrystal facets were assessed by comparing the electrochemical stability of {100}-bound nanocubes and {111}-bound nanooctahedrons. The photocatalytic activities and efficiencies of electrodes composed of Cu_2O {100}-nanocubes and {111}-nanooctahedrons were also compared in order to appraise their suitability for constructing highly efficient and economical photocathodes. Both Cu_2O nanocube and nanooctahedron electrodes demonstrated higher photocatalytic responses to light and greater stabilities than conventional silicon-based solar panels, resisting degradation at higher equivalent energies for longer periods of time compared to current silicon technologies. These novel Cu_2O solar cells were determined to be more highly optimized for use within the solar emission spectrum, improving upon silicon-based cells' maximum experimental efficiency of 21.5%, achieving 53.6% and 62.7% efficiency in the nanocube and nanooctahedron cells, respectively, indicating their promise as a new, inexpensive material suitable for the production of clean, renewable energy.

Awards Won:

United States Steel Corporation: Third Place Award of \$750