

Binder-Free Porous Photocathode Based on Cuprous Oxide for High-Performing P-Type Dye-Sensitized Solar Cells

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Abstract : Characterized by a simple structure, easy and low cost fabrication, the dye-sensitized solar cell (DSSC) attracted the interest of the scientific community as an attractive alternative of conventional Si-based solar cells and thin-film solar cells. Over the past 20 years, the main efforts have attempted to enhance the efficiency of n-type DSSCs, the highest efficiency record of 14.30% was achieved using the co-sensitization of two metal-free organic dyes and Co (II/III) tris(phenanthroline)-based redox electrolyte. In the last years, the development of the efficient p-type DSSC has become a research focus owing to the fact that the concept of tandem solar cell was proposed as the solution to increase the power conversion efficiency. A promising alternative for the photocathodes of p-type DSSC, cuprous (Cu₂O) and cupric (CuO) oxides have been investigated because of its nontoxic nature, low cost, high natural abundance, a good absorption coefficient for visible light and a higher dielectric constant than NiO. In case of p-type DSSC based on copper oxides with I³-/I⁻ as redox mediator, the highest conversion efficiency of 0.42% (Cu₂O) and 0.03% (CuO) has achieved. Towards the increase in the performance, we have fabricated and analyzed the performance of p-type DSSC prepared with the binder-free porous Cu₂O photocathodes. Porous thin film could be an attractive alternative for DSSC because of their large surface areas which enable the efficient absorption of the dyes and light. We propose a simple and one-step hydrothermal method for the preparation of porous Cu₂O thin film using copper substrate, cupric acetate and ethyl cellulose. The cubic structure of Cu₂O has been determined by X-ray diffraction (XRD) and porous morphology of thin film was emphasized by Scanning Electron Microscope Inspect S (SEM). Optical and Mott-Schottky measurements attest of the high quality of the Cu₂O thin film. The binder-free porous Cu₂O photocathode has confirmed the excellent photovoltaic properties, the best value reported for p-type DSSC (1%) in similar conditions being reached.

Keywords : cuprous oxide, dye-sensitized solar cell, hydrothermal method, porous photocathode

Conference Title : ICPRET 2018 : International Conference on Power and Renewable Energy Technology

Conference Location : Barcelona, Spain

Conference Dates : May 17-18, 2018