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INVESTIGATION OF LONG-TERM STABILITY OF DYE-SENSITIZED SOLID-STATE SOLAR CELLS SENSITIZED WITH INDOLINE DYES USING CUPROUS IODIDE AS THE HOLE COLLECTOR

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Abstract

Over recent years, there has been a growing interest in dye-sensitized solar cells (DSCs) owing to their low cost of production, simple fabrication technology, low toxicity, and decorative nature. However, there are certain drawbacks associated with liquid electrolyte based DSCs, including leakage of the electrolyte and the dye due to faulty sealing, and the corrosive nature of the employed electrolyte, which would lead to deterioration of the counter electrode. Liquid electrolytes could be replaced with p-type solid semiconductors to solve issues associated with liquid-type DSCs. This study was conducted to investigate the durability of dye-sensitized solid-state solar cells (DSSCs) sensitized with D131 dye that uses CuI as the hole conductor. In this work, TiO_2 films with a thickness of 15-17 µm were fabricated by depositing Degussa P-25 TiO_2 nanoparticles containing TiO_2 colloidal suspension on the conducting glass substrate. Then, these cells were sensitized with the D131 dye and CuI was deposited on the working electrode employing triethylamine thiocyanate as the crystal growth inhibitor. Initially, an overall efficiency of 2.72% was obtained for this DSSC with the corresponding cell parameters of open circuit voltage 0.49 V, short circuit current density 10.22 mA cm^{-2}, and fill factor 0.54 under 1.5 AM illumination. The incident photon to current conversion efficiency (IPCE) exceeds 55% in a wide spectral range from 405 to 520 nm, reaching a maximum of 62% at 430 nm. A 50.5% decrease in overall efficiency and a 25.8% decrease in maximum IPCE were reported for this DSSC after 90 days. The lowest unoccupied molecular orbital (LUMO) of the D131 dye extends to the anchoring carboxylic group. This allows D131 dye to form a strong bond with the TiO_2 surface, making it highly stable. These findings indicate that DSSCs fabricated employing D131 as the sensitizer and CuI as the hole collector offer prolonged stability even without a sealant.

Keywords: Dye-sensitized solid state solar cells, stability, Cuprous iodide, Indoline, dyes, Titanium dioxide