

Fabrication of Solid State Dye-Sensitized Solar Cells Using Squaraine Dyes as Sensitizers

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Dye-sensitized solar cells (DSSCs) are 3rd generation solar cells combining both high efficiency and low cost of production. A solid-state dye sensitized solar cells are fabricated by using a hole-transporting p-type semiconductors replacing the liquid electrolyte used in DSSCs. Metal complexed dyes exhibit highest efficiencies over metal free organic dyes in DSSCs. However, there are several advantages of metal free organic dyes with respect to the metal centered dyes such as, low cost, and large absorption coefficients. The liquid electrolyte present in DSSCs exhibits several disadvantages such as evaporation, and degradation. Therefore, we made an attempt to produce solvent free, DSSC using two metal free organic dyes squaraine 3 (sq3) and squaraine 4 (sq4) dyes. In order to do that, a mesoporous TiO₂ layer was deposited on a compact layer of TiO₂ and sq3 and sq4 dyes were deposited on TiO₂ by immersing them in the dye solution for 12 hours. The dye - coating process was carried out in an oil bath. Dye coated electrodes were dried in nitrogen atmosphere. Then hole conductor CuI was deposited on dye coated TiO₂ films until the conductivity of the CuI film reaches 50 Qcm⁻¹. The cell was constructed by pressing a Ni-coated FTO glass plate on the TiO₂/dye/CuI electrodes. UV-Vis spectra show both sq3 and sq4 absorb visible light in the visible region. Three different electron transitions with different intensities were observed for sq3. Broad peak over visible region was observed for sq4 when dissolved it in water. Almost constant absorption over near infrared (NIR) region was observed for sq4 when dissolved in acetonitrile and ethyl acetate. Both sq3 and sq 4 have surface chelating groups (COOH) with metal oxides. Thus, an efficient chelation was observed for sq3 and sq4 with TiO₂ electrodes. sq3 and sq4 exhibit a broad absorption band in solid-state compare to liquid state because of the aggregations of dye molecules. Coupling sq3 and sq4 dyes with via COOH groups were confirmed by FTIR measurements. The current-voltage characteristics of TiO₂/dye/CuI cells with sq3 sq4 dyes are studied under simulated one sun, the best achieved performances of the cells are sq3 dye efficiency 0.27% and sq4 dye exhibits 0.43% of efficiency which makes sq4 dye the better sensitizer than sq3 dye.

Keywords: Dye sensitized solar cells, P-type semiconductors, Electrolyte, Chelation, aggregations