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Use of electrolytes with I_3^-/ I^- redox couple as UV filter of dye sensitized solar cells

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Dye-sensitized nanocrystalline TiO_2 solar cells offer an alternative for fabrication of low cost thin film solar cells. These solar cells consists of a dye adsorbed porous nanocrystalline TiO_2 matrix deposited on conducting tin oxide glass (CTO) interpenetrated by I_3^-/I^- redox electrolyte. Since TiO_2 is a high band gap semiconductor electron and hole pairs are generated in conduction band and valence band of TiO_2 by the absorption of ultraviolet radiation. But dye only absorb light in visible region and inject electrons to the conduction band of TiO_2. Electrons in conduction band diffuse to the CTO glass on which the TiO_2 film is deposited. Hole in the valence band transfer to the electrolyte could reduce the constituents of the electrolyte as well as the dye. Therefore photo generation of holes in TiO_2 due to absorption of UV light has to be eliminated by filtering the UV component of the incident light. We have found that electrolyte with I_3^-/I^- redox couple itself is a good UV filter in this study.

TiO_2 films on CTO glass was deposited by doctor blade method using a slurry made by grinding 1 g of Diggusa p-25 powder, 2 ml of acetic acid and ethanol in an agate mortar and sintering at 500 °C. The film was dye coated by immersing in a solution of Indoline dye dissolve in ethanol. The cell is fabricated by placing the dye coated film on a CTO glass and filling the capillaries of the film with an electrolyte containing I_3^-/I^- redox couple in acetonitrile. Sticking a glass slide on the CTO glass with two strips of double-sided tape at two edges such that to make a space between the CTO glass and the glass slide makes the UV filter on the top of the cell. Electrolyte was introduced in between to form the filter.

From the absorption spectra it was clear that electrolyte absorb all the radiation less than 500 nm. The Indoline dye absorbs light in visible region and the action spectrum of the photo electrochemical cell peaked at around 600 nm. I-V measurement data clearly showed that there is no any significance change in the photocurrent and photo voltage after imposing the electrolytic filter. The photovoltage and photocurrent of the cell was also observed illuminating the cell from the backside. When the cell was illuminated from the backside, light passes through a thin layer of electrolyte in between the TiO_2 film and counter electrode. This seems an easy way to cutoff the UV component of the incident light. But the photocurrent and photovoltage of the cell was reduced when it was illuminated from the backside. This is attributed to the series resistance of the TiO_2 matrix since the germination of electron occurs far apart the CTO glass. But when the cell is illuminated from the front, most the incident radiation is absorb by the dye on TiO_2 close to the CTO glass so that the injected electrons travel only a short distance.

The need of a storage tank of electrolyte arises to compensate the build up of pressure inside the cell due to thermal expansion of electrolyte when the cell was placed outdoor. These results indicate that it is more advantages to make the storage tank in front of the cell to function also as a UV filter.

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