Enhancing the Performance of Dye-Sensitized Solar Cells by Utilizing Multilayered TiO_2 Nanoparticle Photoanodes in Combination of Novel PEO-Gel Polymer Electrolytes

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There is sustained attention to achieve high energy conversion in dye-sensitized solar cells (DSCs), as they exhibit the potential to overcome some of the pitfalls of conventional solar cells. Systematically arranged multi-layers of TiO_2 nanoparticles prepared to enhance light-harvesting efficiency and electron transport across the photoanode are suitable to make highly efficient DSCs. Further, the power conversion efficiencies of DSCs can be improved by employing binary iodides in the gel polymer electrolyte. In present work, photoanodes stacked to 1–6 layers are combined with gel electrolyte based on Poly(ethylene oxide) having LiI and tetrahexylammonium iodide (Hex_4NI) binary salts with the ratio of 2:3. The first two layers and 3rd layer of the photoanode are prepared by spin coating dispersions of TiO_2 nanoparticle of the size 13 and 21 nm respectively on the conducting glass substrate of fluorine-doped tin oxide. For the preparation of 4th, 5th, and 6th layers polyethylene glycol and Triton X 100 are also combined with TiO_2 nanoparticle dispersion of the size 21 nm before the spin coating. DSCs were assembled by sandwiching gel electrolyte between N719 dye-sensitized TiO_2 photoanodes consisting of 1-6 layers separately and Pt counter electrodes. The DSC with photoanode having five layers of TiO_2 nanoparticles exhibits *J*sc of 12.55 mA cm^{-2}, *V*OC of 698 mV, and efficiency of 5.45% under the irradiation of 1000 W m^{-2}. The active area of the cell was 0.19 cm^2. Hence, this study reports a reliable and simple fabrication method to augment solar cell efficiencies by merging the positive effects of multilayered TiO_2 photoanode with well-ordered thicknesses and quasi solid-state gel polymer electrolytes with mixed salt system.

Keywords: Dye-sensitized solar cells, Binary iodides, Gel polymer electrolyte, Spin coating, Multilayered photoanode