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Performance Enhancement of Dye Sensitized Solar Cells by Co-sensitization of Triple Layered Photoanode Consisting of TiO_2 Nanofibers

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Abstract

Morphology of the photoanode in Dye Sensitized Solar Cells (DSSCs) is one of the crucial factors determining their overall efficiencies. Despite the use of composites with other semiconductors or the modification of the morphology of the material, the efficiency enhancement of these devices can be achieved by increasing the light harvesting rate of the photoanode. On the other hand, harvesting of photon energies in full solar spectrum by co-sensitization of photoanodes is another approach towards the efficiency enhancement in these devices. Here we report the possibility of enhancing the efficiency of DSSC by employing a co-sensitized triple layered photoanode with electrospun nanofibres (NF) and nanoparticles (NP) of TiO_2. Performances of DSSCs comprising with TiO_2 NP/NF/NP triple layered structures were compared with the devices fabricated with conventional NP TiO_2 photoanodes under the identical conditions by using inexpensive Eosin-Y and Rose Bengal dyes. Dramatic enhancement in the efficiency of DSSC was obtained due to the incorporation of the NF layer. DSSCs fabricated with Eosin–Y dye sensitized triple layered structure showed 1.77% overall efficiency whilst the cells fabricated with the conventional photoanodes showed 0.89% efficiency thus giving an increase in efficiency by ~ 98% under the irradiance of 1000 W m^{-2}. DSSCs sensitized with Rose Bengal dye showed 0.25% and 0.76% efficiencies with conventional and triple layered photoanodes respectively. UV-Vis absorption measurements suggest that the main cause for this improvement could be due to the enhanced light harvesting by scattering effect within the electrospun TiO_2 NF layer. While the DSSC fabricated with co-sensitized TiO_2 NP/NF/NP photo anode showed energy conversion efficiency of 2.09%, the cells fabricated with co-sensitized conventional photoanode showed an efficiency of 1.04%. Incorporation of triple layered co-sensitized photoanode enhanced the efficiency of DSSCs by two fold.