

Improvement of dye sensitized solar cell performance using different particle sizes of double layered TiO₂ photoanodes

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Dye-Sensitized Solar Cells (DSSCs) offer an exciting alternative to conventional p-n junction solar cells, combining low-cost & easy manufacturing and impressive device performance to revolutionize the solar energy landscape potentially. This study investigated the solar performance influence of titanium oxide (TiO₂) double layers with different particle sizes on Dye-Sensitized Solar Cells (DSSCs). The TiO₂ powder (Titanium (IV) dioxide), ethanol, and acetic acid were mixed to make TiO₂ paste. Doctor blade technique was employed to evenly spread the TiO₂ layer on indium-doped tin oxide (ITO) conducting glasses. DSSCs were created using natural grape dye and a candle soot carbon counter electrode. The solar cell devices were characterized using absorption spectra and current density - voltage (J-V) curves. Double layers of TiO₂ can enhance light absorption more than single layers. A single-layer DSSC uses TiO₂ particles of the same size, while a double-layer DSSC has two layers with TiO₂ particles of two different sizes. Double-layered DSSC exhibited a conversion efficiency of 0.09%, photocurrent density (J_{sc}) of 568 μA cm⁻², open circuit voltage (V_{oc}) of 0.46 V, and fill factor (FF) of 34%. J_{sc} increased significantly from 249 μA cm⁻² to 568 μA cm⁻², efficiency improved from 0.03% to 0.09%, and V_{oc} increased from 0.40 V to 0.46 V, compared to the best single-layer device, which consists of small particle size. Large particle sizes in the bottom layer increase the conductivity of the films due to less grain boundaries. TiO₂ layers with small nanoparticle sizes have a large contact area. DSSCs with small particle sizes in the top layer and large particle sizes in the bottom layer can achieve better solar cell efficiency in multiple layers. This study identified combining large and small particles as an attractive approach to increase solar cell efficiency.

Keywords: Double layer, Dye-sensitized solar cells, Natural dye, Particle size

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