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EFFECT OF THE NANO-STRUCTURE OF TiO_2 PHOTOANODES ON THE PERFORMANCE OF DYE-SENSITIZED SOLAR CELLS

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Dye-sensitized solar cells (DSSCs) are considered as an alternative source in the field of renewable energy resources. In DSSCs, the photoanode based on nanocrystalline TiO_2 plays a key role in achieving excellent photo-electric conversion efficiencies. The surface morphology, surface area, crystalline phase of TiO_2, the dispersion of TiO_2 nanoparticles and the degree of dye absorbance are the most important factors influencing the properties of a photoanode. In this study, the effect and significance of different types of TiO_2 based photoanodes on the performance **o**f dye-sensitized solar cells have been investigated. DSSCs fabricated from Ruthenium (N719) dye adsorbed photoanodes made from commercial grade (P-25 Degussa) TiO_2 nanoparticles (TNP) as the starting material, by doctor-blade technique and the cathodic electrophoretic deposition (EPD) at 25 V, show photoelectric conversion efficiencies of 5.55% and 3.05%, respectively, for liquid based electrolyte containing I_3^-/I^- (0.5 M tetrapropylammonium iodide + 0.05 M iodine in a 1:3.6 by volume mixture of acetonitrile + ethylene carbonate). The cells assembled with TiO_2 films prepared on FTO by anodic electrophoretic deposition of titania nanotubes (TNT), synthesized via the hydrothermal process, using commercial P-25 nanoparticles as the starting material, at 40 V show an average efficiency of 1.83% for the same electrolyte. Subsequently, two different types of DSSCs were fabricated having different double layers of TiO_2. For this purpose TiO_2 films were prepared by anodic electrophoretic deposition of above titania nanotubes (TNT) either, on a TiO_2 compact layer (~110 nm) which was obtained by spin coating an acidic-alcoholic solution of titanium isopropoxide on FTO (type-1) or on a TiO_2 film prepared by doctor-blading commercially available Solaronix-T nanopaste (type-2). While the DSSCs fabricated with only Solaronix-T nanopaste showed an efficiency of 2.21%, DSSCs fabricated from type-1 and type-2 TiO_2 films were able to enhance the efficiency of 1.83% of the above mentioned pristine TNT solar cells prepared with anodic EPD up to 3.06% and 7.68%, respectively, with photocurrent density increments from 3.41×10^4 mA m^{-2} up to 5.18×10^4 mA m^{-2} and 17.06×10^4 mA m^{-2} respectively. Therefore, it is evident that although TNP-based DSSCs are superior to pristine TNT-based DSSCs, the efficiency of TNT-based DSSCs can be improved further by integrating the TNT electrode with other types of TNP electrodes and constructing composites.