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The effect of Fe_2O_3 doping on TiO_2 particle/nanotube composite layer for enhancement photovoltaic efficiency of dye-sensitized solar cells

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The dye-sensitized solar cell (DSSC) are composed of a dye-adsorbed nanoporous TiO_2 layer on a fluorine-doped tin oxide (FTO) glass substrate, redox electrolytes and a counter electrode. The heart of the system is a mesoporous TiO_2 film composed of nanometer-sized particles possessing a large specific surface area. However, an unusual feature of this kind of DSSCs is the lack of the space charge layer, which separates the injected electrons from the holes in the dye or electrolyte. A unidirectional charge flow with no electron leakage at the interfaces is essential for high energy-conversion efficiency. In this paper, DSSC were constructed by application of Fe_2O_3 and TiO_2 nanoparticle/TiO_2 nanotube (TNT) composite particles with various percentages. The use of oxide semiconductors in the form of nanorod, nanowires and nanotubes may be an interesting approach to improve electron transport through the film. In addition suitable amount of TNT in the film could provide large surface area for the adsorption of the dye. The Fe_2O_3-doped reduced the surface trap states of TiO_2 suppressed the charge recombination, and increased the driving force of electron injection, thereby improved its power conversion efficiency. The impedance results indicate improved electron transport at the TiO_2/dye/electrolyte interface. This result is attributed to the prevention of electron recombination between electrons in the TiO_2 conduction band with dye or electrolytes. TiO_2 passivating layer was deposited on the substrate by hydrolysis of $TiCl_4$ aqueous solution. TiO_2 layer was coated on FTO glass by doctor blade method. The dye-sensitized solar cells were fabricated using dye of ruthenium (II)(N719) and electrolyte (I-/I3-)The DSSC based on Fe_2O_3/TiO_2/TNT composite particles hybrids showed a better photovoltaic performance than the cell purely made of TiO_2 nanoparticles. The crystalline structure and morphology were characterized by X-ray diffraction (XRD), scanning electron microscope (SEM). The absorption spectra were measured by UV-vis spectrometer. The conversion efficiency was measured by solar simulator (100 mW/cm2).

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