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TiO_2 photo-anode with reduced graphene oxide for efficiency enhancement in dye sensitized solar cells

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Dye sensitized solar cells (DSSCs) first reported by Grätzel et al in 1991 have been extensively studied as a low-cost alternative to conventional silicon solar cells. DSSCs mainly consist of a dye adsorbed nanocrystalline semiconductor such as TiO_2 as the photo-anode, a redox electrolyte and a counter electrode. The efficiencies of these devices essentially depend on the properties of the semiconductor, the dye and the electrolyte. Among these components, photoanode has been receiving greater attention for the reason that photoanode not only transports photo-induced electrons but also acts as a matrix to adsorb organic dyes, which directly determines the photo current density. Graphene based materials have been extensively utilized in organic photovoltaic cells owing to its excellent optical and electrical characteristics. Reduced graphene oxide (RGO) has attracted a lot of attention because of its unique mechanical, thermal electrical and optical properties. As a 2D material, RGO is a zero-band gap material with a single molecular layered structure. TiO_2 nanoparticles can anchor on to RGO so that RGO could provide a fast channel for electron transportation which can accelerate the electron transport, lowered the recombination losses, and promote the light scattering. Therefore, these unique properties of RGO could be applied in DSSCs, in order to gain efficiency enhancement. In this study, TiO_2/RGO composite semiconductor materials were prepared by mixing RGO with TiO_2 paste and the effect of RGO content on the performance of DSSCs were investigated. After the addition of RGO, the photoanodes displayed enhanced dye adsorption properties with lower charge transfer resistances and faster transport times which resulted in enhanced performance of DSSCs. The DSSC fabricated with 0.36 wt% RGO powder incorporated TiO_2 composite photo-anode exhibited the best efficiency of 7.11 %, which is 14 % higher than that of a DSSC without RGO.

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