Effect of TiO$_2$/graphene nanocomposite in multilayer photoanode on the performance of dye sensitized solar cell

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Abstract

Four different configurations of double layered TiO$_2$ and TiO$_2$/graphene oxide (TG) composite on photoanode as illustrated in Figure 1, were investigated in order to study the effect of graphene oxide on the performance of dye solar cell (DSC). TiO$_2$/GO nanocomposite has been successfully prepared by mixing graphene oxide solution in ethanol directly with commercial TiO$_2$ paste for making photoanodes of DSC. The composition process was carried out during the thermal treatment of printed photoanodes with double layer of nanocomposite and TiO$_2$. The composite [Figure 2] was made by a facile, efficient and novel method of direct mixing of GO solution in ethanol and commercial TiO$_2$ paste followed by usual thermal treatment carried out after printing the paste on the photoanodes. I-V characterization [Figure 3] reveals that anodes with top layer of TiO$_2$/GO composite over a single layer of pristine TiO$_2$ exhibited the best efficiency (3.28%) and highest $I_{sc}$ (9.79 mA) compared to other DSCs with different layer configurations. This increase is attributed to the improvement of top layer conductivity that speeds up electron transition from active area to the external load and minimizing the recombination of electrons and holes in the TiO$_2$/dye/ electrolyte interface [1, 2]. In addition, the presence of rGO sheets in top layer can scatter the light and increase the light harvesting by the dye molecules. Moreover, BET characterization shows that the layer surface area increased by incorporating graphene into the anode, resulting in an enhanced dye absorption. FTIR results confirmed good thermal reduction of graphene oxide and the formation of strong composition bonds between carbon and titanium atoms. As evident from Raman spectrum, the quality of GO [3] was not affected by the composition process.

References


Figures

Fig 1: Four configuration of layers on FTO glass

Fig 2: SEM image of the composite layer

Fig 3: I-V curves for different categories of cells