Effect of TiO_2 /graphene nanocomposite in multilayer photoanode on the performance of dye sensitized solar cell

Norani Muti Mohamed, Seyed Esmaeil Mahdavi Ardakani, Balbir Singh Mahinder Singh**,** Mohamed Shuaib Mohamed Saheed

Centre of Innovative Nanostructures and Nanodevices (COINN),
Department of Fundamental and Applied Sciences,
Universiti Teknologi PETRONAS, 32610 Bandar Seri Iskandar, Perak Darul Ridzuan, Malaysia.
noranimuti_mohamed@petronas.com.my

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

[1] Fang X, Li M, Guo K, Zhu Y, Hu Z, Liu X, et al. “Improved properties of dye-sensitized solar cells by incorporation of graphene into the photoelectrodes”, *Electrochimica Acta*. 2012;65:174-8.
[2] Yang N, Zhai J, Wang D, Chen Y, Jiang L.“Two-Dimensional Graphene Bridges Enhanced Photoinduced Charge Transport in Dye-Sensitized Solar Cells”. *ACS nano*. 2010;4:887-94.
[3] Tang B, Hu G, Gao H, Shi Z. “Three-dimensional graphene network assisted high performance dye sensitized solar cells”, *Journal of Power Sources*. 2013;234:60-8.

Figures

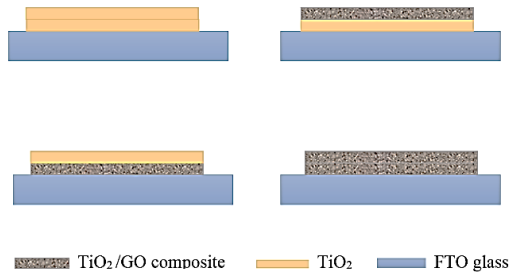

Fig 1: Four configuration of layers on FTO glass

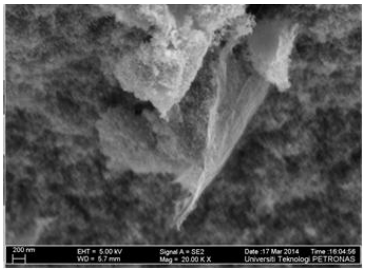

Fig 2: SEM image of the composite layer

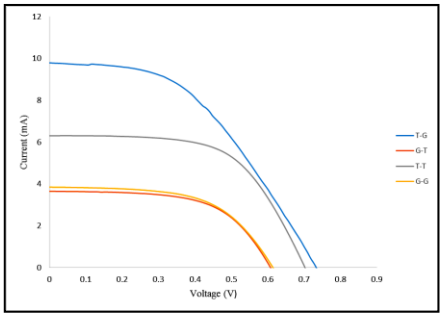

Fig 3: I-V curves for different categories of cells