Graphene-modified working electrode for dye sensitized solar cells

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The demand for more efficient and cheap energy conversion and storage devices are increasing as a result of the depletion of non-renewable energy sources. Dye sensitized solar cells (DSSC) are one of such alternative devices which are relatively cheap, but could give higher power conversion efficiency in many applications. The major issues in DSSCs are, replacing expensive ITO (indium tin oxide) or FTO (fluorine-doped tin oxide) coated electrodes[1] and platinum counter electrodes[2], and also to suppress the recombination loss of photogenerated electrons[3].

Graphene with excellent electron mobility and transparency can be applied as a charge carrier and transfer media there by preventing the recombination loss of electrons. Here we report graphene (both pristine graphene and chemically reduced graphene oxide-RGO) as an interfacial layer between TiO_2 and FTO glass, which is expected to minimize charge recombination and thereby improve the power conversion efficiency of DSSCs.

The two graphene materials were used as follows. In the first method, pristine graphene was grown by atmospheric pressure chemical vapour deposition (CVD) on Cu foils. As-prepared graphene was transferred on to FTO glass plates, and TiO_2 was sprayed on to graphene functionalized FTO plate. In the second method, a thin layer of graphene oxide (GO), made by modified Hummers' method[4], was deposited on FTO plates and reduced by annealing at 1000 °C in Ar/H_2 flow. N719 dye was used as the sensitizer and I^-/I_3^- was used as the electrolyte. The current-voltage (I-V) measurements of the fabricated DSSCs were carried out using HAL-320, ASAHI spectra solar simulator with Xenon lamp under global air mass (AM) 1.5 condition. Active area of the cells is 0.25 cm^2.

Although there are few reports on RGO based interfacial layers in DSSCs, to the best of our knowledge this is the first time to apply CVD graphene as an interfacial layer on the working electrode. Our preliminary results on RGO-based DSSC show 26% increment in efficiency with 56% increment in short circuit current density (J_{SC}) compared to DSSC without interfacial layer. Further studies on CVD graphene-based DSSC will be done.

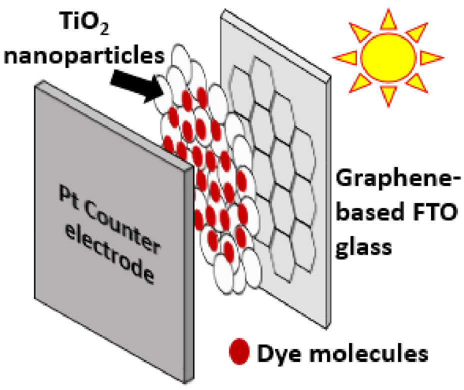

Fig. 1 Schematic representation of a DSSC with the graphene-modified working electrode

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