EMCMRE-1
Marrakech-Morocco
November 21-25 2011
First Euro-Mediterranean Conference on Materials and Renewable Energies (EMCMRE-1) 21-25 November 2011

Improved Photocurrent of a ClO_4^- Doped Poly(3,4-ethylenedioxythiophene)/TiO_2 Thin Film-Modified Counter Electrode for Dye-Sensitized Solar Cells

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Abstract:

In recent years, solar energy has received considerable attention as a renewable, environmentally friendly energy source. In particular, dye-sensitized solar cells (DSSCs), one type of photoelectric conversion device, have attracted considerable interest because they have certain advantages, including lower production cost than typical crystal silicon-type solar cells and a high theoretical conversion efficiency. Usually, as a reduction catalyst, a Pt-sputtered FTO glass electrode is employed as the counter electrode (CE). However, Pt is a rare metal, and is expensive and not abundantly available. Accordingly, the development of a Pt substitute would help enable the development of more practical devices. In addition, CE materials require a high electronic conductivity, corrosion resistance against iodides, and the ability to act as a reduction catalyst for the I^-/I_3^- redox couple. In a previous paper[1,2)], we reported that the performance of a CE can be significantly improved by using a ClO_4^- doped PEDOT (PEDOT-ClO_4^-)/TiO_2 composite film or a PEDOT-ClO_4^-/TiO_2 particle film electrode with increased roughness, but that the photocurrent was not improved by this technique. Therefore, to further improve the photocurrent, the use of reflected light may be effective. However, there are few research papers on the improvement of DSSC performance in non-Pt CEs using reflected light.

In this work, we prepared a TiO_2 thin film (TiO_2 (tf)) on an FTO glass electrode by sol-gel processing, and subsequently deposited a PEDOT-ClO_4^- by electropolymerization. Using cyclic voltammetry and electrochemical impedance measurements of an as-prepared counter electrode, and measuring the performance of a solar cell with a transparent PEDOT-ClO_4^-/TiO_2 (tf) electrode, we evaluated the performance of a TiO_2 (tf) CE, and compared it with a PEDOT-ClO_4^-/TiO_2 particle film (TiO_2 (pf)) electrode. In addition, we attempted to investigate the influence of reflected light on the photocurrent using a modified CE. As a result, the photocurrent-voltage characteristic indicated that a DSSC with a PEDOT-ClO_4^-/TiO_2 thin film counter electrode had a high photovoltaic conversion efficiency, similar to that of a PEDOT-ClO_4^-/TiO_2 particle composite film electrode. Furthermore, it was found that the photocurrent was improved by attaching a reflector to the opposite side of the transparent counter electrode.

1) Sakurai, S.; Jiang, H.-Q.; Takahashi, M.; Kobayashi, K., *Electrochim. Acta*, **54**, 5463-5469 (2009).
2) Sakurai, S.; Jiang, H.-Q.; Takahashi, M.; Kobayashi, K., *Bull. Chem. Soc. Jpn*, **84**, 125-131 (2011).