Modification of TiO2 Photoanode and Its Improvement in Efficiency for Dye-sensitized Solar cells

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ABSTRACT

In this study, Sol-Gel TiO_2 were used as the working electrode (pHoto-anode) of the dye-sensitized solar cells(DSSC). The key process parameters in fabricating high efficiency of DSSC including the deposition of wide band gap semiconductor thin films, the sensitized dye(chromopHore), the mediator(redox couples, electrolyte), cell assembly, etc. It has been investigated by the preliminary tests for further detailed study later. The porous TiO_2 thin films were indeed formed by the sintered Sol-Gel TiO_2, which resulting in being essential to deposited porous TiO_2 thin film with controlled morphology both with large surface area as well as optimal porosity. Unfortunately,due to these two factors of contradiction each other: if the porosity becomes too large, the surface area of the films will decrease.;on the other hand, if the pore size of the porous films becomes smaller, the overall surface of TiO_2 films will increase rapidly while the smaller the pore radius will hinder the diffusion of redox couple which can in turn decrease the photocurrent from the TiO_2 photoanode. As for the most optimal cell performance, it is laborious to find the suitable parameters in DSSC fabrication.

In this study, the process parameters in fabricating high efficient TiO_2 working electrodes for the photo-injected electron transport had been investigated.

Finely ground Sol-Gel TiO_2 was evenly deposited on ITO by spin coating. Different ratio additives, such as PEG were tested. The as-deposited films were further annealed at different temperature with different thickness of the TiO_2 films. Two Iodide/Iodine electrolytes was used to compare the influence of redox mediator in regenerative photo-electrochemical reaction in this system.

The addition of PEG was capable of manipulating the pore size of porous photo-anode by which the ions transferring rate at the counter-electrode interface was improved. Under higher annealing temperature, the sintering of TiO_2 microstructures were more prominent while the crystalline phase might have transformed to the thermodynamically stable phase. The photocurrent conversion efficiency was closely related to the sintering crystalline phase of TiO_2.

The result of the preliminary results in this study shows that the best cell performance was under theses given conditions:V_{OC}=0.7 V，J_{SC}=10 mA/cm^2，FF=63%，η ?l 4.05%. In addition to the process parameters, the choice of chromopHore is still another vital factor for high efficient DSSC. Owing to the unstable character and relatively low spectrum response, the sensitized dye used here suffered from low photocurrent and FF which need endeavor to recognize more efficient ones.

Keywords : Dye-sensitized solar cells、Sol-Gel、TiO_2、SnO_2

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