Design and Fabrication of Novel Front Electrode to Improve Photovoltaic Performance of Dye Sensitized Solar Cells

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Introduction

As a cheap alternative to fossil fuel, dye sensitized solar cells (DSSCs) still have to be improved. In achieving this, charge transportation and surface area play major roles. In this research, effort was taken to fabricate a cavity and a FTO layer inside the TiO$_2$ film in order to facilitate better charge collection and higher surface area.

Experimental

Three kinds of photoelectrodes were prepared by using the spray pyrolysis deposition method. One is (T) a reference with TiO$_2$ colloidal suspension. Second electrode (TC) is prepared with curcumin layer for leaving a cavity between two TiO$_2$ layers. Third one (TF) has a secondary FTO layer. All the samples were sintered and dipped in a N719 dye solution for 12 h and finally characterized by SEM and I-V measurements. All the sprayings were performed at 150°C using an improved spray deposition method except for the secondary FTO layer which was done at 500°C.

Results and Discussion

Figure 1 reveals that TiO$_2$ films are well porous and about 8–10 µm in thickness. It is clear that curcumin layer has been burnt out leaving a cavity (Fig. 1(b)). The secondary FTO layer is visible in the TiO$_2$ layers with a thickness of about 500 nm (Fig. 1(c)).

It is found from the I-V characteristics and the photovoltaic performance that TF gives the highest $J_{SC}$ and efficiency but the least $V_{OC}$ and FF. The improved charge collection through secondary FTO layer may cause better $J_{SC}$ while the compressed bottom TiO$_2$ layer may be an origin of the reduced $V_{OC}$ and FF. TC is not effective as expected. The poor charge collection from the top TiO$_2$ layer may be the reason for the poor performance.

Conclusion

Fabricating the front electrode in layered structure improves the performance of a DSSC. In order to get better results, the layer thicknesses and charge collection has to be optimized.