Application of metallic titanium as the substrate for photoelectrode of dye sensitized solar cells

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1. Introduction

DSCs have been concentrated to develop the efficiency and reduced the production cost. This cell is composed of a FTO transparent conducting glass covered with nano-sized TiO_2, dye molecules attached to the surface of TiO_2, a redox couple electrolyte, and counter electrode. The two conducting glasses are estimated to be about 60% of the total cost of the DSCs. Although the conducting glass are generally used for supporting nanocrystalline TiO_2 for using as a photoelectrode and coating with Pt for using as a counter electrode, the conducting glass is relatively high sheet resistance (10-15 Ω/□), and fragile. In addition, an increase in the active cell area is one of the obstacles to produce the large solar cells. It is expected that the application of a metallic titanium sheet as a support of TiO_2 in DSC cannot only reduce the cost of solar cells, but can also contribute to improve the performance of the solar cells by reducing internal resistance.

2. Experimental

Nanocrystalline TiO2 coated on FTO, Ti, and stainless steel substrate was investigated. Transparent counter electrodes were prepared by sputtering Pt on FTO. Solar energy conversion efficiency was measured under simulated solar light, i.e., AM 1.5, 100 mW/cm^2.

3. Results and discussion

The sheet resistance of metal substrate seems to be constant after annealing at 500°C but the FTO have a low ability to withstand heat during the annealing processes, leading to an increase in sheet resistance. The efficiency of DSC using Ti substrate was higher than that of the DSCs using stainless steel, and FTO as shown in Fig. 1. To retain the decrease in cell performance, the DSCs based on FTO need the metal track for collecting electrons. A decrease in cell performance of large DSCs could be due to the higher sheet resistance of the FTO as shown in Fig. 2. The DSCs based Ti substrate did not need the metal track for transferring the electron. The efficiency of DSC based on Ti substrate was higher than that of DSC based on FTO substrate with metal track. The efficiency of DSC using Ti substrate attained 3.2% with Jsc 6.94 $mAcm^{-2}$, Voc 0.75 V, and FF 0.610. Moreover, the rate of decrease in fill factor of DSC using Ti substrate was lower than that of the FTO as shown in Fig. 3. These results show that Ti sheet is a possible substrate for supporting TiO2 to produce the large DSCs.

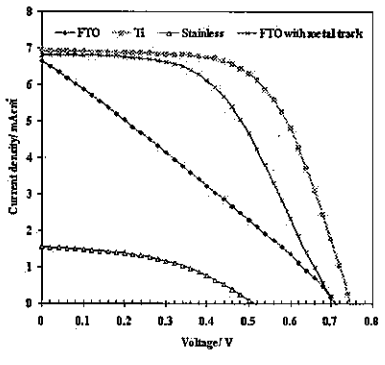

Fig. 1 The photovoltaic properties of DSCs based on Ti, stainless steel,FTO, and FTO with metal track

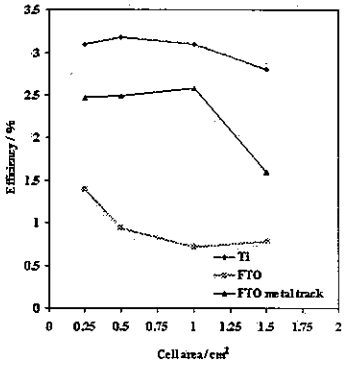

Fig. 2 The effect of cell area on efficiency

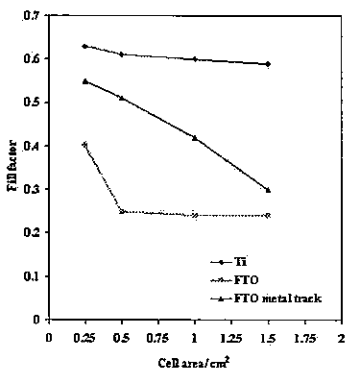

Fig. 3 The effect of cell area on fill factor