Preparation of TiO_2 Photoanode on Flexible ITO Coated PET for Dye Sensitized Solar Cell

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Abstract: This paper discussed the progress of research on fabrication of flexible dye-sensitized solar cells (DSSCs) using ITO/PET in replacing the conventionally used FTO glass substrates. A major challenge for making DSSCs on plastic substrates is the temperature limitation of the plastic in producing the TiO_2 photoanode. Such test using low-temperature fabrication methods for TiO_2 films, such as hydrothermal treatment of paste using binder and free-binder paste were applied, the timing for sintering in oven and furnace, also the resultes after dipped in dye were discussed.

Keywords: DSSC*,* Flexible, ITO, PET, Photoanode

INTRODUCTION

Dye-sensitized solar cells (DSSCs) have attracted much attention for the last more than a decade since they were developed by Gratzel in 1980s [1] because of their low-cost, environment friendliness and high conversion efficiency of solar energy into electrical energy compared to silicon cells [2]. Flexible DSSCs, based on the substrates of Indium Tin Oxide (ITO) coated Polyethylene Terephthalate (PET), substituting for rigid glass substrates, are regarded as one possible breakthrough in the field of DSSC regarding their commercialization, because flexible DSSCs have presented great advantages of low cost of production and wide application [3]. Conductive plastic substrates, such as ITO/PET greatly decreasing the production cost of the solar cells. In addition, it is light weight, having portable character [4]. Usually, porous TiO_2 electrodes are prepared by depositing a film of TiO_2 particles on the surface of a transparent glass electrode, followed by sintering at 450/500 °C. This thermal treatment eliminates organic residues and induces electrical contact between the particles and the substrate. Since PET-ITO degrades at such temperatures, alternative processes need to be applied to prepare the porous photoanode.

MATERIALS AND METHODS

The following materials were purchased from commercial suppliers: ITO/PET (< 15ohm/sq.; > 76 % ; Zhuhai Kaivo Optoelectronic Technology Co., Ltd.), Glacial Acetic Acid (99.7% for ACS Analysis; J.T Baker), Acetone, Ethanol, Isopropyl Alcohol (Quality Reagent Chemical), Di-tetrabutylammoniumcis-bis(isothiocyanato)bis(2,2′-bipyridyl-4,4′-dicarboxylato)ruthenium(II), Alpha Terpineol, Titanium (IV) Oxide anatase-nanopowder, Ethyl Cellulose [Sigma Aldrich]. Two types of paste were used in this experiment. (i) TiO_2 with binder prepared with TiO_2, Acetic Acid, Alpha Terpineol and Ethyl Cellulose [5]. Another (ii) TiO_2 photoanode was prepared with free-binder paste. Briefly, a certain amount of treated P25, distilled water, and absolute ethanol were mixed with a mole ratio of 1:1:5, sonicated for 30 min before transferring to a 150-ml Teflon-lined autoclave (packing volume <80%), and then heated in an oven at 200°C for 24 h with no intentional control of ramping or cooling rate. Both paste were applied using doctor blading method and sintered. Finally, the TiO_2/ITO/PET film was immersed in 0.4 mM of dye N719 ethanol/acetonitrile solution for 24 h to absorb the dye adequately. Thus, a flexible dye-sensitized photoanode was obtained.

RESULTS AND DISCUSSION

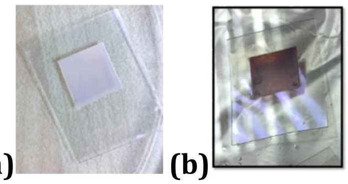
(a) **(b)**


Fig. 1: (a) Sample sintered at 120°C for 24 hours in oven, (b) Sample after dyed for 24 hours

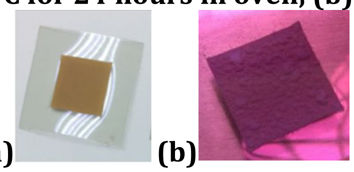
(a) **(b)**


Fig. 2: (a) Sample after 150°C at 1 hour in furnace, (b) Sample after dyed at 24 hours

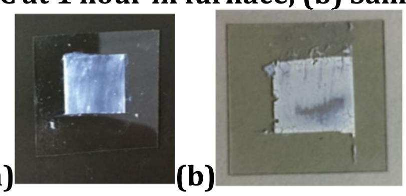
(a) **(b)**


Fig. 3: (a) Sample after doctor blading using free binder, (b) Sample dried after 30 minutes

TiO_2 paste prepared in method (i) is applied to ITO/PET using doctor blading method. The sintering temperature is set to 120°C for 24 hours in an oven as it gave a result of a good contact shown in Fig. 1 (a). Fig.1 (b) shows better dye adsorption after 24 hours.
Then the same TiO_2 paste is also printed on ITO/PET using the same technique and sintered at 150°C for 1 hours in furnace. The results show a brownish TiO_2 film formed as shown in Fig. 2 (a). While as shown in Fig. 2 (b), after immersing in dye, the TiO_2 peeled off slowlyand after removed and rinsed, TiO_2 completely detached from ITO/PET substrate.
Fig. 3 (a) shows a binder free TiO_2 printed on ITO/PET substrate. The samples was left on air for 30 minutes to dry. Unfortunately the TiO_2 cracked and changed into powder as in Fig. 3 (b).

CONCLUSIONS

Fabrication of flexible DSSC at low temperature was studied. In this experiment, TiO_2 paste with binder and free binder as photoanode for flexible DSSC were investigated. The TiO_2 with binder applied on ITO/PET showed a good contact compared to the free binder TiO_2.

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