Electron beam irradiation of silica and titania based hybrid polymer for PEC application

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1. Introduction

Photoelectrochemical(PEC) cell is a devise to convert photon energy to electrical or chemical energy using a semiconductor material as a photo-anode. Titania has been widely used for this application as a semiconductor material, even though it has a wide band-gap which is inappropriate for conversion of photo energy to electrical energy due to the poor absorption of visible light. [1] Recently, dye sensitization became a good solution to increase the absorption of visible light. [2] However, this approach includes several processes in fabrication which can be time consuming and inappropriate for commercialization. In this study, electron beam was irradiated to a silica and titania based hybrid polymer to form a semiconductor material which has a good visible light absorption property. This approach may be a very simple method to fabricate a photo-anode.

2. Experimental methods and Results

In this section, sample preparation methods and electron beam irradiation conditions are described. UV-VIS and cyclic voltammetry measurements were performed to observe the optical and electrochemical properties of the prepared samples. PEC cell was made up to generate photo-current which the prepared sample is load as a photo-anode.

2.1 Sample preparation

A silica and titania based hybrid polymer was synthesized as reference. [3] Ethanol and the polymer were mixed with 9:1 by volume percent to make a dilute solution. 200μL of the dilute solution was droped on a 2cm x 2cm ITO glass and spin coated at 2000rpm for 60s to form a thin polymer film. This pristine sample was irradiated by a home-made electron beam devise. [4] The electron energy was 50keV and the total electron fluence was varied from 1.030 x 10^{18} cm^{-2} to 4.120 x 10^{18} cm^{-2}.

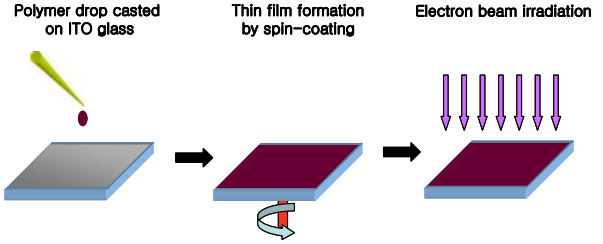

Fig.1 Schematic representation of sample preparation process

2.2 UV-VIS, cyclic voltammetry

For UV-VIS measurement, the silica and titania based polymer was spin-coated on a KBr pellet prior to electron beam irradiation and post transferred on a quartz substrate. For cyclic voltammetry measurement, the electron beam irradiated sample was loaded on a plate material evaluating cell as a working electrode. The plate material evaluating cell was consisted of total three electrodes, electron beam irradiated sample as working electrode, Ag/Ag^{+} electrode as reference electrode, and Pt wire as counter electrode. 0.1M TBAP acetonitrile solution was used as electrolyte. The scan rate was 10mV/s.

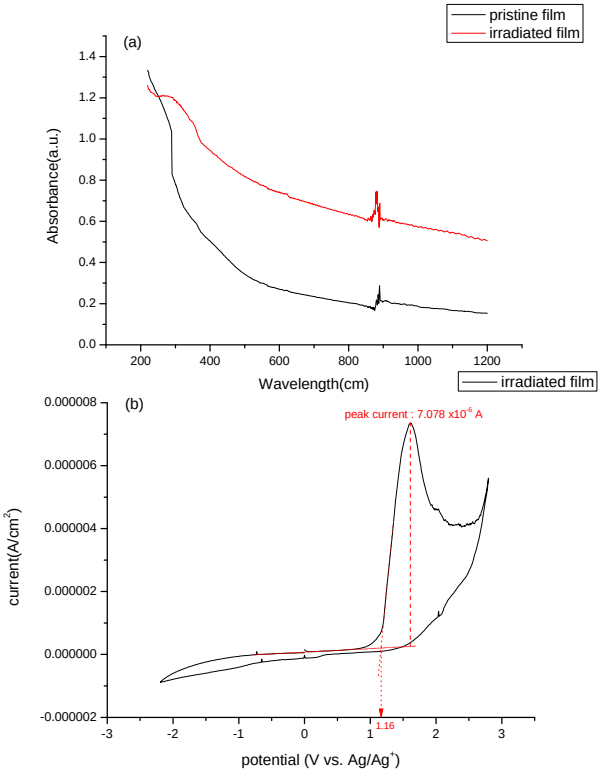

Fig.2 (a)UV-VIS absorbance spectra of pristine film and electron beam irradiated film. (b)Cyclic voltammogram of electron beam irradiated film.

2.3 PEC cell

PEC cell was prepared in a pyrex beaker consisting with three electrodes, electron beam irradiated sample as photo-anode, Pt wire as cathode, and SCE as reference electrode. 0.5M H_2SO_4 aqueous solution was used as electrolyte. Photo-current was measured by an illumination of 500W Xe lamp. Anatase TiO_2 film was

prepared to compare with the electron beam irradiated film. Anatase TiO_2 powder 1g was well dispersed in 5ml ethanol. 200uL of the dispersion solution was droped on a 2cm x 2cm ITO glass and spin coated at 2000rpm for 60s.

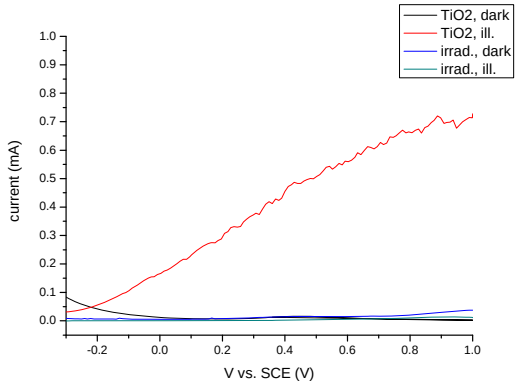

Fig. 3 Photocurrent-voltage curve of electron beam irradiated film and anatase TiO_2 film at dark and illumination.

3. Conclusions

Silica and titania based hybrid polymer film was irradiated by electron beam and its optical and photoelectrochemical properties were evaluated. Based on the UV-VIS and cyclic voltammetry data, the electron beam irradiated polymer film did not showed semiconductor properties. Compared to anatase TiO_2, photocurrent generation was also poor for the electron beam irradiated polymer film. Further studies including changes on irradiation condition, pristine material should be perform.

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