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Photosensitizing Effect of Porphyrin Films as Organic Photodetector

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Abstract: A set of organic photodetector devices arranged as indium doped tin oxide (ITO)/porphyrin/TiO_2/aluminum has been fabricated and its performance has been tested in dark and under various illumination of visible light intensity from 20-100 mW/cm^2. Four devices were prepared using natural porphyrin by 1, 3, 5 and 7 times of spin coating. First, porphyrin film was deposited onto indium doped tin oxide (ITO)-covered glass substrate by spin coating technique. Second, titanium dioxide (TiO_2) film was deposited on top of the porphyrin film using similar technique. Porphyrin was isolated from spirulina microalgae and TiO_2 nanoparticle was prepared by controlled hydrolysis technique using titanium(IV) etoxide, $Ti(OC_2H_5)_4$, and potassium chloride. The films were characterized by UV-vis spectrophotometer to investigate their absorption spectra. The porphyrin film has maximum absorbance at 660 nm, which is in the red region. Then, an aluminum electrode was prepared on top of TiO_2 film by electron beam evaporation technique. The resulting device shows rectification property in dark and shows photosensitizing effect under illumination. The device prepared by 3 times of spin coating of porphyrin films shows the highest current density, J_{sc}, of 5.76 μA/cm^2 and open circuit potential, V_{oc}, of 648 mV, respectively.

Key words: Organic photosensitizer, natural porphyrin, titanium dioxide anatase, photocurrent.

1. Introduction

Successful design of dye-sensitized solar cells (DSSCs) depends heavily on the effective conversion of the solar light into electricity. The attention in the design of DSSCs has shifted from inorganic semiconductors to organic sensitizers. Sensitizing wide band gap inorganic semiconductors such as TiO_2 and ZnO by organic dye sensitizers is one way to increase the solar cell efficiency. When the dye that has a chromophore group is excited by solar light, it will inject electrons to the inorganic semiconductors and cause the electric current to flow. TiO_2 sensitized by N3 dye, a polypyridyl ruthenium complex, can have efficiency of conversion of sun light to electricity up to 11% [1-3].

Sensitizers of organic dyes are of special interests because they have high molar absorptivity, are inexpensive, easy to prepare and fairly stable. The DSSCs that use sensitizers of the dyes derived from coumarin, indoline, thiophene, triarylamine, perylene, cyanine, hemicyanine. Some dyes can give efficiency of 5-9%. A highly efficient sensitizer of metalloporphyrin has been used in DSSCs, in which efficiency of >5% is achieved [4]. Dye sensitizer of zinc porphyrin can yield efficiency of 6% [5-6]. Porphyrin is naturally

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