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Solar Cells with 5,10,15,20-tetra(o-nitro) Phenylporphyrin-Atomagnesium Sensitization with Poly(*N*-Vinylcarbazole)

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We fabricated two types of solar cells based on poly(*N*-vinylcarbazole)(PVK) mixed with metalloporphyrin/Alq_3 p-n junction system and evaporated metalloporphyrin/Alq_3 p-n junction system. 5,10,15,20-tetra(o-nitro)phenylporphyrinatomagnesium (MgTNPP) was used as a photosensitizer and PVK was used as a hole transporter. Photovoltaic parameters (open circuit voltage (V_{oc}), short circuit current (J_{sc}), fill factor (*FF*), and conversion efficiency (η)) of ITO/PVK(MgTNPP)/Alq_3/Al cell were calculated from the photocurrent-voltage characteristics.

Keywords porphyrin; photovoltaic; solar cell

INTRODUCTION

Much efforts have been expanded to convert solar energy effectively to electric energy by organic solar cells. The organic solar cells have

especially attracted attention since Tang reported a relatively large power conversion efficiency for a two-layer organic photovoltaic cell fabricated from copper phthalocyanine and a perylene tetracarboxylic derivative [1]. Polymeric and organic materials are suitable for use in photoelectric conversion devices owing to easy fabrication of devices with low cost. Many organic cells using dyes with p-type organic semiconductors such as porphyrin [2], and phthalocyanine [3] were

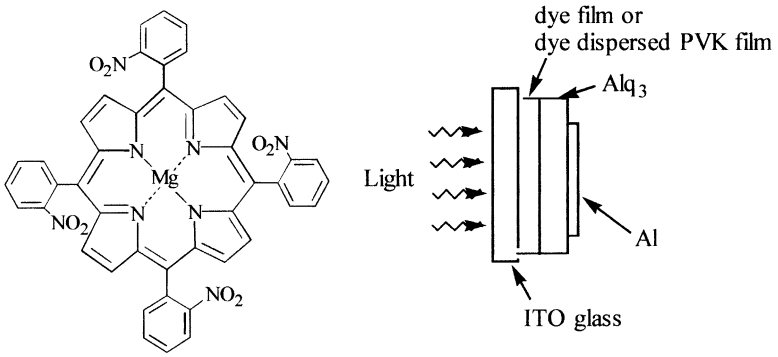

FIGURE 1. Molecular structure of MgTNPP and the configuration of solar cell.

investigated, as well as polymers such as poly(*N*-vinylcarbazole) [4]. The authors reported the p-n junction solar cell with the sensitization of 5,10,15,20-tetra(o-nitro)phenylporphyrinatozinc [5]. In this work, we fabricated two kinds of p-n junction solar cell devices by using poly(*N*-vinylcarbazole) (PVK) with metalloporphyrin dye-dispersing and by using vacuum deposition of 5,10,15,20-tetra(o-nitro)phenylporphyrinatomagnesium (MgTNPP) and tris(8-hydroxyquinolineato)aluminium (Alq_3) for the production of films. The photovoltaic parameters were calculated from the analysis of the photocurrent –voltage characteristics.

EXPERIMENTAL

Tris(8-hydroxyquinolineato)aluminium (Alq_3) and poly(*N*-vinylcarbazole) were purchased from Aldrich and used as received. 5,10,15,20-tetra(o-nitro)phenylporphyrinatomagnesium (MgTNPP) was synthesized as reported elsewhere [5]. PVK (0.2 g) was dissolved in tetrachloroethane (4.8 g), then MgTNPP (0.01 g) was added to the solution. The molecular structure of MgTNPP is described in FIGURE 1. The polymer solution was passed through a 0.2 μm filter and then spin coated at 1500 rpm on ITO glass. The polymer film (100 nm) was dried at 60 °C for 24 hrs. Porphyrin and Alq_3 films were fabricated by vacuum deposition on the PVK coated film or ITO glass at 10^{-5} torr. Aluminium electrode (100 nm) was eventually deposited on the porphyrin film or the PVK film. The photoactive area was 0.19 cm^2. The deposit rate was 0.2 nm/s. The photovoltaic measurements were

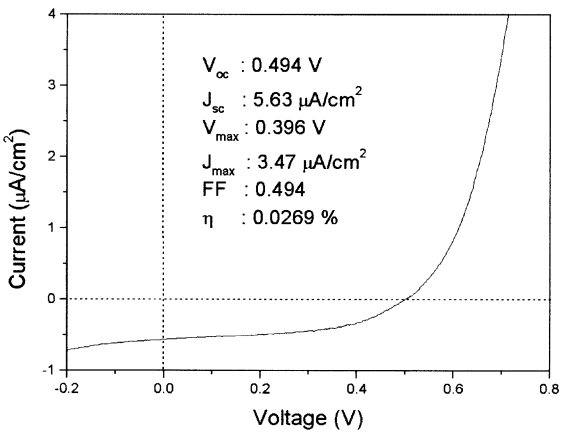

FIGURE 2. Photocurrent-voltage characteristics of the ITO/PVK(MgTNPP)/Alq_3/Al cell.

carried out by using an electrometer (Kiethley, model 237) under irradiation of white light from a 150 W Xenon lamp. Light power (White light) was 5.10 mW/cm^2. Light intensity was measured with an International Light Instruments ILI 1700 radiometer with a calibrated silicon detector.

RESULTS AND DISCUSSION

Two different types of solar cell devices were presented here. The configurations of the organic and polymeric solar cells are depicted in FIGURE 1. The photocurrent-voltage characteristic of ITO/PVK (MgTNPP)/Alq_3/Al cell is presented in FIGURE 2. The open circuit voltage (V_{oc}) is 0.494 V. The short-circuit current (J_{sc}) is 5.63 $\mu A/cm^2$. The fill factor (FF) is 0.494, and the overall energy conversion efficiency is 0.0269 %. The porphyrin evaporated solar cell, ITO/MgTNPP/ Alq_3/Al, showed V_{oc} = 0.507 V, J_{sc} = 0.0731 $\mu A/cm^2$, FF= 0.456, η = 3.3 x 10^{-4} %. MgTNPP dispersed p-n junction cell showed higher efficiency and photocurrent than that of the phorphyrine deposited cell. It is concluded that PVK serves as a good hole transporter and helps to make charge separation from the excitons, while porphyrin is a hole generator [6]. It is also suggested that a deposited film of the dye have less effective communication than a dye-dispersed PVK film.

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