Extended Abstract

Photoconductive Properties of Polyimide Films Derived from Pyromellitic Derivatives

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I. Introduction

Polyimides (PI) are known as super-engineering plastics exhibiting high thermal and chemical stability, flame and radiation resistance, mechanical strength and good flexibility. Further, electro-conductive [1] and photoconductive properties of PI films have been investigated by several researchers. In particular, PIs containing triphenylamine (TPA) structures represent high photoconductivity [2]. The mechanism of charge carrier photogeneration was considered to be caused by two steps: First, the charge transfer (CT) complexes are generated by irradiation, and next, they are dissociated into free carriers under strong electric field. Recently, we have reported that the intensity of UV/vis absorptions and photocurrents increase with increasing the electron affinity (*EA*) of dianhydride moiety, which is due to the enhanced CT interactions [3]. In this study, the photoconductivity of PIs derived from three dianhydrides having larger *EA*s is investigated based on UV/vis absorption spectra and electrical measurements.

II. Experimental

The molecular structures of the PIs used in this study are shown in Fig.1. PI films were prepared as follows: Solutions of poly amic acids (PAA), precursors of PIs, were spin-coated onto ITO substrates, followed by thermal imidization at 300°C. Silver electrodes(ϕ=1 mm) were directly formed on the PI films by magnetron sputtering through a mask under vacuum. UV/vis absorption spectra were measured using a Hitachi U-3500 spectrophotometer. Electrical measurements were performed using a home-buldt equipment shown in Fig.2. A DC electric field (50 kV/cm) was applied for 9 min, and the film was irradiated for 3 min in the middle. In this study, photocurrent density was defined as the difference between the current densities at 180 s after applying DC field (dark current density) and that at 360 s (maximum of photo-current).

III. Result and Discussion

The absorption and photo-current spectra of three PIs shown in Fig.3. From Fig.3(a), the CT interactions of PI films tends to increase with increasing electron acceptor properties of dianhydrides. On the other hand, from Fig.3(b), the photoconductivity did not show clear correlation with intensity of CT interactions. P3FDA /DATPA, having strong CT interaction in the second, showed significantly higher photoconductive property. As mentioned in introduction, the carrier generation in organic materials was influenced by two factors that were exciton generation and charge separation. Enhancement CT interactions increase the amount of exciton, but high photoconductivity is not occurred without charge separation. Therefore this experimental results suggests that the charge separation efficiency is changed by chemical structure of PIs. So the molecular design of PIs having high photoconductive properties, it is necessary to consider that not only enhancement CT interactions but also ease of charge separation.

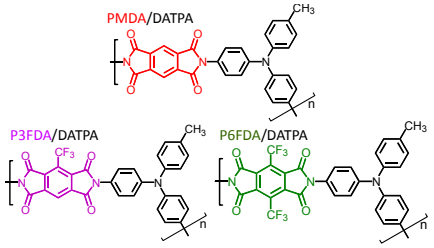

Figure 1. Structure of PIs

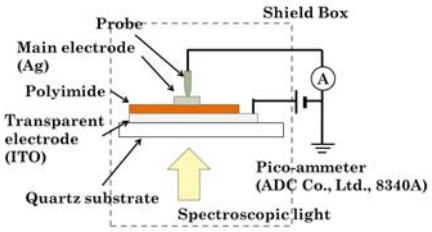

Figure 2. Home-built Equipment for electrical mesurements

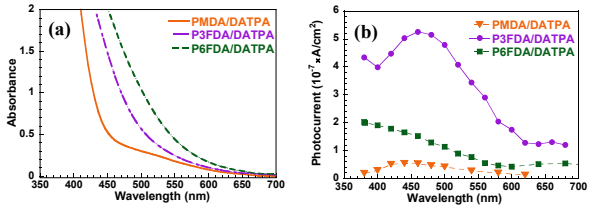

Figure 3.(a) UV/vis absoption spectra and (b) photocurrent spectra of PIs

References

[1] K.Takizawa, S.Asai, S.Ando. "Temperature Dependence of Electric Conduction in Polyimides having a Triphenylamine Structure in the Main Chain", *Polymer J.*, **46**, 201 (2014).
[2] E. L. Aleksandrova, "Structural Properties of Polyimides and the Mechanism of Carrier Photogeneration in Polyimide-Based Molecular Complexes," *Opt. Spect.*, **93**, 118 (2002).
[3] K.Takizawa, S.Fukuchi, S.Asai, S.Ando, "Photoconductive Properties of Polyimides having Triphenylamine Structure in the Main Chain," *Pacific Polymer Conf.* (PPC-2013, Kaohsiung, Taiwan) (2013).