Photocurrent Characteristics of High Charge Transfer Polyimides having Triphenylamine Moiety

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Introduction

Aromatic polyimides (PIs) exhibit high heat resistance, mechanical strength, and good electrical insulation. Recently, PIs having strong charge transfer (CT) interactions between the diamine and dianhydride moieties were reported to exhibit high photoconductivity (PC) which is induced by photo-irradiation. This property can be applied to optical devices such as optical memories and photodetectors [1,2]. In this study, for the purpose of developing PIs with good optical transparency and photoconductivity, we investigated the photocurrent characteristics of a series of PIs derived from a diamine having triphenylamine (TPA) moiety and fluorinated dianhydrides which have strong electron donating and accepting abilities, respectively.

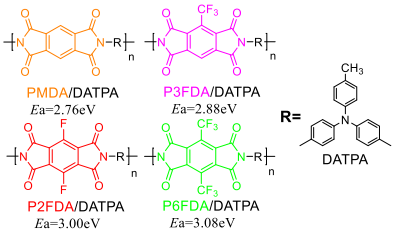

Fig.1 Structure of PIs used for measurement and electron affinities of the dianhydride parts.

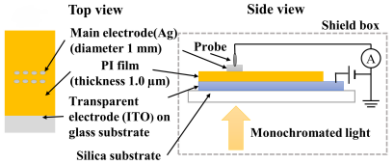

Fig.2 Schematic drawings of the setup for photoconductivity measurements.

Experiment

Fig. 1 shows the PI structures used for photoconductivity measurements, and **Fig. 2** shows the measurement system of photoconductive properties. The photocurrent value was defined as the difference in electric currents between photo-irradiated and dark states.

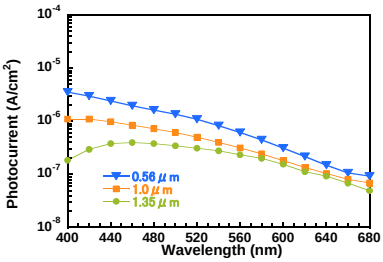

Fig. 3 Thickness dependence of the photo-current spectra for PMDA/DATPA films.

Results and Discussion

The photocurrent value decreased with increasing the film thickness and slightly decreased in the shorter wavelength region (**Fig. 3**). For the thick films, charged carriers are expected to be accumulated near the boundary between irradiated and unirradiated regions because shorter wavelength light cannot penetrate to deep inside the film. In the boundary region, charge recombination can frequently occur, effectively decreasing carrier density. As shown in **Fig. 4**, P6FDA showed lower photocurrent values than P2FDA, although P6FDA exhibited higher electron affinity (*Ea*) of the dianhydride and stronger CT interaction. P6FDA has bulky -CF_3 groups which suppress intermolecular CT interaction and the hopping conduction, resulting in the lower carrier density and PC. Consequently, the photocurrent characteristics are affected, not only by CT interactions, but also by penetration depth and higher order structures including in-plane/out-of-plane orientation of PI chains.

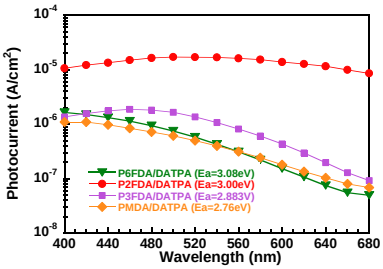

Fig. 4 Photocurrent spectra of PI films.

References

[1] Takizawa, K.; Asai, S.;Ando, S. *Polymer. J.*, 2014, 46, 201-206

[2] Takizawa, K.; Fukuchi, S.; Takemasa, C.; Ishige, R.; Asai, S.; Ando, S. *Polymer*, 2018, 157, 122-130