Photocurrent Characteristics of High Charge Transfer Polyimides having Triphenylamine Moiety

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Introduction: Aromatic polyimides (PIs) are polymers that exhibit high heat resistance, mechanical strength, and electrical insulation. Recently, PIs enhanced charge transfer interaction were reported to exhibit high photoconductivity (PC), which is an electric conductivity induced by photo-irradiation. This property is expected to be applied to optical devices such as optical memories and photodetectors [1][2]. Charge transfer (CT) interactions between the diamine and dianhydride moieties is essential to enhance their PC. However, the photocurrent value of PIs with stronger CT interactions is lowered because optical penetration length is shallow and charged carriers generated near the surface readily resulted in recombination and quenching. Therefore, in this study, for the purpose of developing PIs with excellent transparency and photoconductivity, we investigated the photocurrent characteristics of PIs with triphenylamine (TPA) moiety, which has a bulky substituent that suppresses aggregation of molecular chains that cause lower absorption, and has strong electron donating ability.

Experimental Methods: **Fig. 1** shows the PI structures used for measurements, and **Fig. 2** shows the measurement system of photoconductive properties. The difference in current values before and after irradiation was defined as a photocurrent value.

Results and discussions: The photocurrent value decreased with increasing the film thickness, and the photocurrent value decreased in the shorter wavelength range (**Fig. 3**). This is attributable to the deep penetration depth of the light, owing to the low transparency. Charged carriers were accumulated at the interface between light irradiated part and unirradiated (dark) part, and charge recombination was likely to occur at the interface. As shown in **Fig. 4**, the order of photocurrent is weakly correlated with the electron affinity of dianhydrides. In conclusion the photocurrent characteristics are affected not only by the CT interactions determined by dianhydrides but also by the higher order structures related to the stereo-chemical structures of PIs.

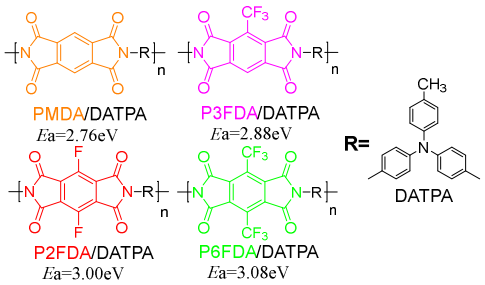

Fig.1 Structure of PIs used for measurement and electron affinity of acid dianhydrides (*Ea*)

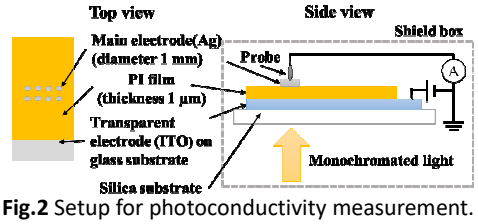

Fig.2 Setup for photoconductivity measurement.

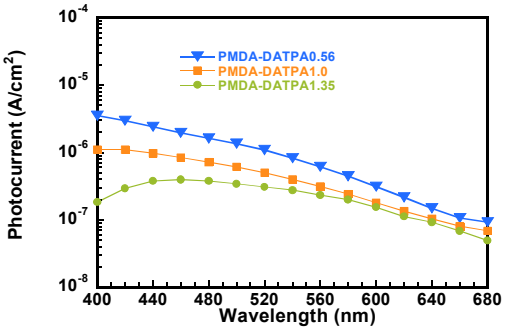

Fig.3 Thickness dependence of Photocurrent of PI films.

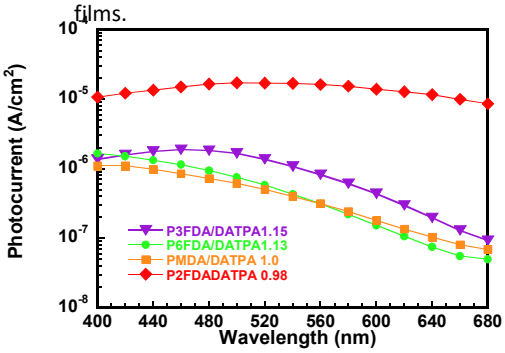

Fig.4 Photocurrent spectra of PI films.

Reference: [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

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