Photoconductivity of Polyimide Films Having Enhanced Charge Transfer Interaction

○Kahori Takatsuki[1], Chiaki Takemasa[1], Shigeo Asai[2], Ryohei Ishige[1] and Shinji Ando[1]

([1] Dept. of Chem. Sci. and Eng., [2] Dept. of Mat. Sci. and Eng., Tokyo Institute of Technology)

Introduction: Recently, polyimides (PIs) containing triphenylamine (TPA) structure or diphenylbenzidine structure have been reported to exhibit high photoconductivity (PC), which is an electric conductivity induced by photo-irradiation [1,2]. These PIs are potentially applicable to multi-valued optical memory and photo sensors. We have previously investigated PC properties of various PIs and reported that charge transfer (CT) interactions between the diamine and dianhydride moieties is essential to enhance their PC [2]. In this study, we synthesized a series of novel PI films using several fluorinated dianhydrides having higher electron-accepting abilities (E_a, Fig. 1) and investigated the relationships between their higher ordered structures and PC properties.

Experimental & methods: The chemical structures of PIs used in this study are shown in **Fig. 1**. PI films with 0.5 μm thickness were spin-coated onto an indium tin oxide (ITO) substrate, and a silver electrode was deposited on the films as electrodes. The substrates with electrodes were installed in a shield box filled with dry N_2 (**Fig. 2**). Out-of-plane photocurrent was measured by applying positive voltage onto the ITO electrode under irradiation of visible or UV light monochromated from a xenon light source. Wavelength dependence of absorbance and PC were measured from longer to shorter wavelengths.

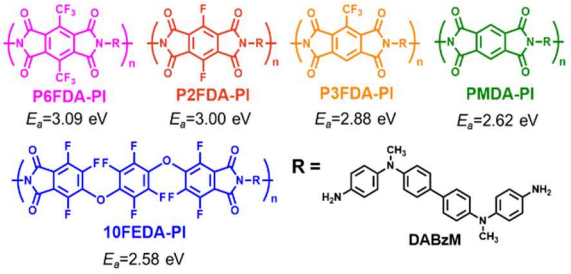

Fig. 1 Chemical structures of the target PIs.

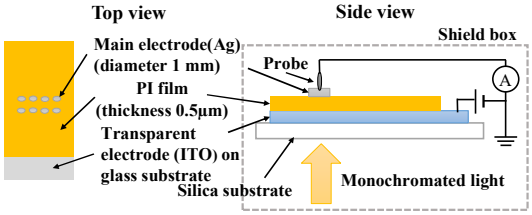

Fig. 2 Setup for photoconductivity measurement.

Results and discussions: The photoconductive spectra shown in **Fig. 3** increased with increasing the CT interactions which is proportional to E_a values in **Fig. 1**. However, P2FDA-PI exhibited significantly stronger PC than P6FDA-PI, while the E_a value of P2FDA is smaller than that of P6FDA. This is because intermolecular CT interaction (inter-CT) dominates the PC of P2FDA rather than intramolecular CT (intra-CT). The red-shift of absorption edge of P2FDA is one of the evidence of the stronger inter-CT of P2FDA-PI, whereas E_a value is an indicator of intra-CT. Furthermore, 10FEDA-PI exhibited higher PC than that of PMDA-PI in the shorter wavelength region, which is attributable to the higher transparency of 10FEDA-PI. It brings larger penetration depth of UV light and charged carriers are generated more inside the film. Consequently, charge recombination, which blocks the charge transportation, is suppressed to increase the charge mobility through the film. In conclusion, the enhanced inter-CT interactions and higher optical transparency are the essential key factors for the enhancement of photoconductivity of PI films.

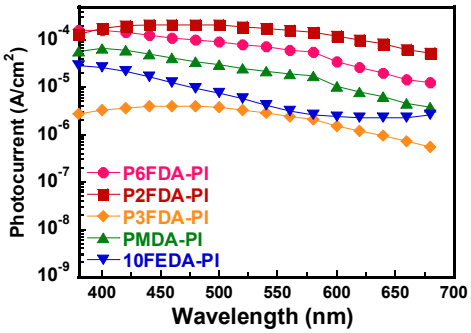

Fig. 3 Photocurrent spectrum of the PI films.

Reference: [1] C. Takemasa, T. Chino, R. Ishige, S, Ando, *Polymer.*, **2019**, 180, 121713.
[2] K. Takizawa, S. Fukuchi, C. Takemasa, R. Ishige, S. Asai, S. Ando, *Polymer*, **2018**, 157, 122-130.
[3] S. Ando, T. Matsuura, S. Sasaki, *Polym. J.*, **1997**, 29, 69-76.

Photoconductivity of Polyimide Films Having Enhanced Charge Transfer Interaction

K. Takatsuki[1], C. Takemasa[1] S. Asai[2] R. Ishige[1] and S. Ando[1] ([1]*Dept. of Chem. Sci. & Eng.,* [2] *Dept. of Mat. Sci. & Eng., Tokyo Institute of Technology, Ookayama 2-12-1-E4-5, Meguro, Tokyo, Japan*) 1Tel: +81-3-5734-2889, Fax: +81-3-5734-2889, E-mail: ktakatsuki@polymer.titech.ac.jp