Correlation between Photoconductive Properties of Polyimides and Their Anhydride Structures

K. Takatsuki[1], C. Takemasa[1], S. Asai[2], R. Ishige[1] and S. Ando[1]
([1] Department of Chemical Science and Engineering, [2] Department of Materials Science and Engineering, Tokyo Institute of Technology,)

Introduction: We have previously investigated PC properties of various PIs and reported that charge transfer (CT) interactions between diamine and dianhydride moieties is essential to enhance their PC [1]. CT interaction can be strengthened by enhancing the electron-accepting ability of dianhydride and the electron-donating ability of diamine. In this study, we synthesized novel PI films using several fluorinated dianhydrides having enhanced electron-accepting abilities and investigated the relationships with their PC properties.

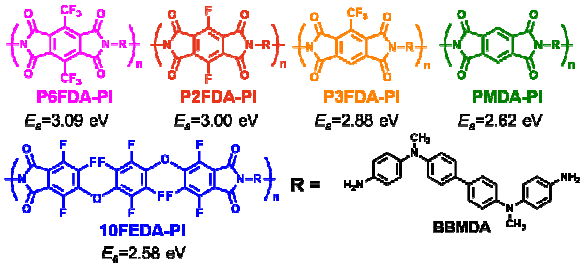
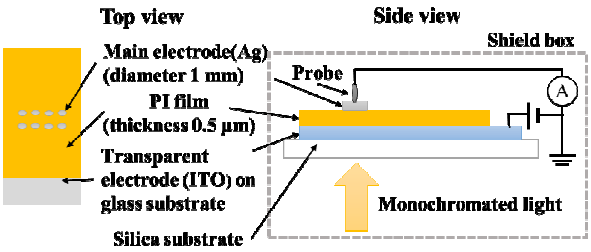


Figure 1 Chemical Structures of PIs

Experimental and 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 silver electrode was deposited on the films. The measurement setup filled with nitrogen and installed in a shield box is shown in **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 xeon light source. Wavelength dependence of absorbance and PC were measured from longer to shorter wavelengths.



films.Figure 2 Setup for photoconductivity

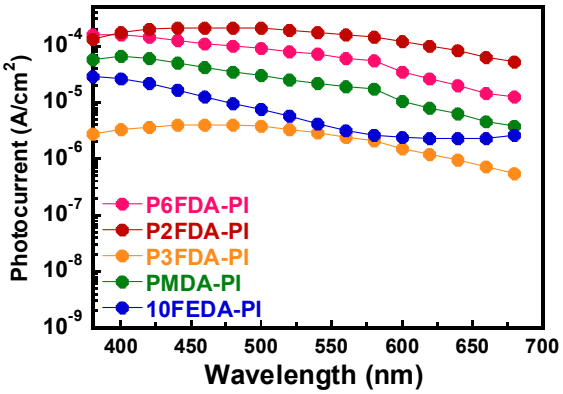


Figure 3 Photocurrent spectrum of the PI

Results and discussions: As shown in **Fig. 3**, photoconductivity of PIs is enhanced with increasing the CT interactions as expected. However, that of P2FDA-PI was significantly stronger than that expected from the electron affinity (*E*a) of P2FDA. We have reported that the absorption edge of PIs with stronger CT interaction is shifted to longer wavelengths [2], and Ea is a parameter which diamines inherent 'intramolecular CT (intra-CT) interaction'. The red-shift of the absorption edge of P2FDA-PI indicates that this PI has a stronger 'intermolecular CT (inter-CT) interactions', which enhances the photocurrent of P2FDA-PI. In addition, 10FEDA-PI demonstrated higher PC than that expected from the *E*a at shorter wavelengths, which is attributable to the large penetration depth of the light. Owing to the high transparency of 10FEDA-PI, charged carriers are generated deep inside the film and efficiently transported through the PI film.In conclusion, the enhanced inter-CT interactions and higher optical transparency are the key factors for the enhancement of photoconductivity of PI films.

Reference:

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

Correlation between Photoconductive Properties of Polyimides and Their Anhydride Structures
K. Takatsuki[1], C. Takemasa[1] S. Asai[2] R. Ishige[1] and S. Ando[1] ([1] Dept. Chem. Sci. Eng., [2] Dept. Mat. Sci. Eng., Tokyo Institute of Technology, E4-5, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8552, Japan)