Photoconductivity of Polyimide Films Having Enhanced Charge Transfer Interaction

K. Takatsuki*, C. Takemasa* S. Asai** R. Ishige* and S. Ando*
* Department of Chemical Science and Engineering,
e-mail: takatsuki.k.ab@m.titech.ac.jp
** Department of Materials Science and Engineering

I. INTRODUCTION

Polyimide (PI) are one of the super-engineered plastics exhibiting high thermal and chemical stability as well as mechanical strength. Recently, PIs containing triphenylamine (TPA) structure or diphenyl-benzidine structure were 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 memory and alignment layer of liquid crystal displays. 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 [2]. 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.

II. EXPERIMENTAL

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 absorbace and PC were measured from longer to shorter wavelengths.

III. RESULT AND DISCUSSION

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 [3], and E_a is a parameter which diminates inherent 'intramolecular CT (intra-CT) interaction'. The red-shift of the absorption edge of P2FDA/BBMDA 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

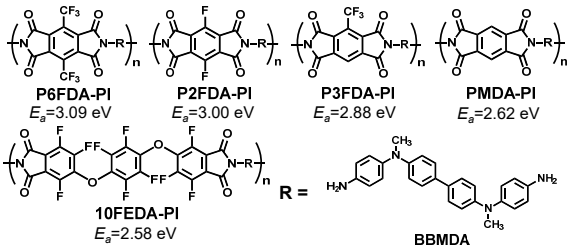

Figure 1 Chemical Structures of PIs.

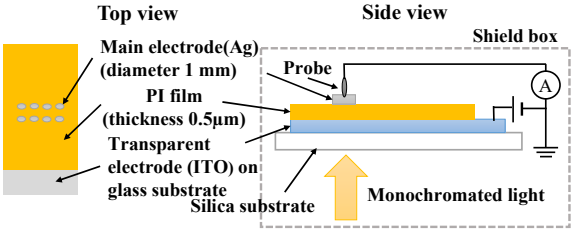

Figure 2 Setup for photoconductivity measurement.

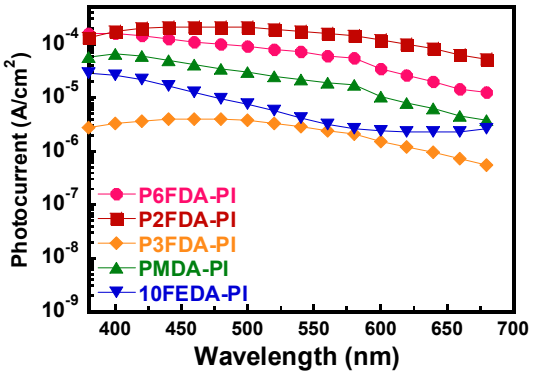

Figure 3 Photocurrent spectrum of the PI films.

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.

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