Fine tuning of photo-luminescence colors by copolymerization of polyimides based on Förster resonance energy transfer (FRET)

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I. Introduction

Organic luminescent materials are applicable to many devices; such as displays, light emitting devices (LEDs), and spectrum convertors for solar cells (**Fig.1**). Recently, polyimide (PI), a super engineering plastic with excellent thermal and chemical stability, has been attracting much interests owing to its potential applications as novel luminescent materials. Previously, we have proposed a concept for molecular design toward fluorescent and phosphorescent PIs [1]. In particular, phosphorescent PIs, exhibiting extremely large Stokes shifts, can be a good candidate due to the high spectrum converting property. However, some phosphorescent PI films show absorption bands in the visible region, caused by their aggregation state, which deteriorates the optical transparency [2].

In this study, a series of copolyimides (co-PIs) were synthesized by combining fluorescent and phosphorescent dianhydrides to develop colorless and emissive PI films with large Stokes shifts. We aimed to control the optical properties of co-PIs based on Förster resonance energy transfer (FRET).

II. Experimental

Co-PIs were prepared by the conventional two-step procedure using BPDA and DBrPMDA as dianhydrides, and DCHM as a diamine (**Fig. 2**). Absorption and emission spectra were measured by Jasco V-670 spectrophotometer and a Hitachi F-7100 spectrofluorometer, respectively.

III. Results and Discussion

The absorption spectra of PI films are shown in **Fig. 2**. It should be noted that all co-PIs exhibited higher transparency than DBr-PI homopolymer. The luminescence spectra and CIE coordinates of the co-PI films are displayed in **Fig. 3**. Excitation of the BP-PI moiety at 350 nm gave dual blue and orange emissions, which are assignable to fluorescence from the BP-PI moiety and luminescence from the DBr-PI moiety, respectively. Moreover, luminescence intensity at around 580 nm was gradually enhanced with increasing the copolymerization ratio of DBr-PI. These results indicate that efficient FRET process occurred from the BP-PI to DBr-PI moieties. As a consequence, it was demonstrated that co-PIs exhibited high transparency due to the suppression of aggregation of DBr-PI moiety as well as finely tunable luminescence colors from blue to yellow via white by adjusting the copolymerization ratio.

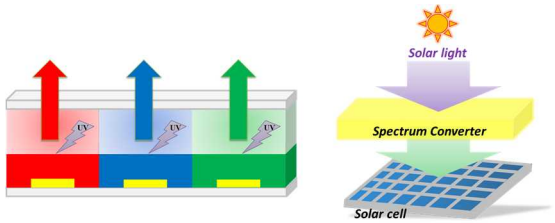

Fig.1. Schematic drawing for applications of fluorescent materials.

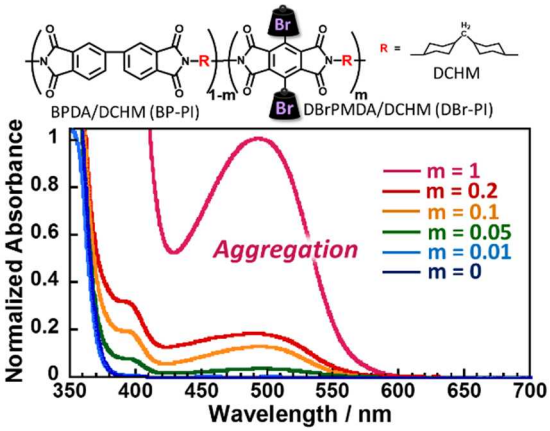

Fig.2. Chemical structure and absorption spectra of co-PIs.

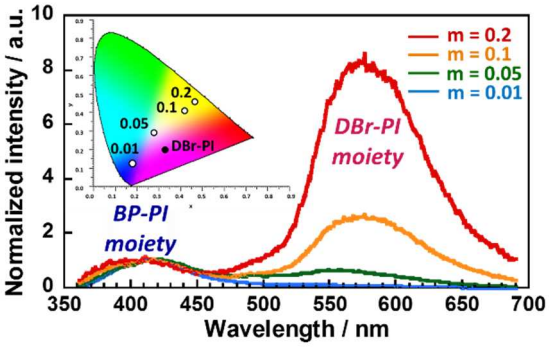

Fig.3. Luminescence spectra of co-PIs with different ratio.

References

[1] J. Wakita, H. Sekino, K. Sakai, Y. Urano, S. Ando, "Molecular Design, Synthesis, and Properties of Highly Fluorescent Polyimides", *J. Phys. Chem. B*, **113**, pp. 15212-15224, October 2009.

[2] Kenta Kanosue and Shinji Ando*, "Polyimides with Heavy Halogens Exhibiting Room-Temperature Phosphorescence with Very Large Stokes Shifts", *ACS. Macro. Lett*, **5**, pp. 1301-1305, November 2016.