

Room-temperature Phosphorescence Properties of End-capped Polyimide Including Heavy-atoms

Mayuko Nara¹, Ryoji Orita¹, Ryohei Ishige¹, Shinji Ando¹

¹Department of Chemical Science and Engineering, Tokyo Institute of Technology

Introduction

Polyimide (PI) has been attracting much interests owing to its potential applications as novel luminescent materials bearing high thermal and radiation stabilities. Previously, we have designed versatile highly fluorescent (FL) PIs [1] and room-temperature phosphorescent (RTP) PIs [2,3]. In particular, RTP PIs can be applied to solar spectrum convertor because they exhibit extremely large Stokes shifts. However, most of RTP films have absorption bands in the visible region, which originates from their aggregation and decreases the optical transparency [2]. In this study, we designed and synthesized a novel colorless and transparent RTP PI which has end groups containing bromine as heavy halogen. We successfully controlled the optical properties by the use of Förster resonance energy transfer (FRET).

Experiment

End-capped PI films (OD-4Br) were prepared by the conventional two-step procedure using ODPA as dianhydride, DCHM as diamine, and 4BrNA as end groups as seen in **Fig. 1** insets.

Results and Discussion

The absorption and emission spectra of OD-PI and OD-4Br are shown in **Fig. 1**. OD-4Br film was almost colorless despite a small absorption band at 420 nm. In the emission spectra, OD-PI exhibited blue fluorescence ($\lambda_{em}=405$ nm) by excitation at 340 nm. On the other hand, OD-4Br exhibited dual emission ($\lambda_{em}=401, 523$ nm) by exciting the main chain at 350 nm, which are assignable to fluorescence from the main chain and luminescence from the end groups, respectively. This clearly indicates that efficient FRET occurred from the main chain to the end groups. As shown in **Fig. 2**, a luminescence peaks at 560 and 600 nm were dramatically enhanced under vacuum conditions, which revealed the RTP property of the end groups. In summary, it was demonstrated that a fluorescent PI having end groups containing bromines exhibited high transparency and RTP properties via the efficient FRET process.

References

- 1) J. Wakita, H. Sekino, K. Sakai, Y. Urano, S. Ando, *J. Phys. Chem. B*, **19**, 15212-15224 (2009).
- 2) K. Kanosue, S. Ando, *ACS. Macro. Lett*, **5**, 1301-1305, (2016).
- 3) K. Kanosue, S. Hirata, M. Vacha, R. Augulis, V. Gulbinas, R. Ishige, S. Ando, *Mater. Chem. Front.*, DOI: 10.1039/C8QM00409A (2018).

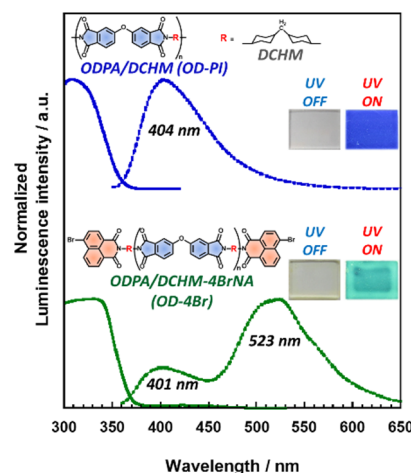


Fig. 1. Absorption / emission spectra of OD-PI and OD-4Br.

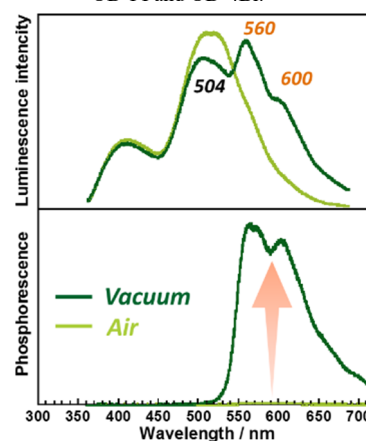


Fig. 2. Luminescence spectra of OD-4Br film under air or vacuum conditions ($\lambda_{exc}=350$ nm) in FL mode (upper) and phosphorescence mode (lower).