Detection of Local Relaxation Motion of Amorphous Polymers using Phosphorescence Properties of Imide Compounds

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Abstract: Organic photoluminescence (PL) materials have attracted huge attention because of their versatile chemical structures and environmental friendliness[1]. The PL properties of organic fluorophores can be altered by external stimuli: temperature, pressure, and characteristics of solution and polymer matrices. By utilizing these properties, it has been reported that the local relaxation (LR) motions of polymer matrices were estimated using the PL properties by dispersing the fluorophore in the polymer film as a probe[2]. However, since the LR motions of polymers at temperatures lower than T_g have rarely been investigated, it is expected to be clarified by a novel optical probe.

Recently, we have reported the effect of the LR motions of PMMA film at lower temperatures on the phosphorescence (PH) of imide compound containing biphenyl core (sBP-IC, Fig. 1)[3,4]. Fig. 2(a) shows the variable temperature PL spectra of sBP-IC under O_2 at 100–220 K, while Fig. 2(b) shows the temperature dependence of spectral areas of PH (A_{PH}). sBP-IC exhibited intense PH below 150 K even in the presence of O_2, suggesting that O_2 diffusion was inhibited below 150 K. This observation indicates a potential relationship between the PH property of sBP-IC and the LR motion of PMMA; the O_2 diffusion was facilitated above 150 K by the activated motions of side chains such as γ-relaxation in PMMA[5], resulting in the significant temperature dependence of PH.

The objective of this research is to detect the LR motions of amorphous polymer matrices at low temperatures, especially β- and γ-relaxations, using the PH behaviors of phosphors dispersed in the matrices. Thus, variable temperature PL measurements of sBP-IC dispersed in various polymer matrices (e.g., polystyrene, cycloolefin polymers) under O_2 will be performed and compared with those of PMMA. This new analytical method can be extended to investigate the relaxation behaviors of a broad range of amorphous polymers.

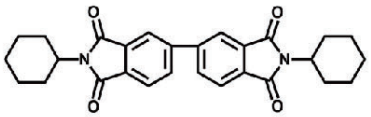
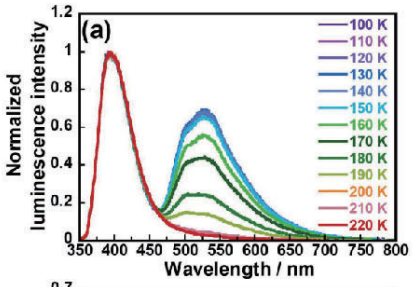
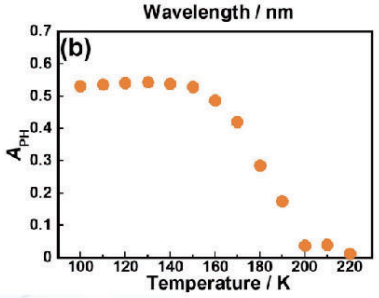


Fig.1 Chemical structure of *s*BP-IC





Keywords: Phosphorescence, Polymer dynamics, Low temperature, Oxygen quenching

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