Estimation of O_2 Mobility within Amorphous Polymer Films under Low Temperature via Phosphorescence of Imide Compound

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Photoluminescence (PL) of organic molecules can be classified into fluorescence (FL) and phosphorescence (PH). In general, PH is easily quenched by O_2 molecules, known as O_2 quenching. In this study, we investigated variable-temperature O_2 permeability via PH intensity of an imide compound to investigate the O_2 mobility under low temperatures.

The PL spectra of SD/PS under O_2 atmosphere were measured from 300 K to 100 K (**Fig. 1**). The PH intensity increased with decreasing temperature, which is attributable to the suppression of O_2 quenching.[1] The activation energy (E_a) of O_2 quenching was calculated as 27.8 kJ/mol for PSF, and 20.8 kJ/mol (300-200 K) and 11.5 kJ/mol (200-100 K) for PS. It has been proposed that the motion of O_2 molecules within polymer films can be classified into two modes: jumping mode, which requires local polymer-chain motion, and diffusive mode, which does not.[2] Consequently, the motion in the high-temperature region for both PSF and PS was attributed to the jumping mode, while the motion in the low-temperature region, only observed in PS, was inferred as the diffusive mode. Additionally, the O_2 permeability of PS and PSF was measured by constant-volume/variable-pressure method from 200 K to 360 K. PSF exhibited an exponential change in the range of 240 K to 360 K, with E_a of 25.0 kJ/mol; besides PS displayed a deviation from the exponential curve below 300 K, resulting in two distinct E_a values of 22.9 and 6.31 kJ/mol. Therefore, the two different O_2 diffusion modes, jumping and diffusive, were experimentally observed both from the *in-situ* PL measurement and *ex-situ* O_2 permeability measurement.

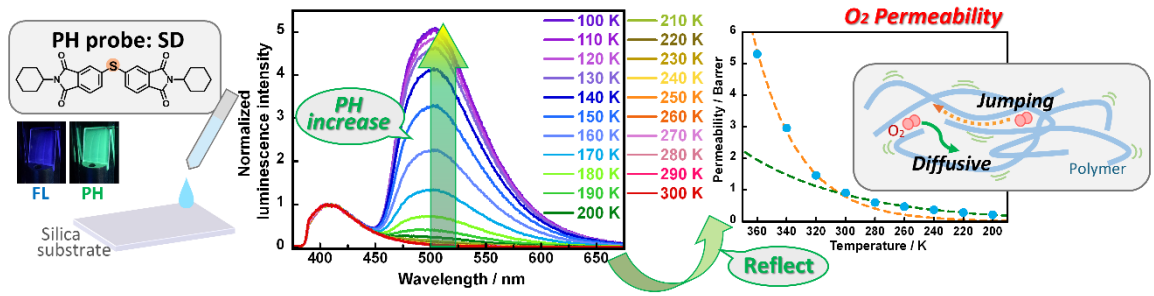

Fig. 1 The chemical structure of SD with its photographs (FL and PH) under UV light. Variable-temperature PL and O_2 permeability measurement of SD-dispersed PS film with the schematic image of jumping and diffusive modes.

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(2) K. L. Tung and K. T. Lu, *J. Memb. Sci*., 272, 37 (2006).

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