Photoluminescence characterization of phosphor contained silica gel for a sensor application

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Sensor materials for detecting the volatile organic carbons (VOC), such as formaldehyde (HCHO), toluene ($C_6H_5CH_3$), xylene ($C_6H_4(CH_3)_2$) and benzene (C_6H_6) are strongly required because these vaporized organic compounds result in the sick building syndrome. Fiber-optic fluorescence sensors using luminous organic pigments are expected to be a potentially useful technique for these applications. In this paper, variations in the photoluminescence (PL) spectra from porous silica gel containing the rhodamine and/or the fluorescein were evaluated before and after the exposure in the vapors of formaldehyde (HCHO), toluene ($C_6H_5CH_3$) and acetic acid (CH_3COOH).

Porous silica (silica gel) was dipped into the methanol solutions of fluorescein ($C_{20}H_{12}O_5$) and rhodamine ($C_{28}H_{31}ClN_2O_3$). These were then dried at 374 K for 1 hr. Dried specimens with organic luminous pigments were exposed in the vapors of HCHO, $C_6H_5CH_3$ and CH_3COOH. PL spectra were measured before and after the exposure using ultra violet excitation with xenon lamp and/or UV light emitted diode (LED) with the wavelength at λ=365 nm. Temperature dependence of PL lifetime of luminous pigments was also measured using UV LED (λ=365 nm) as an exciting light. PL decay was also evaluated using pulse YAG laser as an exciting source.

Strong PL was observed from both rhodamine and fluorescein contained specimens with the excitation at λ=365 nm. PL lifetime is in ns both for rhodamine and fluorescein specimens. PL peaking at the wavelength, λ=560 nm, is seen in the rhodamine contained specimens as shown in Fig. 1. PL spectra from the specimens exposed in the vapors of formaldehyde (HCHO), toluene ($C_6H_5CH_3$) and acetic acid (CH_3COOH) are shown in Fig. 1 as compared with that of the specimen before the exposure. Peak wavelength of PL (λ=560 nm) does not change after the exposure. Peak intensity of the PL from the specimens vary after the exposure. PL intensity increases in HCHO. While it decreases in $C_6H_5CH_3$ and CH_3COOH.

In the fluorescein contained specimens, relative intensity ratio of the PL peaks (λ=460, 510 and 540 nm) from the specimens varies after the exposure (Fig. 2). PL intensity at λ=460 nm increases and that at λ=540 nm decreases in CH_3COOH. PL intensity both at λ=510 nm and λ=540 nm increases in HCHO and $C_6H_5CH_3$.

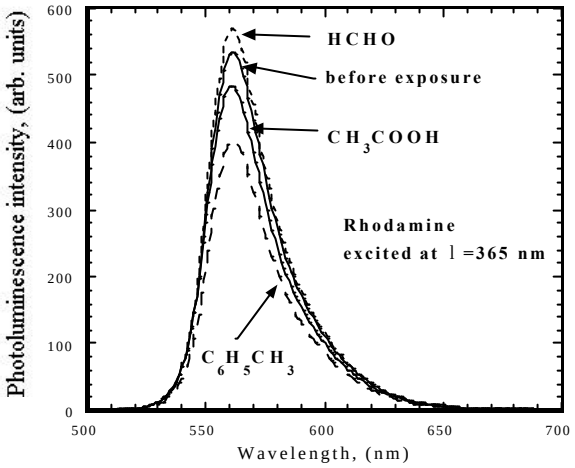

Fig. 1. PL spectra from the specimens before and after exposed in the vapors of HCHO, $C_6H_5CH_3$ and CH_3COOH.

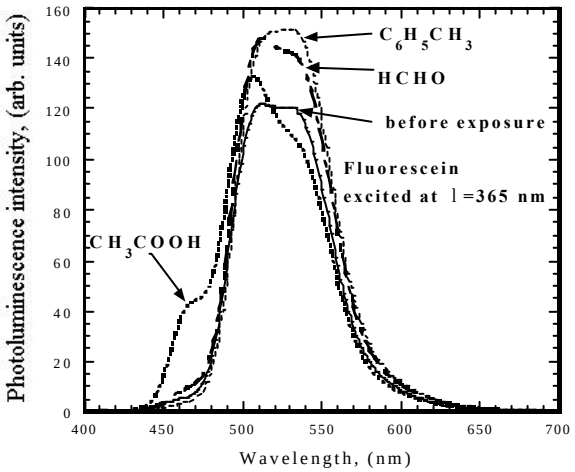

Fig. 2. PL spectra from the specimens before and after exposed in the vapors of HCHO, $C_6H_5CH_3$ and CH_3COOH.