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Photoluminescence of Liquid Crystal with Organic Thin Film of (2-(Naphtha[3,4]imidazol-2-yl) Quinoline)

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A complex sample structure including nematic liquid crystals (NLC) with organic thin film (2-(naphtha[3,4]imidazol-2-yl) quinoline) (NIQ) is applicative to the photoluminescence (PL) study in this report. The pumping beams of 325 nm and 390 nm are used to excite the complex sample structure and the NIQ thin film. The excitation polarization about directorial orientation can cause the changing of absorption intensities in PL spectrum. Peak intensities can thus be modulated when the polarization of pumping beam adjusted. Consequently, the peak shifting in the PL spectrum of complex sample structure is revealed the energy transformation between NLC and NIQ.

Keywords Luminescence; nematic liquid crystals; polarization

1. Introduction

In the last few years, there has been much attention in the field of the study of photoluminescence (PL) for liquid crystals [1–9]. Normally, NLC doped with chromophores [4–6] or solid thin films of nematics connecting conductive substrates can influence the polarization of the emitted light from the source [10–14]. NLC can be excited by linearly polarized laser beam to have specific PL spectrum to improve the brightness that the liquid crystal displays (LCD) being limited [10,11]. But few reports of the PL of the NLC with organic thin film have been discussed. Accordingly, in this study, we have investigated the PL of complex sample structure of NLC with an organic thin film, 2-(naphtha[3,4]imidazol-2-yl) quinoline (NIQ). In our experimental design, we observed the absorption intensity peak at both 390 nm and 362 nm being stimulated at 325 nm by pumping laser beam for NLC. However, an absorption peak was observed at 460 nm by pumping beam excited at 390 nm for complex sample structure in the PL spectrum. Moreover, the peaks intensities gradually decreased when the polarization of pumping beam rotated from Z-axis to X-axis that was caused by the director of NLC. Meanwhile, the peak

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shifting was observed in PL spectrum, which may involve the energy transformation between the NLC and NIQ.

2. Experimental Methods

The combined sample structure and experimental setup is schematically shown in Figure 1. The NLC adapted herein is E7 ($n_o = 1.5216$, $n_e = 1.7462$ at 25°C from Merck). The NIQ thin film was prepared by spin coating method and cast onto a glass substrate with the thickness of 3 μm. The thin layer of polyimide was spin coated onto another glass substrate and rubbed with a velvet cloth unidirectionally (parallel to z-axis initially) as a fixture for E7. The sample cell was assembled from a pair of glass substrates coated with NIQ and PI films, respectively, and spaced by a pair of 15-μm-thick Teflon sheets. The details of experimental setup of deposition thin film of NIQ have been described in reference [14]. Briefly, the excitation beams were employed both at 325 nm and 390 nm. The half-wave plate and polarizer were used for controlling the intensity and the polarization of the excitation beam. The excitation beam should be in incident at the angle of 45° respect to the normal surface of the sample. The PL signals from the samples were detected using a monochromator.

3. Results and Discussion

In Figure 2, it presents the PL of the NLC sample. The peaks were located at 362 and 390 nm being excited by laser beam at 325 nm. The intensities of the peak in the spectrum with various orientations of the director of the NLC about the polarization of the excitation beam was also depicted in Figure 2. When the orientation angle between the director and polarization of the excitation laser beam was adjusted from 0° to 90° (z-axis to x-axis), the intensity of luminescence gradually decreased with increasing the angle. The peak intensity at 390 nm was plotted and depicted in Figure 3. When the director is located at 0°, the absorption of NLC was observed the strongest. This accounts for the characteristic of energy absorption of NLC at orientation angle of 0°, the strongest absorption results in the maximum peak

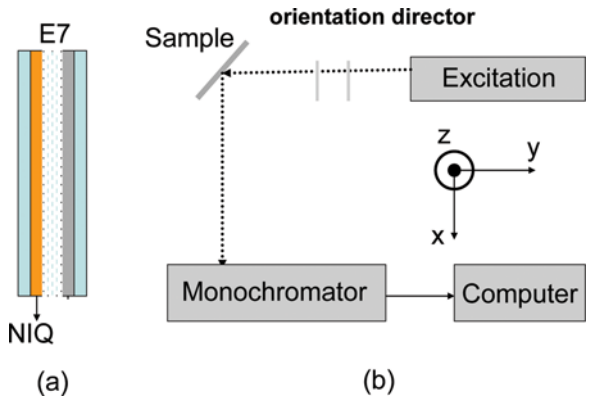

Figure 1. (a) Complex sample structure (b) Experimental setup. (Figure appears in color online.)

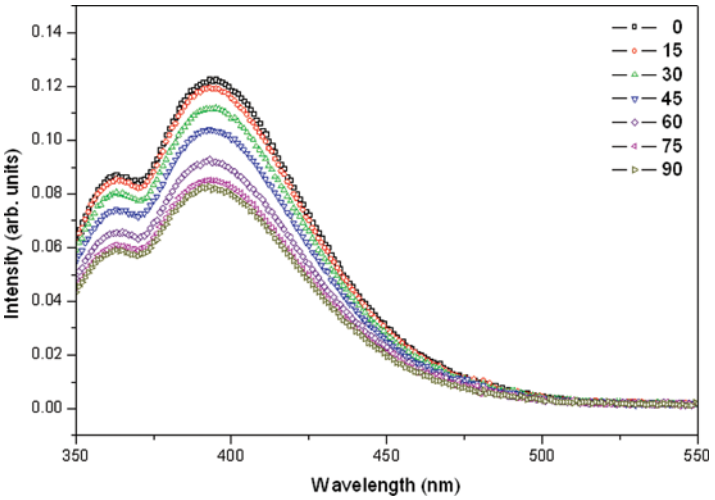

Figure 2. The PL spectrum was depicted two peaks at 362 nm and 390 nm where the orientation angle dependence about the polarization of excitation laser beam was excited at 325 nm for NLC sample.

intensity in PL spectrum. Thus, the modulation of the absorption in PL can be obtained by rotating the director for NLC. At orientation angle of 90°, the weakest absorption can result in the minimum peak in PL spectrum.

In Figure 4, it shows the PL of NLC with NIQ thin film under laser beam excitation at 390 nm. The absorption peaks were located at 460 and 490 nm.

In Figure 5, it shows the PL of complex sample structure under excitation at 325 nm. A absorption peak was located at 460 nm. The intensity of PL gradually decreased with increasing the orientation angle. Experimental evidence revealed that the PL spectrum of complex sample structure (NLC with NIQ thin film) can be

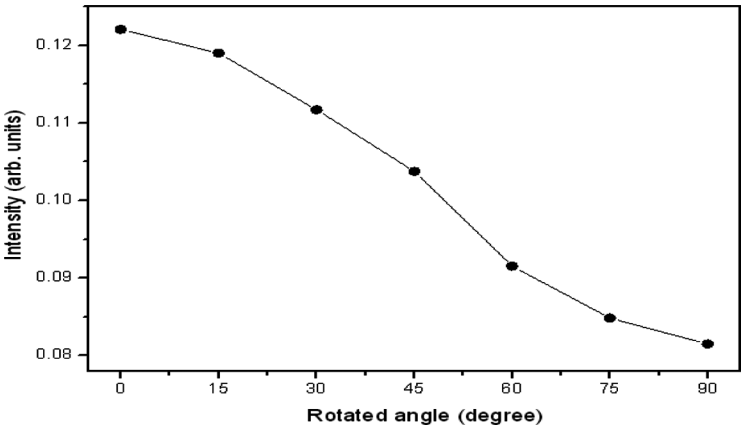

Figure 3. The peak intensity of PL spectrum with various orientations of the director for NLC.

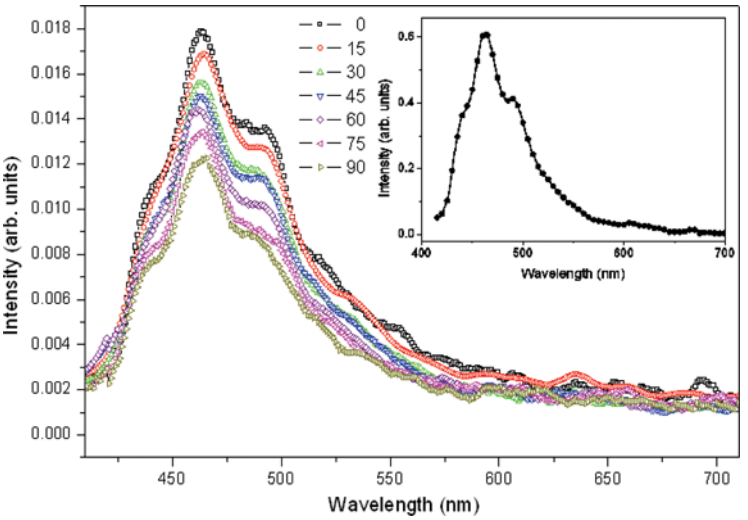

Figure 4. The PL spectrum of the complex sample structure under laser beam excitation at 390 nm is depicted the absorption peaks both at 460 nm and 490 nm, the PL spectrum of NIQ thin film stimulated by laser beam excitation at 390 nm was shown the same peaks at 390 nm and 460 nm in the inset. However, the peaks intensities of the NIQ thin film PL spectrum are about 28 times higher than the complex sample structure.

accounted for the contribution from NIQ being stimulated at 390 nm, which was excited by laser beam at 325 nm. The peak intensity of 390 nm was suppressed because of the energy transformation to excite the peak at 460 nm in PL spectrum. The PL of complex sample structure initially occurred at 390 nm under excitation at 325 nm and then excited the sample again causing another peak at 460 nm.

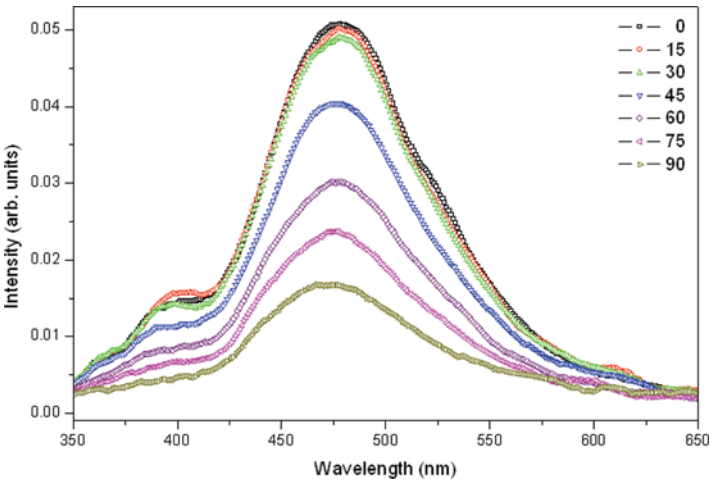

Figure 5. The PL spectrum with low intensity peak at 390 nm and high intensity peak at 490 nm of complex sample was depicted under laser excitation at 325 nm.

4. Conclusions

We have demonstrated the orientation angle dependence of PL signal of complex sample structure of NLC with organic NIQ thin film. The strongest absorption resulted PL when the polarization of excitation is parallel to the director of NLC. The modulation of the absorption of complex sample is revealed in spectrum and depicted in Figure 5. The possible mechanism is the peak energy transfer occurred in PL under laser excitation at 325 nm. The peaks in PL spectrum of complex sample initially occurres at 390 nm, then the energy at 390 nm stimulates the complex sample again to result the peak at 460 nm in PL spectrum.

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