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Control of Reversible Phase Transition between Blue Phase and Cholesteric Phase using Photothermal-responsive Chiral Dopants with Anthracene Parts

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Abstract

We synthesized two new chiral dopants consisting of a binaphthyl skeleton as an optically active unit and two anthracene parts as a photothermal-responsive unit. In the presence of these chiral dopants in a liquid crystal mixture, we observed reversible photo-thermal structural change of the anthracene motility and photo-thermal-induced phase transition between blue phase and cholesteric phase.

1. Introduction

Blue phases (BPs) that appear in a very narrow temperature range between a cholesteric (N^*) and an isotropic liquid phase have three-dimensional periodic structures with the same lattice size as a visible light wavelength. Thus, BP liquid crystals (LCs) have attracted much attention in the field of photonics devices. In this study, we present new chiral dopants with a binaphthyl skeleton as an optically active unit and two anthracene parts as a photothermal-responsive unit. When the chiral dopants are added to a host LC, it is expected to show reversible phase transition behavior of the LC by the structural change of the chiral dopants using a combination of light and thermal stimuli.

The compounds **1a** and **1b** were synthesized by the condensation reaction of (*S*)-binaphthol and the corresponding anthroic acid.

2. Experiments

We measured the helical twisting power (HTP) of 10 wt% **1a** or **1b** in the nematic LC mixture (JC-1041XX, JNC Co. Ltd.). The HTP of **1a** and **1b** were 48.8 and 30.0 μm^{-1} at 50 °C, respectively.

3. Results and Discussion

As shown in Fig. 1a and 1d, 10 wt% **1a** or **1b**/host LC exhibited BP I by polarizing optical microscope observation. In the case of both samples, a phase transition from BP I to N^* phase was observed on UV exposure at 365 nm, finally, a heterogeneous N^* phase appeared (Fig. 1b and 1e). It is suggested that the chiral dopants became insoluble in the host LC by photodimerization of anthracene partes. Besides, by heating LC mixture at 160 °C, BP I appeared again (Fig. 1c and 1f). Hence, in the process of UV exposeure, the structral changes of the chiral dopants by the dimerization of anthracene units brought a remarkable decrease of solubility in the host LC, thereby the induced chirality of the host LC reduced. By contrast, the initial state was almost restored by thermal dissociation of the anthracene moieties.

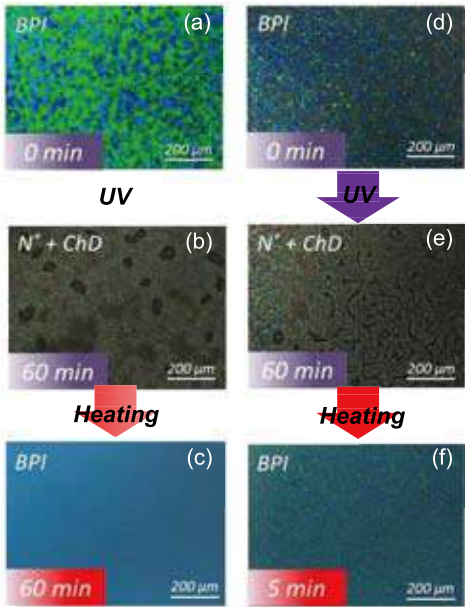

Fig 1. Changes of polarizing optical microscope images of 10 wt% **1a**/JC-1041XX (a-c) and 10 wt% **1b**/JC-1041XX (d-f); (a, d) before UV light irradiation, (b, e) after UV light irradiation at 365 nm (60 min), (c, f) followed by heating at 160 °C.

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