Electro-optical behavior of polymer dispersed blue phase liquid crystals

Emine Kemiklioglu and Liang-Chy Chien*

Liquid Crystal Institute and Chemical Physics Interdisciplinary Program, Kent State University, Kent, Ohio 44242, USA

Blue phase liquid crystals (BPLCs) have attracted enormous fundamental and applied research interests because of its ubiquitous nature of optically isotropic and self-assembled 3D structures. We introduce a new class of electro-optical materials; polymer dispersed blue phase (PDBP) liquid crystals, combining BPLC droplets dispersed in a polymer matrix. The PDBP films are prepared via solvent evaporation-induced phase separation of a mixture of a BPLC and polymer binder. Images of blue phase texture were recorded with a polarizing optical microscope as shown in Fig. 1. The observed textures of PDBP samples show bluish-green color droplets of the BPI dispersed in polymer matrix at room temperature. Our studies reveal that by optimizing the composition and phase separation, non-uniform size of droplets (Fig. 1a, b) can be tuned to become more uniform droplets (Fig. 1c).

Figure 1: Photomicrographs of PEBP films at 27°C with (1) 32% BP (2) 50% BP, and (3) 68% BP prepared from a mixture of polymer/BPLC. The white-colored scalar bar represents a length of 40 µm.

Electro-optical behavior of the PDBP films at different concentration was investigated for field-induced birefringence with cells used for in-plane-switching mode of operation. Figure 2 shows the voltage-transmittance curves of three PDBP samples. The BPLC samples with concentration of 32% and 50% behave a reverse-mode of operation, that is, transparent at zero voltage and opaque or light scattering in response to an applied voltage (~60V, insert). The two-stage switching behavior is caused by non-uniformity of droplets. By contrast, the PDBP sample with a high BPLC concentration behaves a normal mode of operation which is switched from opaque to light transmittance at a lower applied voltage of 40V. Our work suggests a method to control and manipulate the electro-optical behavior of encapsulated blue phase materials and open the avenue for potential applications for active optical elements and displays.

Figure 2: The plots of normalized transmittance versus applied voltage of PEBP films of (a) 32% BP (b) 50% BP, and (c) 68% BP in an IPS cell with 15-µm cell gap at 27°C.

* presenting author; E-mail: ekemikli@kent.edu