Effect of the Chiral Dopant with High Helical Twisting Power in Blue Phase Liquid Crystals

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Blue phase liquid crystals are highly chiral materials that self-organize into an arrangement characterized by strong helical twisting along any radial direction around a central director that is perpendicular to all twist axes, which are the so-called double twisted cylinders [1]. Blue phases exist within a very narrow temperature range between the isotropic and cholesteric phases. A total of three types of blue phases, Blue phase (BP) I, BP II, and BP III, were discovered. Two (BP I and BP II) of the three types of blue phases pack into a cubic lattice on a scale ranging from one to two hundreds of nanometers, while the third type (BP III) is amorphous. The field-induced birefringence, the so-called Kerr effect, in a BPLC has been reported without the alignment layers. Recently, the polymerization of a small amount of reactive monomer in a BPLC has been another breakthrough. The phase-separated polymer tends to nucleate at the defect regions and is capable of stabilizing the cubic lattice against the temperature variation [2]. With the discovery of new blue phase liquid crystal mixtures and polymer composites, fast switching displays have been explored; however, the issues of high switching voltage, hysteresis, light scattering and long-term stability are still challenges for practical applications.

One of important is to study about the relationship between the electrooptic response properties and the chiral pitch of a blue phase [3]. The variation of BP temperature range according to the concentration of chiral dopant was approximately small. The effect of the chiral pitch on the response time was dependent on type of electric field-induced birefringence of the BP, while the effect of the chiral pitch on the response was insignificant due to few millisecond response times. Recently, the temperature range of BP I in a sample mixture of bent-core molecules having a nematic (N) phase and some percentage of a chiral additive with high helical twisting power (HTP) was reported [4]. They experimentally confirmed the existence of BP over a wide temperature range (~15 °C) in a bent-core molecular system, which was already predicted by theoretical studies.

Here, we report a study of the effect of the chiral dopant with high HTP on blue phase liquid crystal medium. The BP temperature range decrease with increasing the concentration of chiral dopant with high HTP to keep approximately same chiral pitch, while the isotropic temperature of the BP mixture was increased. We also report the relationship between the electrooptic response properties and the chiral dopant with high HTP.

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