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Study of Phase Transition of Mixture of Ferroelectric Chiralsmectic Liquid Crystal and Liquid Crystal Polymer with Concentration

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Abstract *- The present investigation is to study the texture analysis of mixture of liquid crystalline samples as a function of temperature and the study also covered the possibility of enlarging Blue Phase temperature range of liquid crystal compound 4-(2-methylbytyl) phenyl 4-(4-octylphenyl) benzoate(CE8) by doping with liquid crystal polymer. The compound CE8 is a ferroelectric liquid crystal composed of rod-like molecules shows a chiral smectic phase with stable Blue phase range, only for temperature of 1.9^0C. It is attempted to widen this temperature range. The liquid crystal polymer(LCP) used in the present study is poly [6-[4-(4-Cyanophenyl)phenoxy]hexyl methacrylate],which is a side chain liquid crystal polymer having molecular formula $C_{23}H_{25}NO_3$with melting point in the range of $102^0C – 107^0C$. Mixture of with 97% CE8 and 3% of LCP exhibits stabilised Blue phase up to 5^0C. Mixture of these molecules exhibits Blue phase, cholesteric, SmA and SmC sequentially when specimen is cooled from its isotropic phase. These phases have been characterised by using microscopic technique. The phase diagram of CE8 and LCP mixture is drawn for different concentration temperature with different weight percentage.*

Key words – *Optical texture, Blue phase, Doping, Phase transition*

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I. Introduction

Many of materials showing liquid crystalline behaviour belong to two general classes: Thermotrophics and Lyotropics. Transition into mesophases obtained by purely thermal process is called “Thermotrophics” where as in which mesophases are obtained by the influence of a solvent on solid is called “Lyotropics”. Thermotropic liquid crystals generally exhibits three types of Phases, namely, Nematic, Cholesteric and Smectic phase. Blue phases are liquid crystalline phase that appear in a narrow temperature between isotropic and cholesteric phases. In cholesteric liquid crystals with high twist, three district Blue phases can appear BP I, BP II and BP III with increasing temperature. Three Blue phases differs in Quantum of order and structures in chiral molecules form. However, Blue phase can exist only in a small temperature range of 0.5^0C to 2^0C between isotropic and Chiral nematic phases. The compound CE8 is a ferroelectric and thermotropic liquid crystal exhibits Blue phase temperature range of 1.9^0C. Liquid Crystalline polymers (LCP) are those, shows liquid crystalline phases. They can be either rod-like or disc-like and rod and disc like together in One. With rod shaped repeating units, mesophases similar to nematic, cholesteric and Smectic are observed. In the present investigationtextural changes of mixture of CE8 and LCP as function of temperature is observed and recorded. Also the study aims at the possibility of enlarging the temperature range of Blue phase of liquid crystal compound CE8 by doping it with LCP.

II. Material And Methods

In the present investigation, the mixtures of different concentrations of liquid crystal compound 4-(2-methylbytyl)phenyl 4-(4-octylphenyl)benzoate i.e., CE8 and Poly[6-[4-(4-Cyanophenyl)phenoxy]hexyl methacrylate] i.e., LCP were prepared. The mixtures of different concentrations of samples were kept in desiccators for a long time. The samples were subjected to several cycles of heating, stirring and centrifuging to ensure homogeneity. The optical textures of these mixtures at different temperature are observed and recorded with the help of a Gippon-polarising microscope in conjunction with a hot stage. The samples are sandwitchedbetween the slide and coverslip, then sealed well for microscopic observations. The temperature-concentration phase diagram for mixture of CE8 and LCP with different weight percentage is drawn to observe possibility of widening of temperature range of Blue phase of CE8.

III. Optical Texture Studies

Molecular Orientations of Optical textures shown by the sample were observed and recorded using Gippon polarising microscope in conjunction with hot stage. The specimen, in each case, is taken in the form of thin film and sand witched between the slide and covering slip. The concentrations of 1% to 10% of LCP in CE8 have been taken for experimental study. When the specimen of 97% of CE8 and 3% of LCP is cooled from isotropic phase, specimen passes through Blue phase, Cholesteric, Sm A and Sm C sequentially. This has been recorded. However, the similar sequential phase changes have been noted for all concentrations of 1% to 10% of LCP in CE8. while sample is cooled from its isotropic phase, the genesis of nucleation starts in the form of small bubbles growing radially, which are identified as spherulitic textures of cholesteric phase. Shown in fig(a). On further cooling the specimen, the texture slowly transform to Sm A phase in which molecule are arranged in layers and the texture is shown in fig(b). On further cooling the specimen, the unstable Sm A phase changes to Sm C phase as shown in fig1(C). The specimen enters to the crystalline phase on further cooling.

Fig-1(a)

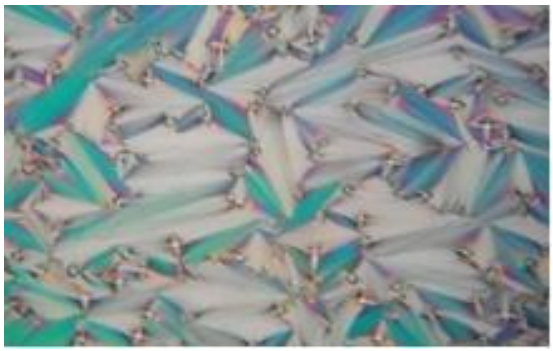


Fig-1(b)

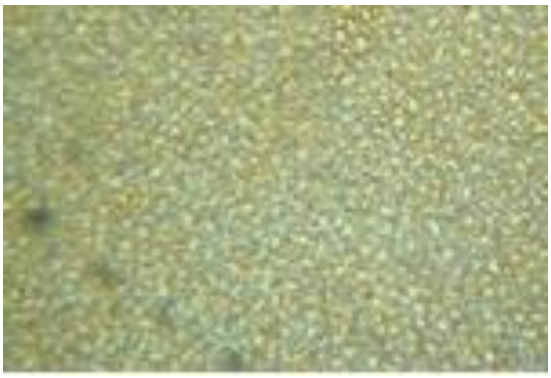
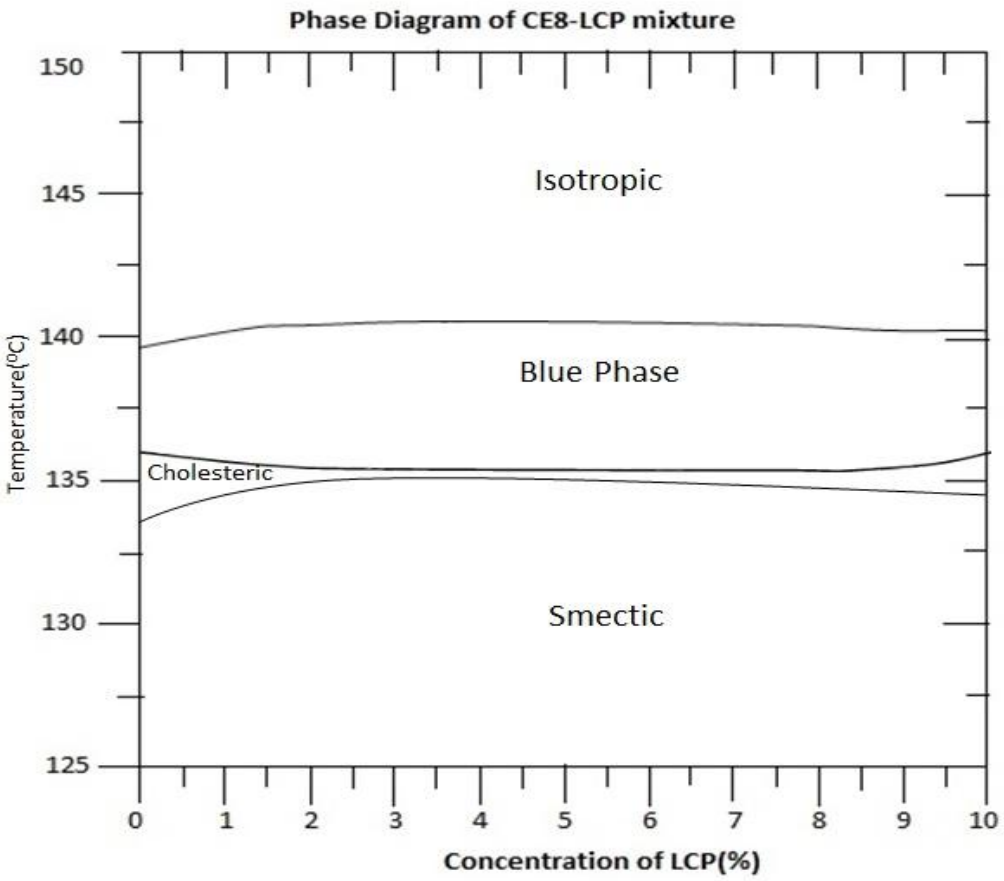


Fig-1(c)

Figure1.Microphotographs obtained in between the crossed polar
1(a)Spherulitic texture of cholesteric phase , 1(b)Texture of Sm A phase(250 X), 1(c)Texture of Sm C phase(250 X)

IV. Phase Diagram



The temperature concentration phase diagram of homogeneous mixture of CE8 and LCP with different weight percentage is shown in fig(2). The phase diagram indicates, Blue phase appears to be stable for considerable range of temperature up to 5^0C with concentration of 97% of CE8 and 3% of LCP. Also, the Blue phase appears to be stable over an increased concentration of up to 10% addition of polymer liquid crystal to CE8. The enlarging of temperature range of Blue phase may be due to localisation of polymer networks in declination centres and hence rapid decrease in the ordered structure in liquid crystal phase.

V. Conclusion

Microscopic investigation of mixture of liquid crystal compound CE8 and Liquid crystal polymer(LCP) for concentrations of 1% to 10% of LCP in CE8 indicated the existence of Blue phase, cholesteric, SmA and SmC phases sequentially when the mixture is cooled from isotropic phase. The enlargement of temperature range of Blue phase starts with doping of LCP to CE8 from 1% of LCP and 99% of CE8. A mixture with 97% of CE8 and 2% of LCP, there is stabilisation of Blue phase up to 5^0C. The Blue phase is stable over a concentration of upto 10% addition of LCP.

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