

ABSTRACT

The Effect of Electric Fields on The Optical Activity of Chiral Nematic Liquid Crystals

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According to the Landau-de Gennes theory, orientational order in chiral systems can be represented by a linear combination of five structural modes as opposed to one in nematics. Fluctuations of these five modes, labelled $m = \pm 2, \pm 1, 0$, follow different temperature dependencies. The $m = \pm 2$ modes are planar spirals, the $m = \pm 1$ are conical spirals and the $m = 0$ mode represents a non chiral nematic structure. The Landau-de Gennes free energy functional for each of these modes vanishes at a characteristic temperature T_m^* .

Optical activity is a sensitive probe for studying fluctuations in chiral systems. This study is an investigation of the effect of high electric fields on the pretransitional optical activity of the chiral nematic system CB15:E9 mixtures. CB15 represents 4-cyano-4'-(2''-methyl butyl)-biphenyl and E9 represents a BDH eutectic mixture of 4-cyano-4'-(n-alkyloxy) biphenyl and 4-cyano-4'-(n-pentyl) triphenyl ($n = 3, 5, 7$).

A rotating analyzer system was used to measure the optical activity of the mixtures. This method is very sensitive and accurate in measuring optical activity and from these measurements, the second order transition mode temperatures, T_1^* and T_2^* can be determined.

To investigate the effect of chirality on the optical activity fluctuations, the experiments were performed with various concentrations of CB15 and E9. The value

$T_c - T_2^*$ grows further apart as the chirality is increased as predicted by theory. Furthermore, the transition becomes more continuous with increasing chirality. The zero field optical activity results obtained compared favourably with predictions of the existing theory of pretransitional optical rotation.

The results reveal that the pretransitional optical activity and the maximum optical activity both decrease with increasing field. For some mixtures, the optical rotation changed sign on the application of a strong electric field and furthermore the discontinuity became more pronounced as the fields increased. On application of the field, small shifts in transition temperature away from T_c in both directions were observed in all samples studied. It was also observed that large electric fields destroyed the contributions from the planar spiral ($m = 2$) mode.