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Investigation of the phases and the nature of the corresponding phase transition of a chiral ferroelectric liquid crystalline compound

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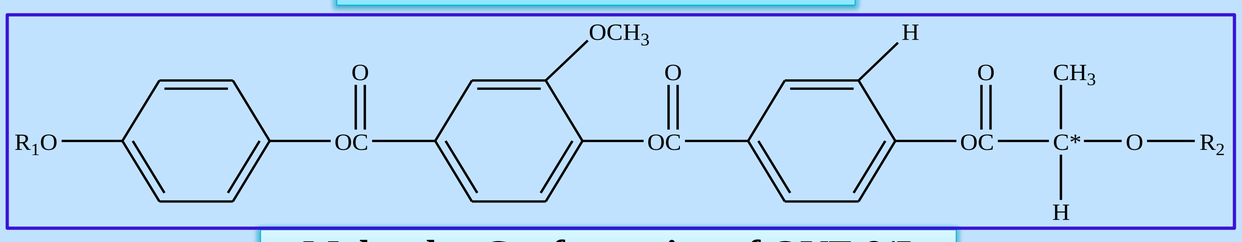
Introduction and Objective

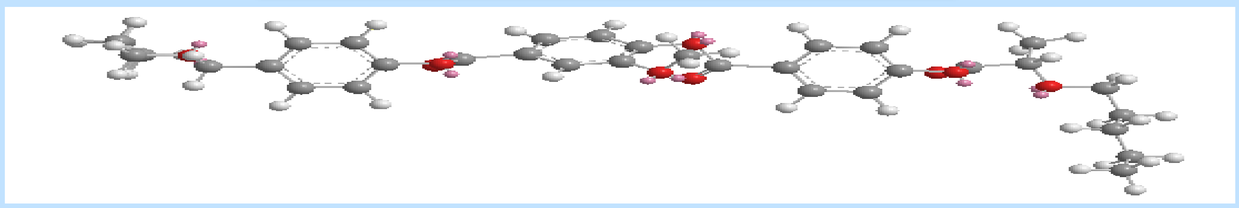
- ***Investigation of Ferroelectric Liquid Crystalline Compounds (FLCs) Composed of Chiral molecules becomes a subject of significant interest both in Theoretical as well as Practical points of view [1].***
- ***The rich variety of structures exhibited by the Chiral Ferroelectric Liquid Crystalline materials has initiated the development of new theoretical approach for the description of phase transitions of the mesophases associated with Chiral FLCs. This work mainly focusses on the characteristics of the N* to SmC* phase transition of a pure Chiral Ferroelectric Liquid Crystalline (FLC) compound namely QVE 8/5 [2].***

Materials under investigation

Structure of QVE n/m Series



Molecular Conformation of QVE 8/5



Cr 318 K SmC 346.7 K N* 363.8 K Iso*

Experimental Methods

TEXTURE STUDY

The phase transition temperatures and sequence of mesophases were determined using a polarizing optical microscope (BANBROS) equipped with INSTEC HCS302 hot stage which was controlled by INSTEC mK 1000 thermo system with an accuracy of ± 0.1 °C. The heating rate was 1°C min^{-1} and the cooling rate was 0.5°C min^{-1}. The phase transition temperatures were taken during cooling cycle [3].

OPTICAL TRANSMISSION METHOD

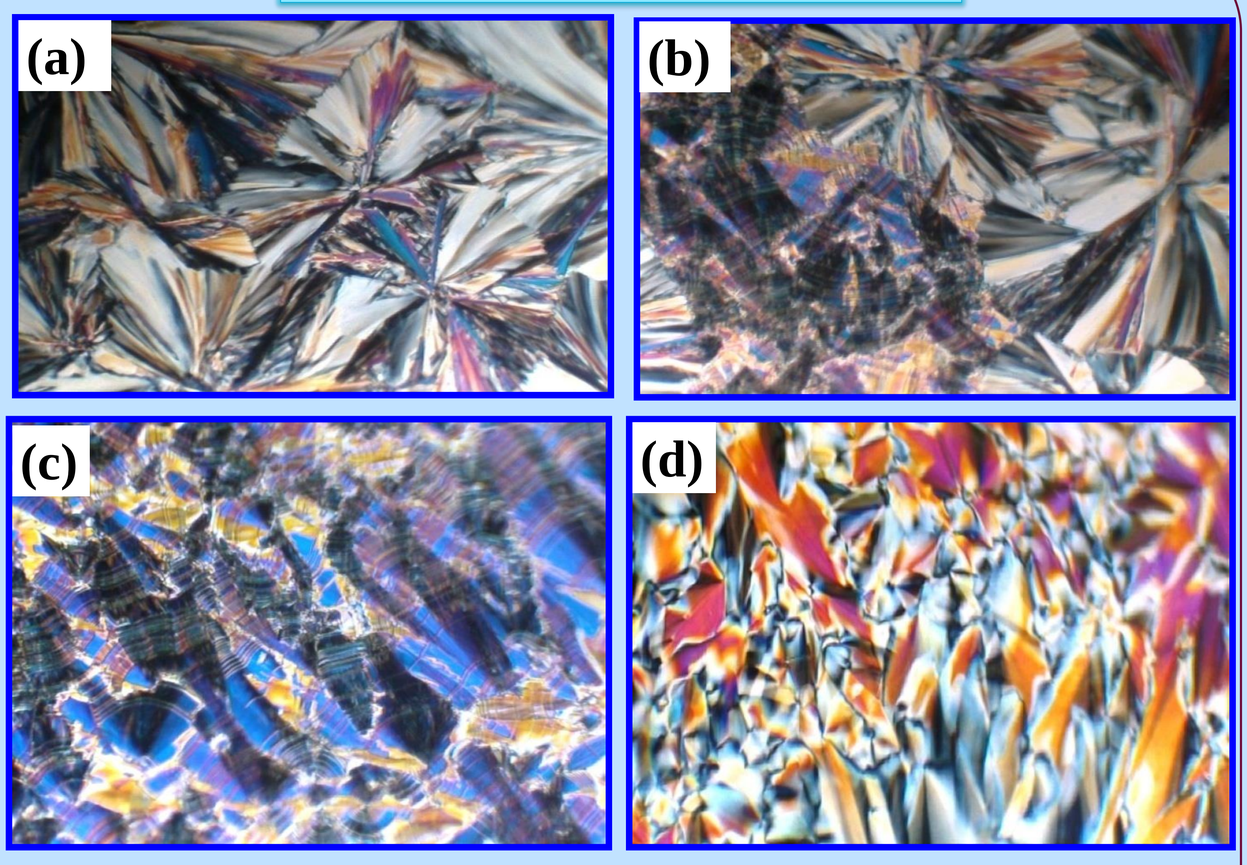
$$Q(T) = -[\Delta n(T) - \Delta n(T_C)]/[T - T_C]$$

$$Q(T) = \frac{A^{\pm}}{\alpha'}|t|^{-\alpha'}\left(1 + D^{\pm}|t|^{\Delta}\right) + E(T - T_C) + B$$

This is the renormalization-group expression, where $t = (T\text{-}T_C)/T_C$ is the reduced temperature and the superscripts ± denote those above and below T_C, where T_C represents the phase transition temperature , $A^{\pm}$ represents the critical amplitudes , α' is the critical exponent similar to the specific heat critical exponent α , $D^{\pm}$ are the co-efficients of the first order corrections-to-scaling terms. The term $E(T\text{-}T_C)$ corresponds to a temperature dependent part of the regular background while B is a constant giving the combined critical and regular backgrounds [3].

Results and Discussions

Textures of the mesophases of QVE 8/5



Textures for the compound QVE8/5 corresponds to (a) Crystal (b) changing from crystal to SmC phase (c) SmC* Phase (d) N* Phase.*

Optical Birefringence of QVE 8/5

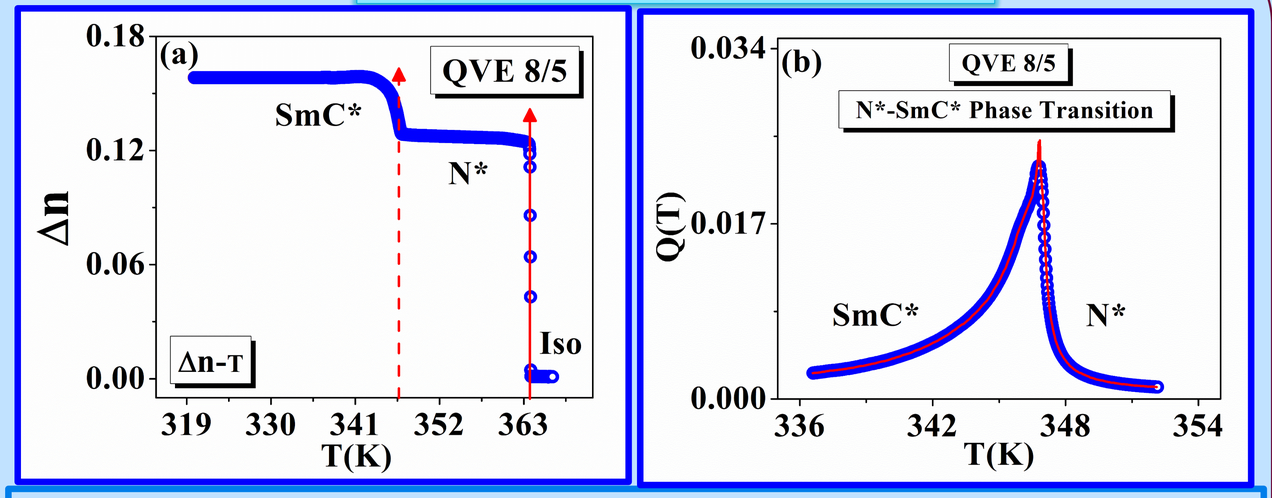


Figure-(a) depicts the temperature dependence of optical birefringence data for the investigated compound QVE8/5. Figure-(b) shows the plot of Q (T) versus T for the N to SmC* phase transition of QVE8/5. The red solid lines in Figure-(b) indicate fit to renormalization-group expression. The experimental data provides very well defined Δn curves in the near vicinity of the transition temperatures. It has been found that the quantity –d(Δn)/dT is related to specific heat capacity anomaly [3] and utilized to investigate the critical fluctuation associated with the investigated phase transition.*

CONCLUSIONS

The data have been analyzed in detail with the renormalization-group expression with correction-to-scaling terms. For the investigated compound QVE 8/5, the evaluated critical exponent (α') value comes out to be 0.040±0.015. The values of the ratio of the co-efficients A-/A+ and D-/D+ are found to be 0.979±0.020 and 1.010±0.010 respectively which agrees well with those obtained from the theoretical prediction of 2nd order phase transition of the LC phases.

Acknowledgement

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References

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[3] B. Barman, S.K. Sarkar, M. K. Das; Phase Transit., 91, 58 (2018).