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Simultaneous Observations of Textural Characterisation and Birefringence in Liquid Crystals

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The authors made an attempt to combine the characterization and one of the physical property measurements simultaneously to avoid this environment change while the measurements are made. Here, the authors presents the details of the setup fabricated indigenously to observe the textures (microscopy) and the measure of birefringence simultaneously in liquid crystals. The advantages of such an experimental setup are, a physical property can be measured (birefringence) along with the characterization of the sample, thereby reducing time spent for individual measurements, identical environment can be created for the sample for both the measurements and the manifestation of different liquid crystalline phases as well as the birefringence change at the phase interface can be visually observed which paves the way for finding out the fluctuation dominated non-linear regions (FDNLR) on both sides of the inter face.

Keywords: birefringence; FDNLR; identical environment; simultaneous observation

I. INTRODUCTION

A new liquid crystal material synthesized need initially characterized optically [1] and thermally [2] before its thermo tropic identity is established. Generally, the optical characterization involves the optical textural observations under crossed polarizers, whereas the thermal characterization is done by differential scanning calorimeter. These

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two methods provide details regarding the LC phases, phase transition temperatures and the heats of transitions exhibited by it. In addition to these, X-ray [3] measurements will also be carried out to determine the crystalline class of the material viz., through the study of the molecular length and the layer spacing in liquid crystalline phases.

The physical property measurements that follow the preliminary textural and calorimetric characterization to establish the phase sequence and variance usually include the study of different properties viz., the density [4], the birefringence [5], dielectric relaxation [6] etc. Since, these materials are thermotropic, the properties vary with temperature. As such high quality thermal stability must be needed during such measurements. This implies that as the environment in each experiment is different, it leads to the variance in the determination of thermal stability through different phase transitions temperatures. The authors made a humble attempt to overcome this usual temperature variance of observation by combining the textural characterization and a LC pertinent physical property measurement simultaneously.

II. EXPERIMENTAL

In this direction, the authors presently describe a setup fabricated indigenously which ensures simultaneous observation of the textures

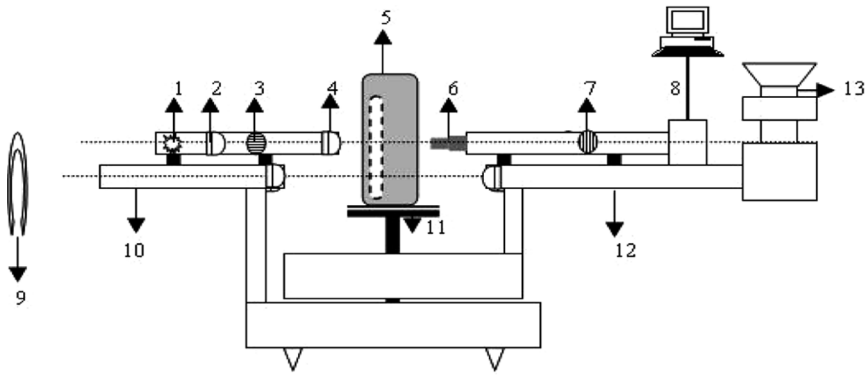

FIGURE 1 The block diagram of the setup.

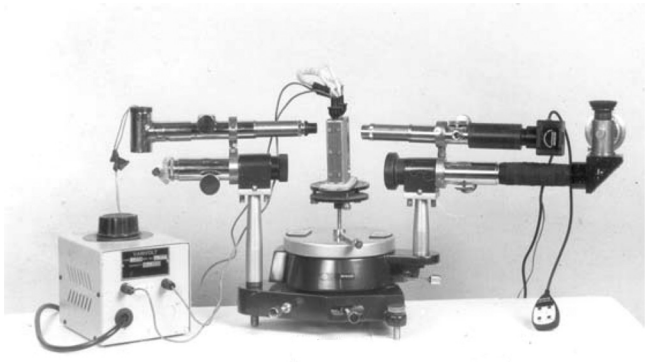

FIGURE 2 Experimental setup.

(microscopy) and the LC birefringence. The relevant block diagram of the setup is presented in the Figure 1. The experimental setup is depicted in Figure 2. The provision for identical environment of the LC material is achieved by using the same sample for both the measurements and placing the sample holder in one heater. Although, the light sources used in both the measurements are different, they are not spoiling the homogeneous thermal environment in bulk. Thus, the present apparatus helps to observe simultaneous onset of LC textures and the birefringence which manifests by cooling the high temperature isotropic melt.

III. RESULTS AND DISCUSSION

The compound N-(p-n-decyloxybenzylidene)-p-toluidine, 10O.1, of well known nO.m series is used in the present study. This compound exhibits nematic (N), smectic-A (A), smectic-B (B) mesophases in between the isotropic liquid and crystalline solid. The following table gives the transition temperatures observed for the sample using different experimental techniques including the present values.

The values in the table reveal the differences of transition temperatures recorded from different experiments where the environmental conditions are different for the sample. The simultaneous observations, textures and LC birefringence at temperatures in all the LC phases (including the isotropic phase) exhibited by 10O.1 are shown in Figure 3A–E.

The variation of the refractive index (n_e and n_o), the birefringence (Δn) and $\Delta n/dT$ are shown in Figure 4 for the compound 10O.1.

TABLE 1 The Phase Variants, Transition Temperatures (°C) and the Enthalpy Values from Different Techniques

Compound	Phase variant	Method		I-N/A	N-A	A-B	A/B-K
10O.1	NAB	DSC	Heating	77.50[#]	76.65[#]	–	69.60
			ΔH (J/gm)	16.29			106.25
			Cooling	73.94[#]	72.58[#]	60.33	43.75
			ΔH (J/gm)	17.58		8.02	86.10
			Heating[*]	75.95	74.89		
			ΔH (J/gm)	3.66	11.29		
			Cooling[*]	75.58	74.28		
			ΔH (J/gm)	3.96	11.29		
		TM	Cooling	75.4	74.1	62.5	45.6
			Density	73.9	73.1	65.3	
			Birefringence	74.1	72.9	61.2	
			Simultaneous measurement	73.8	72.8	61.0	

[#]The peaks are not resolved in 10O.1 compound.

[*]The scan rate is 1°C/minute (otherwise 10°C/minute) to resolve the I-N and N-A transitions in 10O.1 compound.

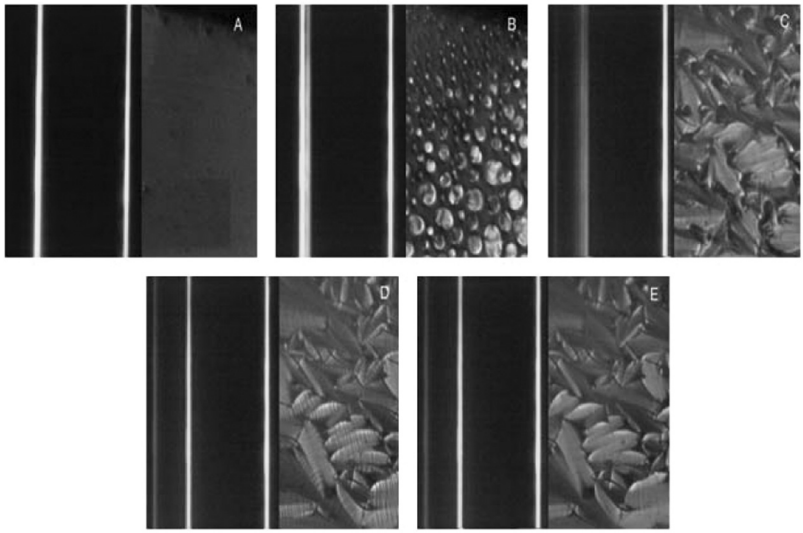

FIGURE 3 (A) Isotropic phase, (B) Isotropic to nematic interface (nematic droplets), (C) Smectic-A phase (focal conic fan texture), (D) Smectic-A to Smectic-B interface (transient transition bars across fans) and (E) Smectic-B phase (smooth focal conic fans. (In Figs. 3A–E the direct ray is also shown).

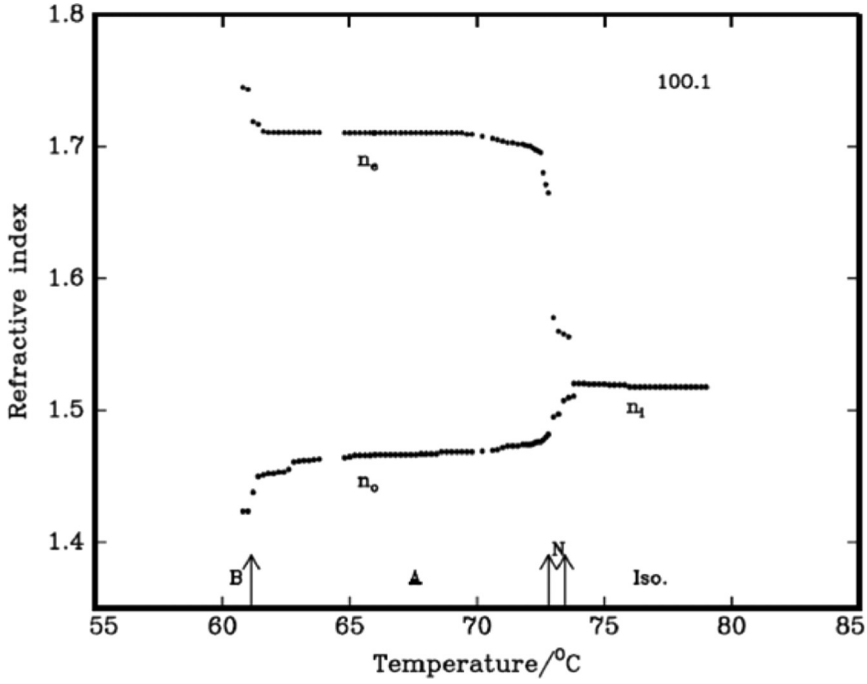

FIGURE 4 Variation of refractive index (ordinary and extraordinary) with temperature in 10O.1.

In summary, the advantages of the present apparatus are

1. A physical property (birefringence) can be measured along with the characterization of the sample, thereby reducing time spent for individual measurements,
2. Identical and homogeneous environment can be created for the sample for both the measurements, and
3. The manifestation of different liquid crystalline phases as well as the birefringence change at the phase interface can be visually observed. In turn, it helps a way out to determine the fluctuation dominated non-linear regions (FDNLR) on both sides of the LC transition point.

REFERENCES

[1] Gray, G. W. & Goodby, J. W. (1984). *Smectic Liquid Crystals: Textures and Structures*, Leonard Hill, Glasgow.
[2] Ajeetha, N. & Pisipati, V. G. K. M. (2005). *Z.naturforsch*, *60*a, 1.

[3] Pisipati, V. G. K. M. & Rananavare, S. B. (1993). *Liquid Crystals*, *13*, 757.
[4] Gogoi, B., Ghosh, T. K., & Alapati, P. R. (2005). *Cryst. Res. Technol.*, *40*, 709.
[5] Palanie, I. & Florea, C. (2005). *I. Opto-Elec. & Adv.Mat.*, *7*, 997.
[6] Rani, G. P., Potukuchi, D. M., Rao, N. V. S., & Pisipati, V. G. K. M. (1994). *Solid State Communications*, *92*, 349.