

Optical Birefringence Studies on Cholesteric and Induced Smectic Phases of Ternary Mixture of Liquid Crystalline Materials

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ABSTRACT: In the present work, our investigation is to study on the optical and thermal properties of multi-component system of Cholesteryl oleate (CO), Sodium oleate (Naol) and Glacial acetic acid (GAA). Mixtures of these molecules exhibits Cholesteric, SmA, SmC and SmG phases sequentially when the specimen cooled from its isotropic phase. These phases have been characterized by using microscopic technique. The temperature variations of optical anisotropic measurements have also been discussed.

KEYWORDS: Ternary mixture; Molecular orientation; Optical textures;

I. INTRODUCTION

Many of materials showing liquid crystalline behaviour belong to two general classes: lyotropic materials, in which fluid anisotropy results from interactions between anisotropic aggregates of amphiphilic molecules and thermotropic materials, in which the orientational order arises from interactions among partially rigid anisotropic molecules. Amphiphilic compounds can form a variety of thermotropic liquid crystalline phases as a function of temperature by themselves and lyotropic liquid crystalline phases upon addition of some solvent, such as water or diethylene glycol [1]. Thermotropic liquid-crystalline systems composed of amphiphilic molecules can exhibit smectic phases with layered structure [2] or nematic (eventually cholesteric) phases. Lyotropic systems usually form a lamellar liquid-crystalline mesophase, i.e., a lyotropic analogue of the thermotropic orthogonal smectic A (SmA) phase [3] and more rarely nematic, columnar and cubic mesophases [4, 5]. Combination of thermotropic and lyotropic properties for materials with definite molecular structure has been intensively studied so far and is of high importance in particular for developing new types of functional LC materials [6].

II. LITERATURE SURVEY

In the present investigation, our aim is to study the mixture of multi-components, namely, Cholesteryl oleate (CO), Sodium oleate (Naol) and Glacial acetic acid (GAA), which exhibits cholesteric and smectic phases, such as SmA, SmC and SmG phases, respectively at different temperatures. They were observed using microscopic technique and also have been verified from the results of optical anisotropic techniques.

III. MATERIALS AND METHODOLOGY

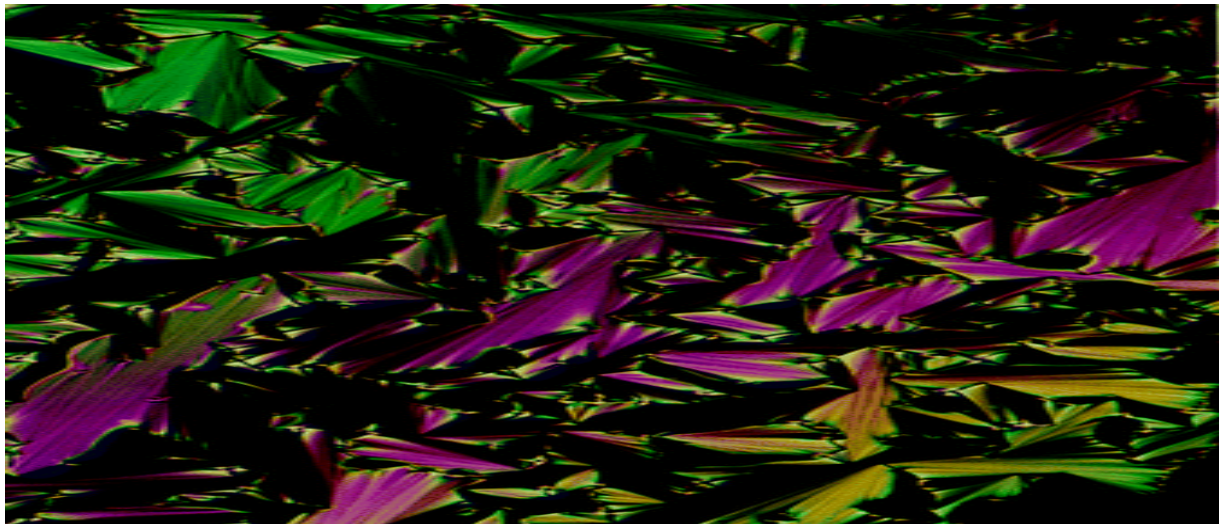
In the present investigation, we have been considered the multi-components systems of molecules namely; Cholesteryl oleate (CO), Sodium oleate (Naol). Mixtures of different concentrations of CO in (Naol+GAA) were prepared and were mixed thoroughly. The mixtures of different concentrations of the samples 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 concentrations were measured with the help of a Gippon-Japan-polarizing microscope in conjunction with a hot stage. The samples were sandwiched between the slide and cover slip and were sealed for microscopic observations. Refractive indices in the optical region are determined at different temperatures by employing the techniques described by the earlier investigators [7].

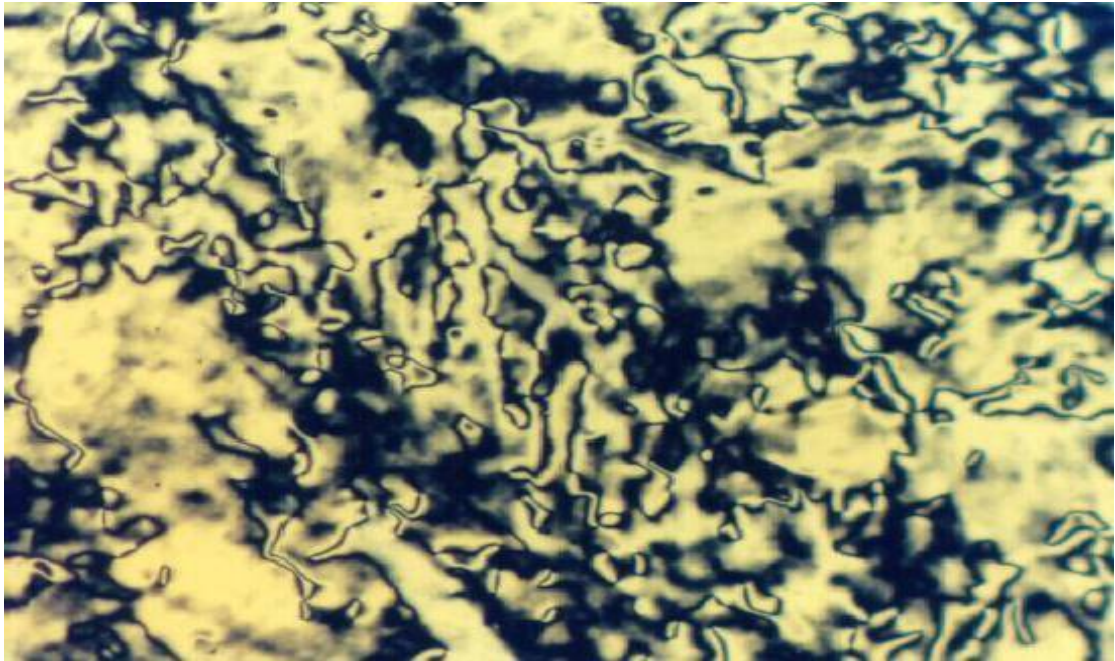
IV. SIMULATION RESULTS

OPTICAL TEXTURE STUDIES:

Molecular orientations of optical textures exhibited by the samples were observed and recorded using the Gippon-Japan-polarizing microscope in conjunction with hot stage. The specimen was taken in the form of thin film and sandwiched between the slide and cover glass. The concentrations from 10% to 80% of ternary mixture of CO in (Naol+GAA) have been considered for the experimental studies. When the specimen of 50% CO in (Naol+GAA) is cooled from its isotropic melt and hence it exhibits cholesteric, SmA, SmC and SmG phases sequentially. While the 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. On further cooling the specimen, the texture slowly transform to focal conic fan texture of SmA phase in which the molecules are arranged in layers and the texture is as shown in Figure1(a). On further cooling the specimen, the unstable SmA phase changes over to schlieren texture of SmC phase and it as shown in Figure1(b). Sequentially on cooling the specimen, SmC phase slowly changes over to SmG phase and then it remains stable at room temperature [8].



a) Focal conic fan shaped texture of SmA phase (250X).



b) Schlieren texture of SmC phase (250X).

OPTICAL ANISOTROPY:

Temperature variations of refractive indices and optical birefringence studies for the sample 50% CO in (Naol+GAA) is presented in Figure 2 and 3. From the figure, it can observe that the value of ordinary refractive index increases where as the extraordinary refractive index decreases. Then the value of ordinary refractive index as well as extraordinary approaches sharply to isotropic refractive index and becomes same at smectic - isotropic transition after that the refractive index decreases almost linearly with the temperature like any liquid for given binary mixture. Optical birefringence value decreases slowly with increase in temperature and then its value decreases sharply with increase in temperature. The values of electrical susceptibility for 50% CO in (Naol+GAA) have been calculated using Neugebauer relation [9] at different temperatures. The temperature variations of electrical susceptibility for the mixture are as shown in Figure 4. From the figure, it can be observed that wherever there is an isotropic-liquid crystalline phase transition, the value of electrical susceptibility changes appreciably, which indicates that each change corresponds to the occurrence of different liquid crystalline phases. Further, with increase in the concentration of CO, the value of electrical susceptibility decreases with temperature, because the effective optical anisotropy associated with the molecules of CO also decreases.

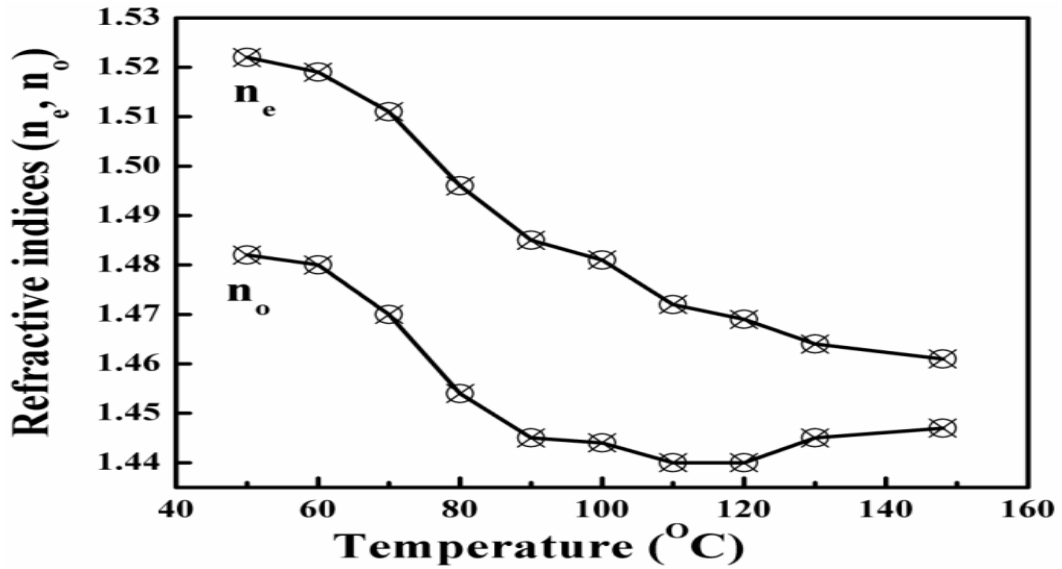


Figure 2. Temperature variations of refractive indices for the given sample 50% CO in (NaOl+GAA).

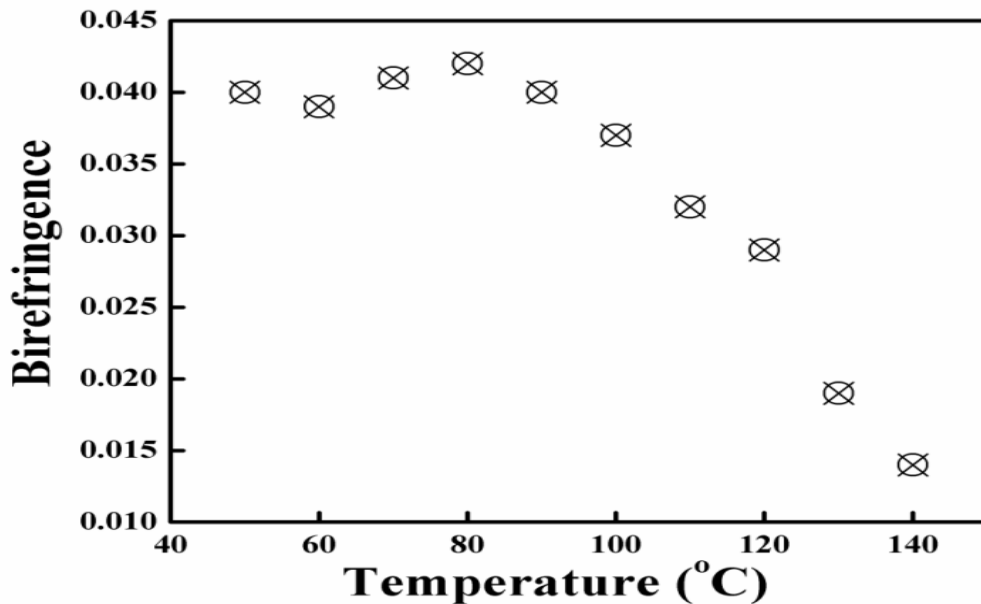


Figure 3. Temperature variations of optical birefringence for the given sample.

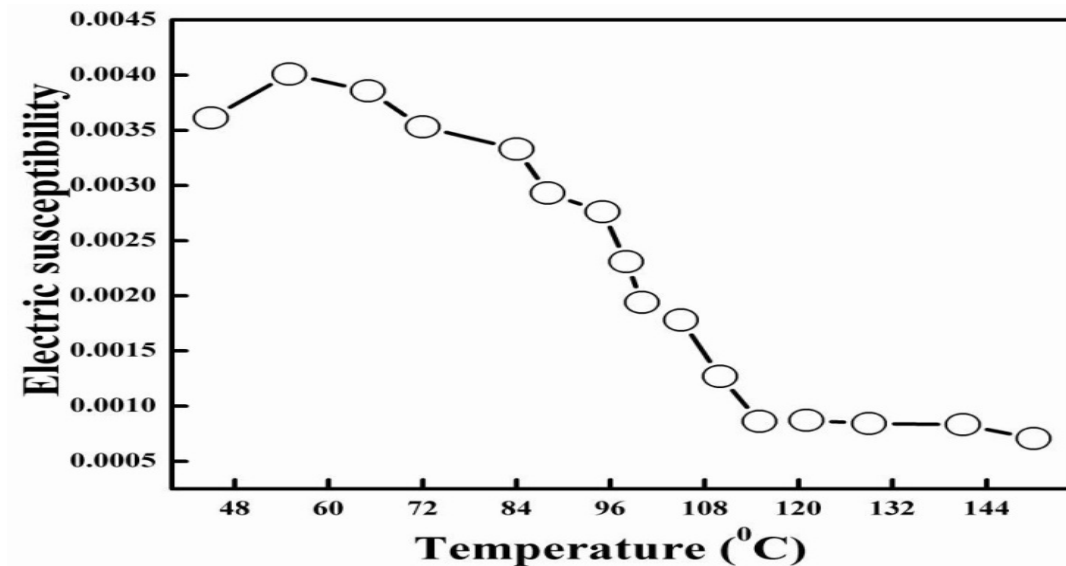


Figure 4. Temperature variation of electrical susceptibility for the mixture of 50% CO in (NaOl+GAA).

V. CONCLUSION

Microscopic investigation of the multi-component system of CO in (NaOl+GAA) shows existence of cholesteric, SmA, SmC and SmG phases for all concentrations of the given mixture. The drastic changes in optical anisotropic measurements values unambiguously correspond to different liquid crystalline phases: respectively at different concentrations and temperature.

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