Research Inventy: International Journal 0f Engineering And Science
Vol.3, Issue 12 (December 2013), PP 45-49
Issn (e): 2278-4721, Issn (p):2319-6483, www.Researchinventy.Com

Lyotropic liquid crystalline phase in binary mixtures of Cetostearyl alcohol and Dimethyl sulfoxide

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ABSTRACT: *DSC and Optical microscopic studies shows that the mixtures of two non mesogenic compound viz. Cetostearyl alcohol and DMSO exhibit polymorphic mesophases at different temperatures. With the help of phase diagrams of this binary mixture, the phase behavior is discussed. The clear measurement of transition temperature, from the isotropic liquid phase to anisotropic mesophase plays an important role in the study of physic-chemical properties of materials.*

Key words: *Lyo phase, Density, birefringence, Optical microscopy, Phase transition*

I.INTRODUCTION

Comprehensive studies on the mesomorphic behavior of mixtures of non mesogenic compounds have been well investigated [1-5]. Binary mixtures of some non mesogenic compounds exhibit lyotropic and thermotropic mesophases [6,7]. Generally, the chemical structure is the most salient feature of molecules forming lyotropic mesophases in the presents of solvent. It is quite interesting to investigate the molecular ordering in lyomesophases formed by alcohol solvent system.

The present paper reports the results of our studies on a mixture of non mesogenic compounds viz. Ceto stearyl alcohol and DMSO. The polymorphism exhibited by the mixture is characterized based on the results of DSC, Optical microscope, Density and Birefringence studies.

II.EXPERIMENTAL

The cetostearyl alcohol used in this investigation was obtained from M/S Loba Chemic Pvt.Ltd, Bombay and is further purified twice by recrystalization in benzene solution. The purified CSA (99.8%) has a transition temperature of 53°C (±0.5°C) as observed under polarizing microscope [8]. The composition of CSA used by us was determined to be 40% stearyl alcohol and 60% of cetyl alcohol using Walter's equation

$$T_m = \left(\frac{t_1 C_1 + t_2 C_2}{C_1 + C_2} \right)$$

for the melting point of the binary mixtures of isomorphous substances. The melting points of cetyl alcohol and stearyl alcohol were taken as 50°C and ~58°C respectively [9]. Mixtures of five different concentrations of CSA (by wt percent) in DMSO are prepared. The phase transition temperature of this concentration was measured with polarizing microscope with hot stage. The prepared mixture was scaled for microscopic observation. All dynamic DSC studies were carried out on Mettler DSC with $STAR^e$ SW 8.10 . The density and refractive indices studies were determined at different temperature.

III.RESULTS AND DISCUSSIONS

3.1. Optical studies:

The transition temperature for the mixtures of different concentration of CSA in DMSO was determined by optical microscope attached with hot stage. The following textures have been identified from photo-micrographs. Fig.(1). The battonnets typical of lamellar phases for concentration of 22%CSA in DMSO, (a). Small droplets with pin wheeled crosses and circular discs for the same concentrations, (b). Oil steaks and tubes from the concentration of 42% CSA in DMSO, (c). Isotropic polyhedral textures for concentration 53%of CSA in DMSO,(d). Focal conic textures for the concentration of 85% CSA in DMSO, (e). Similar textures are also seen in samples of concentration range 90%, 95% of CSA in DMSO, (f).

The phase diagram of binary mixtures of CSA in DMSO is shown in Fig. (2). The phase diagram shown in Fig.(2) is observed by drawing the phase diagram temperature determined from DSC as function of concentration of CSA in DMSO.

3.2. Birefringence studies:

The above observed results are further supported by refractive index and density measurements. The refractive index measurements of 5 mixtures of CSA in DMSO for varying concentrations have been studied making use of Abbe's refractometer. The temperature variation of the refractive indices of these 5 mixtures to an accuracy of ±0.0005 and temperature variations of ± 0.1^{o}c accuracy have been studied. The principle involved in the measurement of refractive index using this refractometer is the critical angle. A few drops of this sample to be studied are placed between the illuminated prisms which are maintained at the desired temperature by water circulation arrangements around the prisms [10]. The lower prism of Abbe refractrometer is rubbed using fine cotton along the transverse direction of the prism gently several times till it is ensured that the oriented sample is deposited. The sample is taken in the liquids state at the higher temperature. Few drops are taken over this rubbed prism and the prism is closed. Thus the sample is embedded between two prisms. Slowly lowering the temperature the refractive index which is directly calibrated is measured at different temperature. the refractive indices along the directions of the molecular orientation and in the direction perpendicular to the molecules are identified by the known vibration directions of an external analyzer used along with the refractomter following the earlier procedure [11,12] . The refractive indices for extraordinary n(e) and ordinary ray n(o) of the mixtures with different concentration were determined. The variation of n(e) and n(o) as a function of temperature for 5 mixtures were presented in Fig(3).

3.3. Density studies:

The non mesogenic CSA in its pure state and DMSO are separately subjected to densitometry studies. The experimental density measurements of these compounds in their pure state are carried out using the capillary tube which is standardized by distilled water and compared the results obtained by the method of specific gravity bottle. The densities of these compounds have been measured over a range of 34-60^{o}C to an accuracy of ±0.001 gm/cc and ±0.5^{o}c. The specimen at different temperature by using heater separately fabricated for this purpose by us and the input potential maintained by means of variac, correction for the thermal expansivity for the glass of the capillary tube has been made. Densities of 5 mixtures of CSA in DMSO for various concentrations are presented in Table(1). The transition temperature of binary mixture of CSA in DMSO is observed in the density measurements as a function of temperature. These transition temperature measures from densitometry studies appears to agree satisfactorily with these observed using optical polarizing microscope and refractive index studies within ±1^{o}c.

Table:1. Variation of density Vs Temperature of Binary mixtures of CSA in DMSO

Temperature in ^{o}C	CSA Wt%:22	CSA Wt%:42	CSA Wt%:53	CSA Wt%:85	CSA Wt%:95
38	0.9825	0.9800	0.9715	0.8780	0.8440
40	0.9780	0.9740	0.9690	0.8710	0.8400
42	0.9740	0.9660	0.9580	0.8650	0.8370
44	0.9690	0.9590	0.9540	0.8585	0.8325
46	0.9630	0.9500	0.9475	0.8500	0.8300
48	0.9560	0.9420	0.9450	0.8430	0.8255
50	0.9505	0.9350	0.9380	0.8340	0.8175
52	0.9430	0.9280	0.9320	0.8280	0.8120
54	0.9390	0.9240	0.9250	0.8215	0.8050
56	0.9320	0.9180	0.9200	0.8160	0.8000
58	0.9280	0.9160	0.9135	0.8115	0.7945
60	0.9230	0.9110	0.9085	0.8065	0.7900

IV. CONCLUSION

Mixture with different concentration of CSA in DMSO exhibit polymorphism. This type of polymorphism is rare in nonmesogenic binary mixture. The drastic change in the values of density, refractive index with temperature corresponds to phase transition temperature is well established with DSC studies.

V. ACKNOWLEDGEMENT

We thank Prof. C. Radhakrishna Murthy and Prof. K. Gopal kishan Rao for their keen interest and for helpful discussions.

Figure.1

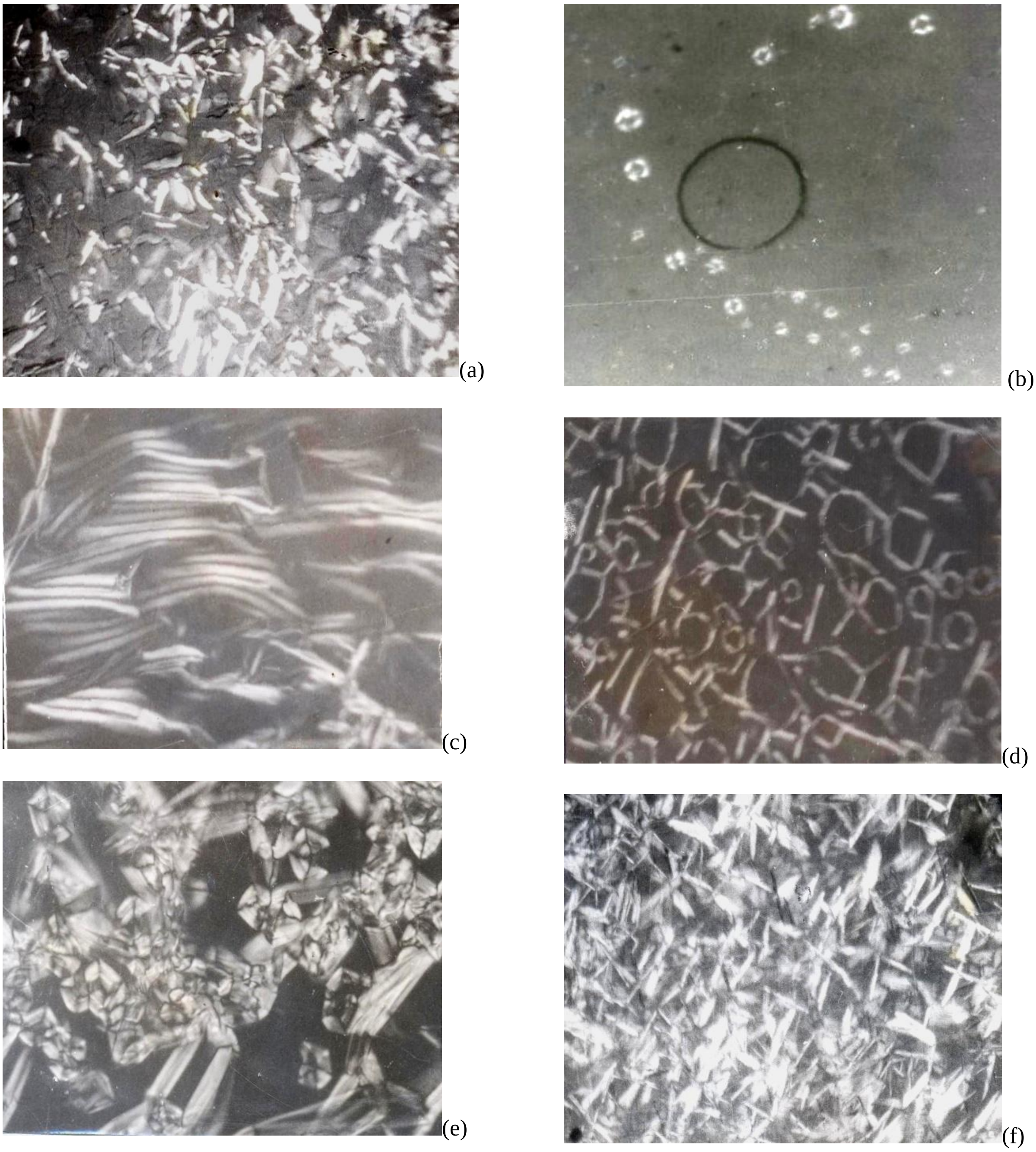


Figure. 1. The battonnets typical of lamellar phases for concentration of 22%CSA in DMSO (a). Small droplets with pin wheeled crosses and circular discs for the same concentrations (b). Oil steaks and tubes from the concentration of 42% CSA in DMSO (c). Isotropic polyhedral textures for concentration 53%of CSA in DMSO (d). Focal conic textures for the concentration of 85% CSA in DMSO (e). Similar textures are also seen in samples of concentration range 90%, 95% of CSA in DMSO (f).: (Magnification: 200X)

Figure. 2

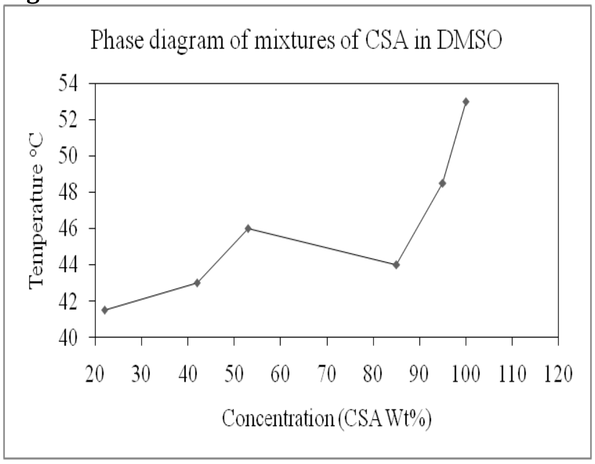
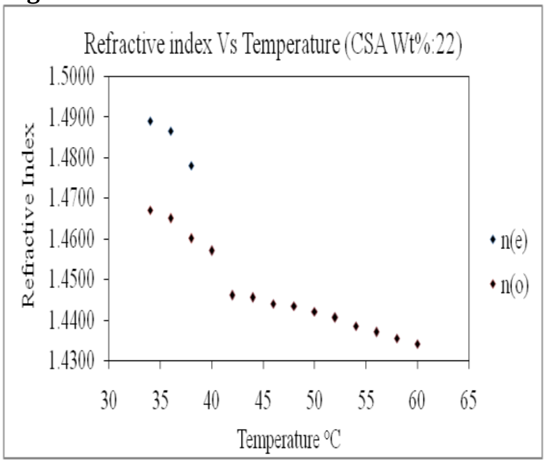
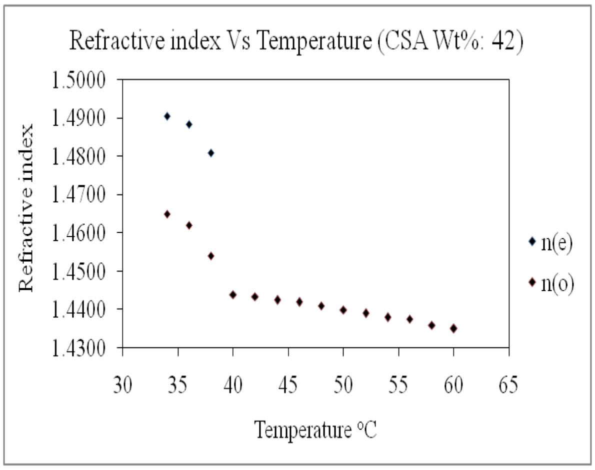
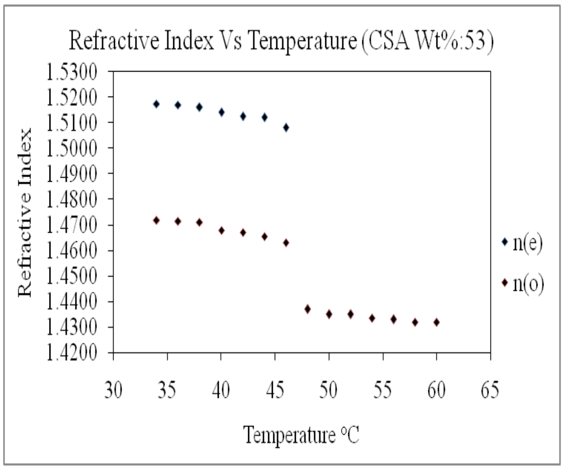
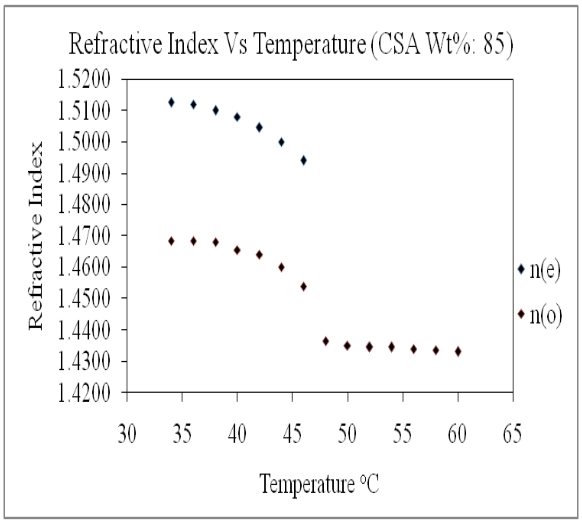


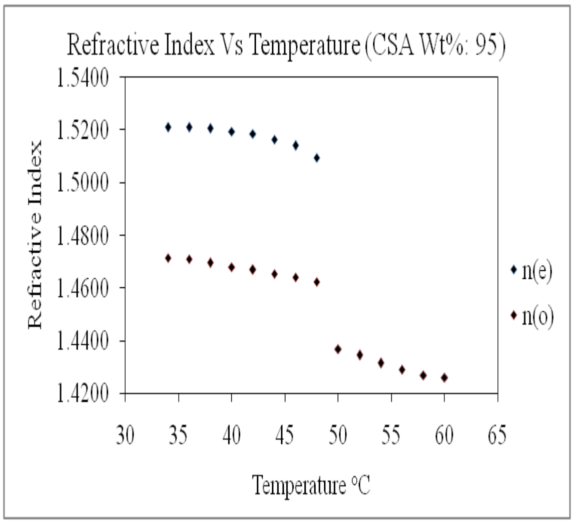
Figure. 3











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