

Study on Physical Properties of Binary Mixtures of Cetostearyl Alcohol-Orthophosphoric Acid Showing Lyotropic Mesomorphism

Sreelatha .C.J., Anuradha.P, Ch.Satyanarayana
Department of Physics, Kakatiya University, Warangal, Telangana, India

Abstract: Binary mixtures of two non mesogenic compounds Cetostearyl alcohol (CSA) and Ortho Phosphoric acid (H_3PO_4) are found to exhibit lyotropic mesophases over wide range of concentrations. The Optical, Density and Refractive index studies of the binary mixtures of CSA and H_3PO_4 exhibit polymorphic mesophases at different temperatures have been studied. The Refractive Index and Density studies of these mixtures are presented in this paper. The Optical Microscopy shows the Polymorphic textures of these binary mixtures showing lyophase is also presented.

Keywords: Density, Optical Microscopy, Polymorphic Mesophase, Refractive Index, Textures

I. Introduction

Lyotropics can be formed by binary mixtures of some non-mesogenic compounds have created a new era in the field of liquid crystal [1]. Lyotropic liquid crystals can be often be formed in binary mixtures of surfactants in polarized solvent such as water and in ternary or quaternary systems in which assistant surfactant or other polar organic component is in existence . Characteristic, structures and forming conditions of this type of liquid crystals have drawn great attention around the world [2-8] due to the utilizing value in cosmetics industry, material science and technology. Cetostearyl alcohol (CSA) is a solid mixture consisting of stearyl alcohol and cetyl alcohol. It can be extracted from sperm oil in which the alcohol occur or by reduction of the mixture of stearic and palmitic acid of natural fats. The compound is purchased from M/s. Moly Chem, Mumbai. It showed melting point of CSA is $53^\circ C (\pm 0.5^\circ C)$ as observed under polarizing microscope. Ortho phosphoric Acid (88%) supplied by M/s. SDFCL, Mumbai, was used as a solvent. Naggappa et. al. [9] has extensively studied the lyotropic systems of cetyl alcohol and stearyl alcohol with Ortho Phosphoric Acid. It is quite interesting to investigate the molecular ordering of micellar lyomesophases that are formed by alcohol-solvent system [10]. In the present study we have prepared the mixtures of two non mesogenic compounds Viz Ceto Stearyl Alcohol (CSA) and Ortho Phosphoric acid (H_3PO_4). The lyotropic liquid crystalline phases were observed using optical microscope and they have been verified from the result of density and Refractive Index studies.

II. Experimental

The Cetostearyl alcohol purified twice by recrystallisation in Benzene. The melting point of CSA is in good agreement with the reported value. The H_3PO_4 was used after boiling at $433^\circ K$ for six hours. The mixtures of four different concentrations of CSA in H_3PO_4 were prepared and kept in desiccator for a long time. The phase transition temperature of these mixtures with different concentrations was measured using Olympus Polarizing Microscope with a hot stage. The sample was sandwiched between the slide and cover slip which was sealed for microscopic observations. When the sample is allowed to cool slowly at the transition temperature, the textures typical to the lyotropic lamellar mesophase have been observed in the binary mixture of CSA in H_3PO_4 . The following textures have been identified from microphotographs. (1) Small droplets with pin wheeled crosses and batonnets typical of lamellar phases are observed for 20% (Wt %) of CSA in H_3PO_4 . (2) Oil streaks and tapes are observed for 40% CSA in H_3PO_4 . (3) The mixture of 60% and 80% of CSA in H_3PO_4 shows focal conic structures and platelets. The microphotographs are shown in Figure (a-d)

Abbe Refractometer is used to study the refractive index of the samples. The refractive index studies of the mixtures of CSA in H_3PO_4 for four samples were carried out as described in our earlier paper [11]. The experimental values of refractive indices for extraordinary ray (n_e) and ordinary ray (n_o) of four samples of binary mixtures of CSA in H_3PO_4 are tabulated in Table - 2. The mean refractive index for all samples is calculated for all four samples the mean refractive index appears with decrease with increase in temperature. The temperature dependence of refractive indices is shown in Figure (e-h).

The densities of the mixtures of different concentrations of CSA and in H_3PO_4 have been measured at different temperature by the method described in our earlier paper [11]. The sudden change in the value of density at certain temperature corresponds to phase transition temperature of the mixture. The value of density at different temperatures are presented in Table -1

III. Figures And Tables

TABLE- 1: Density vs. Temperature for different concentrations

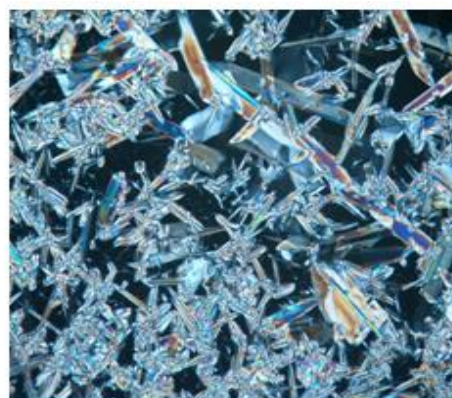
Temperature in °C	Densities for different Concentration of CSA in H ₃ PO ₄			
	CAS 20% Wt.	CAS 40% Wt.	CAS 60% Wt.	CAS 80% Wt.
30	1.5600	1.3110	1.1665	0.9980
40	1.5503	1.3072	1.1655	0.9960
50	1.5450	1.3050	1.1645	0.9940
60	1.5400	1.3025	1.1640	0.9860
62	1.5360	1.2750	1.1560	0.9740
70	1.4990	1.2500	1.1460	0.9620
80	1.4540	1.1998	1.1344	0.9560
90	1.4210	1.1542	1.1245	0.9480
100	1.3936	1.1086	1.1130	0.9320

TABLE- 2: Refractive index vs. Temperature for different concentrations

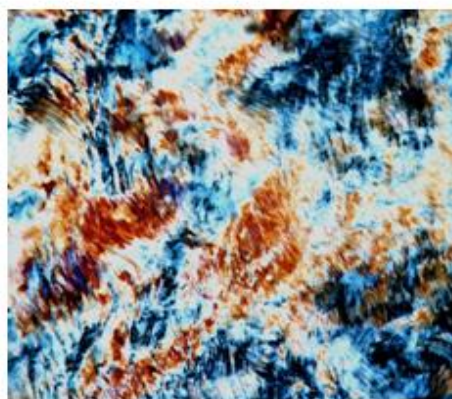
Temperature in °C	Refractive index for different Concentration of CSA in H ₃ PO ₄							
	CAS 20% Wt.		CAS 40% Wt.		CAS 60% Wt.		CAS 80% Wt.	
	n _e	n _o	n _e	n _o	n _e	n _o	n _e	n _o
30	1.4890	1.4700	1.4950	1.4650	1.4900	1.4650	1.5125	1.4685
40	1.4850	1.4650	1.4850	1.4600	1.4850	1.4550	1.5120	1.4655
50	1.4800	1.4600	1.4800	1.4550	1.4800	1.4500	1.5080	1.4650
60	1.4750	1.4550	1.4450	1.4450	1.4350	1.4350	1.4330	1.4330
70	1.4400	1.4400	1.4300	1.4300	1.4300	1.4300	1.4300	1.4300
80	1.4350	1.4350	1.4250	1.4250	1.4250	1.4250	1.4250	1.4250
90	1.4340	1.4340	1.4230	1.4230	1.4200	1.4200	1.4200	1.4200
100	1.4300	1.4300	1.4200	1.4200	1.4150	1.4150	1.4150	1.4150



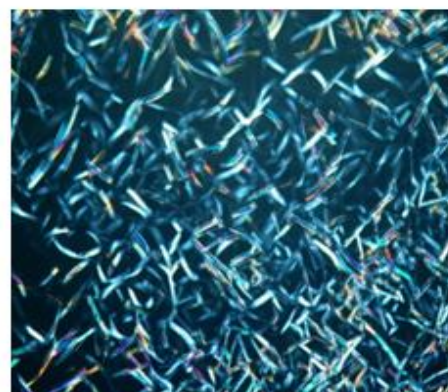
(a)



(c)



(b)



(d)

Figure: a) Micrograph showing droplets and batonnets in CSA (20%)-H₃PO₄ (200X)

b) Micrograph showing oil streaks and tapes in CSA (40%)-H₃PO₄ (200X)

c) Micrograph showing focal conic textures and platelets in CSA (60%)-H₃PO₄ (200X)

d) Micrograph showing focal conic textures in CSA (80%)-H₃PO₄ (200X)

Fig.(e):Refractive Index Vs Temperature of binary mixture of CSA(Wt%:20)+H₃PO₄

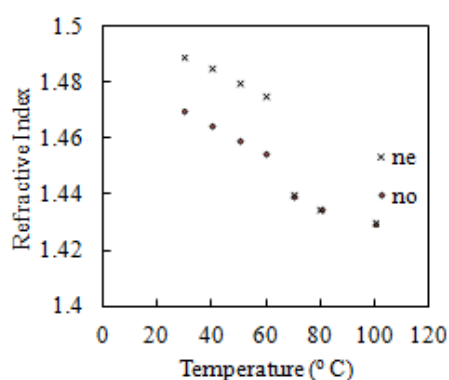


Fig.(g): Refractive Index Vs Temperature of binary mixture of CSA(Wt%:60)+H₃PO₄

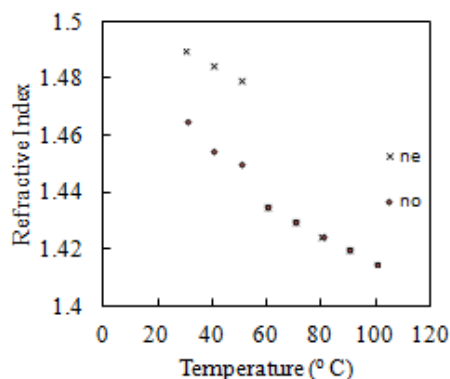


Fig.(f): Refractive Index Vs Temperature of binary mixture of CSA(Wt%:40)+H₃PO₄

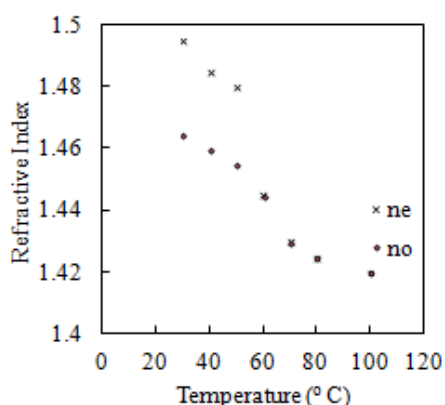
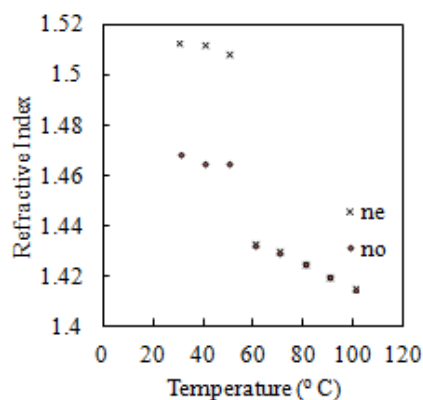


Fig.(h): Refractive Index Vs Temperature of binary mixture of CSA(Wt%:80)+H₃PO₄



IV. Conclusion

Microscopic investigation of binary mixtures of Cetostearyl alcohol and Ortho phosphoric acid for different concentration shows lyotropic liquid crystalline phase and there is drastic change in the values of refractive index, density of the samples with temperature correspond to lyotropic mesomorphism. This type of polymorphism is rare in the binary mixtures of non mesogenic compounds.

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