Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Induced Smectic and Ceiral Smectic Pease in Racehic Mixture of Cholesteryl Compounds

Nacappa [a], K. N. Jacadish [a], A. Shivaprasad [a], J. Mabadeva [a] & P. R. Alapati [a b]

[a] Department of Studies in Physics, University of Mysore, Manasagangotri, Mysore, 570 006, INDIA

[b] Department of Chemistry, University of Southampton, S017, IBJ, UK

Version of record first published: 04 Oct 2006

To cite this article: Nacappa, K. N. Jacadish, A. Shivaprasad, J. Mabadeva & P. R. Alapati (1997): Induced Smectic and Ceiral Smectic Pease in Racehic Mixture of Cholesteryl Compounds, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 301:1, 1-6

To link to this article: http://dx.doi.org/10.1080/10587259708041741

Mol. Cryst. Liq. Cryst., 1997, Vol. 301, pp. 1–6
Reprints available directly from the publisher
Photocopying permitted by license only

INDUCED SMECTIC AND CHIRAL SMECTIC PHASE IN RACEMIC MIXTURE OF CHOLESTERYL COMPOUNDS

NAGAPPA, K N JAGADISH, A SHIVAPRASAD,
J MAHADEVA AND P R ALAPATI[a]
Department of Studies in Physics, University of Mysore, Manasagangotri, Mysore - 570 006, INDIA.
[a]Department of Chemistry, University of Southampton, SO17,1BJ,UK.

Abstract: The racemic mixture of cholesteryl chloride(ChCl) and cholesteryl myristate(ChMy) exhibit a compensated nematic phase at critical concentration and temperature. The mixtures of concentration from 1 to 10% ChCl and 88% to 100% of ChCl exhibit smectic phase and cholesteric phase respectively. The middle concentrations are exhibiting S_A-Sc^*-S_C phases. Typically the mixture with 72.3% cholesteryl chloride exhibit I-S_A-Sc^*-S_C phases sequentially. X-ray diffraction, DSC and optical texture studies have been carried out for five concentrations. The pitch and tilt angle of the chiral smectic phase is measured. Interesting optical textures are also illustrated.

INTRODUCTION

Optical properties of racemic mixture of liquid crystalline compounds are well investigated by earlier authors[1,2]. It is well known that racemic mixture of cholesteryl compounds exhibit induced smectic A, C, C^*, A^* phases. The smectic liquid crystal phase(ex, I* and F*) which has infinite pitch length obtained from material with opposite helical twist sense is determined by their helical twisting power[2]. These phases possess spontaneous polarization and be ferroelectric[2]. In racemic mixtures the optical activities of each individual component will not in general be compensated at some point and temperature. Goodby et.al[3,4]

investigated the racemic modification by mixing the R and L enantiomorphs. A racemic modification appears at this junction of the two materials[5]. The compensatable systems are also exhibit blue phase. In the present investigation the mixture of two L and R enantiomorphic liquid crystals are studied and the mixture exhibit I-Ch-S_A-Sc^*-Sc-S_B phases sequentially when the specimen is cooled from isotropic phase.

EXPERIMENTAL

The liquid crystalline compound used in the present experimental investigations are cholesteryl chloride(left handed) and cholesteryl myristate(right handed). The specimens are recrystallized twice using benzene as a solvent. Ten mixtures with different concentrations of cholesteryl chloride in cholesteryl myristate were prepared. The phase transition temperatures of the mixtures were determined using Litz polarizing microscope and hot stage. The DSC traces of all the concentrations were obtained at Raman Research Institute, Bangalore using Perkin-Elmer DSC 2 Instrument. In the case of 65%, 72% and 74% of ChCl, DSC thermogram shows three peaks and which are corresponds to Iso-S_A-Sc^*-Sc. The phase transition temperatures as a function of concentrations are shown in the phase diagram [fig(1)].

The phase diagram illustrates that the mixtures of concentration from 1 to 10% of ChCl and 88 to 100% ChCl exhibits smectic phase and cholesteric phase respectively. The intermediate concentrations exhibit S_A, ferroelectric Sc^* and Sc phases. It is interesting to note that an island of ferroelectric phase is formed between the concentration 20 to 88% ChCl. Frequently one may encounter the compensated nematic phase in racemic mixtures at critical concentration and temperature.

X-RAY STUDIES

To understand the variation of the layer spacings in S_A and S_C^* phases X-ray diffractometer traces were taken. The traces obtained for the mixture of 60% of ChCl at different temperature corresponds to S_A and S_C^* phases. It is observed that as temperature increases the layer spacing also increases in S_C^* phase but in S_A phase the layer spacings are almost constant[10]. The variation is shown in the fig(2). The tilt angle is calculated using the equation $\beta=\cos^{-1} d/L$[11] where d is the molecular spacing and L is the length of the molecule.

OPTICAL TEXTURE STUDIES

The optical microscopy suggest that when the mixture of concentration between 1 to 20% ChCl cooled from isotropic state only a S_A phase is observed upto room temperature. The concentration between 88 to 100% ChCl exhibit a texture of finger print pattern which is characteristic of cholesteric phase. The intermediate concentration between 21 to 88% of ChCl exhibit Iso-S_A-S_C^*-Sc phases sequentially when the specimen cooled from isotropic phase. Typically 72% ChCl exhibit a focal conic texture between 69 to 52°C which is the characteristic of smectic A phase shown in fig 3(a). This phase is metastable and at 52°C, the fringes developes on the fans of the focal conic texture. This phase is correspond to chiral smectic phase. The bands observed on fans may be corresponds to integral multiples of the pitch of the helix of the phase, which are shown in fig3(b). The striations are due to helical pitch bands and dechiralization lines. Obviously the axis of the helix of the focal conic domains of the S_C^* phase is approximately parallel to the glass plate[7]. To confirm the position of the helical axis we carry out the experiment in which the material is taken in tin oxide coated glass plate and homogeneous

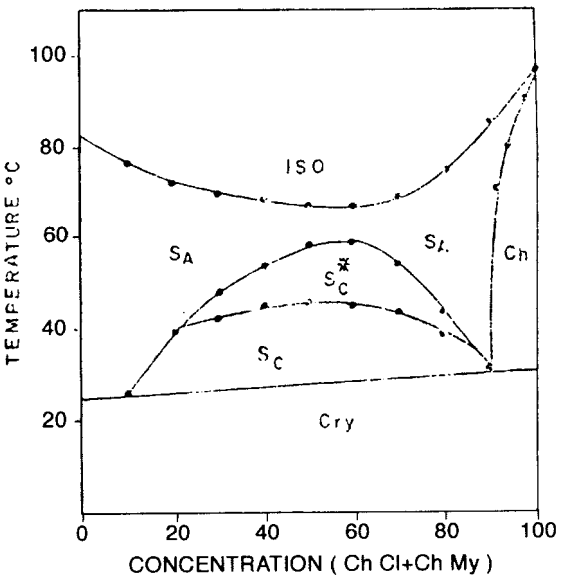

FIGURE 1 Phase diagram of binary mixture of ChCl and ChMy

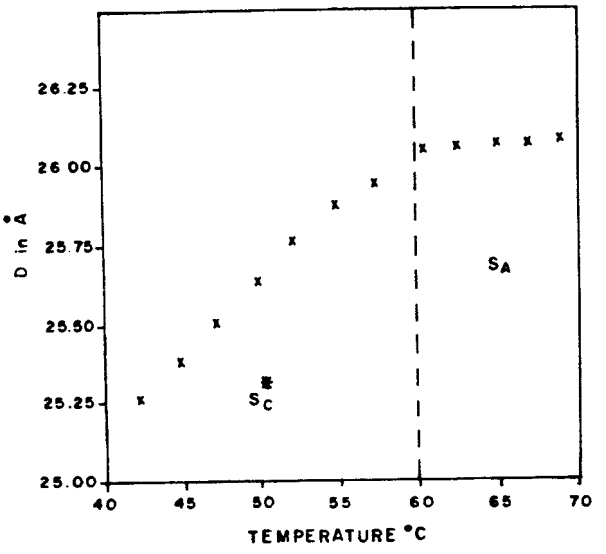

FIGURE 2 Variation of layer spacing with temperature

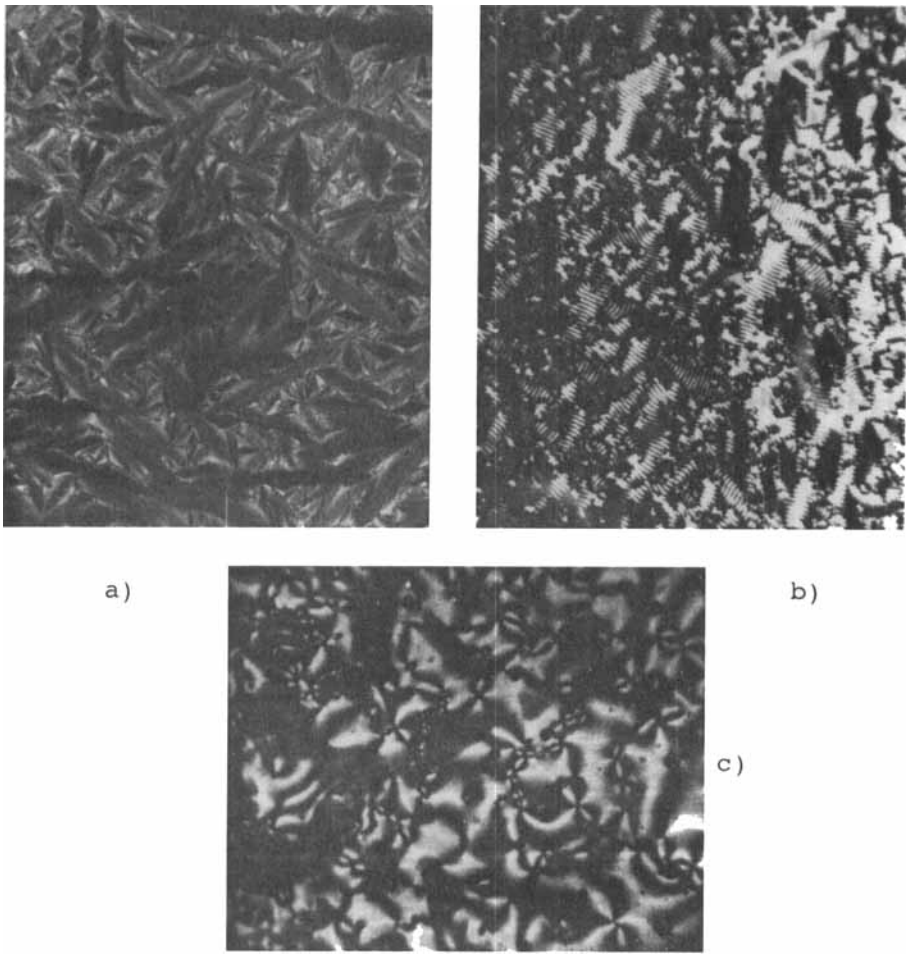

FIGURE 3 Microphotographs of a) S_A phase (150X) b) Sc^* phase (185 X) c) Sc phase (180 X)

growth of liquid crystals is achieved. Rotation between crossed polarizers produced no extinction, indicating that the molecules were symmetrically disposed to the viewing direction[11].

When the electric field is applied to the specimen which is exhibiting chiral smectic phase, the de chiralization lines were oriented approximately to the tilt angle of the Sc^* phase to the buffing direction[11]. The helical axis is in the plane of the cell and perpendicular to the layers.

At the interface, the racemic mixture exhibit compensated nematic phase. There is continuous miscibility of the S_A and chiral smectic phase[10]. If we further cool the specimen the Sc* phase change over to Sc phase. The optical schlieren texture of Sc phase is as shown in fig.3(c).

The density and refractive indices n_e and n_o of the different phases were measured and the optical anisotropy of the different phases were estimated. It is also observed that wherever the change in phases there is a drastic change in the values of n_e, n_o and optical anisotropy.

ACKNOWLEDGEMENT

The authors thanks to Prof. N V Madhusudan of Raman Research Institute, Bangalore for his valuable discussion and help. One of us Mr J Mahadeva is thankful to University of Mysore for giving permission to do research and Prof Nagappa thanks to DST, Govt. of India for financial support.

REFERENCES

1. J W Goodby and T M Lestic Mole.Cryst.Liq.Cryst. 110 175-203 (1984); L.A.Berson, V A Biklov, M Blinor, E P Pozhidaev and G V Purvanetskas JETP lett 33 536 (1981)
2. H Stegemeyer, T H Blumel, K Hittrop, H Onusseit and F Porsche Liquid Crystals 1(1) 3 (1986)
3. J W Goodby, M A Waugh, S M Stein, E Chin, R Pindak and J S Patel Nature 337 2 (1989)
4. J W Goodby, E Chain, T M Lestic, J M Gary, J S Patel J. Ame. Chem. Soc., 108 4729 (1986)
5. F Gandjean, Compt Review 172 71 (1921)
6. J W Goodby, M A Waugh, S Stain, E Chin & J S Patel Nature 337 (1989)
7. S R Renn and T C Lubeutuy Phys. review A 38 2132 (1988)
8. S A Patel ad J W Goodby Apply Physics 59 2355 (1986)
9. H A Sackman and D Demous Mol.Cryst.Liq.Cryst. 2 81 (1966)
10. Lesley, Robert M Richordson, Jason Ebbutt, J Cliff Jones, D R A Malvern Mol.Cryst.Liq.Cryst. 263 255 (1995)
11. A De Vries Mol.Cryst.Liq.Cryst. 10 31 (1970)