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The Smectic H Phase of TBBA*

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Abstract

The texture and conoscopic interference figure of the smectic H phase of TBBA has been studied. The texture appears to contain two sets of parallel lines making an angle of 55 degrees with each other. The conoscopic interference figure shows the projection of the tilted molecular long axis to be approximately along the bisectrix of this angle. The molecular structure of this phase is discussed.

Introduction

Terephthal-bis-butylaniline (TBBA) has various phases as follows[1]:-

$$X_L \xrightarrow{113^\circ C} S_G \xrightleftharpoons[144^\circ C]{} S_C \xrightleftharpoons[172^\circ C]{} S_A \xrightleftharpoons[200^\circ C]{} N \xrightleftharpoons[236^\circ C]{} IS$$

$$\uparrow \quad \downarrow 84^\circ C$$

$$(VII) \xrightleftharpoons[68^\circ C]{} S_H$$

An x-ray study of the smectic H phase (or smectic VI phase) carried out by Doucet et.al.[1] indicated the freezing of the motion of the molecules around their axes. The monoclinic lattice parameter give an angle of 53.6 degrees between the two diagonals of the unit cell. Since this phase is very ordered, it is able to give a large area of planer texture that shows some interesting characteristic which will be discussed below.

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Experimental Procedure

The sample in between a glass slide and a cover slip was mounted on a hot stage placed between crossed polarizers in the microscope. The sample was first heated into the nematic phase, then cooled down to the smectic A phase to get the homeotropic texture and the uniaxial centered cross of the conoscopic interference figure with the smectic layers presumably parallel to the glass slide and the molecular long axis normal to the layers. The temperature was decreased slowly through the smectic C, G, and H phases. The texture and conoscopic interference figure of the same area of the sample were observed.

Results and Discussion

Texture. As the temperature decreased from smectic G to smectic H phase, two sets of parallel lines making an angle of about 55 degrees with each other slowly appeared in the smooth mosic texture. The number of parallel lines increased as the temperature decreased for some degrees below the G–H transition, then remained the same throughout the temperature range of the smectic H phase as shown in figure 1. This texture is similar to that observed by Demus and Richter.[2]

Conoscopic interference figure. The centered cross interference figure in the smectic A phase moved off center as the sample entered the smectic C phase, indicating the molecular tilt of the smectic C phase as expected. As the temperature decreased, the tilt angle increased continuously through the C, G and H phases, projecting in the same direction through all these three phases. In the smectic H phase, the projection of the molecular tilt is directed approximately along the bisectrix of the angle between the two sets of parallel lines in the texture, as shown in figure 2.

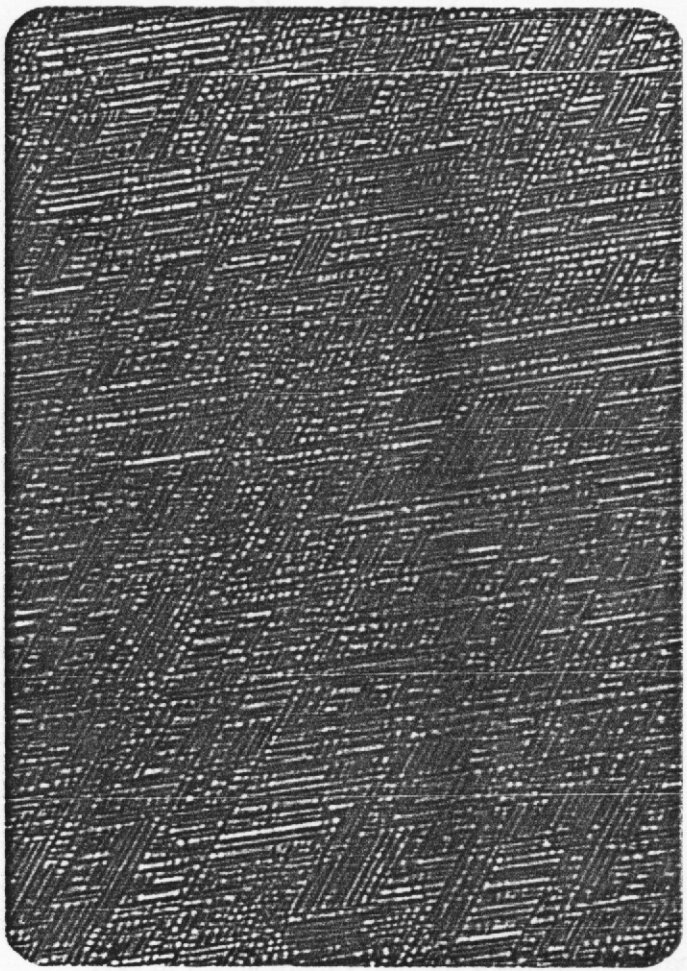

Fig.1. The texture of smectic H phase of TBBA at 79^{0}C, X 40

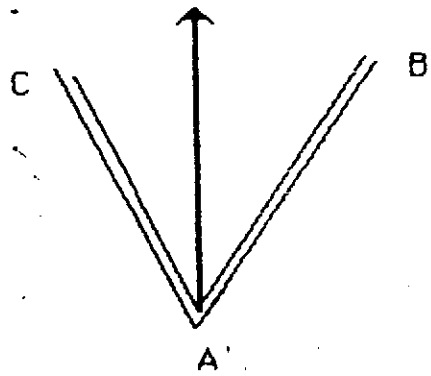

Fig. 2. AB and AC are two sets of parallel lines. The arrow indicates the direction of the average molecular tilt angle observed from the conoscopic interference figure.

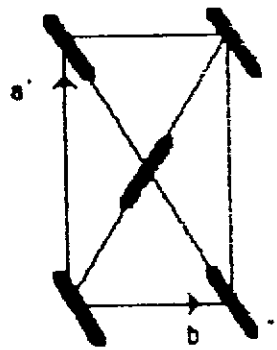

Fig.3. The molecular arrangement seen along the long axes of the molecules, b is the b axis of monoclinic lattice, a' is the projection of the a axis on the plane of drawing.

This could be explained by assuming that the molecules of the smectic H phase prefer to tilt in their own planes,approximately along the two diagonals of the unit cell as shown in figure 3. This could cause the two parallel line-sets in the texture making an angle about the same as the angle between the two diagonals. The avevage tilt angle then would be along the bisectrix of this angle which agrees with de Vries model of the smectic VI phase.[3]

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