A Liquid Crystal Mixture for Use in Smectic Liquid Crystal Display Devices

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Summary The transition temperatures of mixtures of 4-cyano-4′-n-octylbiphenyl and 4-cyano-4′-n-decylbiphenyl have been obtained and plotted against composition; the eutectic mixture has a wide smectic range (**5**—40 °C), a narrow nematic range (40—43 °C) and appears to be suitable for use in smectic liquid crystal display devices.

SMECTIC liquid crystals have recently been used in laser-beam addressed smectic liquid crystal display devices either to store data[1] or to produce synthetic images.[2] Taylor and Kahn[1] used mixtures of 4-n-alkylbenzylidene-4′-cyanoanilines to produce near room temperature smectic phases. However, these materials have certain disadvantages; firstly they are chemically and photochemically unstable and secondly they have to be maintained at a temperature of 24 °C to prevent crystallisation and hence the loss of the stored data.

Hareng and Le Berre[2] used 4-cyano-4′-n-octylbiphenyl (8CB) in their display devices. This material is stable and does not crystallise at room temperature. However, 8CB has a fairly wide nematic range (7 °C); this is a disadvantage in this type of system, since the response time and the amount of thermal energy required to produce an image increase as the width of the nematic range increases.

In an attempt to find a material more suitable than 4-cyano-4′-n-octylbiphenyl, the 4′-n-decyl derivative of 4-cyanobiphenyl was synthesised by methods already described[3] for lower homologues. However, this compound does not exhibit a nematic phase; it melts at 44 °C to give a smectic A phase, which gives the isotropic liquid phase at 51·5 °C. The enthalpy of fusion of 4-cyano-4′-n-decylbiphenyl (10CB) was found by differential thermal analysis to be $5{\cdot}6 \pm 0{\cdot}5$ kcal mol^{-1}.

Mixtures of 8CB and 10CB were then prepared and some of these compositions gave wide range smectic phases and

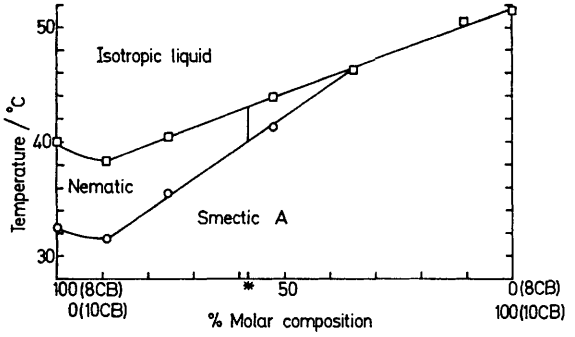

FIGURE The transition temperatures of binary mixtures of 4-cyano-4′-n-octylbiphenyl (8CB) and 4-cyano-4′-n-decylbiphenyl (10CB); ○ smectic A–nematic transition temperatures; □ nematic or smectic A–isotropic liquid transition temperatures; * eutectic composition (42% 10CB).

fairly narrow range nematic phases. The transition temperatures of mixtures of 8CB and 10CB over the complete composition range are plotted in the Figure. The eutectic composition and melting point were calculated by the technique of Harrison *et al.*[4] The value of the predicted melting point was confirmed by optical microscopy. The eutectic mixture had the transition temperatures:

$$\text{solid} \xrightarrow{5^\circ C} \text{smectic A} \xrightarrow{40^\circ C} \text{nematic} \xrightarrow{43^\circ C} \text{isotropic liquid.}$$

The eutectic mixture of 8CB and 10CB appears to be suitable for use in smectic liquid crystal devices. The study of other mixtures of 4′-substituted derivatives of 4-cyanobiphenyl is now under way, since it is possible that different applications of smectic display devices will require different transition temperatures and phase ranges. If these requirements could be made known, then it may be possible to tailor-make various mixtures of compounds, each mixture being best suited to the particular needs of a specific smectic display device.

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[1] G. N. Taylor and F. J. Kahn, *J. Appl. Phys.*, 1974, **45**, 4330.
[2] M. Hareng and S. Le Berre, *Electron. Letters*, 1975, **11**, 73.
[3] G. W. Gray and A. Mosley, *J.C.S. Perkin II*, 1976, 97.
[4] K. J. Harrison, D. S. Hulme, and E. P. Raynes, *J.C.S. Chem. Comm.*, 1974, 98.