

Biaxial Nematics formed from Flexible Molecules

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The early theories and so predictions for the biaxial nematic phase were based on the assumption that the constituent molecules were rigid and possess D_{2h} symmetry [1]. Neither assumption is true for real mesogenic molecules; invariably the molecules contain flexible alkyl chains which cause the molecular shape, symmetry and biaxiality change with conformation. This is especially true when the alkyl chains link the mesogenic groups as in liquid crystal dimers [2] and tetrapodes [3]; both of which have been claimed to form a biaxial nematic phase.

The influence of the flexibility on the phase behaviour is known to be profound for uniaxial nematic phases because of the coupling between the conformational and orientational order. In particular, the elongated conformers are stabilised in the uniaxial nematic phase at the expense of the bent. This results in the classic odd-even effects exhibited by liquid crystal dimers and the prediction of a nematic-nematic transition for odd dimers [4]. It is to be expected that such effects should also influence the stability of the biaxial nematic phase which could favour the bent conformers with respect to the linear. To explore these intriguing possibilities we have used a generic model of liquid crystal dimers in which the various conformers are represented by just two with a linear and a bent form [4].

The model has been investigated using a molecular field approach. In this the two arms of the dimers are taken to be equivalent so that the biaxiality of the bent form depends solely on the interarm angle. In fact, when this is tetrahedral ($\cos^{-1}(1/3)$) the molecular biaxiality is maximal and a system of such bent conformers is found to undergo a weak transition directly from the isotropic to the biaxial nematic phase [5]. We have studied the predicted phase behaviour of a mixture of exchanging bent and linear conformers as a function of the internal energy difference between them. The model system is discovered to exhibit a fascinatingly rich phase behaviour including a biaxial nematic island.

References

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