Ferroelectric Splay Nematic Phase

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Nematic liquid crystals have been known for more than a century, but it was not until the 60s-70s that, with the development of room temperature nematic liquid crystals, they became widely used in applications. Polar nematic phases have been long-time predicted, but have only been experimentally realized recently. In this talk, I will focus on a recently discovered ferroelectric splay nematic phase. A few years ago, R. J. Mandle *et al*[1,2] designed polar liquid-crystalline materials which exhibits two distinct nematic mesophases, the usual uniaxial nematic phase and the lower temperature splay nematic phase[3]. The weakly first order phase transition between the phases is accompanied by pretransitional behavior, manifested as strong splay orientational fluctuations. We showed that the transition between the uniaxial and the new nematic phase is a ferroelectric-ferroelastic phase transition, in which flexoelectric coupling causes simultaneous occurrence of diverging behavior of electric susceptibility and of instability towards splay deformation [4]. The phase transition can be quantitatively described by a Landau-de Gennes type of macroscopic theory. To understand the molecular origin of polar order, we compared two materials of similar chemical structure, one exhibiting the polar nematic phase and one not, by using experiments and simulations. We found out that just a subtle change in the molecular structure enables denser packing of the molecules when they exhibit polar order which indicates that reduction of excluded volume is a driving mechanism of the polar nematic phase formation[5].

References:

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