Field induced transformations in the biaxial order of non-tilted phases in a Bent-Core Smectic Liquid Crystal and biaxiality in the nematic phase

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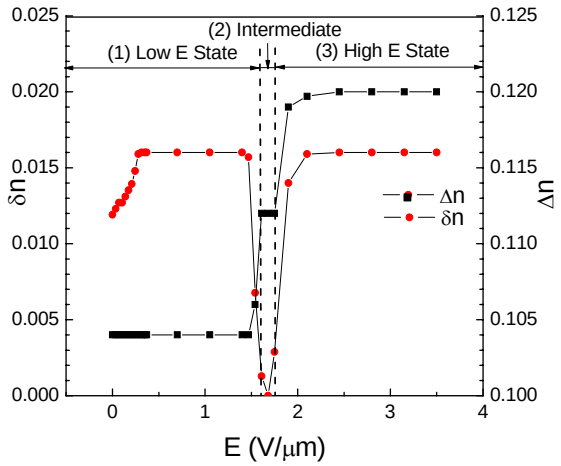
The biaxiality in the non-tilted smectic phases composed of achiral molecules is discussed. In particular, we report the structural and relaxation investigations of an achiral bent-core molecular compound in the $SmAP_A$ phase [1]. In this phase the short directors in the adjacent layers are tilted anti-clinically. The homeotropic cell in $SmAP_A$ phase shows unusual transformation from one biaxial to a second biaxial structure via the quasi-stable uniaxial structure on the application of the electric field. These transformations are explained as a successive transition from antiferroelectric to ferroelectric states, where, the intermediate uniaxial state has the molecular secondary directors in the neighboring smectic layers normal to each other. The biaxiality and the birefringence calculated using the biaxiality-model for the bent-core molecules shows a good quantitative agreement with those obtained experimentally. The field required to achieve a uniform antiferroelectric polar biaxial state to uniaxial state is considerably low ~1V/μm and hence this effect can be used in display applications quite effectively. The cell with a material in such a phase would provide high contrast ratio, wide viewing angle, low driving field and a considerably faster response.



Electric field dependence of the measured biaxiality, δn (■) and birefringence, Δn (●)

We find that in the $SmAP_R$ [2] phase, where the secondary directors are randomly aligned, the second harmonic electro-optic response and the induced polarization show interesting behavior on approaching the lower temperature $SmAP_A$ phase. On applying an in-plane electric field to a cell in the $SmAP_R$ phase, the dipoles gradually orient towards the field direction inducing macroscopic polarization and biaxiality; with the secondary optical axis of the polar directors is directed along the applied field. The distortion of the random distribution obeys the two dimensional Langevin equation and appears as a collective process in the dielectric spectra. Due to a softening of the random structure from $SmAP_R$ to $SmAP_A$ state, the temperature dependence of the relaxation frequency, f_R of the high frequency relaxation process in a planar cell behaves similarly to that observed for the soft mode in FLCs at the SmA* to SmC* phase transition temperature of calamitic liquid crystals. This process is found to be independent of the dielectric measuring voltage and the dc bias.

The determination of biaxiality in the nematic phase using IR spectroscopy will also be discussed.

[1] A. Eremin, S. Diele, G. Pelzl, H. Nádasi, W. Weissflog, J. Salfetnikova and H. Kresse, *Phys. Rev. E* **64**, 051707 (2001).
[2] D. Pociecha, E. Gorecka and J. Mieczkowski, *Phys.Rev. Lett.* **91**, 185501 (2003).