Orientational Transition in a Surface Stabilized Ferroelectric Liquid Crystal Doped with Ferroelectric Nanoparticle

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Nanoparticle doped liquid crystals have been studied broadly. The theory of ferroelectric nanoparticles doped in nematic liquid crystals has been previously developed by Lopatina, et al [1]. Recently, ferroelectric liquid crystals (FLCs) doped with nanoparticles have attracted a wide interest not only from a scientific but also from a practical point of view. The presence of nanoparticles in FLC medium creates strong local fields that produce large alignment effects over the distribution of the nano dispersions [2-3]. Thus, the properties of these nanostructure materials can be significantly different from those of bulk materials. Moreover, the presence of external fields exhibits a very interesting transition, reported by recent experiments [4]. It is well known that the ferroelectric liquid crystals, exhibit smectic layer structures in which the director tilts with respect to the layer normal. FLCs possess a permanent spontaneous polarization which is parallel to the layers. Applying an external field has orientational effects on both director and polarization vectors.

In this work, we investigate the response of a surface stabilized ferroelectric liquid crystal (SSFLC) doped with ferroelectric nanoparticles to applied electric fields. We assume that the smectic layers consist of uniform planes with a fixed orientation and the system is free from dislocation of constant layer thickness due to nanoparticles. The coupling between the nanoparticles and liquid crystal orientations produces a small deviation of the polarization with respect to its initial direction. We obtain the threshold field of orientational transition and the maximum deviation of the polarization vectors for a SSFLC doped with nanoparticles. Then, we discuss the orientational order of the system and formation of inhomogeneous texture.

Our results confirm that the variations in the polarization vector show marked difference with the pure FLC medium and the ferroelectric nanoparticles strongly affect the critical fields, even at low concentrations. It is found that the threshold field depends on the polarization of the nanoparticles as well as both spontaneous polarization and dielectric anisotropy of the liquid crystal host. Furthermore, it reveals that the threshold fields are significantly changed by doping nanoparticles in SSFLC, which is fundamental to operation of many liquid crystal devices.

References:

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