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Theoretical studies of the influence of nanoparticle dopants on the ferroelectric properties of a ferroelectric liquid crystal

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Abstract

Recently, ferroelectric liquid crystals (FLCs) doped with nanoparticles have received extensive interest owing to their fascinating fundamental and technological perspectives. The purpose of this paper is to present our theoretical attempt to study the effects caused by ferroelectric nanoparticles on the properties of a ferroelectric liquid crystal. Our study is based on an extended thermodynamic model of the ferroelectric smectic C (SmC*) phase near the transition to the corresponding smectic A (SmA) phase. We have used the modified Landau free energy, developed for statistical mechanics of the spherical nanoparticles immersed in a FLC medium. The response time of the FLC dispersed ferroelectric nanoparticles is investigated under an applied electric field. The rotational viscosity is also calculated with the possible variation in temperature and the nanoparticle concentration. The obtained results, for the goldstone mode, show a faster response time for the nanodoped system as compared to the pure one. Moreover, a remarkable difference between the rotational viscosities of the pure and doped systems is observed. The variations of polarization and tilt angle are calculated as well. The obtained results for both pure and nanodoped FLC system, near the transition temperature, show the influence of dispersed ferroelectric nanoparticles on the FLC polarization and confirm that the tilt angle is not significantly affected by the presence of the particles. Also, slightly lower spontaneous polarization is revealed for a ferroelectric nanodoped system. Calculations based on this model