Structure, elasticity and phase transitions in the nematic liquid crystals doped with spherical nanoparticles

N. V. Kalinin and A. V. Emelyanenko

Lomonosov Moscow State University, Moscow, Russia

A molecular-statistical theory describing the nematic complexes with nanoparticles is proposed. An influence of anisotropic properties and curvature of the surface on the nematic order parameters of the surrounding liquid crystal is investigated. The order parameters and elasticity constants are evaluated in the framework of a unified approach based on the features of the pair interaction potentials of individual liquid crystal molecules. We explain the two-step heat-driven transformation from the nematic phase with nanoparticles to the isotropic phase, which is observed experimentally in [1]. It is shown that, in contrast to the case of flat surfaces [2,3], the transition from nematic phase to the isotropic phase near the strongly distorted surface (the first step) happens at lower temperatures than the transition in the bulk of liquid crystal (the second step). The molecular features responsible for the nematic order parameters change at both transitions and for the temperature interval between two transitions are outlined.

Spherical nanoparticle in the centre of a large spherical nematic droplet

The distorted surface promotes the two competing effects on the nematic liquid crystal: (1) orientation due to anisotropic interactions of the LC molecules with molecules of the solid surface, and (2) disorientation due to the deformations of the director field, which arise due to the distortion of the surface. We propose a theoretical description of these two competing phenomena on the basis of the molecular-statistical approach. A correlation between the elasticity constants and the constants responsible for propagation of the order parameters into the bulk is found. Both the elasticity constants and the propagation constants are evaluated on the basis of the symmetry aspects of pair potentials of the individual liquid crystal molecules [4,5].

References:

* presenting author; E-mail: emel@polly.phys.msu.ru; http://polly.phys.msu.ru/~emel/