Preparation of Stable Colloids of Nanoparticles in Liquid Crystals and their Dielectric and Magneto-optical Properties

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The prospect of combining the unique properties offered by inorganic nanoparticles (NPs) with the remarkable responsive properties of liquid crystals (LCs) is of intense interest. Particularly, doping LCs with magnetic NPs is a promising route towards enhancing the sensitivity of LCs in response to external fields. However, fundamental research and the development of applications that utilize this class of materials are hampered by the very strong tendency of NPs to aggregate in the LC when the surface of NPs is modified with surfactants even comprising the promesogenic units (PMU), see eg [1]. Recently, we successfully introduced a concept of the development of true stable LC colloids that was based on idea of minimization of the distortion of the LC ordering around the particles using luminescent quantum dots (QDs) as the model NPs and specially designed surfactants (S1-S3) [2].

Here we report on obtainment of stable suspensions of magnetic NPs in nematic LCs (ferronematic LCs) using the developed approach [2]. The produced suspensions are stable and do not reveal any sedimentation up to concentrations $c \approx 5 \%$ by weight. The basic mesogenic, dielectric and magneto-optical properties of the developed suspensions are studied.

![Diagram of Nanoparticles and Surfactants]

It was found an essential decrease of the dielectric constants and dielectric anisotropy of the QDs suspensions in 5CB with respect to the pure LC. At the same time, almost no changes of the clearing temperature and the Fredericksz transition voltage were observed. For the suspension of spherical ferromagnetic CoFe$_2$O$_4$ NPs ($c = 0.05\%$) in 5CB magnetically-induced reorientation of the director of the LC in a cell (50 $\mu$m thickness) with the planar boundary conditions was studied by measuring the dependencies of the birefringence of the suspension on the magnetic field that was perpendicular to the initial orientation of the director. It was found an evident increase of the Fredericksz transition threshold in the suspension with respect to its value in a pure LC. This fact points out to vertical alignment of the LC molecules on the NP surface and formation of anisometric chain-like aggregates of spherical NPs in the LC matrix. The obtained characteristics are reliable and changed a little within a year since the production of the suspension.

References:

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