Colloids of Carbon Nano-Tubes Stuffed with γ-Fe in Liquid Crystals

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Introduction of nano-particles possessing a strong dipole moment into a liquid crystal (LC) is a way to increase sensitivity of LC to external fields. Since the coupling of LC molecules with a particle strongly depends upon anchoring anisotropy of the latter, the elongated shape of the introduced nano-sized objects should enhance these effects significantly. This is even more important while dealing with magnetic particles because of a rather weak magnetic anisotropy of LC. Therefore, to increase sensitivity to magnetic field one needs to use ferromagnetic particles with large shape anisotropy, so iron-filled (γ-Fe) carbon nano-tubes seem to be excellent candidates to study this effect.

We used ferromagnetic carbon nano-tubes (FCNT), which magnetic moment coincided with their long axis and their elongation factor (the length to diameter ratio) exceeded 10. The carbon shell protected ferromagnetic particles against formation of fractals, coalescence, oxidation etc. The magnetic properties of the nano-tubes could be controlled by their size change. The nano-tubes were incorporated in nematic LC 5CB (pentyl-cyanobiphenyl) at 0.0005% weight fraction. The produced colloid was shown to be macroscopically stable with the uniform nano-tubes distribution during the experiments.

Light scattering investigations of the new composite were carried out. Dynamic light scattering of the FCNT colloids allowed estimating their size. Scattered light intensity and the corresponding correlation functions were measured at different temperatures before and after cooling the colloid down to the nematic state and its consequent heating up to the isotropic phase. The scattered intensities and the correlation functions were almost the same, indicating that the colloids did not aggregate during the isotropic to nematic phase transition. This fact is interesting, and not ordinary: usually a transition to a nematic phase results in a strong enhancement of the aggregation processes in colloids.

The colloids revealed an enhanced sensitivity to magnetic field. In particular, our preliminarily measurements have shown evident decrease of Fréedericksz transition threshold in magnetic field.

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