Multiferroic composite of magnetic nanoparticles and ferroelectric liquid crystal

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Dielectric and magnetic properties of a composite system of magnetic NPs in a ferroelectric LC host 9HL have been studied. Monodispersive maghemite (γ-Fe₂O₃) NPs of size 5.0±0.5 nm have been prepared by thermal decomposition of iron acetylacetonate in organic media. Oleic acid coatings are chosen to keep the NPs apart, reducing mainly magnetic dipolar interactions, leading to agglomeration and surface spin effects. LC compound 9HL, exhibiting the SmA*-SmC* phase sequence, has been mixed with NPs in concentration up to 8 weight % of Fe (11% Fe₂O₃). The SmC* phase disappears at concentration 5.6 % of NPs. For higher concentration the tendency of NPs to cluster together along the smectic layers has been observed, which is addressed to the surface energy of the contact between nanoparticles being lower than the surface energy between the nanoparticles and liquid crystal.

Fig. 1. Microphotograph of the studied 5.6% Fe₂O₃ in 9HL, embedded into a commercial 6 μm thick cell. The width of the photograph is 120 μm.

The strong magnetic field (9 T) influence on the temperature dependence of permittivity has been studied for pure 9HL as well as for 1.4 % of NPs in 9HL host. The magnetic properties of NPs and its composite with 9HL have been studied and found to be typical for a system of superparamagnetic nanoparticles with inter-particle dipolar interactions and surface spin disorder. The magnetic response of the composite samples is somewhat modified due to the reduction of the dipolar interactions strength between the NPs.

References:

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