Photorefractive Response in Liquid Crystal Ferroelectric Suspensions.

O. Buchnev[a], M. Herrington[a], Yu. Reznikov[b] and M. Kaczmarek[a]

a University of Southampton, Highfield, Southampton, SO17 1BJ, United Kingdom
b Institute of Physics, National Academy of Sciences of Ukraine, Prospect Nauky 46, Kyiv 03028 Ukraine

Recent studies of colloids of ferroelectric nanoparticles in nematic liquid crystals revealed their strong electro-optic response. Such nematic ferroelectric suspensions show increased orientational coupling, enhanced dielectric anisotropy and anisotropy of refractive index, as well as the sensitivity to the sign of electric field and fast dielectric response [1, 2]. At the same time, due to the extremely small concentration (< 1%) and small size (≤ 100 nm) of the particles, they do not disturb the overall orientation of liquid crystals and the optical quality of cells containing the suspensions can be as high as in cells with undoped liquid crystals.

Combination of good optical quality and advanced characteristics of ferroelectric liquid crystal colloids makes them very attractive nonlinear-optics materials. In particular, we have found that enhanced orientation coupling in liquid crystal and ferroelectric nanocrystals colloids, results in a strong photorefractive effect and efficient two-beam coupling.

We report on our studies of nematic liquid crystals doped with ferroelectric nanoparticles of $Sn_2P_2S_6$ and $BaTiO_3$. First, the size and shape of nanoparticles were investigated using AFM and TEM. Secondly, the photorefractive response of the colloids in Bragg regime was measured. The cells had one substrate covered by rubbed polyimide and the other substrate by a rubbed layer of polyvinyl carbazole (PVK), doped with fullerene. They were filled either with the suspensions of $Sn_2P_2S_6$ or $BaTiO_3$ in nematic mixture or pure nematic mixtures. One of the nematic mixtures investigated was LC 18523 from Merk. The dynamic gratings were written with an applied dc-voltage by two 532.5 nm beams with the intensity ratio between the two incident beams of 1000:1 and Bragg matched two-beam coupling gain was measured. There was a strong dependence of two-beam coupling on the applied dc-voltage, both in the colloid and in the pure nematic liquid crystals. The beam coupling gain was found to be in one order larger than in the pure nematics. Figure 1 presents a typical example of two-beam coupling gain dependence on the grating spacing. As can be seen, at very small grating spacing (0.8 μm), the gain measured in colloids is up to two orders of magnitude larger than in the pure nematic.

The results on improved photorefractive response from ferroelectric liquid crystal colloids demonstrate their potential for applications in optical processing.

References

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Figures

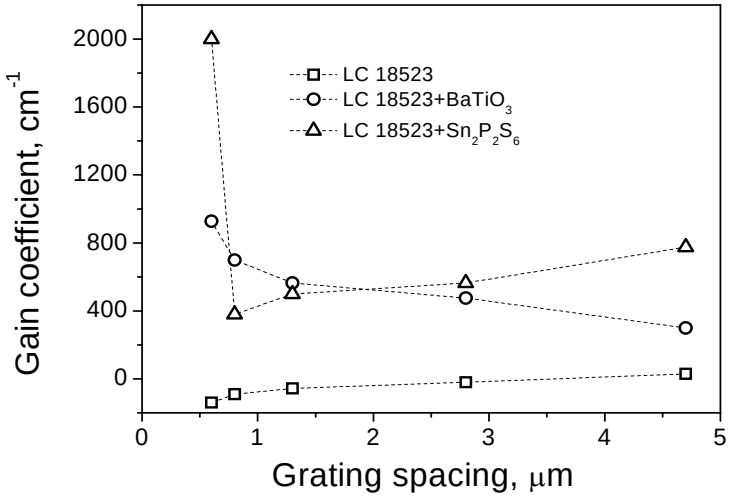

Figure 1. Dependence of the gain coefficient on the grating spacing measured for the LC and the LC ferroelectric suspensions.

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