Dielectric spectroscopy of ferronematics based on 6CHBT liquid crystal

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The great idea to increase the magnetic susceptibility of liquid crystals by doping them with fine magnetic particles originates from F. Brochard and P. G. de Gennes’ theory [1]. Since then, experimental efforts are being made to achieve magnetic field induced liquid crystal phase transitions [2]. However, the dielectric properties of such liquid crystal composites constitute important features in structural and stability characterizations. Especially, the dielectric spectroscopy is a very useful method focusing on relaxation processes happening in complex systems [3].

In our study, the dielectric behaviour of the rod-like liquid crystal (6CHBT) doped with magnetic nanoparticles of spherical shape has been investigated by means of dielectric spectroscopy in the frequency range from 20 Hz to 2 MHz. The experiment was carried out in an electromagnetically shielded anechoic chamber, free of any external electromagnetic interference up to 18 GHz. Two pronounced dielectric dispersions were revealed in the complex permittivity spectra present in nematic and isotropic phases. In order to define the relaxation mechanisms we fitted the dielectric spectra with two Havriliak-Negami relations, conductivity term and corresponding fitting parameters [4]. The low frequency dielectric dispersion is suggested to stem from the polarization of electric double layers present on the ITO electrodes – LC interface as well as on the dispersed particles surfaces. The high frequency relaxation process overlaps with the spurious signal from ITO coated glass plates. To eliminate the unwanted signal and to become more elemental about this mode, we have performed the spectroscopy on several sample thicknesses, while keeping the electric field constant. Finally, we suggest the LC molecular rotation to be accountable for that process. Following the temperature dependent relaxation times analysis we determined the activation energies.

In conclusion, electric double layers form at particles – LC molecules interface according to Schwarz theory. The electric polarization of these layers was detected by means of dielectric spectroscopy as a contribution to the electrode polarization dielectric dispersion.

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