Three dimensional tracking of particles in electrohydrodynamic convection of a nematic liquid crystal

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Nematic liquid crystal (NLC) is an anisotropic fluid exhibited by elongated organic molecules. The nematic phase has only a long-ranged orientational order of molecular direction, i.e. there is no positional order. The orientation of NLC is quite sensitive to external fields such as electric field and surface. The elastic effect of contacting surface is one of the popular candidates for controlling the director orientation. The dispersion of colloids in NLCs has attracted a growing attention since it gives rise to anisotropic interaction between them, depending on the type of surface-modifications, through the elastic distortion in the director field. [1] In particular the dynamics of particles is studied intensively by applying electric fields. For example, electrophoretic transport of the elastic dipoles is enabled by the asymmetric elastic distortion by the radial anchoring of spherical particles. [2] Such an electrically driven transport of particles is very interesting not only from the fundamental interest but also from the viewpoints of practical applications. In this work, we dispersed surface-modified solid and liquid particles in electrohydrodynamic convection of a NLC. Above the threshold, the instability due to ions and anisotropic electric conductivity gives rise to the so-called Williams domain (WD) which accompanies a stripe pattern due to the deflection of polarized light. [3] We characterized the motion of particles in three dimensions. It is found that the surface modification is of importance for the motion of particles even in WD which has the counter-rotating structure. Boojum-colloids are transported in both directions normal to the roll, whereas the elastic dipoles showed a different motion by the persistent electrophoretic effect. Stereoscopic microscope measurements revealed how particles are transported by the emergence of WD as shown in Fig.1.

Fig.1: A cross sectional trajectory of an elastic dipole in WD

References:

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