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Electric Field Induced Surface Instability in a Ferroelectric Nematic Material

In external fields wide range of surface instabilities can be observed in fluids, like the Rosensweig instability in ferrofluids in presence of magnetic field or the Rayleigh-Taylor cone instability in electric field. After the recent discovery of polar nematic materials [1], which have a ferroelectric nematic phase, an obvious question arises: Can an electric field driven surface instability be observed in these materials? We studied the liquid crystal RM734 that exhibits both a ferroelectric and a normal dielectric nematic phase. We investigated the response of RM734 droplets to electric fields in the nematic and the ferroelectric nematic phase using in-plane and normal electrodes in various geometries. In our experiments on the ferroelectric nematic phase, we observed pattern formation (see Fig. 1) as a consequence of an electric field induced surface instability. We characterize the effect and make FEM simulations to visualize the electric field in the material. As a results of our measurements, we provide a model to explain the basic mechanism of the pattern formation observed in ferroelectric nematic droplets with free surface exposed to electric fields.

Figure 1: Electric field induced pattern formation in a ferroelectric nematic fluid (b).

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References:

[1] H. Nishikawa, et al., Adv. Mater. 29, 1702354 (2017); A. Mertelj, et al., Phys. Rev. X 8, 041025 (2018); X. Chen, et al., PNAS 117, 14021 (2020)