

Van der Waals interaction and stability of multilayered liquid-crystalline systems

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In restricted geometry the macroscopic order of confined liquid crystals can be strongly affected by the confining walls resulting in an inhomogeneous order and/or deformation of corresponding director fields. The deformed average order and modified boundary conditions affect the spectra of thermal fluctuations. Substrate induced change of the order gives rise to the structural and fluctuation-induced force between the confining walls. In addition to these two forces the thermal fluctuations of the instantaneous electric dipoles of the constituting molecules yield the van der Waals force which is long known and, thus, assumed to be a solved problem. However, the van der Waals force between macroscopic bodies depends delicately on the symmetry of the dielectric permittivities of the constituting bodies which is often neglected. The total force between the confining walls plays an important role in the stability of thin liquid-crystalline depositions.

Here we apply the study of the van der Waals force to multilayered nematic liquid-crystalline systems: (i) In nematic wetting systems the degree of nematic order is inhomogeneous and results in an effective multilayered structure — solid substrate–nematic/isotropic wetting layer–isotropic/nematic bulk. Here the renormalization of the mean-field description due to the van der Waals interaction results in a modified critical exponent associated with the growth of the order at the transition. (ii) In experimental liquid-crystalline set-ups one is often subject to additional layers such as oxide layers or layers of water condensing from the atmosphere, which can profoundly change the stability of a liquid-crystalline system. We present results of a study of stability of thin multilayered liquid-crystalline depositions in systems with a dominant van der Waals interaction. Our results are in good qualitative agreement with the experimental observations reported in the last few years and in some cases they give a new insight in the observed phenomena.