On the theory of the dielectric susceptibility of ferroelectric nematic liquid crystals.

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A distinguishing feature of ferroelectric nematic LCs is their remarkably high relative dielectric permittivity (~ 10^4), within a frequency range up to the kHz regime which has been measured by many authors [1-5]. At the same time it has been suggested in [6] that in ferroelectric nematics with very high spontaneous polarization, the large measured values of the dielectric permittivity are only apparent values, which result from the very large capacitance of thin alignment layers. . It has also been concluded without proper justification that the electric field inside the nematic layer vanishes and as a result the intrinsic dielectric susceptibility of the polar nematic medium does not contribute to the measured dielectric constant An alternative interpretation of the experimental data, based on the model of the equivalent circles, has been proposed in [5], and the authors arrived at the conclusion that the large measured values are determined by the large polarizability of the ferroelectric nematic medium itself although the relationship between the apparent and the actual dielectric susceptibility is not straightforward.

We have developed a consistent theory of the dielectric permittivity of the ferroelectric nematic phase considering the two different contributions to the total impedance of the ferroelectric nematic cell determined by intrinsic permittivity of the nematic material and by the rotation of the spontaneous polarization caused by the AC electric field, respectively. The rate of the rotation of the spontaneous polarization has been determined using the Landau –Khalatnikov equation and the novel expression for the free energy of the flat nematic liquid crystal cell with two alignment layers which has recently been derived in [7,8]. It has been shown by minimization of the correct thermodynamic potential that the electric field is nonzero inside the nematic layer, and a general expression for the apparent dielectric susceptibility of the ferroelectric nematic cell has been obtained which depends both on the properties of the alignment layers and on the intrinsic susceptibility of the nematic medium. One concludes that in the case of relatively low (< 10^3) intrinsic susceptibility the measured dielectric constant is mainly determined by the alignment layers. In contrast, for large intrinsic susceptibility the measure dielectric constant is mainly determined by the intrinsic susceptibility while the boundary layers make a smaller contribution. Thus the existing experimental data are consistent with high values of intrinsic polarizability of the ferroelectric nematic.

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