Simultaneous Determination of Elastic Constants and Anchoring Energy of Nematic Liquid Crystal Cells from Capacitance-Voltage Measurement

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Elastic constants and anchoring energy of nematic liquid crystal (NLC) cells are important physical quantities for the optimal design of the NLC displays because the electro-optic properties of NLC displays are governed by both elastic constants and anchoring energy. Elastic constants have been determined under strong anchoring condition by measuring the capacitance (C) or the optical phase retardation (R) of NLC cells as a function of applied voltage (V) [1]. On the other hand, anchoring energy has been determined by measuring both C-V and R-V characteristics of NLC cells using the elastic constants pre-determined under strong anchoring condition [2]. It is found, however, that the elastic constants and the anchoring energy should be determined simultaneously because both elastic constants and anchoring energy affect the C-V and R-V characteristics of NLC cells. In this work, we propose a method for determining simultaneously the elastic constants and the anchoring energy of NLC cells by fitting numerically calculated C-V characteristics of NLC cells to the experimental results.

The NLC material used in the experiment was MLC-2039 with negative dielectric anisotropy. The thickness of the NLC cell is 22 μm and the area of the electrode is 1.13 cm^2. A rectangular voltage pulse train (80 Hz) up to ±20 V was applied to the NLC cell to avoid space charge polarization of impurity ions. Capacitance of the NLC cells was measured at 293 K with a lock-in amplifier by superimposing sinusoidal voltage (±50 mV, 1 kHz) onto the rectangular voltage train.

C-V characteristics have been calculated by numerically solving the torque balance equations at the surface and in the bulk of NLC cells [3]. Figure 1 shows C-V characteristics of the homeotropic MLC-2039 cell and numerically fitted results. The fitted results are in good agreement with the experimental results. The splay elastic constant K_{11}=16.8 pN, the bend elastic constant K_{33}=18.1 pN and the anchoring energy A=1.85×10^{-4} J/m^2 of homeotropic MLC-2039 cell are determined simultaneously.

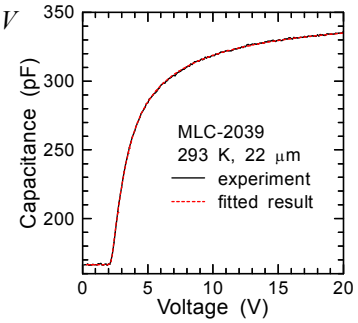

Fig. 1 C-V characteristics of the homeotropic MLC-2039 cell and the numerically fitted results.

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