Continuously controlled liquid crystal pretilt by anchoring competition of the orientation bilayer

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Uniform alignment of Liquid Crystals (LCs) on an oriented polymer layer is essential for high quality liquid crystal displays (LCDs). Aligned hydrophilic surface leads to homogenization of the LC alignment, which reduces the elastic strain energy of the LC. Several methods have been proposed to achieve good alignment. In optical configuration of LCDs, the pretilt is one of the most important parameters because it strongly influences the electo-optical property of various LCD modes [1-3], such as twisted nematic LC mode, super twisted nematic LC mode, ferroelectric LC mode, vertical aligned LC mode, and in-plane switching LC mode. Factors that influence the pretilt of LC have been studied through various approaches. However, continuous pretilt control remains still unsettled issue at middle points between homogeneous and homeotropic alignments.

Many scientists have been interested in the interface between a polymer surface and mesogen phase and especially in the polar anchoring at a polymer-nematic boundary because of scientific and practical value. The pretilt of LC is related deeply to polar anchoring. If we can control the polar anchoring of LC, the pretilt can be controlled successfully.

In this paper, we present an approach controlling continuously LC pretilt by tuning the competition of LC anchoring from two LC alignment layers. If LCs are separated gradually from the surface by air or vacuum or some hydrophobic materials, the surface free energy will increase and polar orientation transition into alignment states with uniform pretilt may be induced continuously to lower their total free energy. It means that polar anchoring of LC can be controlled by two layers showing relatively different interactions (hydrophobic and hydrophilic properties). If the rise of surface free energy is large appropriately, LC system may lower its total free energy further by undergoing a polar orientation transition into an alignment state with uniform pretilt. In our experimental result, a screened electric field decays roughly exponentially with distance according to Exp(-Kd) where the characteristic decay length, 1/k, is known as the Debye screening length or Tomas-Fermi screening length. As a result, therefore, we obtained continuous pretilt control by using such field decay by the screen effect adjusted by the thickness of the first alignment layer. We expect that it can be applied to various LCD applications.

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