Flexible Liquid Crystal Displays Using Polymer Walls and Fibers

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Recently, various display devices using plastic substrates have been proposed as next-generation flexible displays, such as roll-up screen displays and wall-paper displays. Ferroelectric liquid crystal (FLC) devices, using plastic substrates, have great potential for realizing flexible displays suitable for moving TV images because of their high-speed response characteristic, compared to conventional nematic liquid crystal displays. However, the FLC devices generally have the disadvantages of poor mechanical stability and difficulty with grayscale capability. In order to overcome these problems, our group has been developing an FLC device using fine polymer walls and fibers, which can be sequentially formed by photopolymerization-induced phase separation using two-step ultraviolet (UV) irradiation of a molecularly aligned FLC/monomer solution. The lattice-patterned polymer walls adhere to the surfaces of the plastic film substrates and keep the FLC thickness constant. The FLC molecules are also mono-stabilized by the strong anchoring of the aligned polymer fibers which are dispersed in the FLC. These functions enable the device to exhibit a high bending tolerance (curvature radius: 1.5 cm) and grayscale display operation with a fast response of less than 1ms. An A4-paper-sized flexible color display was fabricated with a plastic substrate, based on processes including flexographic printing and lamination. Field sequential color moving images were displayed on this large panel by driving it with an active technique, using external switch transistor array. In this report, the operating principle, fabrication process, bending tolerance and display properties will be discussed in detail.

Keywords:

Ferroelectric Liquid Crystal :
Liquid crystal with chirality and spontaneous polarization.

Photopolymerization-induced phase separation :
A method of forming a composite film of polymer and liquid crystal by polymerizing UV-curable monomers with UV irradiation and segregating the polymers, which are unable to dissolve in the liquid crystal.

Polymer Wall :
A wall structure of high-density polymer, which is formed by local photopolymerization-induced phase separation with patterned UV irradiation through a photomask, in order to achieve a constant thickness of the liquid crystal layer.