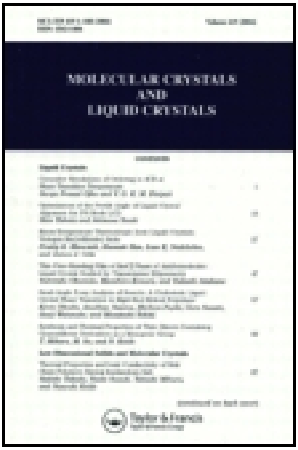


Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Viewing Characteristics of Nematic Liquid Crystal Cells with Homogeneous Micro-Domains Embedded in Omeotropic Alignment

Dong Guk Kim [a], Sin-Doo Lee [b] & Hee-Woo Rhee [a]

[a] Dept. of Chem. Eng., Sogang Univ., Seoul, 121-742, Korea

[b] School of Electrical Eng., Seoul National Univ., Seoul, 151-742, Korea

Version of record first published: 24 Sep 2006

Mol. Cryst. and Liq. Cryst., 2000, Vol. 349, pp. 255-258
Reprints available directly from the publisher
Photocopying permitted by license only

Viewing Characteristics of Nematic Liquid Crystal Cells with Homogeneous Micro-Domains Embedded in Omeotropic Alignment

DONG GUK KIM[a], SIN-DOO LEE[b] and HEE-WOO RHEE[a]

[a]*Dept. of Chem. Eng., Sogang Univ., Seoul 121–742, Korea and* [b]*School of Electrical Eng., Seoul National Univ., Seoul 151–742, Korea*

The hybrid double layer with homogeneous micro-domains embedded in homeotropic alignment was used for improving viewing characteristics of vertically aligned nematic liquid crystal (LC) cells. After surface treatment of a polyimide (PI) layer blended with [poly(vinyl cinnamate)] (PVCi), the homogeneous micro-domains were found to be uniformly distributed over the homeotropic layer. The contrast ratio of LC cells, made with the hybrid double layer, along the direction of 45° to one of the polarizers, was about 10:1 up to ±30° without any compensation film.

Keywords: viewing characteristics; vertically aligned mode; homeotropic-homogeneous hybrid double layer

INTRODUCTION

Recently, liquid crystal displays (LCDs) with multi-domains (typically 2 or 4 domains) have been developed in order to improve viewing angle characteristics [1,2]. One of technologies of improving viewing characteristics is to divide each pixel into sub-domains in which their optical characteristics compensate with each other. However, since the multi-domain method involves complicated and costly processes such as photolithography and multiple rubbing processes, it has still many problems to be employed in mass production of LCDs [3].

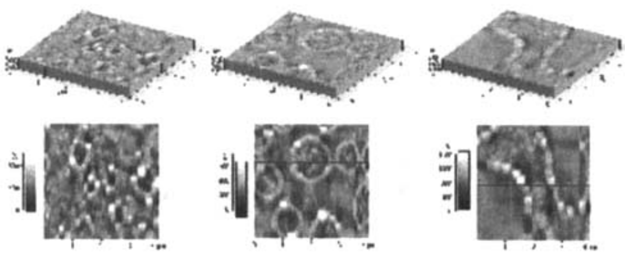
Therefore, we have studied a hybrid double layer with homogeneous micro-domains embedded in homeotropic alignment as an alignment layer for wide viewing LCDs. The contrast ratio of LC cells, made with such hybrid double layer, along the direction of 45° to one of the polarizers, was about 10:1 up to ±30° without any compensation film. Subtle changes in surface treatment of the hybrid layer were found to play an important role in controlling uniformity of the LC alignment.

EXPERIMENTAL

In order to prepare a homeotropic-homogeneous hybrid layer with micro-domains, a homogeneous polyimide (PI) layer (AL 3046, JSR Co.) was first spin-coated on indium-tin-oxide glass. On the top of such layer, another PI (JALS-204, JSR Co.), giving homeotropic alignment, blended with PVCi was subsequently coated. The blending ratio of PI/PVCi was adjusted to find the optimum condition. A mixture of monochlorobenzene and dichloroethane that acts as a good solvent for PVCi but poor one for PI was used for surface treatment. Test cells were then made with rubbed hybrid substrates. The cells were filled with a commercial liquid crystal (EN-40, Chisso Co.) which has negative dielectric anisotropy. The gap of each cell was nominally 5 μm. Surface morphology of the homeotropic-homogeneous hybrid layer with micro-domains was studied by an atomic force microscope (AFM) and an optical polarizing microscope. The viewing angle characteristics were determined from the measured iso-contrast map of the test cells.

RESULTS AND DISCUSSION

The AFM images of the surface treated alignment layer are shown in Figure 1 as a function of the weight ratio of PI to PVCi.



(a) (b) (c)

FIGURE 1 The AFM images of homeotropic-homogeneous micro-domains: (a) PI:PVCi=10:3, (b) 10:5, and (c) 10:7 (scanning size: 4 μm x 4 μm).

Homogeneous domains of less than 10 micrometers are clearly seen in Figure 1. Note that PVCi domains distributed over the homeotropic layer were washed out by surface treatment. The homogeneous domains were varied from 1 μm to 10 μm and they tend to increase with increasing the weight ratio of PVCi. This comes from the aggregation tendency of PVCi in the high concentration regime.

In order to investigate the LC orientation, an optical polarizing microscope was used.

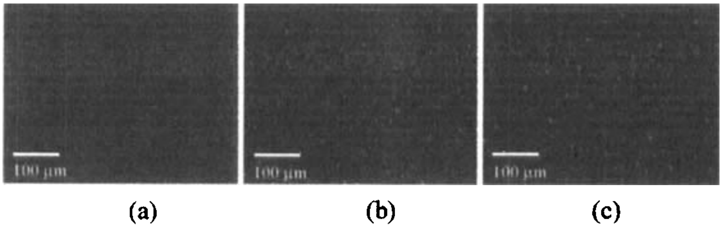


FIGURE 2 The microscopic textures of the test cells:
(a) PI:PVCi=10:0, (b) 10:3, and (c) 10:5 (magnification: x200).

It is clear from Figure 2 (a) that no light can pass through the cell under crossed polarizers because all LC directors are vertically aligned. In Figures 2(b) and 2(c), the observed white spots of less than 10 micrometers are the homogeneous micro-domains embedded in the homeotropic layer. This tells us that PVCi was successfully removed by surface treatment without doing damage to the homeotropic layer.

Viewing characteristics of the test cells with homogeneous micro-domains embedded in homeotropic alignment are shown in Figure 3. The rubbing directions were anti-parallel and polarizers were positioned along the direction of 45° to the rubbing direction. Figures 3(a) and (b) show that the contrast ratio of the test cells, made with the hybrid double layer, along the direction of 45° to one of the polarizers, was about 10:1 up to ±30° without any compensation film. On the other hand, the simulation result of vertically aligned (VA) mode (Figure 3 (c)) indicates that along the rubbing direction of 45° to the polarizer, the contrast ratio of 10:1 was obtained up to ±22°. This value is close to other simulation results [4]. The reason why the cell made with the hybrid double layer showed better viewing characteristics than VA mode one is that LC orientation was influenced by homogeneous micro-domains and compensated for the difference of optical characteristics.

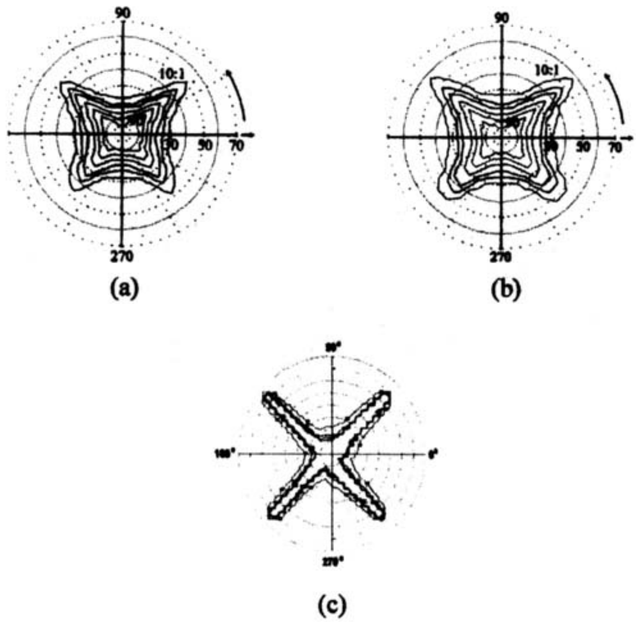


FIGURE 3 Viewing characteristics of test cells: (a) PI:PVCi=10:3, (b) 10:5, and (c) simulation results of the VA mode cell.

References

[1] H. Murai, M. Suzuki, T. Suzuki, T. Konno, and S. Kaneko, *Liquid Crystal,* **25**(2), 131 (1998).
[2] S. A. Lien, C. Cai, R. W. Nunes, and R. A. John, *Jpn. J. Appl. Phys.,* **37**(5B), L597 (1998).
[3] H. Vithana, D. Johnson, P. Bos, R. Herke, Y. K. Fung, and S. Jamal, *Jpn. J. Appl. Phys.,* **35**(1A), 2222 (1996).
[4] C.-K. Wei, and I.-W. Wu, *Proceeding of the 5 th International Display Workshops,* 139 (1998).