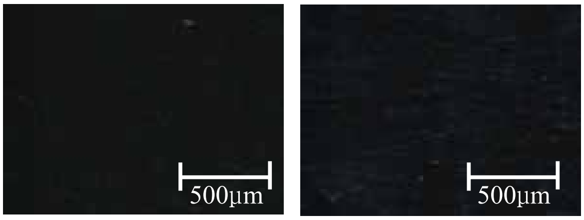
The study of thick cell gap on the alignment of a ferroelectric liquid crystal cell

Jin-Jei Wu, Po-Chang Wu and Fu-Cheng Sie*
Department of Electro-Optical Engineering, National Taipei University of Technology, 1, Sec. 3, Chung-Hsiao E. Rd. 106 Taipei, Taiwan, Republic of China
Phone:+886-2-27712171-4625, e-mail: s4659004@ntut.edu.tw

Abstract
According to the experiment results, the alignment of FLC cell can become more uniform at thick cell gap by adjusting the amplitude of the aligned AC electric field which is applying to the FLC cell during N-SmC* phase transition. If the amplitude of AC electric field is high enough, the FLC molecules forced with the amplitude and aligned to a particular direction.*

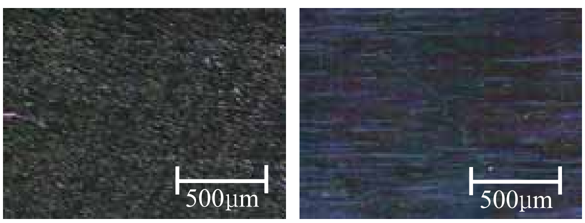
1. Introduction
Ferroelectric liquid crystal (FLC) has attracted a great consideration since the surface stabilized state of FLC discovered by N.A. Clark et al [1]. Its superior features of fast response and wide viewing angle are suitable for displaying high quality moving picture, high definition, and high resolution TV. However, the so called zigzag defect still exists in the layer structure of FLC [2]. The defects reduce the contrast in the applications of FLC display. In order to overcome this problem, many groups have reported the methods of uniform alignment [3-4] and demonstrated the prototype panels [5-6]. In these methods, the basic concept is making the cell gap as thin as possible (under 2μm) to satisfy the condition of surface stabilized FLC. However, the thin cell gap is difficult for the manufacturing to achieve uniform gap in large size panel. The cell gap dependence of a FLC cell becomes a main issue in the application of large size liquid crystal display.
In our pervious research, we have studied the mechanism of alignment and temperature dependence of the FLC materials with N*-SmC* phase sequence in thin cell gap (d=2μm) [7-8]. The alignment can be controlled by applying AC electric field in the FLC cell during N*-SmC* phase transition. By optimizing the aligned frequency and cooling rate, a uniform alignment of whole cell will be achieved. In this study, we investigated the cell gap dependence on the alignment of the FLC cell.

2. Results
The conditions of cell gaps set to 2μm, 3μm, and 5μm. In the case of d=2μm, the optimums of uniform alignment of a FLC cell have been found by our group. Figure 1 shows the microscope texture of FLC cell at d=2μm in the SmC* phase after the application of different aligned conditions. When the FLC cell cooled form N* to SmC* phase without applying any electric field, two types of domain formed in the SmC* phase. As the AC electric field applied to the FLC cell during N*-SmC* phase transition, the uniform alignment can achieve in the SmC* phase under two conditions. The first one is AC electric field at V=±10V, f=0.1Hz and cooling rate at -5°C/min and the other is AC electric field at V=±10V, f=700Hz and cooling rate at -0.2°C/min, as shown in Fig. 1(a) and (b), respectively. Following the above result, the alignment conditions of 3μm and 5μm cells are set as same as the 2μm cell. However, the alignment of 3μm and 5μm cells can not as uniform as the 2μm cell, as shown in Fig. 3 in comparison with Fig. 1. Again, optimizing the aligned conditions for the 3μm and 5μm cells, the amplitude of aligned AC electric field changed to V=20V and 30V, respectively. As shown in Fig. 4, the alignments become more uniform comparing to Fig.3. It suggests that the amplitude of AC electric filed must be high enough that can affect the FLC molecules to align at particular direction and make the alignment more uniform.



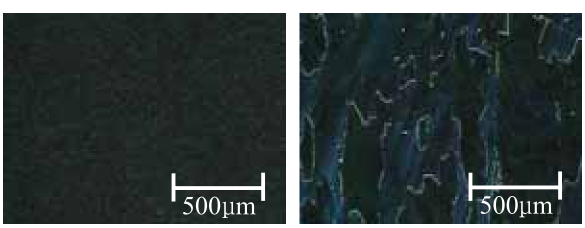
(a) (b)

Figure 1 The microscope texture of 2μm FLC cell in the SmC* phase after the application of different aligned conditions. Applying ac electric field to the cell during N*-SmC* phase transition at (a) V=±10V, f=0.1Hz and cooling rate at -5°C/min and (b) V=±10V, f=700Hz and cooling rate at -0.2°C/min.

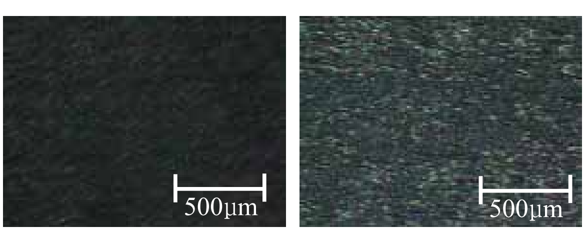


(a) (b)

Figure 2 The microscope texture of 3μm FLC cell in the SmC* phase after the application of different aligned conditions. Applying ac electric field to the cell during N*-SmC* phase transition at (a) V=±10V, f=0.1Hz and cooling rate at -5°C/min and (b) V=±10V, f=700Hz and cooling rate at -0.2°C/min.



(a) (b)



(c) (d)

Figure 3 The microscope texture of 3μm and 5μm FLC cells in the SmC* phase after the application of different aligned conditions. Applying ac electric field to the 3μm cell during N*-SmC* phase transition at (a) V=±20V, f=0.1Hz and cooling rate at -5°C/min and (b) V=±20V, f=700Hz and cooling rate at -0.2°C/min, and 5μm at (c) V=±30V, f=0.1Hz and cooling rate at -5°C/min and (d) V=±30V, f=700Hz and cooling rate at -0.2°C/min.

3. Acknowledgements

This work was supported in part by the National Science Council of the Republic of China under the contract No. NSC-94-2215-E-027-009.

4. References

[1] N. A. Clark and S. T. Lagerwall, Appl. Phys. Lett. 36, 899 (1980).

[2] T. P. Rieker, N. A. Clark, G. S. Smith, D. S. Parmer, E. B. Sirota and C. R. Safinya: Phys. Rev. Lett.

[3] R. Kurihara, H. Furue, T, Takahashi, T. Yamashita, J. Xu, and S. Kobayashi, Jpn. J. Appl. Phys. 40, 4622(2001)

[4] Aira Hotta, Ray Hasegawa and Kohki Takatoh, Jpn. J. Appl. Phys. 43, 6243(2004)

[5] Y. Asao*, T. Togano, M. Terada, T. Moriyama, S. Nakamura and J. Iba, Jpn. J. Appl. Phys. 38, 5977 (1999).

[6] Shunsuke Kobayashi, Jun Xu, Hirokazu Furuta, Yuji Murakami, Satoru Kawamoto, Masafumi Oh-kouchi, Hiroshi Hasebe, Haruyoshi Takatsu, Opt. Eng. 43(2) 290 (2004)

[7] Po-Chang Wu and Jin Jei Wu, submitted to J. Appl. Phys.

[8] Jin-Jei Wu and Po-Chang Wu, and Fu-Cheng Sie, will be published in ILCC'06