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새로운 VA-π cell mode를 이용한 광시야각 및 응답속도에 관한 연구

Study of wide viewing angle and response time by using new VA-π cell mode

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Abstract

We have developed an novel vertical-alignment (VA) - π cell mode that provides a wide viewing angle and fast response times for negative dielectric anisotropy nematic liquid crystal (NLC) on a homeotropic polyimide (PI) surfaces. We had the good voltage-transmittance curves and low driving voltages were achieved with the novel VA - π cell mode without negative compensation film. Iso-viewing angle characteristics using the novel VA - π cell mode without negative compensation film of NLC was also successfully observed. As well a fast response time of 31.7ms for the novel VA - π cell mode was measured. Consequently, It is seen that by using the novel VA - π cell mode the iso-viewing angle, fast response time, and low driving voltage characteristics can be achieved.

Key Words: Vertical alignment(수직배향), wide viewing angle(광시야각), nematic liquid crystal(네마틱액정), VA - π cell mode(VA-π 셀 모드)

1. Introduction

Thin-film-transistor (TFT) - liquid crystal displays (LCDs) are widely utilized in information displays such as notebook computers, monitors, and televisions because they have an excellent resolution quality. However, TFT-LCD performance has not been satisfactory due to a narrow viewing angle and slow response times.

Several methods to improve the viewing angle have been proposed, among these are the addition of birefringence films, domain divided (DD) twisted nematic (TN), in-plane-switching (IPS) mode, and multi domain vertical alignment (VA) mode.[1] MVA-LCD is expected to achieve, eventually a wide viewing angle, fast response time, and high contrast ratio. However, division of each pixel into multi-domains and a fringe field are required for MVA-LCD. As well, the optically compensated bend (OCB) mode has been introduced to try to improve the narrow viewing angle and response time. Unfortunately, this mode may have some difficulties in controlling the LC conformation and pretilt angle. A fast response time for TFT-LCD is required to achieve a high quality image over a large area.

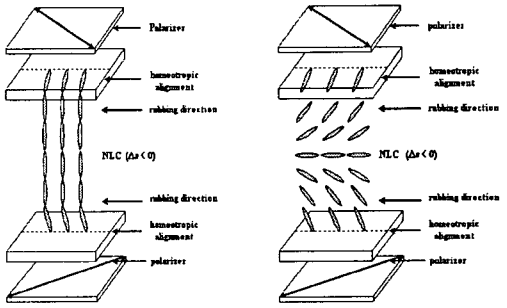
In this work, we report the viewing angle and fast response time characteristics of negative dielectric anisotropy NLC by using the novel VA - π cell mode on a homeotropic PI layer.

2. Experimental

In these experiments, JALS-696-R2 was used for the homeotropic alignment layer. The PI films were coated on indium-tin-oxide (ITO) coated glass substrates by spin-coating, and were imidized at 180℃ for 1 hour. The thickness of the PI layers was 500Å. The PI films were rubbed using a machine equipped with a nylon roller (Y_o-15-N, Yoshikawa Chemical Industries Co., Ltd.). The definition of the rubbing strength (RS) is as given in previous papers.[2] The RS was 187mm for the medium rubbing region. The LC layer thickness of the novel VA - π cell was set at 4.25m. NLC used negative dielectric anisotropy. The voltage-transmittance (V-T), viewing angle, and response time measurements for the novel VA - π cell was done at room temperature (22℃).

3. Result and Discussion

Figure 1 shows the schematic diagram of the novel VA - π cell mode without negative compensation film, in the off- and on-state. In the off-state, the LC directors are aligned vertically to the glass substrates. Under the crossed polarizers and in the normal viewing direction, there was only an ordinary wave and no phase retardation to modulate light polarization. Therefore, the off-state of the novel VA - π cell mode was very dark in the normal direction. In the on-state, in order to does perpendicular to the electric anisotropy need the implication of pretilt to reorient. By the implications of pretilt, the stable LC director field is symmetrically aligned. With this transition, the light was transmitted. Symmetric LC director fields can reduce the gray scale inversion over a large viewing angle.



(a) off-state (b) on-state

Fig. 1 Schematic diagram of the novel VA - π cell mode without negative compensated film in the off - and on - state.

Figure 2 shows the V-T characteristics of the novel VA - π cell without negative compensation film on a homeotropic PI surface. A good V-T curve for the novel VA - π cell was measured; however, light leakage in off-state was measured. Usually light leakage can be compensated for by utilizing negative compensation film. The V-T characteristics of the conventional VA cell on a homeotropic PI surface is shown in Fig. 3. A good V-T curve for the conventional VA cell was also obtained. Table 1 shows the threshold voltage for the novel VA - π cell and the conventional VA cell on homeotropic PI surfaces. It is shown that the threshold voltage of the novel VA - π cell is almost the same as that of the conventional VA cell.

Table 1. Threshold voltage for the VA modes on homeotropic PI surfaces.

modes	V_{10}	V_{90}
novel VA-π cell	2.54	3.72
conventional VA cell	2.56	4.39

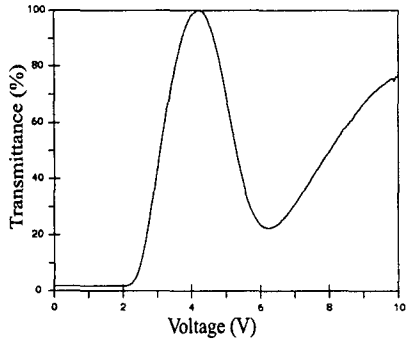


Fig. 2 V-T characteristics of the novel VA - π cell without negative compensation film on a homeotropic PI surface.

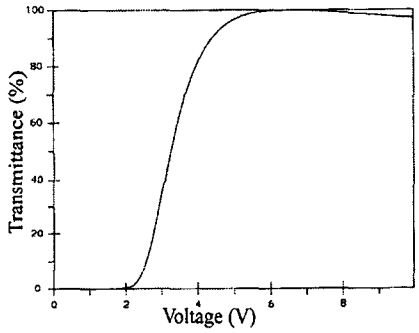


Fig. 3 V-T characteristics of the conventional VA cell without negative compensation Film on a homeotropic PI surface.

Table 2. Response time for the VA modes on homeotropic PI surfaces.

modes	τ_r(ms)	τ_d(ms)	τ (ms)
novel VA-π cell	2.54	3.72	32.7
conventional VA cell	2.56	4.39	36.6

Figure 4 shows the viewing angle characteristics of the novel VA - π cell without negative compensation film on a homeotropic PI surface. Iso-viewing angle characteristics were successfully observed. Additionally, viewing angle characteristics are dependent on the state of darkness. Therefore, a wide viewing angle can be achieved by utilizing a negative compensation film. Asymmetric viewing angle characteristics were measured in the conventional VA cell, as shown in Fig. 5.

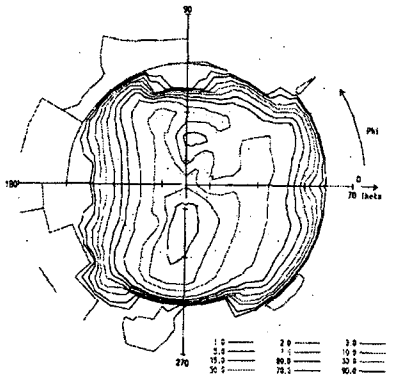


Fig. 4 Viewing angle characteristics of the novel VA-π cell without negative compensation film on a homeotropic PI surface.

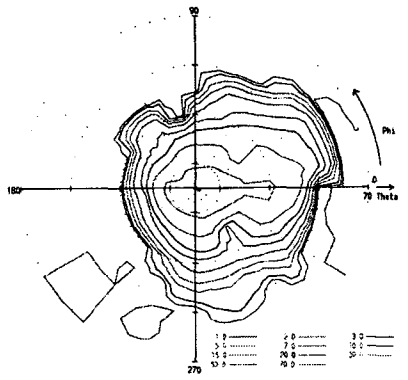


Fig. 5 Viewing angle characteristics of the conventional VA cell without negative compensation film on a homeotropic PI surface.

Figure 6 shows the response time characteristics of the novel VA - π cell without negative compensation film on a homeotropic PI surface. Good response time characteristics were

obtained. Response time characteristics for the conventional VA cell on a homeotropic PI surfaceare shown in Fig. 6. As well excellent response time characteristics for the conventional VA cell were measured. Table 2 shows the response times for the novel VA - π cell and the conventional VA cell on homeotropic PI surfaces. The response time for the novel VA - π cell mode was measured at about 31.7ms. Therefore, the a response time of the novel VA - π cell mode without negative compensation film can be achieved. The response time of the novel VA - π cell is faster than that of a conventional VA cell.

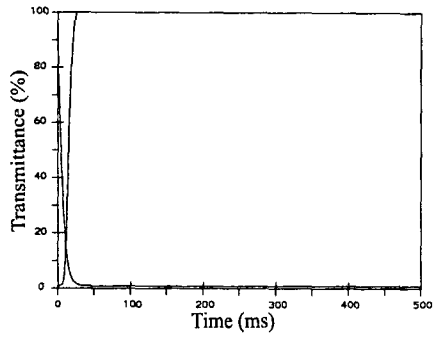


Fig. 6 Response time characteristics of the novel VA-π cell without negative compensation film on a homeotropic PI surface

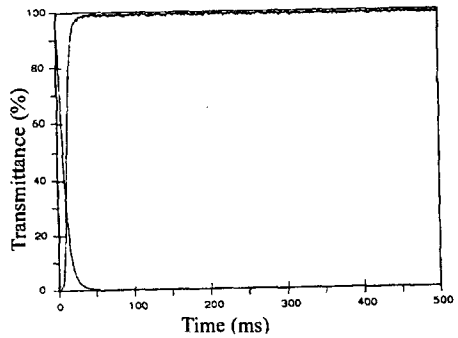


Fig. 7 Response time characteristics of the conventional VA cell without negative compensation film on a homeotropic PI surface

4. Conclusion

We investigated the novel VA - π cell mode without negative compensated film. The iso-viewing angle and fast response time can be achieved by using the novel VA - π cell mode. Based on these results, we suggest that the newly developed the novel VA - cell mode on a homeotropic layer is capable of wide viewing angle, fast response time, and high contrast ratio without the accessory of a multi-domain.

Reference

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