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In this study, the threshold voltage and the response time of thermal stressed TN-LCDs showed the same performances on none thermal stressed TN-LCDs. There was little change in TN cells. Also, while increasing thermal stress time, the transmittances of TN-LCDs on the rubbed PI surface were almost the same, but the thermal stability of TN cell was deteriorated.

Keywords: polyimide (PI); residual DC; response time; thermal stress; transmittance; twisted nematic (TN)

INTRODUCTION

Recently, thin film transistor (TFT)-liquid crystal displays (LCDs) have been widely used in information display devices such as notebook computers, desktop monitors and car navigation systems. It is critical

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that for the long duration, the function of the display should be maintained properly. So it is necessary to examine the problems coming from the long period display [1–2]. The major part of the study of the display stability is the thermal stability, above all, in the area of the projector type LCD. This projector type of LCD has low brightness on the ground of actualization principle. Therefore, to improve brightness, strong source of light is needed and this will induce intensively high heat, causing the characteristics of the LCD to be deteriorated. However, thermal stability of LCD is not reported yet. Therefore, we support that LCD cell used in the LCD projector and projection TV should qualify fast response and high thermal stability. In this paper, we designed to investigate the electro-optic change of LCD when exposed to intense heat for the duration.

EXPERIMENTAL

In these experiments, the polymer (SE-7492, Nissan Chemical Industries Co.) with side chains was used as a homogeneous alignment layer and coated on ITO-coated glass substrates by spin-coatings, which was then imidized at 220°C for 1 h. The thickness of the PI layers was 500 Å. The PI films were rubbed by using a machine equipped with a nylon roller (Y_o-15-N, Yoshikawa Chemical Industries Co.). A definition of rubbing strength (RS) has been given in previous papers [3–8]. The RS used was 187 mm for the medium-rubbing region. The TN cell was used with both-sides rubbed PI surfaces. The LC layer thickness of TN cells was set at 5 μm. NLC(Nematic Liquid Crystal)s(MJ001929, Merck Co.) in positive dielectric anisotropy were used. TN cells were fabricated at room temperature, annealed at 100°C during 6 hr and 12 hr to measure thermal characteristics.

MEASUREMENT

The voltage-dependent transmittance (V-T), response time and residual DC measurements were performed at room temperature (22°C). The EO characteristics were measured by using the LCD evaluation system (LCD7000, Otsuka Co.), and the residual DC was measured by using the Residual DC Measurement System (RDMS-200, SEM, Co).

RESULTS AND DISCUSSIONS

We investigated thermal ability of 90° TN-LCD. This ability in the LCD is important to evaluate the LCD duration because LCD in the

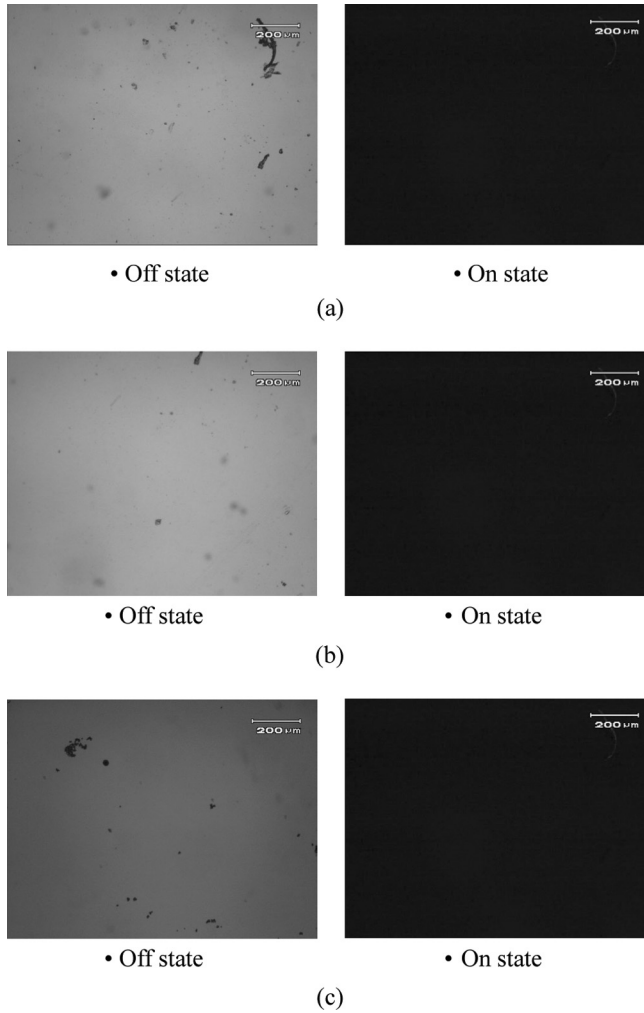

FIGURE 1 Microphotographs of TN cell (in crossed Nicols); (a) No stressed TN cell, (b) Stressed TN cell for 6 h, (c) Stressed TN cell for 12 h.

projection TV was exposed by high temperature. All 90° TN cells had 5.0 μm cell gap. Figure 1 shows the microphotographs of the none stressed 90° TN cell and stressed 90° TN cell on the rubbed PI surface for 6 h and 12 h. The off-state alignment characteristic of the stressed 90° TN cell for 6 h and 12 h was a bit reduced, compared to that of none thermal stressed TN cell, as shown in Figure 1. This indicates that

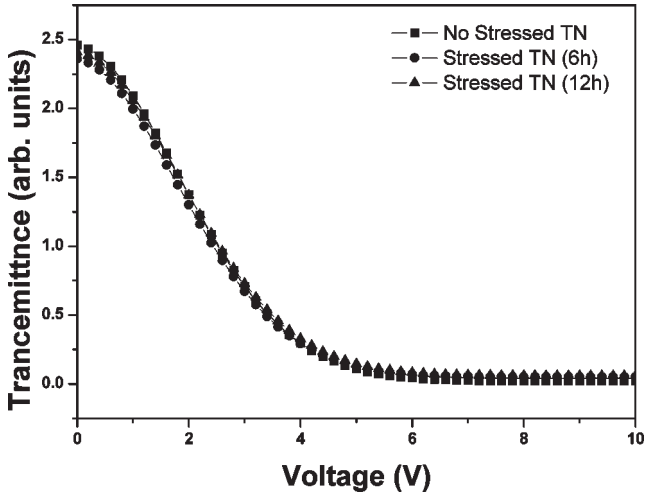

FIGURE 2 The V-T curves of no stressed 90° TN cell and stressed 90° TN cells for 6 h and 12 h on the rubbed PI surfaces.

the addition of thermal stress to the 90° TN cell causes the increase of defects.

The transmittances of the 90° TN cells were almost the same regardless of increasing of the thermal stress, as shown in Figure 2. Furthermore, response time characteristics of none stressed TN cell and stressed TN cells for 6 h and 12 h on the rubbed PI surfaces had little change in values, as shown in Figure 3. Moreover, this change of the response time is negligible enough to be considered the universal characteristic of LCD evaluation.

Figure 4 shows the capacitance-voltage (C-V) characteristics of no stressed TN cell and stressed TN cells for 6 hr and 12 hr on the PI surfaces. As shown in the Figure 4, as the time of thermal stress increases, the width of the hysteresis curve increased more and more. The increase of the width of the hysteresis curve means the residual DC [1]. This characteristic of the residual DC is attributed to the ion impurities inside the LC. The ion impurities are absorbed to the surface of enshrined screen as the DC voltage is stressed and because of this ion absorbed to the enshrined screen, even though there is no voltage applied from the outside, the DC voltage is applied on the layer of the LC. Consequently the residual DC voltage depends on the LC, its operation, enshrined screen and the production method of the LC cell [2]. Therefore, as the continuous thermal stress is given to the LC cell, the movement of the impurity ions is active,

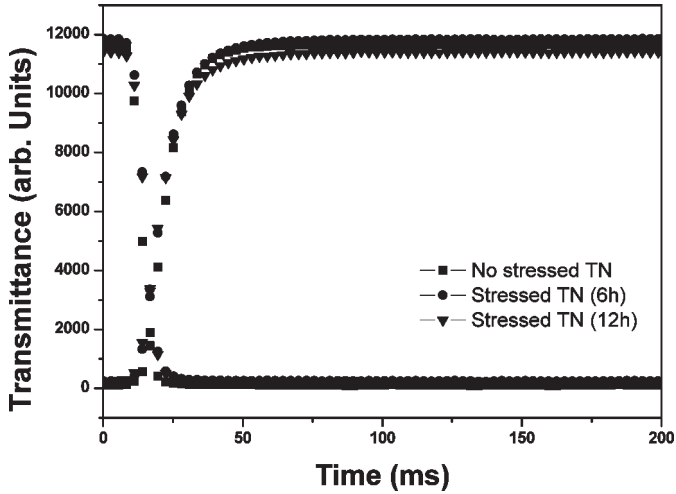

FIGURE 3 The response time characteristics of no stressed TN cell and stressed TN cells for 6 h, and 12 h on the rubbed PI surfaces.

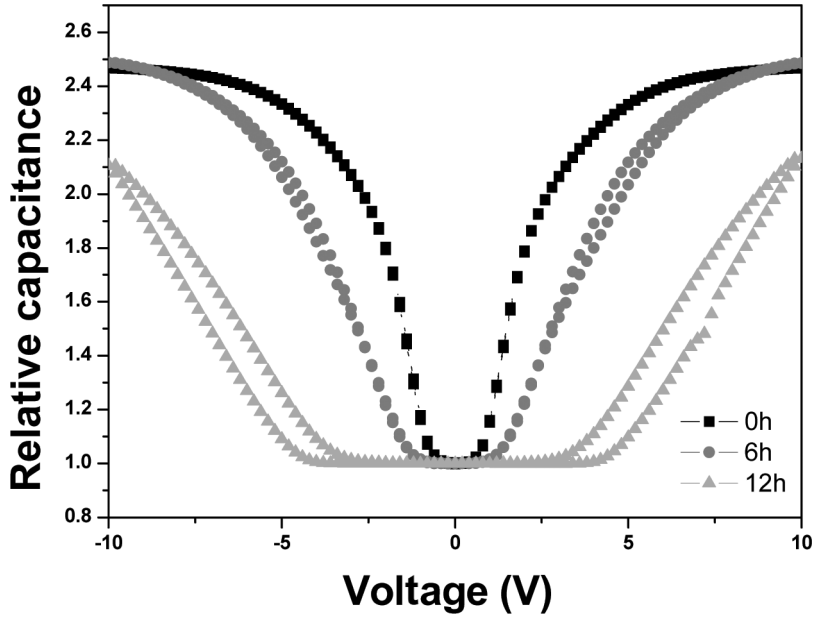

FIGURE 4 The capacitance-voltage (C-V) characteristics of no stressed TN cell and stressed TN cells for 6 hr and 12 hr on the PI surfaces.

contributing to the deterioration of the hysteresis characteristics. Moreover, at the same time this residual DC characteristics affect the flickering among other characteristics of the display. When the LCD runs for the duration, the electro-optic value of the threshold voltage, the vibration properties and so on were not affected, but the residual DC property was much affected. It is considered that these properties contribute to the deterioration of the display function afterwards.

CONCLUSIONS

In this study, the threshold voltage and response characteristics by the TN cell of no thermal stress and the TN cell of the thermal stress showed the similar trends. Also the transmittance of the TN cell was almost the same as the thermal stress increases. On the other hand, residual DC was decreased as the thermal stress increases. Especially, when TN cell was stressed more and more by heating, residual DC was changed a lot. As a result, the residual DC property of LCD in projection TV is affected very much by heating.

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