20.3: Experimental Study on Temperature-dependent Characteristics of Temporal Dark Boundary Image Sticking in 42 in. AC-PDP

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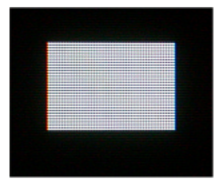
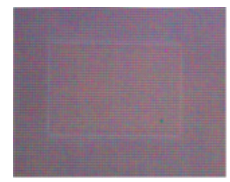
Abstract
The temperature-dependent characteristics of temporal image sticking, especially temporal dark boundary image sticking is investigated by observing the IR emission characteristics with respective to the cell temperature rise during the reset-period in 42 inch AC-PDP. The cell temperature rise in the adjacent cells is induced by that in the discharge cells (i.e., image sticking cells) due to the iterant strong sustain discharge, thus resulting in lowering the firing voltage for both the adjacent and discharge cells during the ramp-up period. However, since the phosphor layers are deteriorated due to the strong discharge in the discharge cells, the cells adjacent to the image sticking cells show the highest luminance under the dark background image displayed only by the reset waveform.

1. Introduction
Alternate current plasma display panels (ac-PDPs) are one of the most promising candidates for digital high definition televisions due to such characteristics as their large surface area (>40-in.), slim structure, and self-emitting color image quality [1]. However, there are still several critical issues related to the image quality of plasma display panels such as a low luminous efficiency, dynamic false contour, low color temperature, low gray level contours, and image sticking. First of all image sticking is a critical issue to be solved urgently for the realization of a high image quality in AC-PDP [2]. However, the detailed mechanism for the image sticking problem has not been exactly understood so far [3, 4, 5]. In particular, the cause for an image sticking phenomenon in the cells adjacent to the discharge cell (even though this region is non-discharge region) is not clear [6]. As an example of temporal dark boundary image sticking, Figs. 1 (a) and (b) show the original image patterns when the white image is displayed for 15 min. and the residual image patterns when the displayed white image abruptly changes to the dark background image, respectively. As shown in the residual image pattern of Fig. 1 (b) captured from the 42 in. AC-PDP, the luminance of the adjacent cells is observed to be higher than the luminance of both the cells with an image sticking and no image sticking.

This paper focuses on examining the relation between the cell temperature rise and the temporal image sticking phenomenon, especially temporal dark boundary image sticking. The iterant strong sustain discharge during a sustain-period when displaying an image causes a serious temperature rise of the panel.
In this paper, the temperature-dependent characteristics of temporal boundary image sticking is investigated by observing the IR emission characteristics with respect to the cell temperature rise during the reset-period in 42 inch AC-PDP.



(a) Original image pattern



(b) Dark background

Fig. 1. (a) Original image patterns and (b) residual image patterns on dark background captured from 42 in. AC-PDP

2. Experiment
Fig. 2 shows the commercial 42-in. WVGA AC-PDP module set and the optical-measurement systems employed in this experiment. The 42-in. WVGA AC-PDP module used in this research has an asymmetric stripe barrier rib structure. The color analyzer (CA-100) and the highly sensitive light detector (Hamamatsu, C6386) were used to measure the luminance and IR (828 nm) waveform, respectively. The temperature on the front panel of the AC-PDP is assumed to be the cell temperature. The temperature on the front glass of the 42-inch AC-PDP was measured by using the pyrometer.

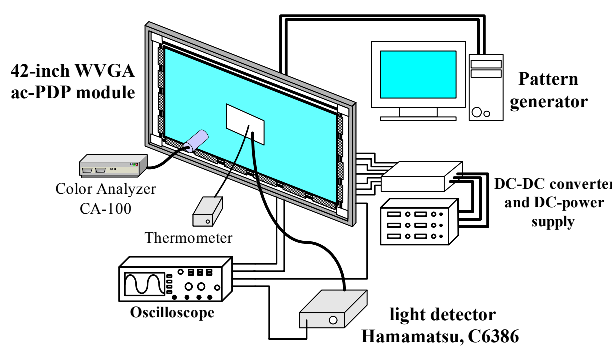


Fig. 2. Schematic diagram of experimental setup.

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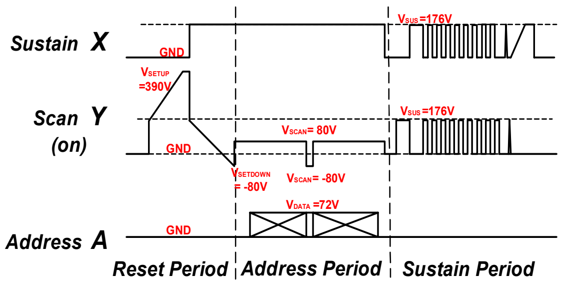


Fig. 3. Driving waveforms for reset-, address-, and sustain-periods employed in this research.

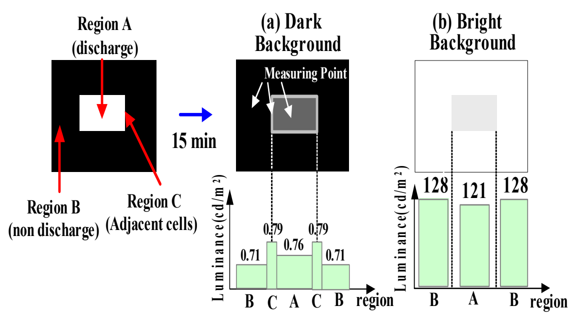


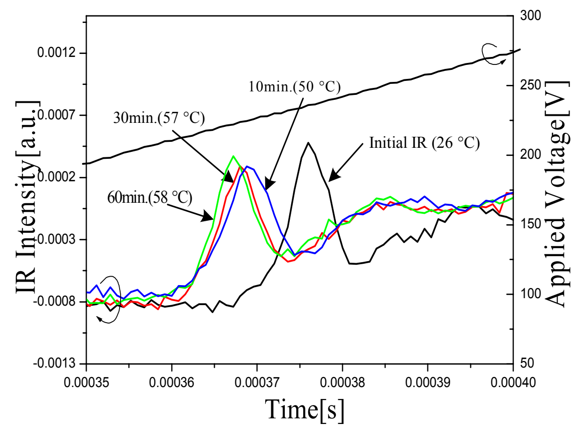
Fig. 4. Luminance difference among regions A (discharge region), B (non-discharge regions), and C (cell adjacent to discharge region) under (a) dark background image and (b) bright background image in 42-in. AC PDP.

Fig. 3 shows the driving waveforms for the reset-, address- and sustain-periods employed in the current research. The ramp-type waveforms shown in Fig. 3 were adopted as the reset pulses to display a dark background image where the ramp-up time was 120 µs and the ramp-down time was 200 µs. The scan and address pulses were simultaneously applied to the scan (Y) and address (A) electrodes during an address-period only when the bright background images were displayed. The amplitude and width of the address pulse were 72 V and 1.2 µs, respectively. The frequency for the sustain-period was 200 kHz, and the sustain voltage was 176 V.

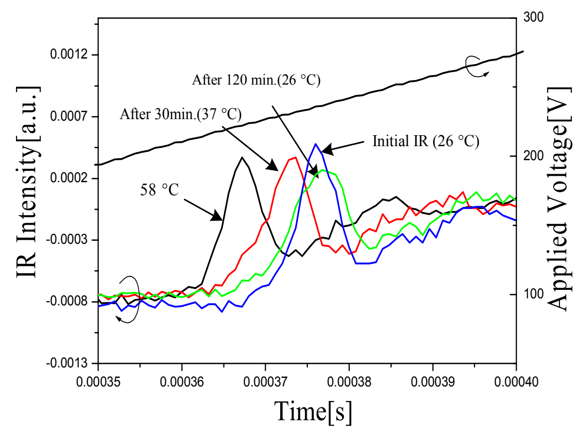
Figs. 4 (a) and (b) show that the luminance difference among the regions, A (discharge region), B (non-discharge region), and C (the cell adjacent to the discharge region) is observed under the dark and bright background image after the iterant several minute-sustain discharge. As shown in Fig. 4, the iterant strong sustain discharge was produced in the region A, so that the image sticking occurred in the region A. Under the dark background produced only by the reset discharge, the luminance of the discharge region A, *i.e.*, image sticking cells was observed to be higher than that of the non-discharge region B. In particular, the cells adjacent to the discharge region A showed the highest luminance. This is called 'temporal dark boundary image sticking'. Under the bright background produced by the sustain discharge, the luminance of the discharge region A, *i.e.*, image sticking cells was observed to be lower than that of the non-discharge region B.

3. Results and Discussion

Fig. 5 (a) shows the changes in the IR (828 nm) waveforms emitted from the discharge cells (*i.e.*, image sticking cells) during a ramp-up period and the cell temperature rise when the white image pattern is displayed for 60 min. Here, the cell temperature is assumed to be the temperature measured on the front glass. As shown in Fig. 5 (a), the IR peak was shifted to the left direction, indicating that the weak reset discharge was initiated efficiently at a lower starting discharge voltage during a ramp-up period. Furthermore, the IR emission was broadened, implying that the reset discharge was produced more efficiently due to the activation of the MgO surface caused by the cell temperature rise. The variations in the IR waveform show the gradual saturation characteristics as the cell temperature was increased due to an iterant strong sustain discharge. Fig. 5 (b) shows the recovery characteristics of the IR waveform in the discharge cells when only the reset discharge is produced after the iterant strong sustain discharge. As shown in the IR recovery characteristics of Fig. 5 (b), it was observed that the IR emission characteristics were returned to the initial state as the cell temperature was recovered to the initial temperature.

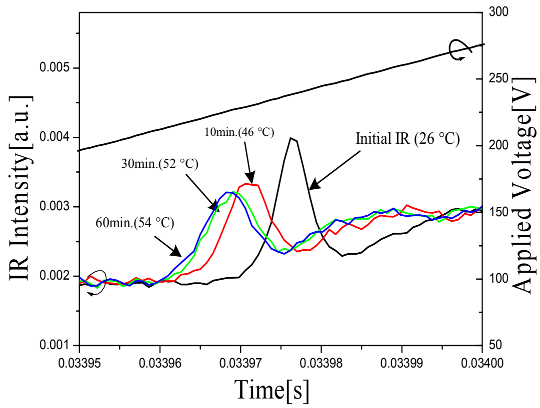


(a) IR waveforms

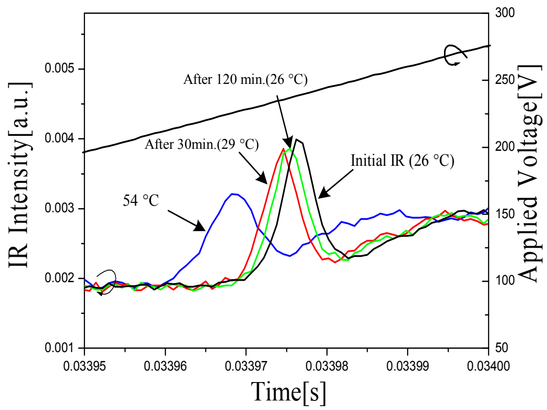


(b) IR recovery characteristics

Fig. 5. (a) IR waveforms emitted from discharge cells including cell temperature rise under white image pattern during ramp reset-period as function of display time and (b) IR recovery characteristics.

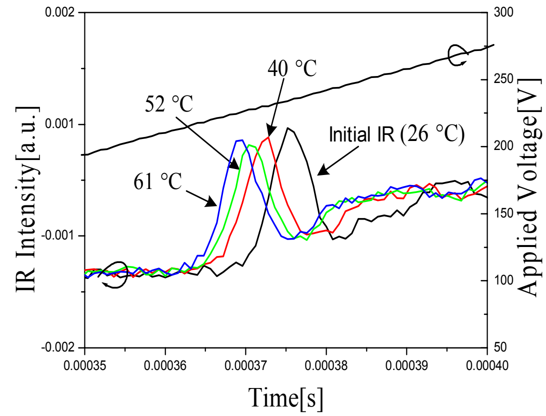


(a) IR waveforms

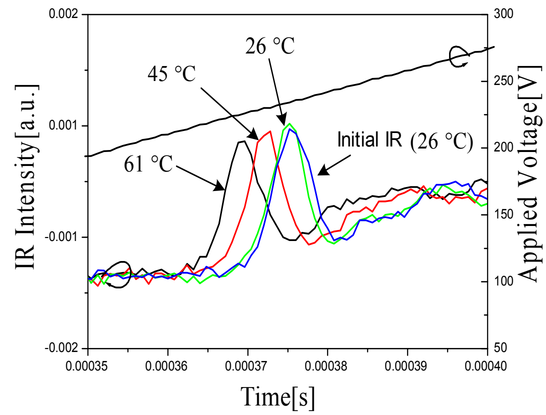


(b) IR recovery characteristics

Fig. 6. (a) Changes in IR waveforms emitted from cells adjacent discharge cells including cell temperature under white image pattern during ramp reset-period as function of display time, and (b) IR recovery characteristics.



(a) Heating case



(b) Cooling case

Fig. 7. Changes in IR waveforms emitted from cells during ramp reset-period when the front panel is heated by heater at various temperatures.

Fig. 6 (a) shows the changes in the IR (828 nm) waveforms emitted from the cells adjacent to the discharge cells (*i.e.*, image sticking cells) during a ramp-up period and the cell temperature rise when the white image pattern is displayed for 60 min. As shown in Fig. 6 (a), the cell temperature rose even in the adjacent cells, even though the cell temperature of the adjacent cells was slightly lower than that of the discharge cells. The cell temperature rise in the adjacent cells is due to the cell temperature rise in the discharge cells, even though the discharge was not produce in the adjacent cells. The resultant IR peak of the adjacent cells was shifted to the left direction due to the cell temperature rise, which is very similar to the result of Fig. 5 (a). The result of Fig. 6(a) means that even in the adjacent cells, the weak reset discharge was efficiently initiated at a lower starting discharge voltage during a ramp-up period. Furthermore, like the case of Fig. 5 (a), it was observed that the IR emission was broadened, which means that the reset discharge of the cells adjacent to the discharged cells was also produced more efficiently due to the activation of the MgO surface caused by the cell temperature rise.

Fig. 6 (b) shows the recovery characteristics of the IR waveform in the adjacent cells when only the reset discharge is produced after the iterant strong sustain discharge. The recovery characteristics of the adjacent cells showed the same tendency as that of the discharged cells of Fig. 5 (b).

Fig. 7 (a) shows the changes in the IR waveforms emitted from the cells during a ramp reset-period when the front panel is heated by the external heater at various temperatures ranging from 26 ℃ to 61℃. Fig. 7 (b) shows the IR recovery characteristics during a ramp reset-period when the front panel is cooled from 61 ℃ to 26 ℃. As shown in Fig. 7 (a), the IR peak was shifted to the left direction, which implied that the breakdown voltage could be decreased simply by increasing the cell temperature without producing the discharge. This phenomenon is the almost same as that of Figs. 5 (a) and 6 (a). As such, it is concluded that once the cell temperature rises due to either the iterant strong sustain discharge or the heating by the external heater, the corresponding breakdown voltage is decreased. The lower breakdown voltage causes the increase in the IR emission during the reset-period, thereby resulting in a temporal dark image sticking phenomenon in either the discharge cell or adjacent cells. By the way, under the dark background image, the luminance of the adjacent cells (*i.e.*, boundary image sticking cells) was observed to be higher than that of the discharge cells (*i.e.*, image sticking cells). This phenomenon can be explained as follows: in the discharge cells, the iterant strong sustain discharge causes a deterioration of the phosphor layers, implying that the luminance characteristics is degraded in the discharge cells, whereas the phosphor layer is not degraded in the adjacent cells because of no discharge.

4. Summary

The image sticking needs to be solved urgently for the realization of a high image quality in AC-PDP. However, the image sticking phenomenon has not been exactly understood so far. In particular, the cause for an image sticking phenomenon in the cells adjacent to the discharge cell (even though this region is non-discharge region) is not clear. In this paper, the temperature-dependent characteristics of temporal image sticking, especially temporal dark boundary image sticking is investigated by observing the IR emission characteristics with respective to the cell temperature rise during the reset-period in 42 inch AC-PDP. It is expected that this experimental result can contribute to solving the temporal dark boundary image sticking problems of the PDP-TV.

5. Acknowledgements

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6. References

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