17.4: Experimental Observation on Image Sticking of 42-inch PDP-TV

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Abstract

The effects of a short time (within 5 minutes) image sticking on the subsequent dark or bright background images are investigated in the 42-inch PDP-TV. In the dark background image displayed by only the reset waveform, the luminance from the cells with an image sticking is observed to be higher than the luminance from the cells with no image sticking. On the other hand, in the bright background image displayed by the sustain waveforms including the reset and address waveforms, the luminance from the cells with an image sticking is observed to be lower than the luminance from the cells with no image sticking. It is concluded that the dark image degradation is caused by the activated MgO surface of the cells with an image sticking, whereas the bright image degradation is caused by the deterioration of the phosphor layers.

1. Introduction

Alternate current plasma display panels (ac-PDP) are spotlighted as the most promising candidate by characteristics such as a large area (>40-in.), slim structure, and self-emitting color image quality in TV market. However there are still many technical problems to overcome for the successful commercialization. To preoccupy TV market, the PDP problems such as a luminous efficiency, image quality and cost, must be improved as soon as possible [1],[2]. One of the issues related to an image quality in the PDP-TV is an image sticking problem including an image smear, and an image retention, which causes the deterioration of an image quality due to the residual image pattern still remaining on the subsequent images. For an example, Fig. 1 shows that when the 'PDP' character (a) is displayed during 15 min. in the 42-in. PDP-TV, the 'PDP' characters still remain on the ensuing dark (b) and bright (c) images, respectively. The image sticking phenomenon occurs when the same image pattern is displayed repeatedly over a few minutes, which implies that the iterant strong sustain discharge during a sustain-period for displaying an image causes an image sticking problem. The intensive efforts for solving this image sticking problem has not been made so far.

In this paper, in order to observe whether the dominant factor for the image sticking problem is the MgO surface or the phosphor layer, the effects of the image sticking on a dark or a bright background images are investigated in the 42-in. PDP-TV. The image sticking phenomena are observed with gray levels in white patterns. In addition, the effects of the MgO surface on the image sticking are investigated depending on the choice of the R, G and B cells. For R, G, and B cells, the changes in the luminance and color coordinate with time are discussed.

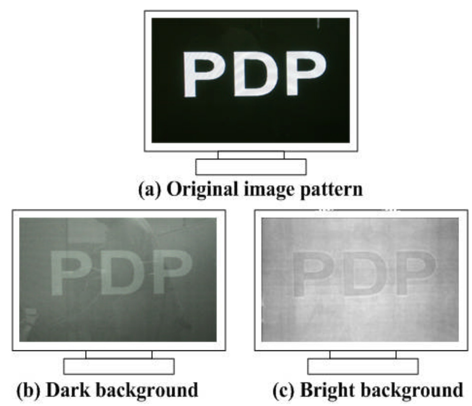

Fig. 1. Original image pattern (a), residual character pattern on dark image background (b) and residual character pattern on bright image background (c) in 42-in. PDP-TV.

2. Experimental Setup

Fig. 2 shows the optical measurement system to analyze an image sticking phenomenon commercial 42-in. PDP module set and. The test pattern made by the pattern generator is transferred into PDP module through image processing. The luminance and color coordinate are measured by the CA-100, whereas the pattern image and IR waveform are measured by the digital camera and monochromator, respectively.

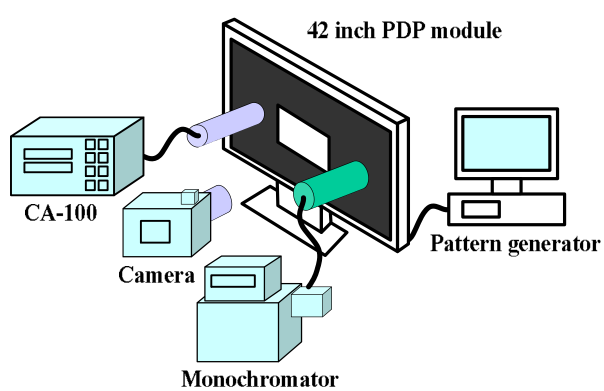

Fig. 2 Optical measurement system employed in current research.

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3. Results and Discussion

3.1 Bright and dark background images in cells with image sticking induced by iterant full white image patterns

Fig. 3 shows the luminance change of the white image pattern with 255 gray levels from the 42-in. PDP-TV with time. As shown in Fig. 3, the luminance of the white image pattern is rapidly decreased up to 5 min, and nearly saturated after 5 min. It is observed that the discharge-on time over 5 min was required to generate a short time image sticking from the luminance degradation data of Fig.3.

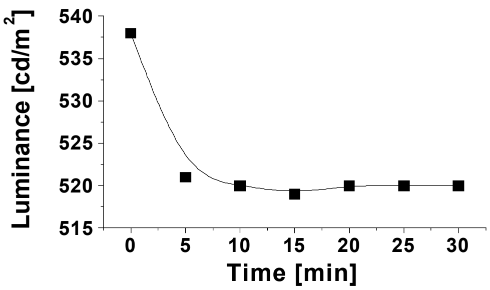


Fig. 3. Luminance degradation with time in white image pattern with 255 gray levels from 42-in. PDP-TV.

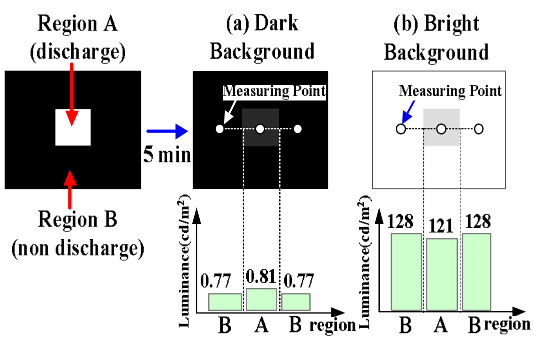
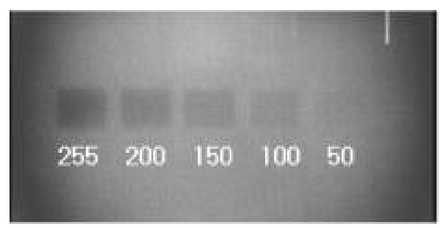


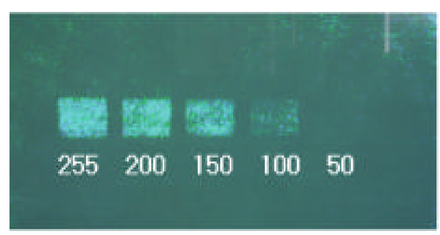
Fig. 4. Luminance difference between regions A and B on dark background image (a) and bright background image (b) in 42-in. PDP-TV.

Fig. 4 shows the luminance difference between the regions A (plasma-on) and B (plasma-off) under the bright (a) and dark (b) background images, respectively, where the discharge of the A region is maintained for 5 min to display full white image patterns. The dark background images of Fig. 3 (a) are displayed by only the reset-period, whereas the bright background images of Fig. 4 (a) are displayed by the sustain period including a reset- and address-periods. In Fig. 4 (a), the luminance from the cells with an image sticking is observed to be higher than the luminance from the cells with no image sticking. In the dark image case, the dominant factor for determining the luminance is an activation degree of the MgO surface because the weak reset discharge is hardly influenced by the phosphor layer. On the other hand, in the bright image case, the dominant factor for determining the luminance is the stimulation of the phosphor layer plus the activated MgO surface. The higher luminance of the cells with an image sticking in the subsequent dark image is mainly due to the MgO surface activated even during the short time discharge-on. The lower luminance of the cells with an image sticking in the ensuing bright image is mainly due to the deterioration of the phosphor layers even though the MgO surface is activated. Fig. 5 (a) shows the initial white image patterns with variations in the gray levels from 50 to 255 maintained for 5 min in the case of applying sustain voltage of 176 V. Fig. 5 (b) shows the 5 image sticking patterns with lower luminance than the background image when the background image is bright. As the gray levels are increased, the image sticking problems become serious, as shown in Fig. 5(b), indicating that the phosphor layers in the cells with higher gray level show the poor luminance characteristics. Fig. 5(c) shows the mage pattern of Fig. 5(b) when the sustain voltage applied is decreased from 176 V to 157 V. As shown in Fig. 5 (c), the bright region with no image sticking is disappeared completely at 157 V condition, whereas the region with image sticking illuminates a bright image even at 157V. This phenomenon is thought presumably due to the more activated MgO surface caused by the higher gray level.

(a) Initial white image pattern



(b) Bright background image at 176 V



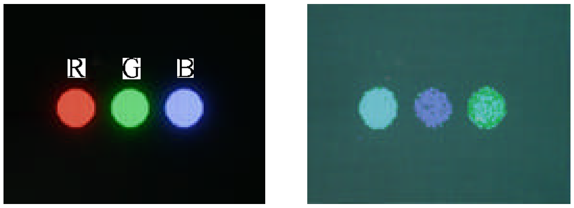
(c) Image sticking patterns at 157 V

Fig. 5. Image sticking with variations in gray levels from 50 to 255 in 42-in. PDP-TV.

3.2 Image Sticking in Red, Green, and Blue Cells

A. Discharge characteristics due to MgO surface in red, green and blue cells with image sticking

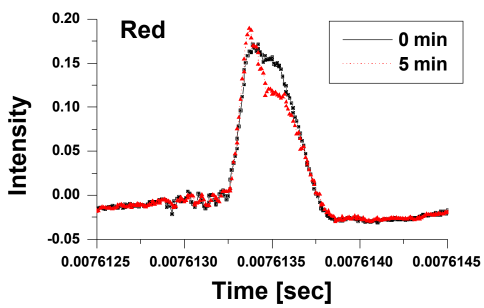
In order to investigate the degree of the MgO activation of the cells having the different phosphor types, the cells are discharged for 5 min at sustain voltage of 176 V only in the R, G, and B image patterns independently chosen in the 42-in. PDP-TV, as shown in the circles of Fig. 6 (a). The other background cells



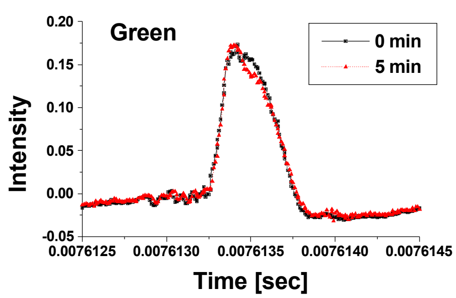
(a) Original R,G,B pattern (b) Degree of MgO activation in R,G,B cell

Fig. 6. Initial image pattern on the dark background in the case of applying sustain voltage of 176V (a) and image pattern in the case of applying low sustain voltage of 157V on the bright background after 5 minute (b).

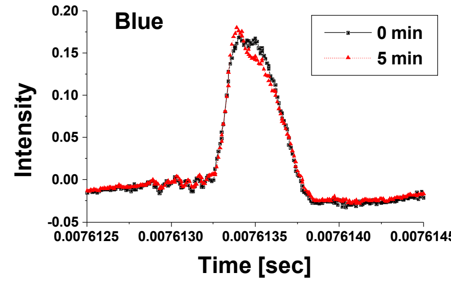
except the R, G, and B cells in the circles of Fig. 6 (a) are not discharged. After discharge-on for 5 min, the 157 V below the minimum sustain voltage is applied to all cells including the R, G, and B cells within the circle during a sustain-period, as shown in Fig. 6(b). Even at the low sustain voltage of 157V less than the minimum sustain voltage, the R, G, and B cells with an image sticking are weakly discharged, whereas no other cells with no image sticking are discharged, indicating that the MgO surfaces of the discharged cells, *i.e.*, the cells with an image sticking, seem to be more activated than those of the non-discharged cells, i.e., the cells with no image sticking. Fig. 7 shows IR (828 nm) waveform emitted from the R, G, and B cells of Fig. 6 (a) with time. The IR peaks of the R, G, and B cell are shown to increase slightly with time, as shown in Figs. 7 (a), (b), and (c), meaning that the MgO surfaces in the R, G, and B cells are activated due to the discharge. However, the activation rate seems to be different among the R, G, and B cells, judging from the result that the IR variation of the G cell is relatively smaller than those of the R, and B cells, as shown in Fig. 7 (b). This phenomenon is almost the same as that of Fig. 6 (b).



(a)



(b)



(c)

Fig. 7. IR waveform change of 828nm with time in the case of R, G and B cell

B. Luminance and color coordinates due to phosphor layers in red, green and blue cells with image sticking

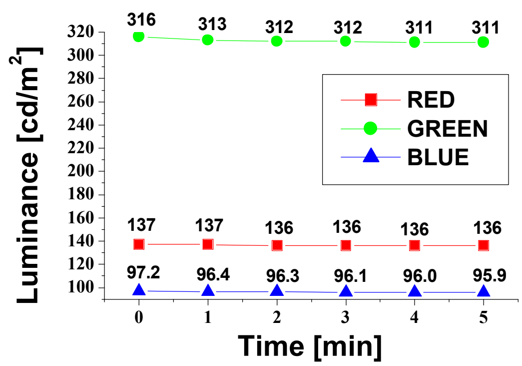
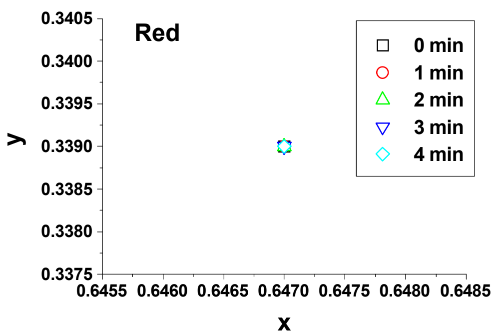


Fig. 8. Luminance changes of R, G and B light with time

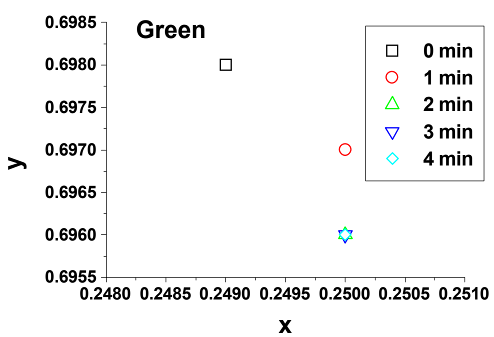
Fig. 8 shows the luminance degradation of the R, G and B lights emitted from the red, green, and blue cells of Fig. 6 (a) with time. The luminance of the green and blue lights is slightly decreased in proportion to the duration of the discharge up to 5 min, whereas the luminance of the red light is not nearly changed. Since the luminance characteristics strongly depend on the stimulation of the phosphor layers, the luminance degradation means the deterioration of the phosphor layers. Accordingly, this result indicates that the visible emission characteristics for the green and blue phosphor layers are more aggravated than those for the red phosphor layer due to the duration of the discharge.

In addition, the changes in color coordinate in the red, green, and blue cells are investigated in proportion to the duration of the discharge up to 5 min, as shown in Fig. 9. This data show that the color purity of the red light is not nearly changed, whereas the color purity of the green and blue lights is deteriorated. This result also guarantees that the visible emission characteristics for the green and blue phosphor layers are more aggravated than those for the red phosphor layer due to the duration of the discharge.

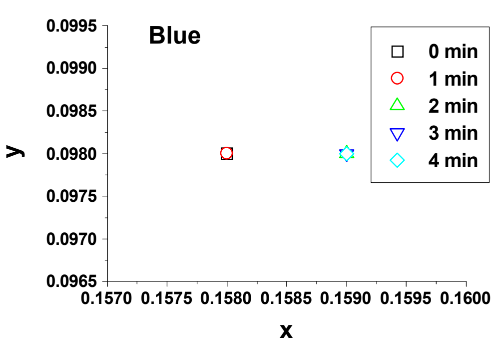
Accordingly, for the dark background image, the higher luminance in the cells with an image sticking is due to the activation of the MgO surface in the red, and blue cells instead of the green cell. On the other hand, for the bright image, the lower luminance in the cells with an image sticking is due to the degradation of the green and blue phosphor layers instead of the red phosphor layer.



(a)



(b)



(c)

Fig. 9. Color coordinates changes of R, G and B light with time

In order to solve the dark background image sticking problem, the background luminance produced by the reset discharge should be minimized. Since the conventional reset discharge is produced between the scan and sustain electrodes, the activated MgO surface in the cells with an image sticking is mainly used to display a dark image, which would cause a higher luminance in the dark image. Accordingly, it is expected that if the reset discharge is produced between the scan and address electrode instead of between the scan and sustain electrodes, the background luminance was reduced, thereby reducing the dark background image sticking considerably. On the other hand, it is difficult to solve the bright background image sticking problem because the deterioration mechanism of the phosphor layers has not been disclosed clear so far. The further study on revealing the culprit for the deterioration of the phosphor layers has been made.

4. Summary

In the current PDP technology, it is very important to analyze the mechanism of the image sticking for improving an image quality of PDP. In this paper, the effects of a short time (within 5 minutes) image sticking on the subsequent dark or bright background images are investigated in the commercial 42-inch PDP-TV. In the dark background image displayed by only the reset waveform, the luminance from the cells with an image sticking is observed to be higher than the luminance from the cells with no image sticking. On the other hand, in the bright background image displayed by the sustain waveforms including the reset and address waveforms, the luminance from the cells with an image sticking is observed to be lower than the luminance from the cells with no image sticking. In conclusion, the dark image degradation is caused by the activated MgO surface of the cells with an image sticking, whereas the bright image degradation is caused by the deterioration of the phosphor layers. It is expected that this result can contribute to solving the image sticking problem of the PDP-TV.

5. Acknowledgements

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6. References

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