Temporal Image Sticking Phenomena and Reducing Methods in AC PDP

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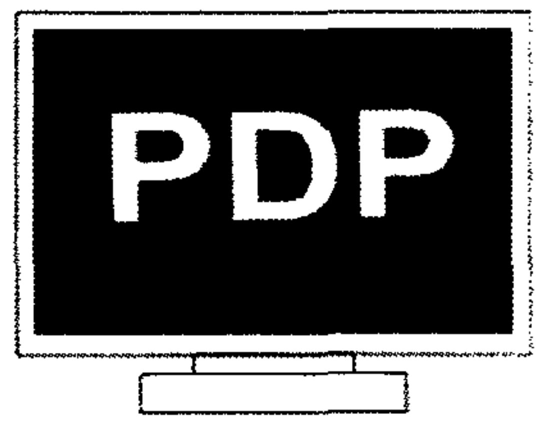
Abstract

The effects of a temporal image sticking phenomenon on the subsequent dark and white background images are investigated in 42-inch PDP-TV and the reducing method is proposed. In addition, the changes in luminance and temperature with an increase in time with the conventional and large sustain gap. The temporal dark image sticking was reduced considerably by decreasing background luminance and it was found that the temporal image sticking with large sustain gap was reduced when compared with the conventional sustain gap.

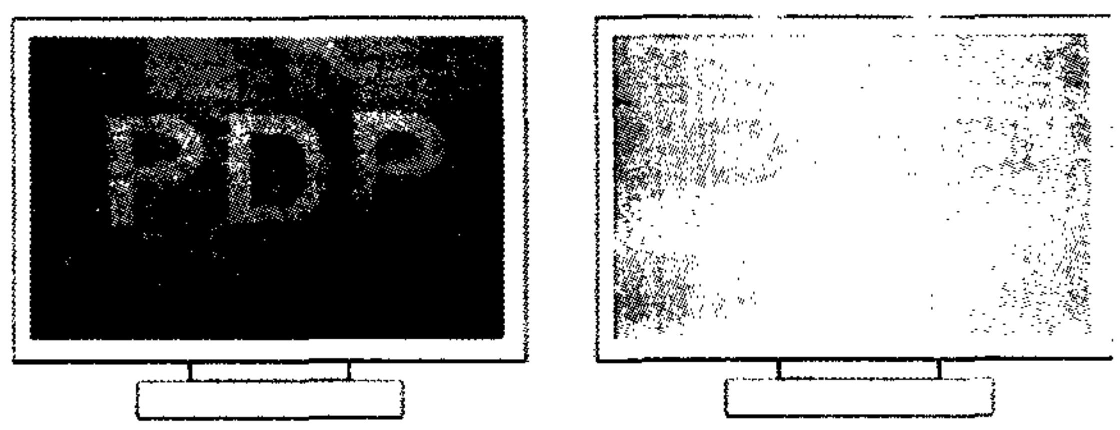
1. Introduction

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-inch), slim structure, and self-emitting color image quality. 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 [1]. 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. However, the image sticking phenomenon has not been exactly understood so far [2, 3, 4].

In this paper, the effects of the image sticking on a dark or a bright background images in the 42-inch PDP-TV are investigated and reducing method is proposed. In addition, the influences of two types of PDP cell structures such as a small and a large sustain gap on the temporal dark and bright image sticking phenomena are examined.



(a) Original image pattern



(b) Dark background (c) Bright background

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. Bright and dark image sticking phenomena

Fig. 2 shows the luminance change of the white image pattern with 255 gray levels from the 42-inch PDP-TV with time. As shown in Fig. 2, 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. 2.

Fig.3 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. 3 (a) are displayed by the sustain period including a reset- and address-periods. In Fig. 3 (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.

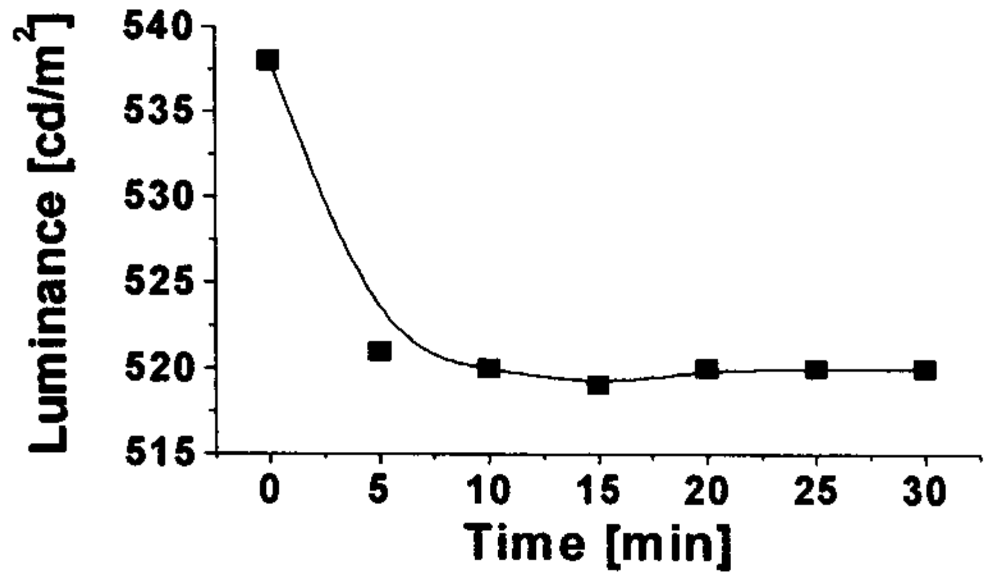


Fig. 2. Luminance degradation with time in white image pattern with 255 gray levels from 42-inch PDP-TV.

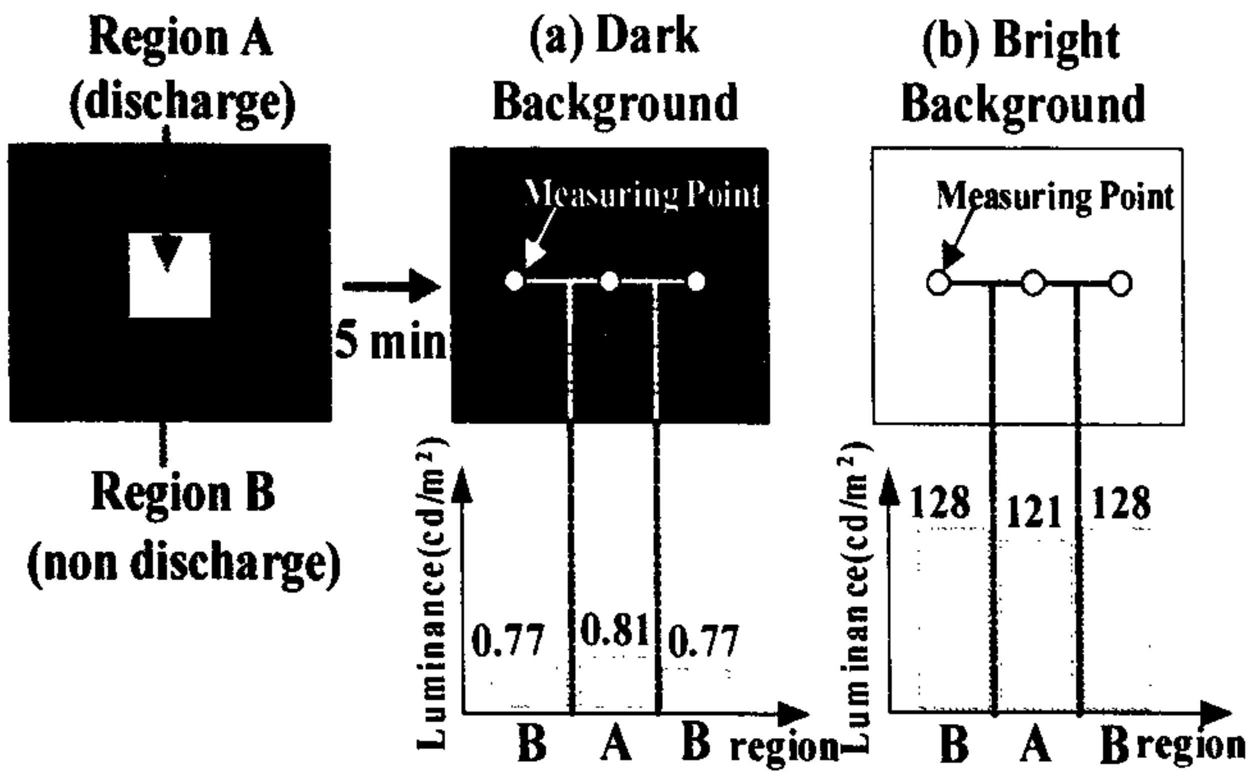


Fig. 3. Luminance difference between regions A and B on dark background image (a) and bright background image (b) in 42-in. PDP-TV.

3. Reducing method of dark image sticking

3-1 Dark image sticking phenomena in conventional ramp reset waveform

Fig. 4 shows the conventional ramp-reset waveform with various voltage slopes during a ramping-up period to produce a surface reset discharge. Figs. 5 (a) and (b) show the image pattern still remaining on the ensuing dark background image (hereafter this image is called 'ghost image') after a ten-minute sustain discharge in case of adopting the conventional ramp-reset waveform. The luminance difference between the ghost image and the dark background image is observed. As shown in Fig. 5 (b), the luminance of the ghost image (*i.e.*, the cells with image sticking) is found to be slightly higher than that of the background dark image (*i.e.*, the cells with no image sticking). In the case of the conventional ramp-reset waveform, it is observed that the luminance difference between the ghost image and the dark background image strongly depends on the voltage slope during a ramp-up period. Fig. 6 shows the luminance changes of the ghost image and dark background image when the reset voltage rising times are varied from 60 μs to 140 μs at intervals of 20 μs during a ramp-up period in the conventional ramp-reset waveform. As the voltage slope during a ramp-up period becomes slower, the luminance level is decreased, and the corresponding luminance difference between the ghost image and dark background image tends to be decreased, as shown in Fig. 5. This phenomenon means that the ramp-reset waveform with a slow voltage slope is preferable for reducing the dark image sticking. Furthermore, it is confirmed that the dark image sticking can be eliminated considerably if the luminance level is reduced in a large degree during the reset period. However, since the reset discharge is finished within a given time, the voltage slopes during a ramping-up period should be restricted to a certain level. Accordingly, it is necessary to design a new reset waveform that can lower the background luminance level so as to reduce the dark image sticking.

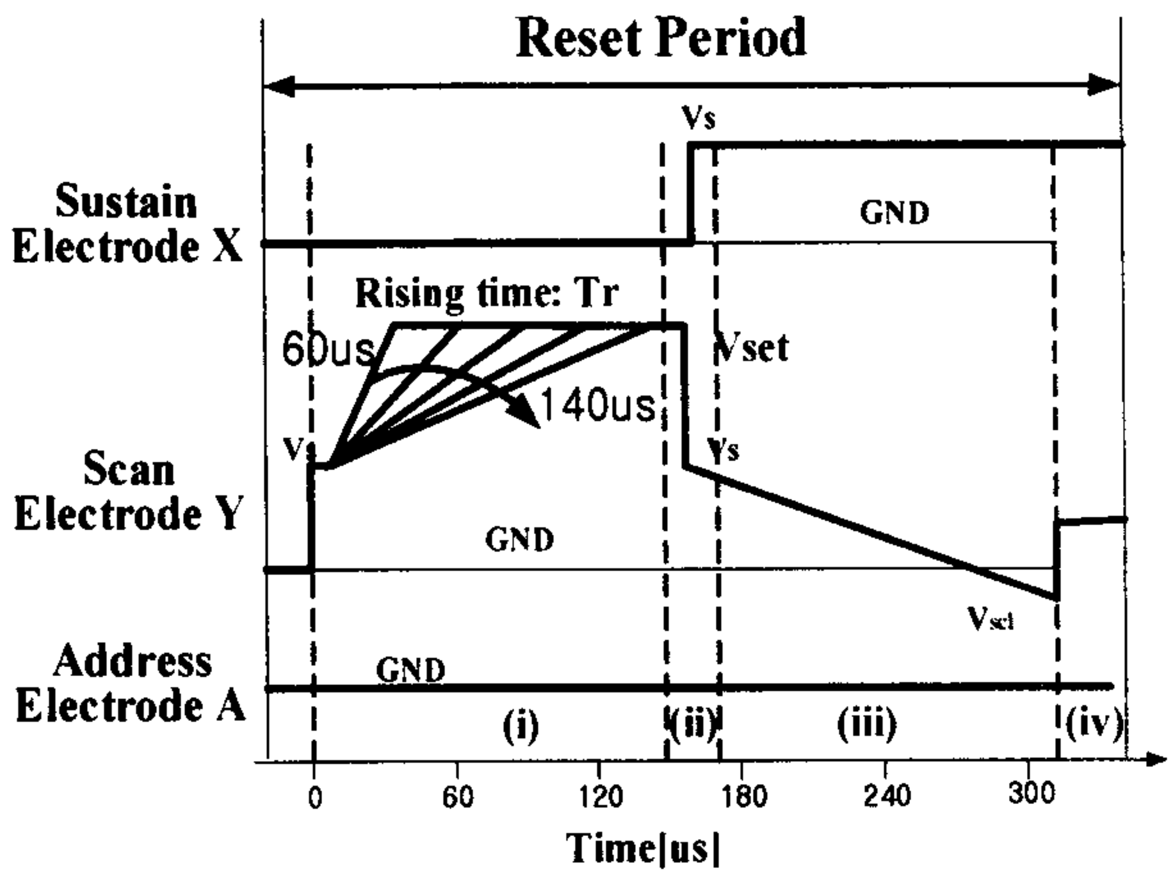
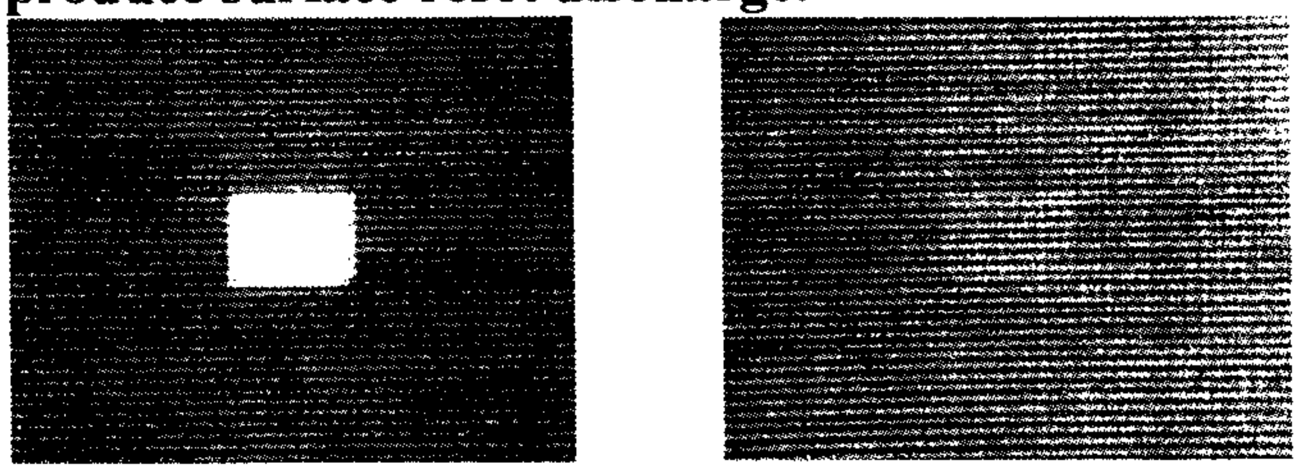


Fig. 4. Conventional ramp-reset waveform to produce surface reset discharge.



(a) (b)

Fig. 5. Original image pattern (a) and residual image under dark background (b) in case of adopting conventional ramp-reset waveform.

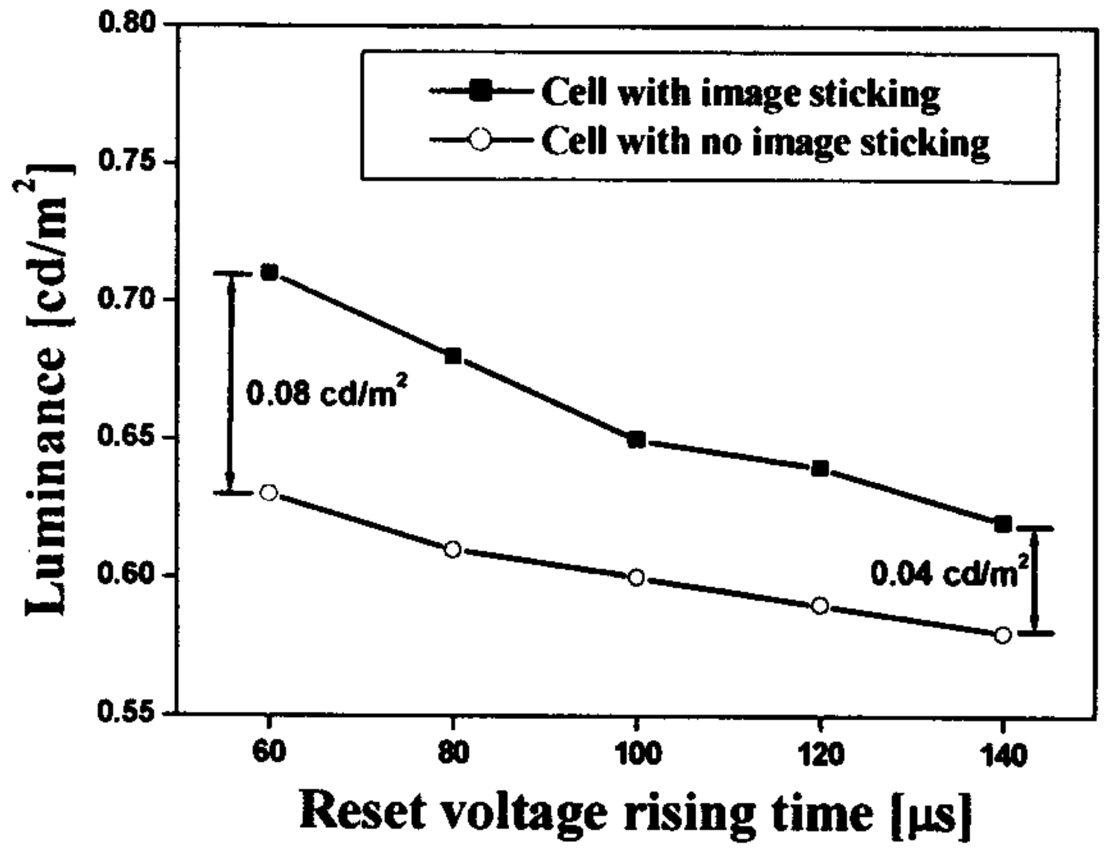


Fig. 6. Luminance changes of ghost image and dark background image relative to voltage slope during ramp-up period in conventional ramp-reset waveform.

3.2 New reset waveform for reducing the dark image sticking

Fig. 7 (a) shows the proposed reset waveforms to produce a reset discharge between the scan and address electrodes. In the proposed reset waveform of Fig. 7 (a), the ramp waveform applied to the scan electrode is a conventional type, whereas another ramp waveform is applied to the sustain electrode. The ramp waveform applied to the sustain electrode has the same voltage slope as the ramp waveform applied to the scan electrode. The ramp waveform applied to the sustain electrode is varied from GND to Vr. Accordingly, the reset discharge is dominantly produced between the scan and address electrodes instead of between the scan and sustain, thereby resulting in a very weak facing discharge. In conventional ramp-reset waveform, the weak discharge is produced twice during the reset period: the first discharge is produced between the scan and the sustain electrodes during the ramp-up period, and the second discharge is produced between the scan and address electrodes during the ramp-down period. On the other hand, in proposed reset waveform, the weak discharge is produced once between the scan and the address electrodes during the ramp-up period, and its intensity is very weak due to the face discharge. As a result of adopting the proposed reset waveform, the background luminance is reduced considerably. Therefore, the dark image sticking is not observed even though the original white image pattern has been displayed for 10 min, as shown in Fig. 8 (b). Table1 shows the characteristics of the conventional ramp-reset and proposed reset waveforms. The dark room contrast ratio of the proposed reset discharge waveform is improved considerably compared to that of the conventional ramp-reset waveform, whereas the minimum address voltage in the new reset waveform requires slightly higher address voltage. The dark image sticking in the proposed reset waveform is totally invisible.

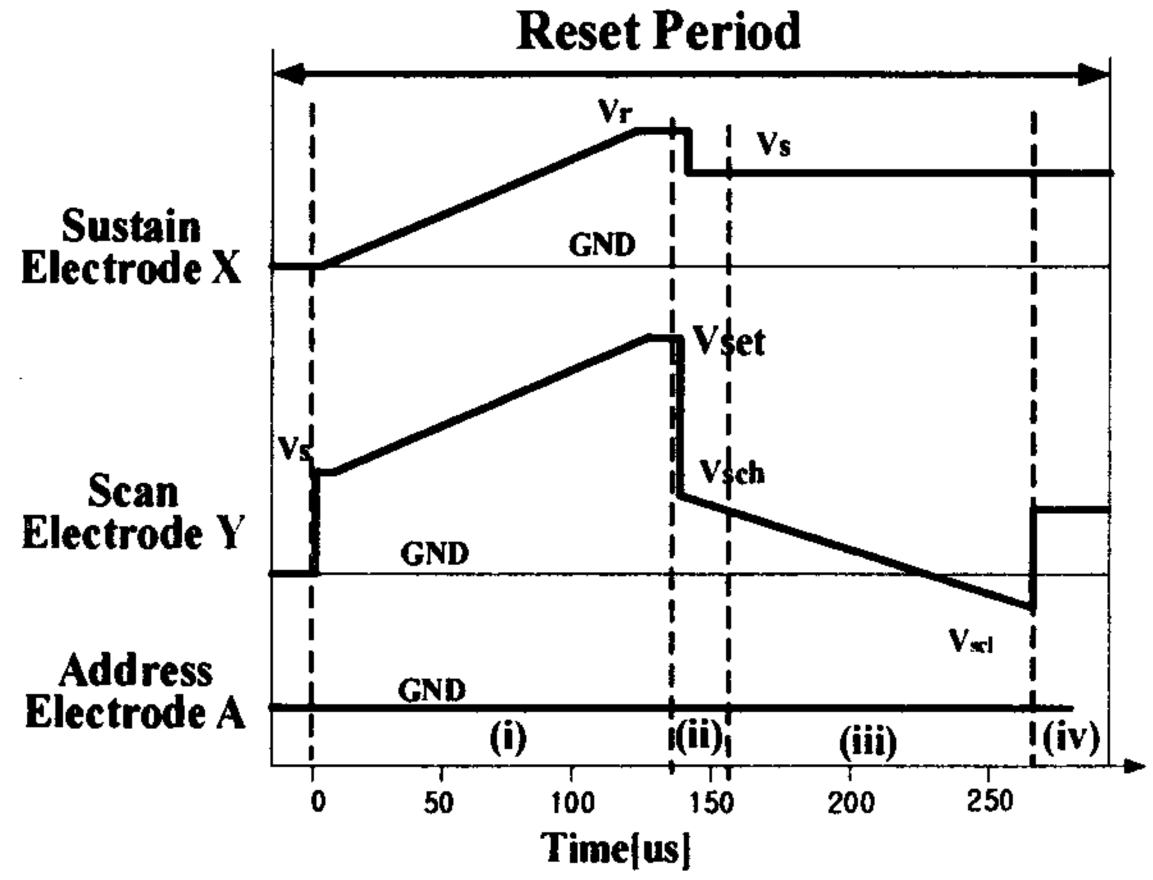
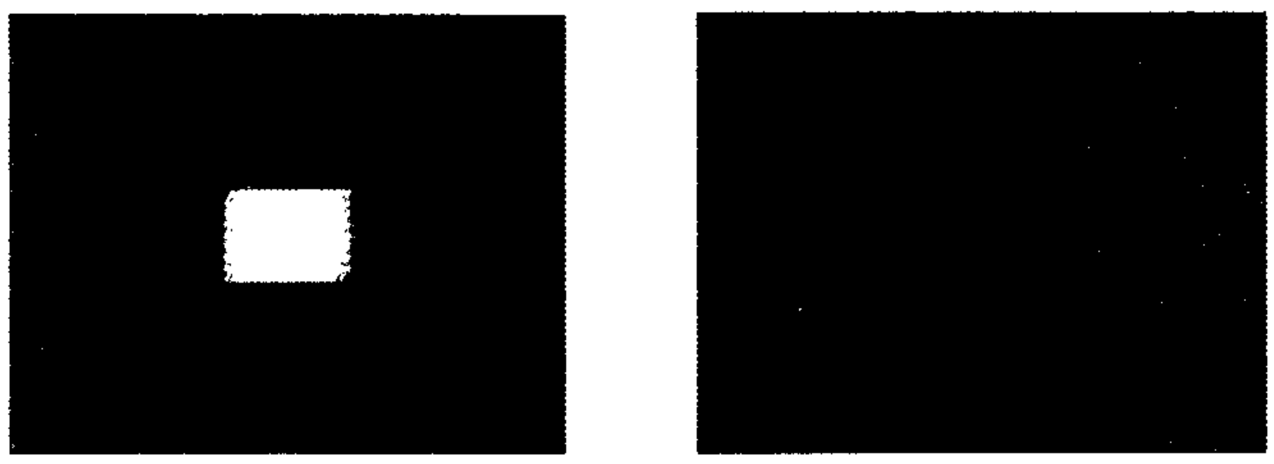


Fig. 7. Proposed reset waveform for producing facing reset discharge.

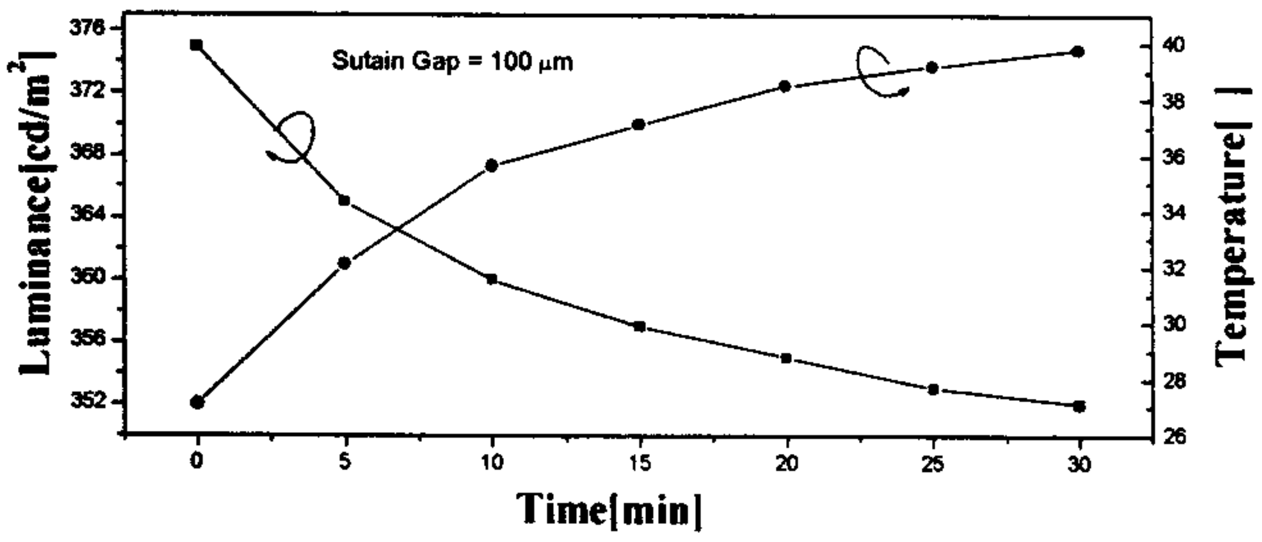


(a) (b)

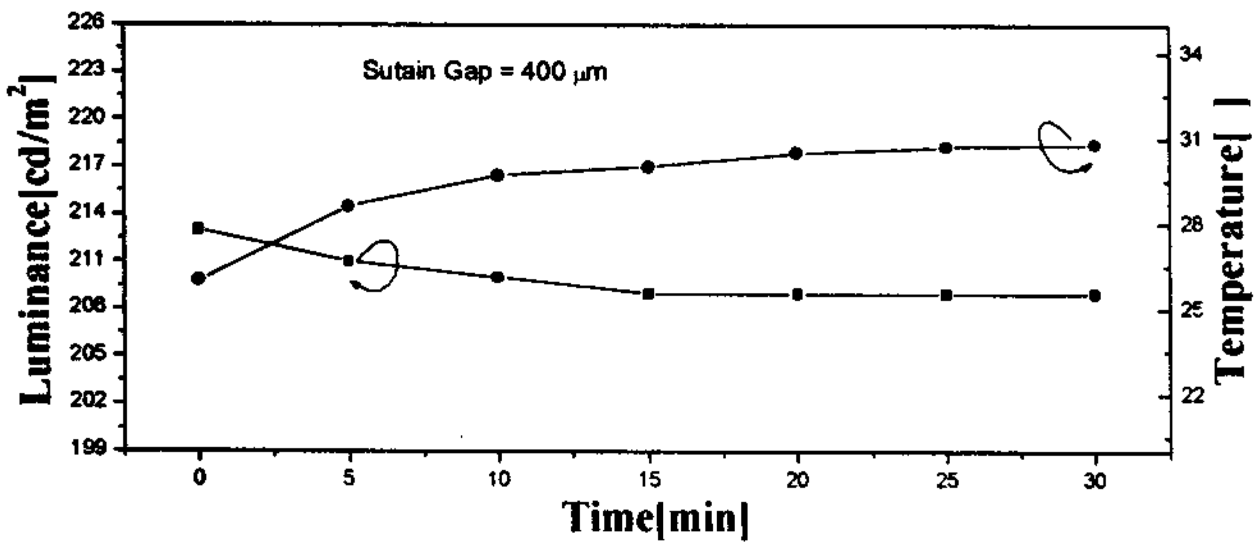
Fig.8. Original image pattern (a) and dark background image pattern (b) after displaying original image pattern for 10 min. in case of adopting proposed reset waveform.

	Conventional ramp-reset waveform	Proposed reset waveform
Dark room contrast ratio	194:1	11200:1
Min. address voltage at pulse width 2us	40V	45V
Dark image sticking	Yes	No

Table1. Comparison of conventional ramp-reset and proposed reset waveforms.



(a)



(b)

Fig. 9. Changes in luminance and cell temperature with an increase of time.

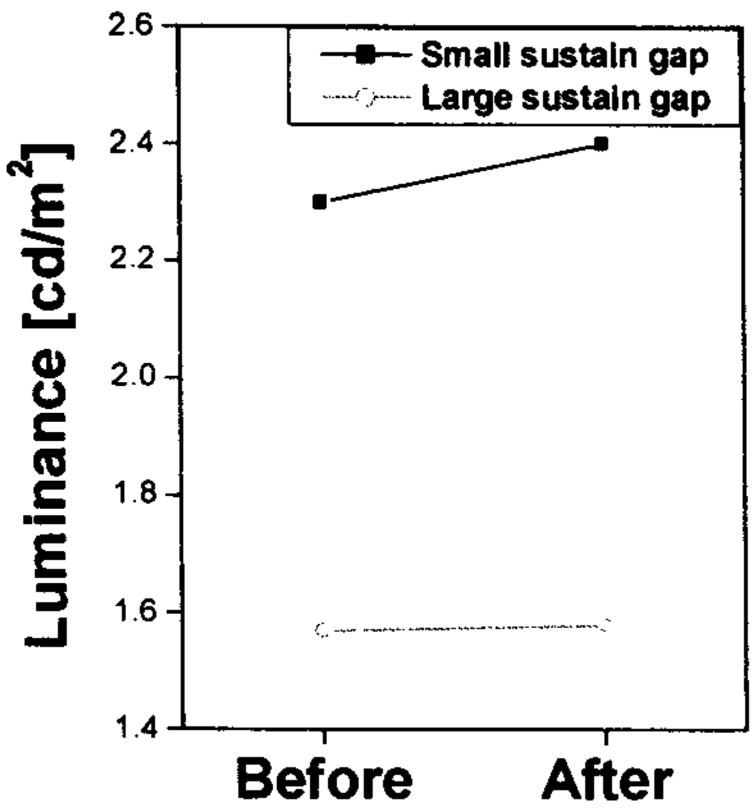


Fig. 10. Changes in background luminance between before and after image sticking with small and large sustain gaps.

4. Image sticking phenomena in large sustain gap

Fig. 9 shows the changes in the luminance and cell temperature as a function of display time when the white image was continuously displayed for up to 30 minutes. In conventional cell structure with a small sustain gap (100 μm), the luminance of the white image decreased from 375 to 352 cd/m^2. The decrease in the luminance was about 23 cd/m^2. Meanwhile, the cell temperature increased from 27.1 to 39.8 ℃. On the other hand, in the cell structure with a large sustain gap (400 μm), the luminance decreased from 213 to 209 cd/m^2. The decrease in the luminance was about 4 cd/m^2. Meanwhile, the cell temperature increased from 26 to 30.8 ℃.

Fig. 10 shows the changes in background luminance between before and after image sticking with small and large sustain gaps. The difference of background luminance in the large sustain gap structure is smaller than that in small sustain gap structure. Therefore, it is expected that the temporal image sticking phenomenon itself is reduced when sustain discharge is produced by the large sustain gap instead of the small sustain gap (100 μm) of the conventional PDP cell structure.

5. Conclusion

A temporal image sticking phenomenon on the subsequent white and dark background images is investigated in 42-inch PDP-TV and the reducing method was proposed by adopting the new reset waveform than can produce a face discharge during the ramp-up period. In addition, the changes in luminance and temperature with an increase in time with the conventional and larger sustain gap was compared. As a result, the temporal dark image sticking is reduced considerably and it is observed that the temporal image sticking phenomena are reduced when sustain discharge are produced by the large sustain gap (400 μs) instead of the small sustain gap (100 μm) of the conventional PDP cell structure. It is expected that the low background luminance and the PDP structure with a large sustain gap are more suitable for reducing the temporal image sticking.

6. References

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