Invited Paper: Prohibition of Boundary Image Sticking in AC Plasma Display Panel Using Vacuum Sealing Method

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Abstract

This paper shows that the boundary image sticking can be prohibited completely by using the vacuum sealing process, which means that the residual impurities such as nitrogen or oxygen can be a critical factor inducing the boundary image sticking. The production of boundary image sticking was checked in the test panel fabricated by the N_2 or O_2 flow during the vacuum sealing process. As a result, the boundary image sticking did not appear in the case of N_2 flow, whereas the boundary image sticking was observed in the case of O_2 flow even though the test panel was fabricated by the vacuum sealing process.

1. INTRODUCTION

Image retention means a temporal image sticking that is easily recoverable through a minor treatment, whereas image sticking means a permanent sticking that is not recoverable even through severe treatment. The image sticking is known to be induced even in the non-discharge cells adjacent to the discharge cells, which is called a halo-type boundary image sticking [1, 2]. Our previous experimental results show that the main culprit for inducing the permanent image sticking is deeply related to the Mg species sputtered from the MgO surfaces of the discharge cells due to the severe ion bombardment during a sustain discharge [3, 4, 5]. The deposition of the sputtered Mg species on the phosphor layer in the discharge cells, or the re-deposition of the sputtered Mg species on another MgO surface of the non-discharge cells adjacent to the discharge cells, can alter the reset or sustain discharge characteristics, thus causing an image sticking or boundary image sticking [3].

In this paper, the effects of the vacuum sealing method on the boundary image sticking phenomenon were examined. The corresponding luminance, IR (828 nm) emission, and V_t close-curve in the cells of the non-discharge region adjacent to the discharge region were observed in comparison with the non-discharge region far away from the discharge region, under the two different image patterns, such as the dark and full-white backgrounds, for two cases.

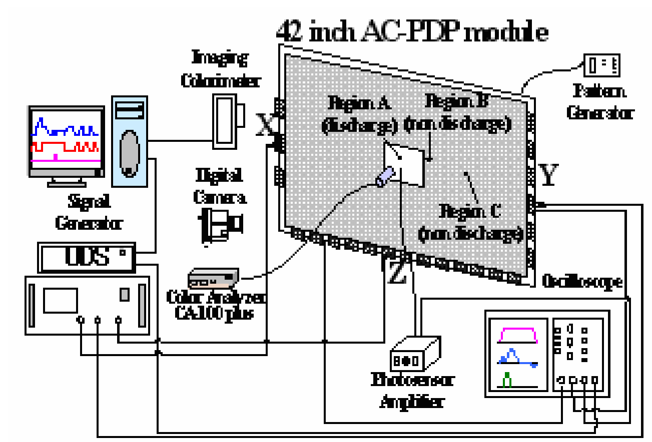
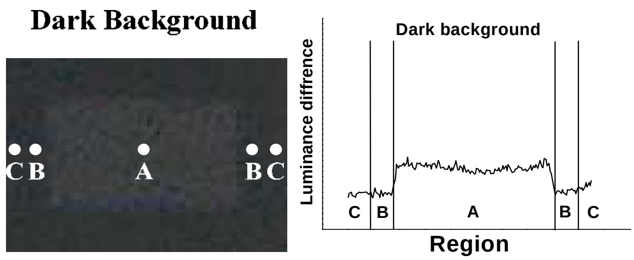


Fig. 1. Schematic diagram of experimental setup.

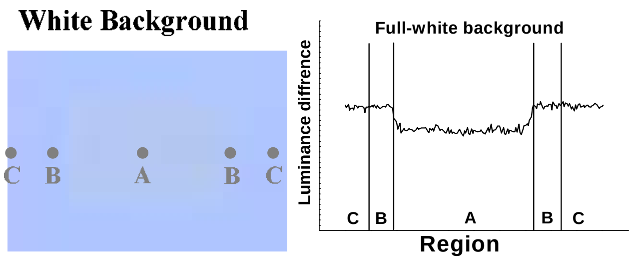
2. EXPERIMENTAL SETUP

Fig. 1 shows the commercial 42-in. ac-PDP module with a box-type barrier rib and the optical-measurement systems employed in this experiment. The color analyzer (CA-100 plus), imaging colori-meter (Prometric PM Series), pattern generator, signal generator and the photo-sensor amplifier (Hamamatsu, C6386) were used to measure the luminance of the local or entire region, IR emission and V_t close-curve, respectively. To produce the permanent image sticking, the entire region of the 42-in. panel was changed to



(a) (b)

Fig. 2. (a) Image sticking pattern under dark background captured from test panel fabricated by vacuum sealing method, (b) luminance difference among regions, A, B, and C in (a).



(a) (b)

Fig. 3. (a) Image sticking pattern under full-white background captured from test panel fabricated by vacuum sealing method, (b) luminance difference among regions, A, B, and C in (a).

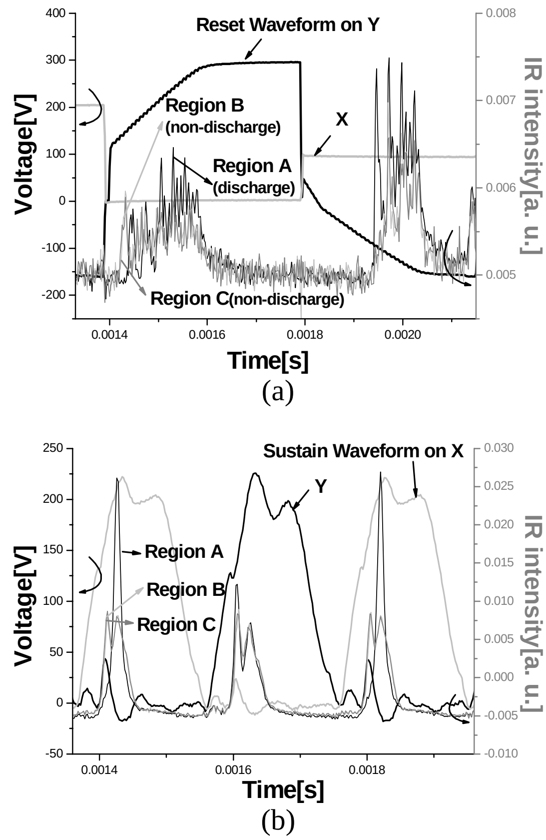


Fig. 4. Comparisons of IR (828 nm) emissions measured from regions A, B, and C of test panel fabricated by vacuum sealing method (a) during reset-period under dark background and (b) during sustain period under full-white background.

the dark and full-white background images immediately after the square-type image with peak luminance was displayed for about 500 hours. The driving method with a selective reset waveform was adopted. The frequency for the sustain-period was 200 kHz, and the sustain voltage was 206V. The gas chemistry in the experiment was Ne-Xe (15%)-He (35%).

3. RESULTS AND DISCUSSION

Fig. 2 shows the luminance difference among the three regions, A, B, and C in the test panel fabricated by the vacuum sealing method under dark background image. The image pattern and luminance in regions, B and C were observed to be the same under full-dark background, as shown in Fig. 2 (b). Fig. 3 shows the luminance difference among the regions, A, B, and C of the test panel fabricated by the vacuum sealing method under the full-white background. The image pattern and luminance of the regions B and C were also observed to be the same under the full-white background, as shown in Fig. 3 (b). As shown in Figs. 2 and 3, no boundary image sticking was observed in region B of the test panel fabricated by the vacuum sealing method.

Fig. 4 (a) shows the changes in the IR (828 nm) emissions during the reset period under dark background measured from regions A, B and C of the test panel fabricated by the vacuum sealing method. The ignition time and intensity of the IR (828 nm) emission waveforms were observed to have no difference between the regions B and C, as shown in Fig. 4 (a). Fig. 4 (b) shows the changes in the IR (828 nm) emissions measured from the regions A, B and C during the sustain period, As shown in Fig. 4 (b), the ignition time and intensity of the IR (828 nm) emission waveforms had no difference between the regions B and C. In order to investigate which was the main factor for having no difference in the luminance and IR characteristics between the regions B and C in the test panel fabricated by the vacuum sealing method, the V_t close-curve was measured in three regions, A, B, and C, respectively. In the test panel

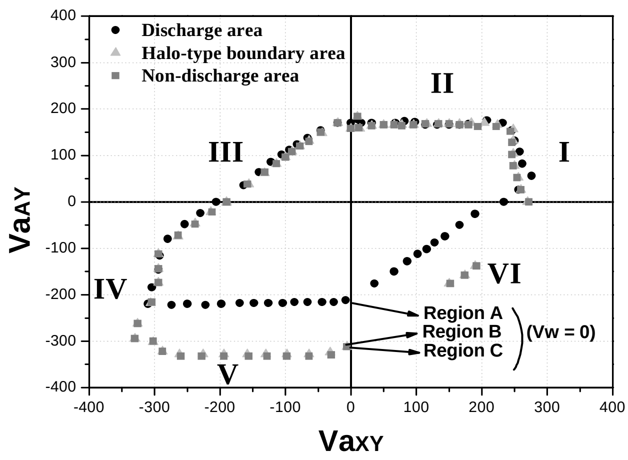


Fig. 5. Comparison of Vt close-curves measured from regions A, B, and C in test panel fabricated by vacuum sealing method without initial wall charges.

fabricated by the conventional sealing method, the firing voltages in the Y-A discharge under phosphor cathode condition) and Y-X discharge under MgO cathode condition in region B were decreased slightly by about 5-10 V and by 10-15 V in comparison with that in region C, respectively [3, 4]. On the other hand, in the test panel fabricated by the vacuum sealing method, as shown in Fig. 5, the firing voltages under phosphor and MgO cathode conditions in regions B and C were almost the same. Consequently, this result clearly shows that the vacuum sealing method contributes to inherently prohibiting the production of the boundary image sticking. The scanning microscope (SEM) and time of flight secondary ion mass spectrometry (TOF-SIMS) were measured to inspect the prohibition of boundary image sticking in the test panel fabricated by the vacuum sealing method.

Fig. 6 shows the SEM images of MgO surfaces captured from regions, A, B, and C. As for the test panel fabricated by the vacuum sealing method, the morphology in region B was almost similar to that in region C after the 500-hour sustain discharge, which meant that the vacuum sealing method contributed to prohibiting the production of the boundary image sticking.

Fig. 7 also shows the Mg-profiles on the red phosphor layer for regions, A, B, and C of the test panel fabricated by the vacuum sealing method. As shown in Fig. 7, the Mg intensity in region B is almost similar to that of the cell in region C, meaning that the

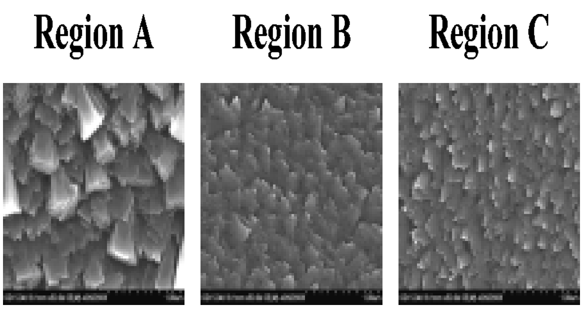


Fig. 6. SEM images of MgO surfaces measured from regions A, B, and C in test panel fabricated by vacuum sealing method.

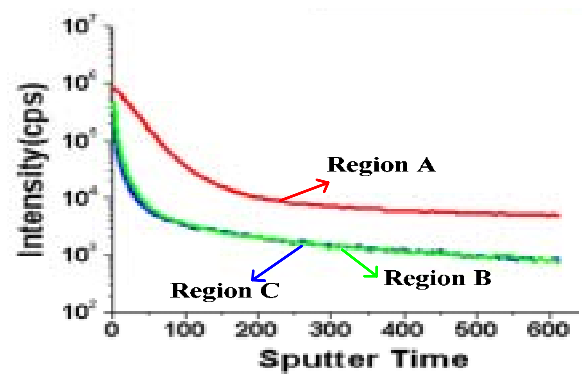
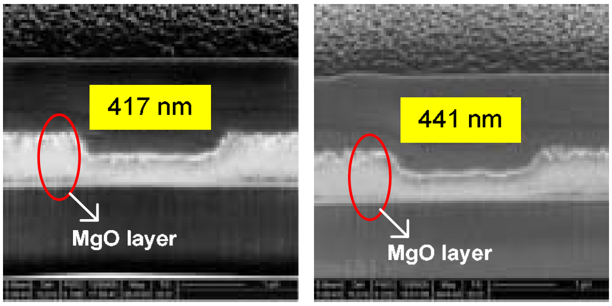


Fig. 7. Mg-profiles of red phosphor layer for regions A, B, and C in test panel fabricated by vacuum sealing method.



(a) (b)

Fig. 8. SEM crossectional images showing different MgO sputtering rates in test panels fabricated by (a) conventional and (b) vacuum sealing methods using focused ion beam (FIB).

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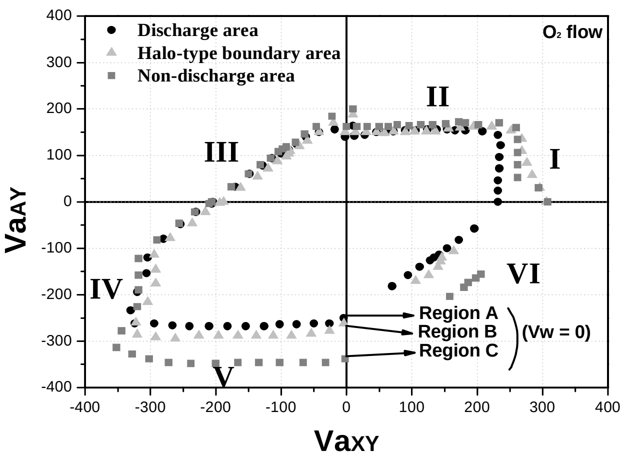
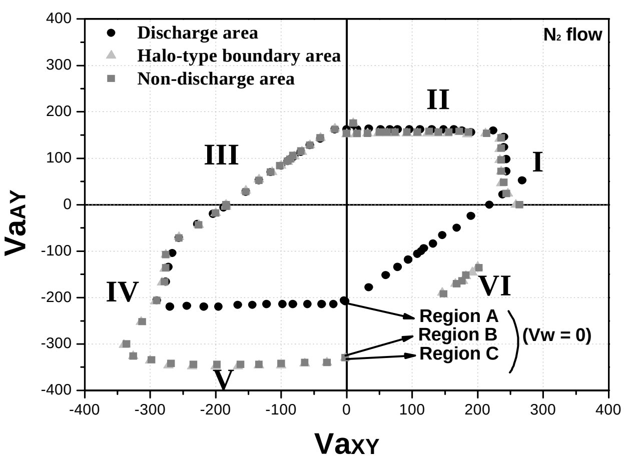
Figs. 8 (a) and (b) show the SEM cross sectional



(a)



(b)

Fig. 9. V_t close-curves without initial wall charges measured from regions A, B, and C in test panel fabricated by vacuum sealing method during (a) O_2 flow and (b) N_2 flow.

images of sputtered MgO layers for the conventional and vacuum sealing methods using the focused ion beam (FIB), respectively. In Fig. 8, the FIB was used to measure the rate of the MgO sputtered from the MgO layer when Ga ions (30keV) struck the surface of the MgO layer during 105 sec. As shown in Fig. 8 (b), the sputtering rate of the MgO layer for the vacuum sealing method was more increased than that of the conventional sealing method, which is caused by an increase in the oxygen vacancy of the MgO layer [6]. The sputtered Mg species onto the MgO layer for the vacuum sealing method was more increased than that of the conventional sealing method. However, in the vacuum sealing method, Mg species were not transported to boundary region.

The inherent prohibition of the boundary image sticking production is mainly related to the reduction of the residual impurities including oxygen or nitrogen caused by the vacuum sealing method. To check which was a dominant factor for prohibiting the boundary image sticking, the O_2 or N_2 gas was flowed during the vacuum sealing process. Although the vacuum sealing method was adopted, in the test panel fabricated by the O_2 flow during a vacuum sealing process, the boundary image sticking was intensely appeared more than that of the conventional sealing method, which is also confirmed by the V_t close-curve data of Fig. 9 (a). However, in the test panel fabricated by the N_2 flow during a vacuum sealing process, the boundary image sticking was not appeared, which is also confirmed by the V_t close-curve data of Fig. 9 (b). This result confirms that the inherent prohibition of the boundary image sticking production is mainly due to the reduction of the residual impurity, especially such as O_2 caused by the vacuum sealing method.

4. SUMMARY

When displaying the square-type image with peak luminance for a long time in PDP-TV, the image sticking appears even in the non-discharge cells adjacent to the discharge cells, which is called a boundary image sticking. Thus, the image sticking needs to be solved urgently for the realization of a high image quality in AC-PDP. This paper shows that the production of the boundary image sticking can be prohibited inherently by sealing the PDP panel under a vacuum condition.

5. REFERENCES

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