6.3: Effects of Various Sustain Gaps on Reset Discharge Characteristic in AC-PDP

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Abstract

The effects of various sustain gaps on the reset discharge characteristics, especially the discharge stability, are examined based on the Vt close curve analysis. The Vt close curve analysis shows that the reset discharge region that can produce the stable discharge under the MgO cathode condition is reduced in proportion to the increase in the sustain gap, thereby causing the discharge instability in the case of applying the conventional reset waveform for the large sustain gap over 200 μm. Based on the Vt close curve analysis, the modified reset waveform that prohibits the unstable discharge is proposed in the large sustain gap of 200 μm and its reset discharge characteristics are examined.

1. Introduction

In the current ac-PDP driving scheme, the PDP driving waveforms applied to the each electrode are constituted with the reset, address, and sustain-periods [1]. The role of the address-period is to determine the ON/OFF of each micro-discharge cell and the role of the sustain-period is to emit the visible light from selective cells. Thus, the address and sustain-periods play an important part in the display of various images. However, to execute a stable address discharge successfully, the accurate control of the wall charge is required. Therefore, the reset-period composed with ramp pulse, comes before the address-period in the PDP driving waveform to control the wall charges. The main role of a reset-period is to prepare the successful address discharge but for high quality ac-PDP, the light emission during a reset-period is very important and must be low and stable. In the reset-period, for low and stable light emission, the reset waveform uses the ramp pulse [2]. And the weak discharge produced by ramp pulse helps the control of wall charge. Whereas, the characteristic of the weak discharge is effected by the cell structures, such as the sustain electrode gap, barrier rib height, gas mixture, and so on.

In this paper, in order to examine the effects of various sustain gaps on the reset discharge characteristics, the conventional reset waveform was applied to the various sustain gaps, *i.e.* 50 μm, 100 μm, 200 μm, and 400 μm. As a result, in the large sustain gap over 200 μm, unstable discharge was observed. Based on the Vt close curve analysis [3], the modified reset waveform that prohibits the unstable discharge is proposed in the large sustain gap of 200 μm and its reset discharge characteristics are examined.

2. Vt close curve and Experiment

Fig. 1 shows the red (R), green (G), and blue (B) cell configurations of a 7-in. test panel and the three related electrodes, X, Y, and A, where X and Y are the common (or sustain) and scan electrodes, respectively, and A are the address electrodes. The gaps between the X and Y electrodes were 50 μm, 100 μm, 200 μm, and 400 μm, respectively. The width of ITO electrode was 300 μm, and the height of barrier rib was 125 μm. The gas mixture of the test panel was Xe (5%)-Ne, and its pressure was 500 Torr.

Fig. 2 shows the Vt close curves measured from the 7-in. test panel used in this work on the cell voltage plane. The Vt close curve with 4 or 6 regions showed the threshold cell voltage among the three electrodes. Each region of Vt close curve means the firing voltage condition between two electrodes; region 1 means Vt_{XY} (threshold voltage between X and Y, anode: X, cathode: Y), region 2 means Vt_{AY} (threshold voltage between A and Y, anode: A, cathode: Y), region 3 means Vt_{AX} (threshold voltage between A and X, anode: A, cathode: X), region 4 means Vt_{YX} (threshold voltage between Y and X, anode: Y, cathode: X), region 5 means Vt_{YA} (threshold voltage between Y and A, anode: Y, cathode: A), and region 6 means Vt_{XA} (threshold voltage between X and A, anode: X, cathode: A). As the sustain gap between the X and Y electrodes is wider, the regions 1 and 4 are narrower, and the firing voltages, Vt_{XY} and Vt_{YX} increase. When the sustain gap between the X and Y electrodes is 400 μm, the regions 1 and 4 disappear, as shown in Figs. 2 (a), (b), (c), and (d). The regions 2, 3, 5, and 6 are wider in proportion to the increase in the sustain gap, however the firing voltages Vt_{AY}, Vt_{AX}, Vt_{YA}, and Vt_{XA} are changed little, since the gaps between the address and the sustain electrodes are fixed with 125 μm. In the regions 2 and 3, the electrodes X and Y act as a cathode and they are covered with MgO layer, whereas in the regions 5 and 6, the electrode A acts as a cathode, covered with only phosphor. As a result, the firing voltages Vt_{AY} and Vt_{AX}, is smaller than the firing voltage Vt_{YA} and Vt_{XA}, and the Vt close curve is shifted down.

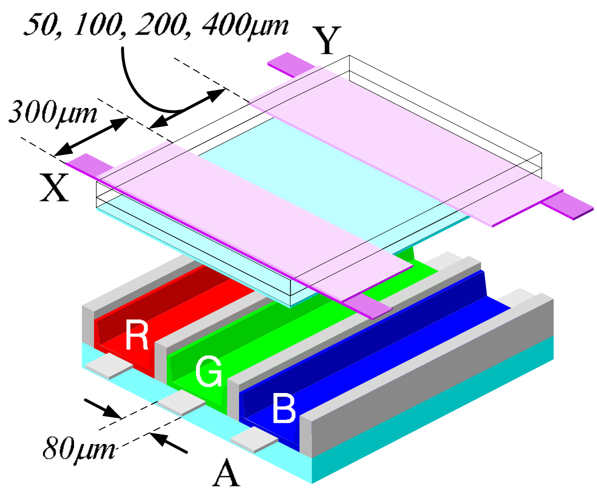
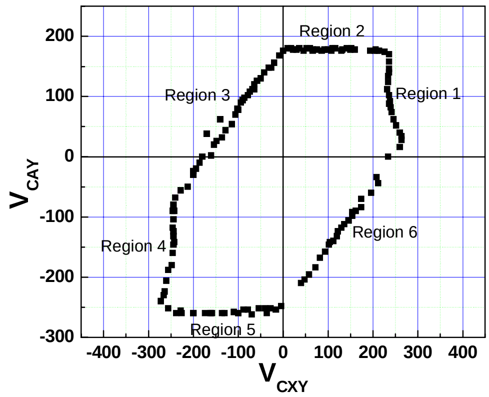
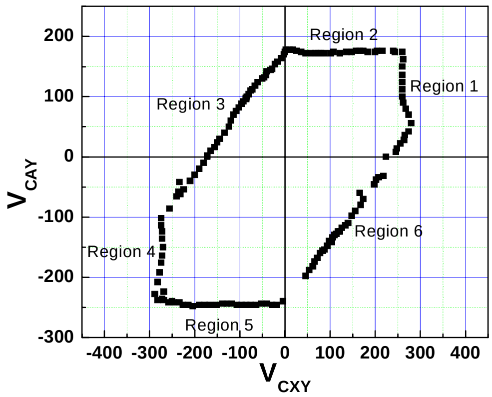


Figure 1. PDP cell structure with various gaps between X and Y electrodes used in this work.

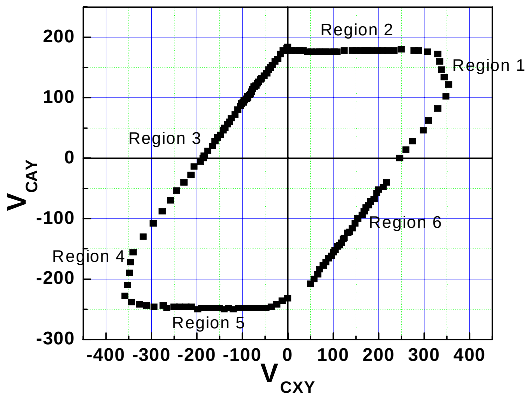
Fig. 3 shows the conventional driving waveform employed in this study to examine the effects of various sustain gaps on the reset discharge characteristics. To remove the effect of the amplitude of reset waveform, a sufficient voltage level was applied to the Y electrode, such as set-up voltage of 440 V and set-down voltage of –150 V. The bias voltage applied to the common electrode X during the reset- and address-periods was 100 V in the cases of the sustain gap 50 μm, 100 μm, and 200



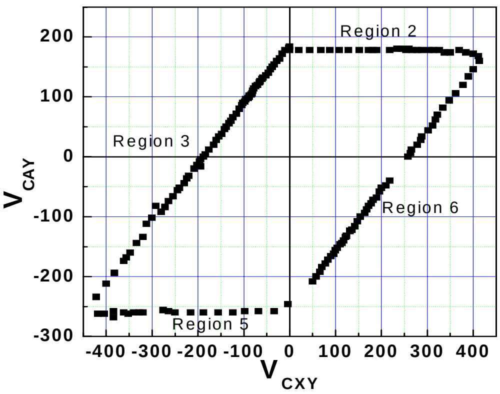
(a) 50 μm



(b) 100 μm



(c) 200 μm



(d) 400 μm

Figure 2. Vt close curves measured from 7-in. test panel with sustain gap of 50 μm (a), 100 μm (b), 200 μm (c), and 400 μm (d).

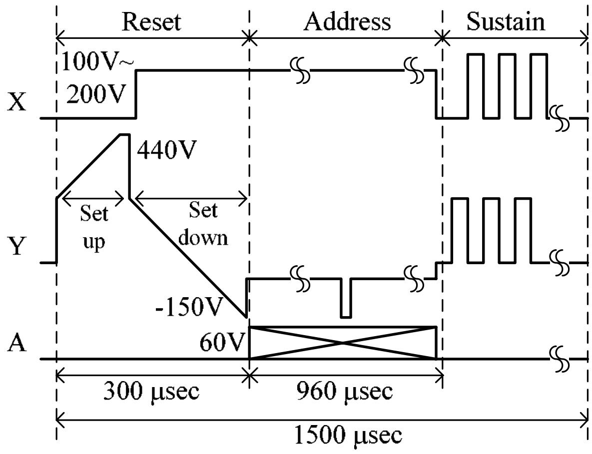


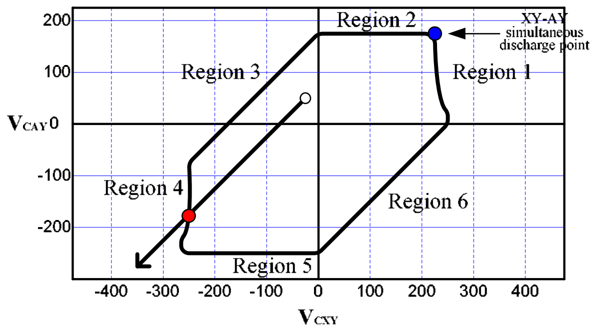
Figure 3. Conventional driving waveform used in this study for verification of reset discharge characteristic.

μm, whereas 200 V in the case of the sustain gap 400 μm. The amplitude of address pulse was 60 V. The sustain waveforms applied to the each sustain gap were not the same because the Vt_{XY} and Vt_{YX} increased in proportion to the increase of the sustain gap. In the sustain gap of 400 μm, the address pulses were applied synchronized with sustain pulse to reduce the voltage level of sustain pulse [4]. The reset- and the address-periods were 300 μsec and 960 μsec, respectively. And this waveform was applied to the each electrode with total period of 1500 μsec, repeatedly.

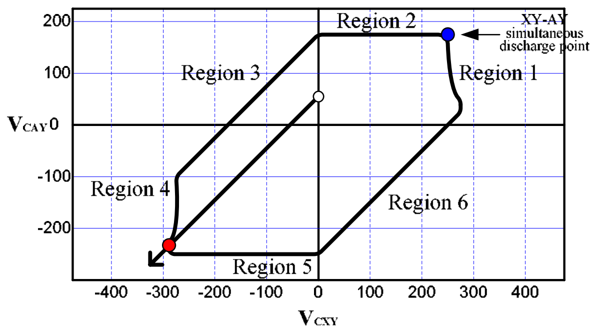
3. Results and Discussion

When the driving waveform shown in Fig. 3 was applied with the address pulse, the sustain discharge was produced stably. Because the wall charges were generated enough by the high external voltages and they were arranged properly for addressing. When the address pulse was not applied, in the cases of sustain gaps of 50 and 100 μm, the stable reset discharge was observed. However, in the case of sustain gap over 200 μm, the unstable reset discharge was observed.

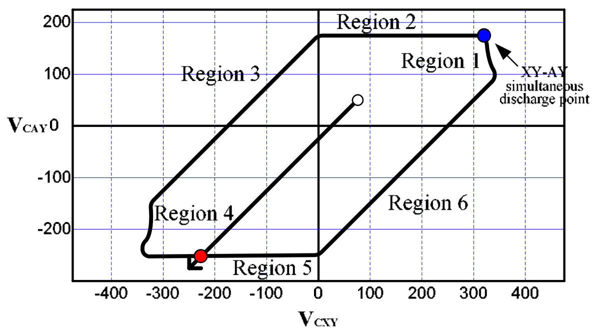
Fig. 4 shows the schematic diagram including the trajectories of the cell voltage generated by the set-up ramp pulse of 440 V and Vt close curve on the cell voltage plane, when the sustain discharge was not produced in the previous state. Under no addressing condition, the initial point of the cell voltage vector was determined by the XY-AY simultaneous discharge point and the applied voltages, *i.e.*, the set-down and the bias voltages [3]. Therefore, when the same driving waveforms were applied, the initial point shifted to the right, due to the shift of the XY-AY simultaneous discharge point as the sustain gap was wider. In the case of Fig. 4 (d) 400 μm, the XA-AY simultaneous discharge point played a role of the XY-AY simultaneous discharge point. By applying the sufficient set-up voltage to the Y electrode, the cell voltage vector exceeded Vt close curve as shown in Fig. 4. In the case of (a) 50 μm and (b) 100 μm, the voltage vector made contact with the region 4 of the Vt close curve. In region 4, the X electrode protected by MgO layer played a role of a cathode, and the resultant weak reset discharge was produced stably. Therefore, in the sustain gaps of 50 μm and 100 μm, the stable reset discharge characteristics were observed. However, in the case of (c) 200 μm and (d) 400 μm, the voltage vector made contact with the region 5 when set-up voltage was applied. Since the phosphor layer performed as a cathode in region 5 and the secondary-electron-emission of the phosphor layer is much smaller than MgO layer, the reset



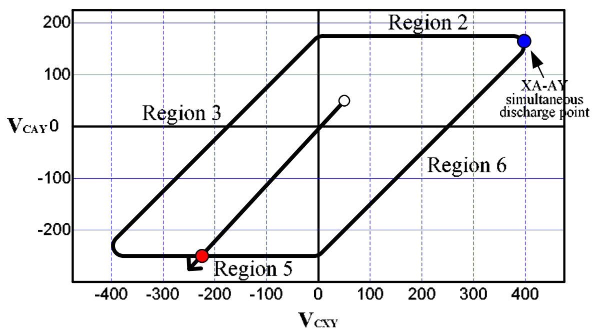
(a) 50 μm



(b) 100 μm



(c) 200 μm



(d) 400 μm

Figure 4. Trajectories of the cell voltage and Vt close curve when set-up voltage was applied to Y electrode.

discharge was generated unstably. To reduce the instability in the reset discharge, the cell voltage vector by the set-up voltage should exceed the Vt close curve via region 4. Consequently, in the case of 200 μm, if the cell voltage vector was shifted up and made contact with region 4, it was expected that the stable reset discharge could be obtained.

Fig. 5 shows the modified reset waveform for the stable reset

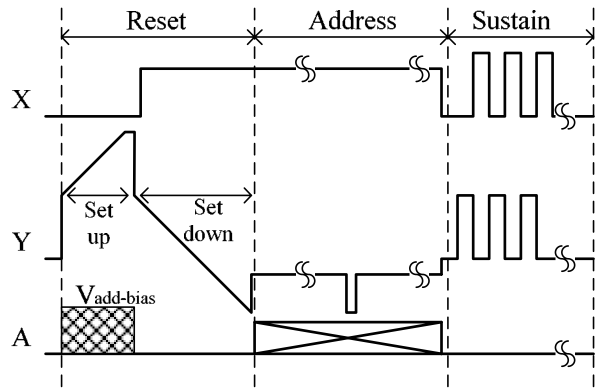


Figure 5. Modified reset waveform for stable reset discharge in case of 200 μm.

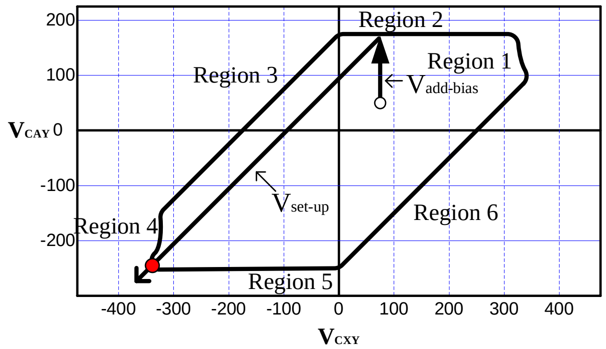


Figure 6. Trajectories of voltage vector when $V_{add\text{-}bias}$ was applied to address electrode.

discharge in the sustain gap of 200 μm and Fig. 6 illustrates the trajectory of the cell voltage in the sustain gap of 200 μm when the modified reset waveform was applied. By applying the bias voltage to the address electrode during a ramp set-up period, the voltage vector shifted up and made contact with region 4, as shown in Fig. 6. As a result, stable reset discharge was observed.

Fig. 7 shows the changes of IR waveform during the reset-period when the conventional and the modified reset waveforms were applied to the test panel with a sustain gap of 200 μm. In the conventional case, many IR peaks were observed because of

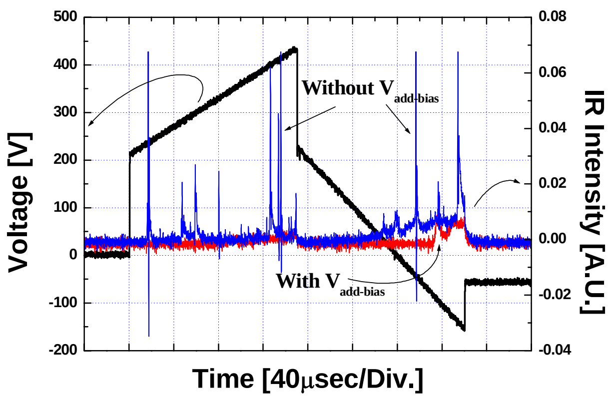
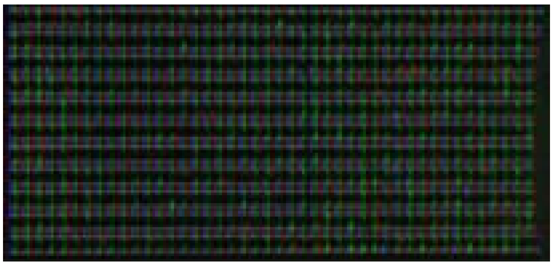
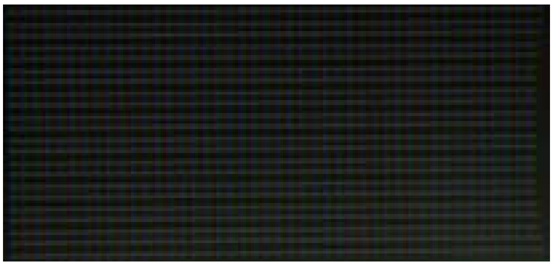


Figure 7. Measured IR waveforms when conventional reset waveform was applied (a) and modified reset waveform was applied (b).

the instability of the weak reset discharge caused by non-MgO cathode condition. In the modified driving waveform, the IR intensity was reduced and became stable in comparison with the conventional case. Fig. 8 shows the images captured from 7-in test panel when conventional reset waveform was applied (a) and modified reset waveform was applied (b). In the conventional case, unstable discharge was observed. Whereas, in the modified reset waveform, the stable reset discharge was observed, as shown in Fig. 8 (a) and (b). Table 1 shows the background luminance when conventional and modified driving waveform involving the reset, address, and sustain-period was applied to the cell with the sustain gap of 200 μm and its period is 1500 μsec. In the conventional case, the luminance was high and was not fixed due to unstable reset discharge. In the modified waveform, the luminance was low and stable.



(a) Without $V_{add\text{-}bias}$



(b) With $V_{add\text{-}bias}$

Figure 8. Images captured from 7-in test panel when conventional reset waveform was applied (a) and modified reset waveform was applied (b).

Table 1. Background luminance in case of 200 μm.

	Background Luminance
Conventional Reset Waveform	6.49~6.70 cd/m^2 (Not Fixed)
Modified Reset Waveform	1.13 cd/m^2

4. Conclusion

In this paper, the effects of various sustain gaps on the reset discharge characteristics, especially the discharge stability, are examined based on the Vt close curve analysis. As a result, the modified reset waveform that prohibits the unstable discharge is proposed in the large sustain gap of 200 μm and its reset discharge characteristics are examined.

5. References

[1] S. J. Yoon, B. K. Kang, N. K. Lee, and Y. H. Kim, “Scan-during-sustain method for driving a high resolution AC plasma display panel,” *Int. J. Electronics*, vol. 89, no. 4, 2002, pp. 289-304.

[2] L. F. Weber, L. F. Weber, “Plasma Panel Exhibiting Enhanced Contrast,” U.S. Patent 5 745 086, April 28, 1998.

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