Relation between Ramp-reset and Barrier Rib Height in AC PDP cells

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Abstract

Difference in the structure of AC PDP cells makes the cells have various discharge characteristics. Therefore, a ramp-reset must be adjusted for the stable driving of AC PDP. If any ramp-reset can reduce the difference in discharge characteristics between cells, the conditions of the address discharge could become almost the same. It is very important to understand these to design a good driving waveform. In this paper, we proved the mentioned facts with the change of barrier rib heights.

1. Introduction

Generally, ADS method, which is divided into reset, address and sustain period, has been used as the driving method in AC-PDP. Although a panel, which consists of cells having the same structure, is fabricated, the discharge characteristics of the cells in the panel are not identical because of the multiformity of cell structure or the difference of phosphor(R, G, B). Moreover, the wall voltage of displayed cells in prior sub-field becomes very different from that of not displayed cells in prior sub-field. Therefore, for a stable driving of AC-PDP, it is important that the address discharge conditions of all the cells must be almost identical by eliminating the difference of such discharge characteristics of each cell in the reset period. As a reset waveform works like this, a ramp-wave has been mainly used. It is because the ramp-wave can control the wall voltage precisely [1].

The change of a cell structure brings the variation of discharge characteristics of the cell [2] and ramp-reset voltage must be adjusted in consideration for the variation. Therefore, for the suitable setting of ramp-reset voltage, the discharge characteristics of each cell have to be grasped. If the change of the discharge characteristics is known, we can predict the change of the ramp-reset voltage.

In this paper, we measured variation of the firing voltage in discharge characteristics according to the barrier rib height using Vt close curve. In addition, we also showed that the variation makes the ramp-reset voltage change. Moreover, when the ramp-reset voltage was equally applied to the panels that have different barrier rib height, we carefully observed the change of minimum address voltage.

2. Experiments

Figure 1 shows the block-diagram of measurement system for Vt close curve. After the initialization that makes the wall voltage between electrodes zero, while various test pulses are applied to X, Y and Z electrode in a cell, firing voltages are detected by photo signals generated at that time. Putting the detected firing voltages on the cell voltage plane, where x-axis is the voltage between X-Y electrodes and y-axis is the voltage between A-Y electrodes, draw Vt close curve [3,4].

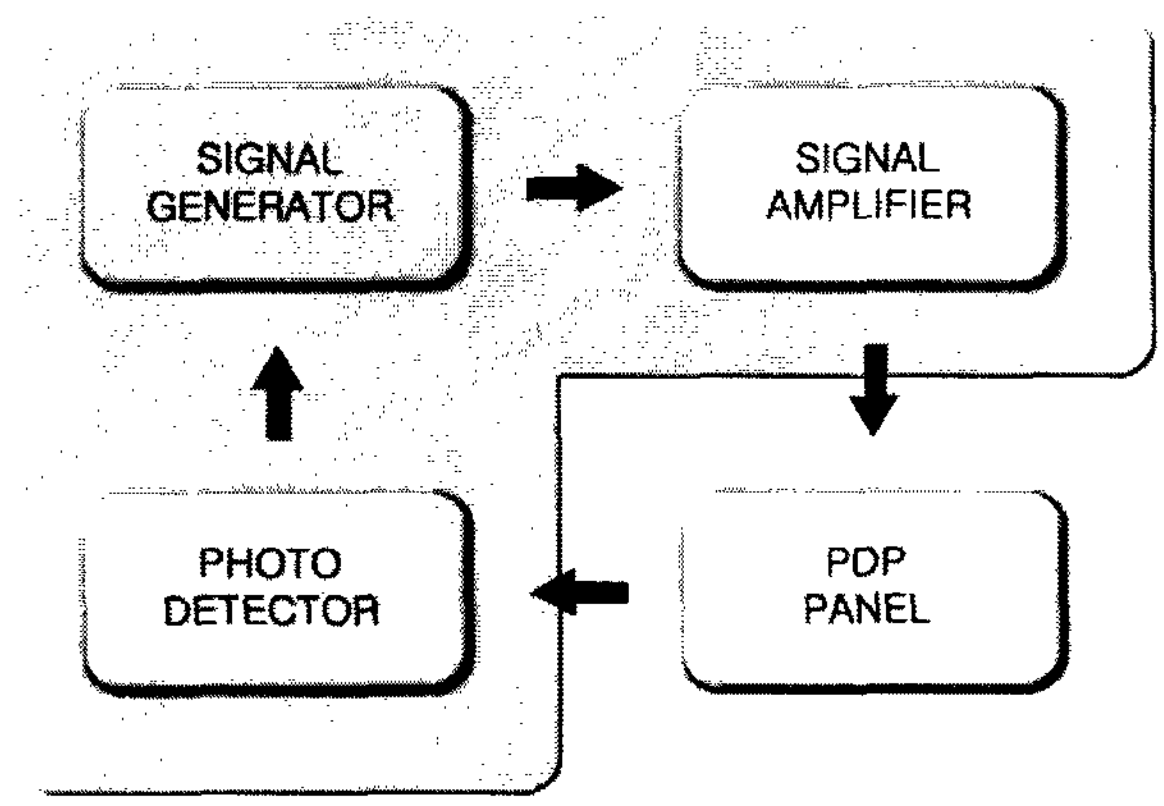


Figure 1. Measurement System for Vt close curve

The ideal Vt close curve is shown in figure 2. In figure 2, A and B is the surface firing voltage between X and Y electrode, C and D is the opposed firing voltage between Z and Y electrode, and E and F is the opposed firing voltage between Z and X electrode.

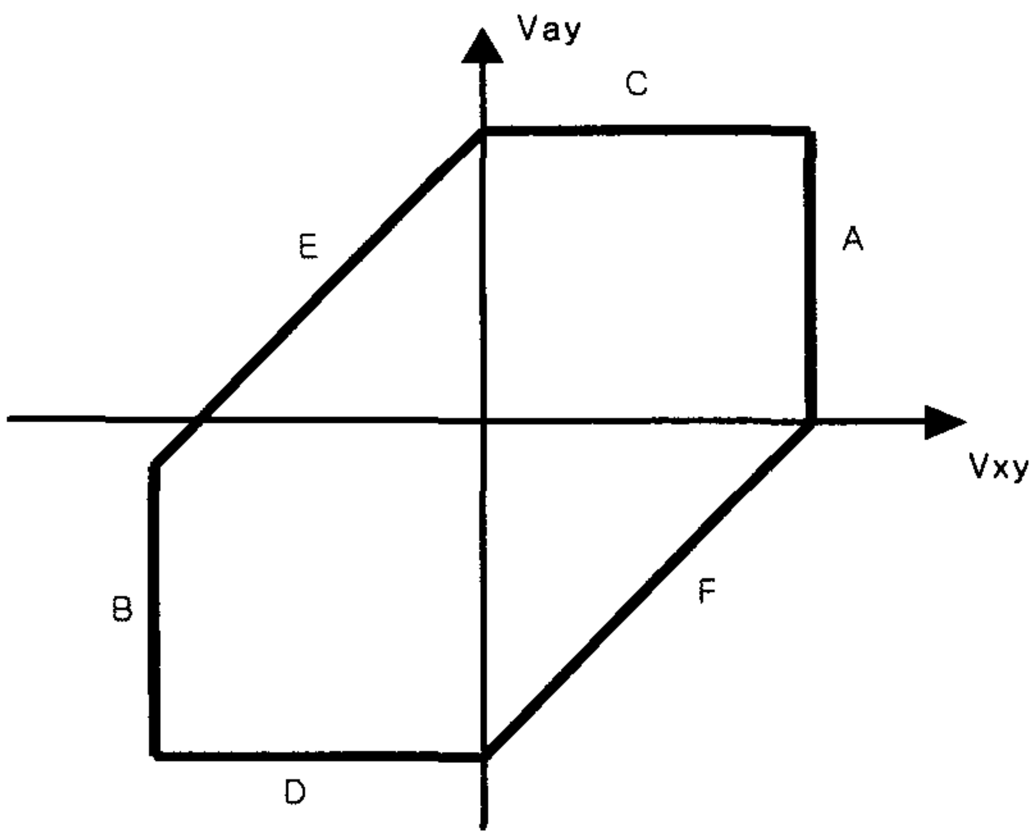


Figure 2. The ideal Vt close curve

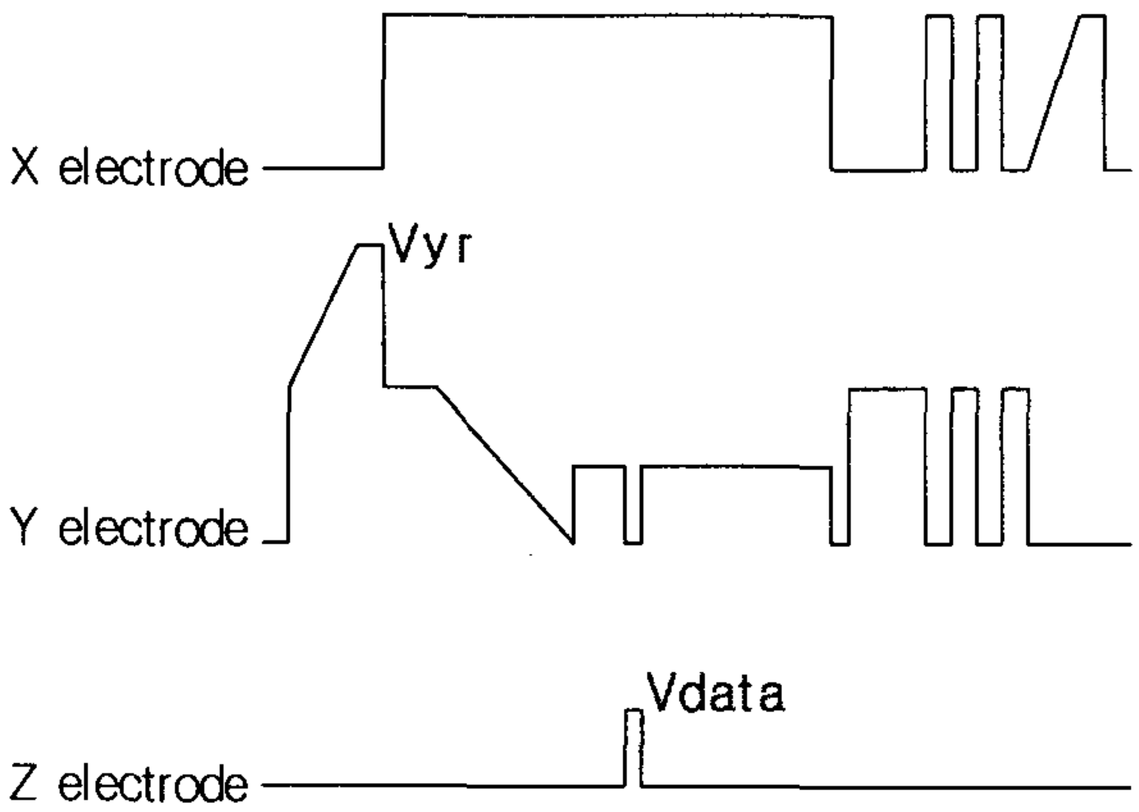


Figure 3. Driving waveform

In this experiment, we measured the Vt close curve for each of R, G, B cells in the five test panels has different barrier rib heights. As the result, we grasped the degree of the variation of firing voltages. The barrier rib heights of the test panels were 100, 120, 140, 160 and 180um, respectively. However, other conditions of each panel were almost the same. All the panels have the conditions that the width of X and Y electrodes is 320um, the gap between X and Y electrode is 90um, the width of Z electrode is 100um, the cell size is 360 × 1,080um^2 and the number of display cells is 33 × 58.

Figure 3 shows the driving waveform used in these experiments. After the driving waveform was applied to the test panels, the variation of minimum ramp-reset voltage (Vyr-min) of each R, G and B cell in the test panels was measured. Moreover, under the same ramp-reset voltage, the variations of minimum address voltage (Vdata-min) were also measured.

3. Results and discussion

Variation of firing voltages

The Vt close curves measured for each of R, G and B cells with different barrier rib heights. However only those of green cells are shown in figure 4. It can be clearly noticed that the increase of the barrier rib height makes the firing voltages change.

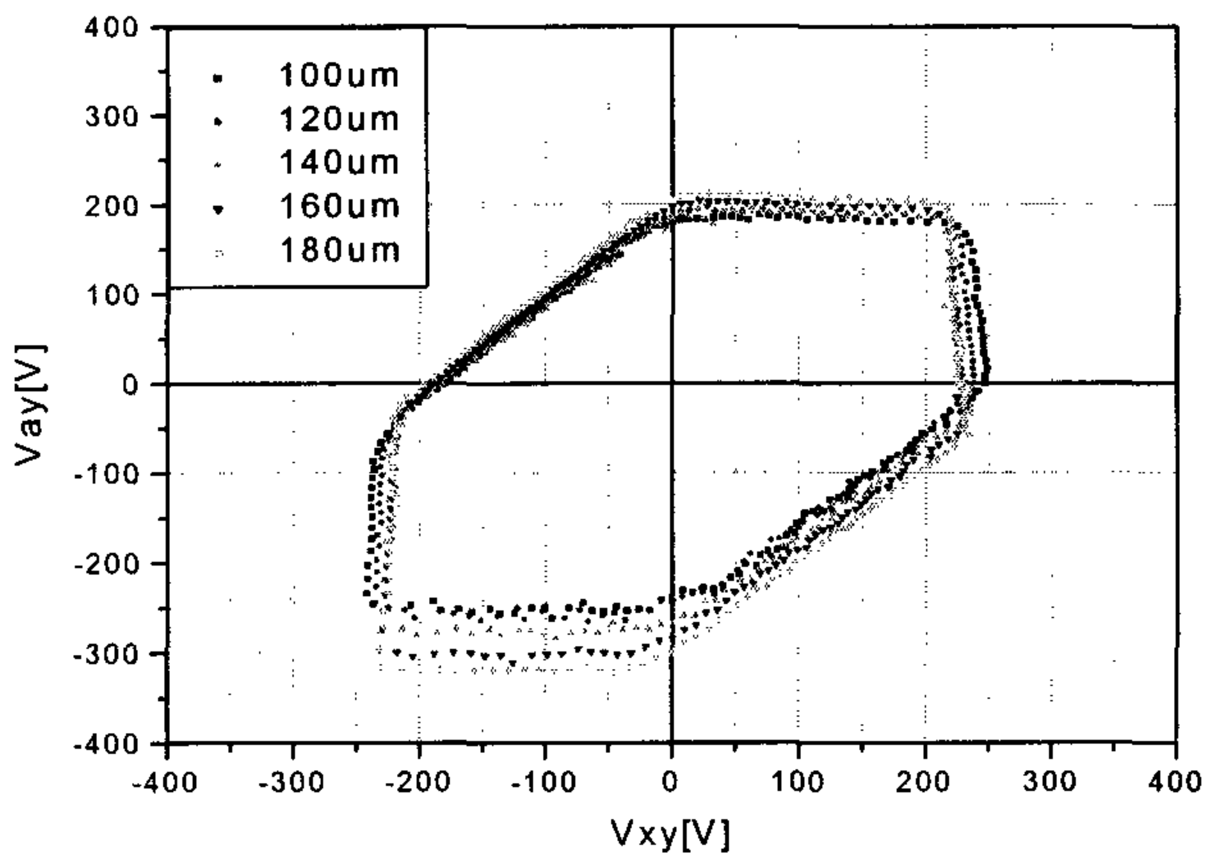
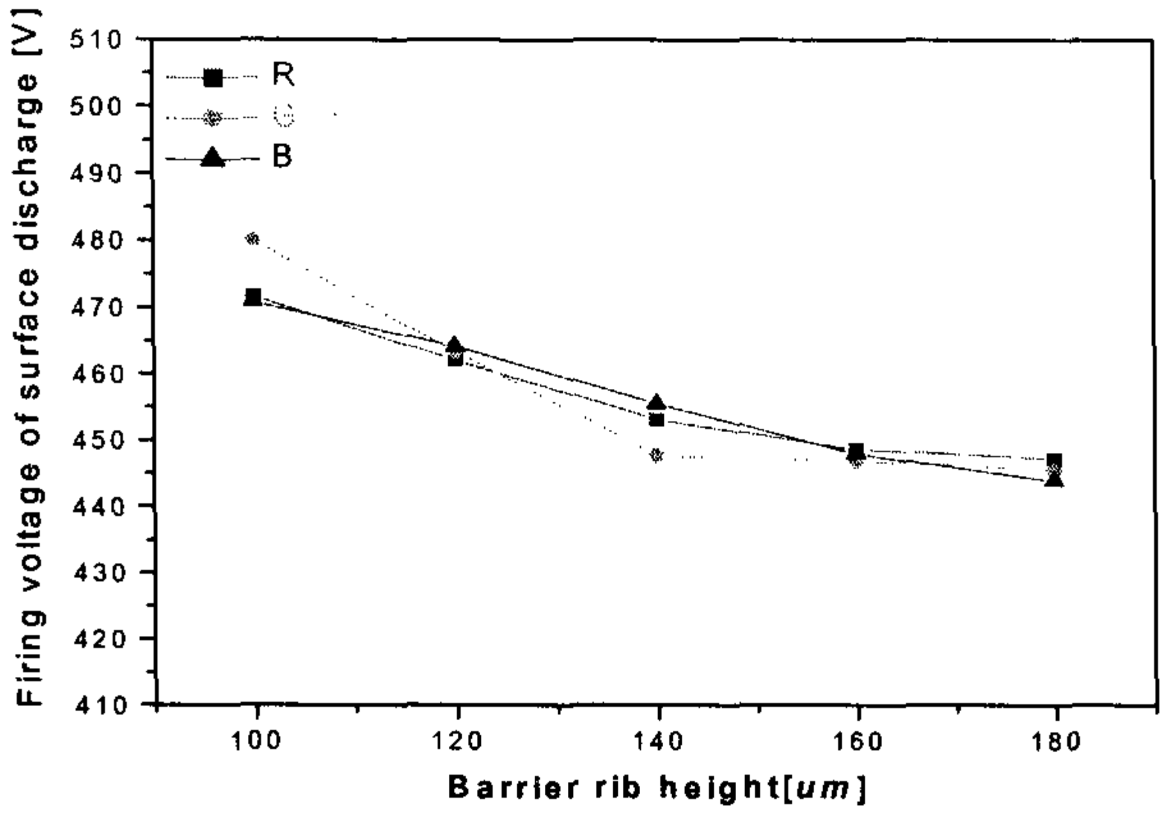
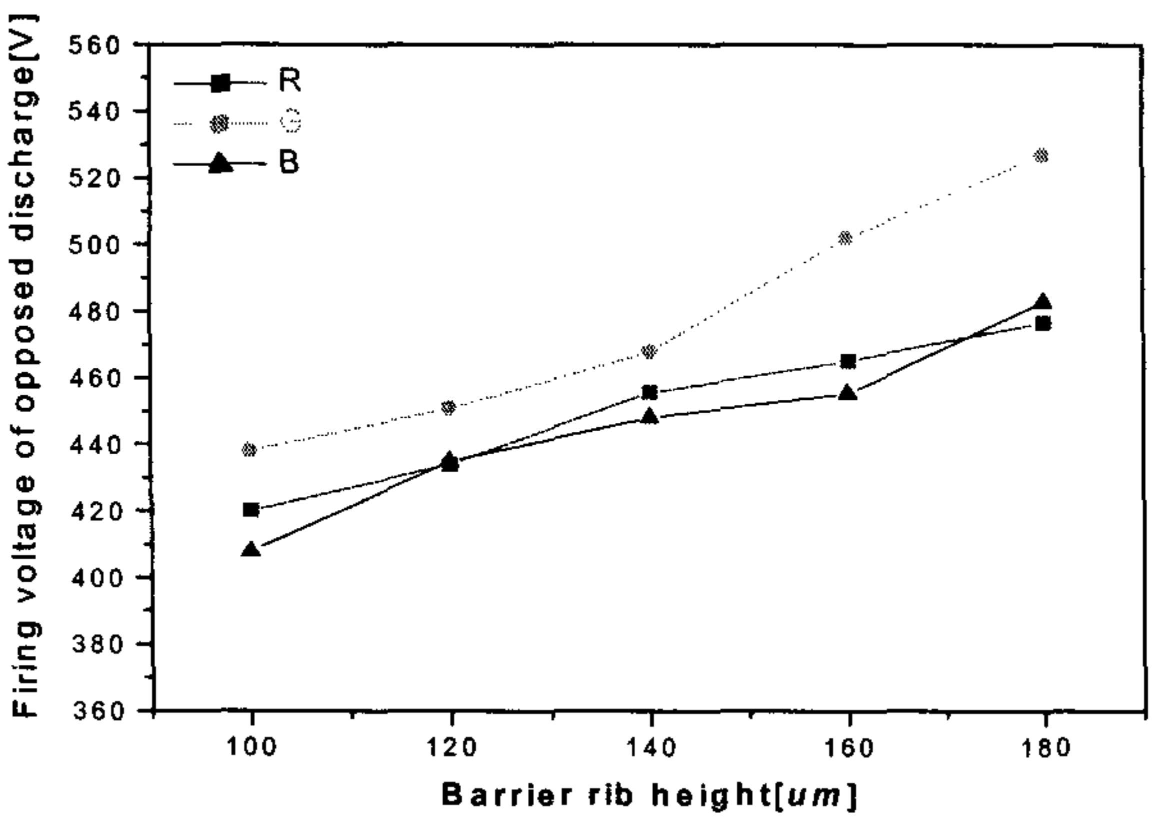


Figure 4. Vt close curves measured according to barrier rib heights (only for green cells)

Figure 5 shows the variation of the surface firing voltage and the opposed firing voltage for each R, G, and B cells, obtained from the measured Vt close curves. In case of the firing voltage of surface discharge shown in figure 5(a), it is represented as the sum of the firing voltage, when X electrode is cathode and Y electrode is anode (A in figure 2), and that of the opposite case (B in figure 2). The firing voltage of opposed discharge shown in figure 5(b) was also obtained by adding the firing voltage, when Y electrode is cathode and Z electrode is anode (C in figure 2), to that of the other case (D in figure 2). First, when we see the figure 5(a), all the firing voltages of surface discharge for R, G and B cells decreased and then saturated as barrier rib height increased. It is because up to some barrier rib height, the distance between front panel and phosphor layer affects surface discharge between X and Y electrode. Next, when we see figure 5(b), the firing voltages of opposed discharge increased continuously as the barrier rib became higher. This matches up to the Pachen's law that the longer a distance between discharge electrodes is, the higher a firing voltage goes. From the result shown in figure 5(b), we can easily expect if the barrier rib height increases, the ramp-reset voltage will be raised.



(a) In case of surface discharge



(b) In case of opposed discharge

Figure 5. Change of firing voltage according to barrier rib height

Ramp reset voltage (Vyr)

Figure 6 shows the variation of the minimum ramp-reset voltage for each cell when Vdata applied to Z electrode is 50V. As predicted through the result for the variation of the firing voltage, according as barrier rib height goes high, the minimum ramp-reset voltages more increase If we see figure 6, the minimum ramp-reset voltage of green cell is higher than that of red and blue cell. It is because the secondary electron emission coefficient (γ) of green phosphor is the lowest. Therefore, when Z electrode is used as a cathode, the firing voltage of G cell becomes the highest. Figure 7, which is the Vt close curves of R, G and B cells with the same barrier rib height of 140um, well shows that the firing voltage of green cell is the highest when Z electrode is a cathode.

As the result, we can make sure that the variation of the firing voltage caused by of the change of cell structure makes the ramp-reset voltage different

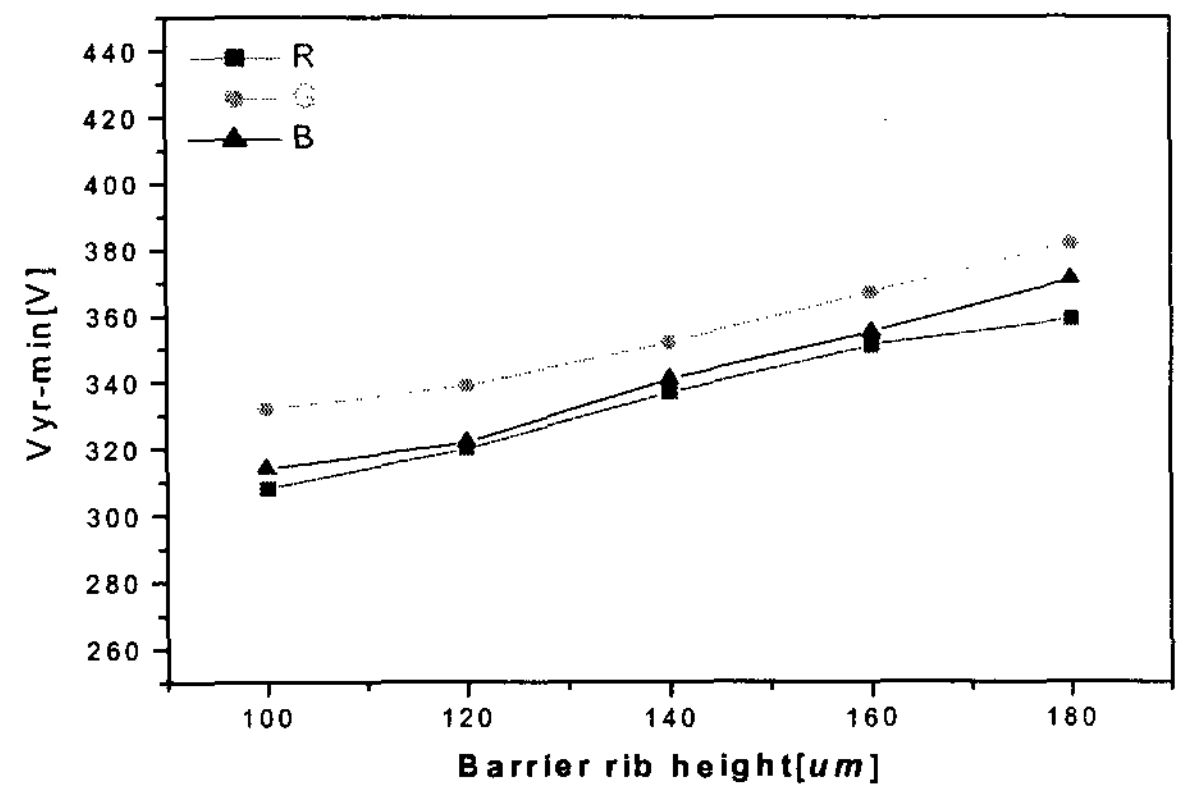


Figure 6. Change of minimum ramp-reset voltage according to barrier rib height

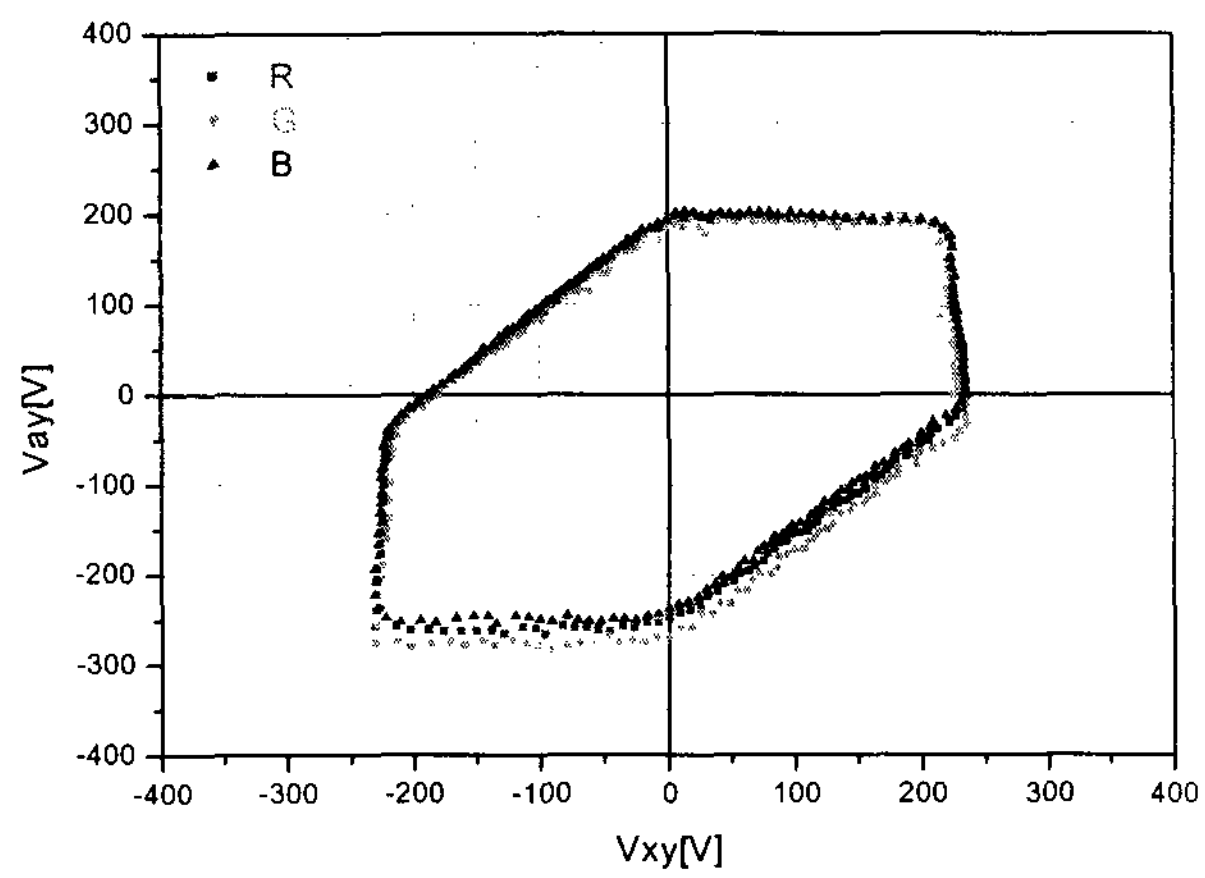
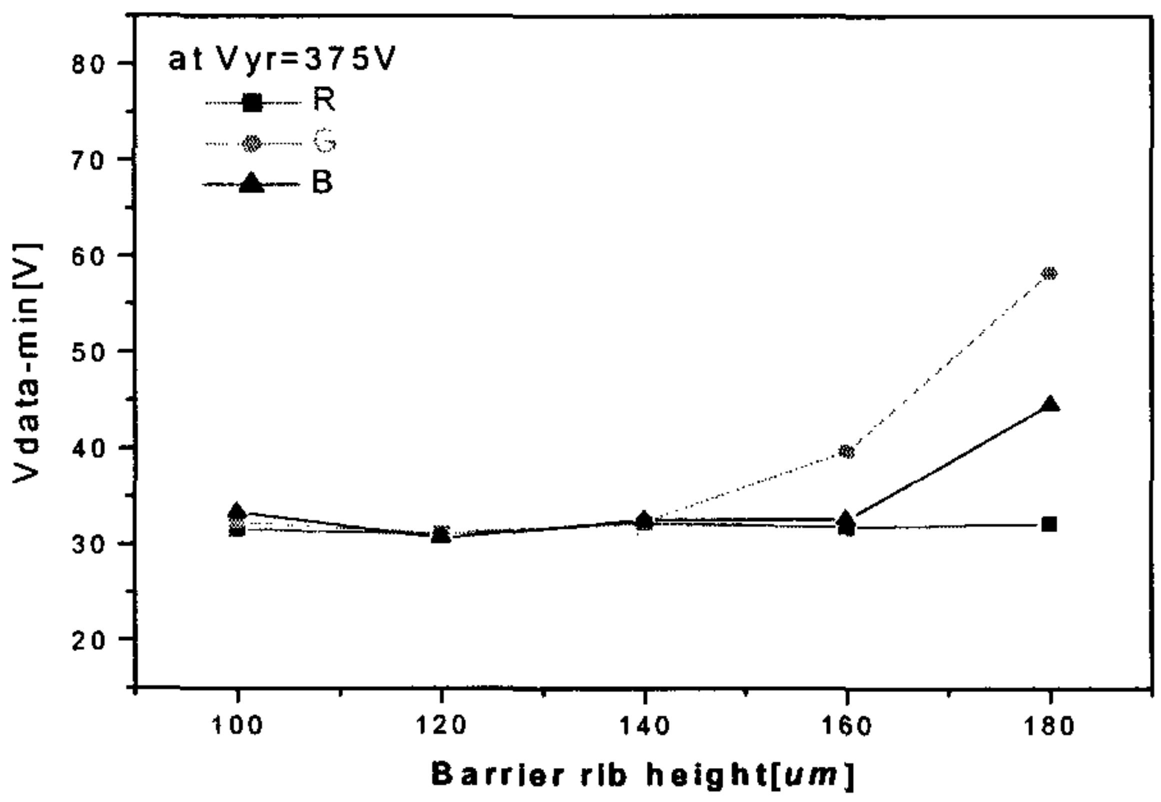


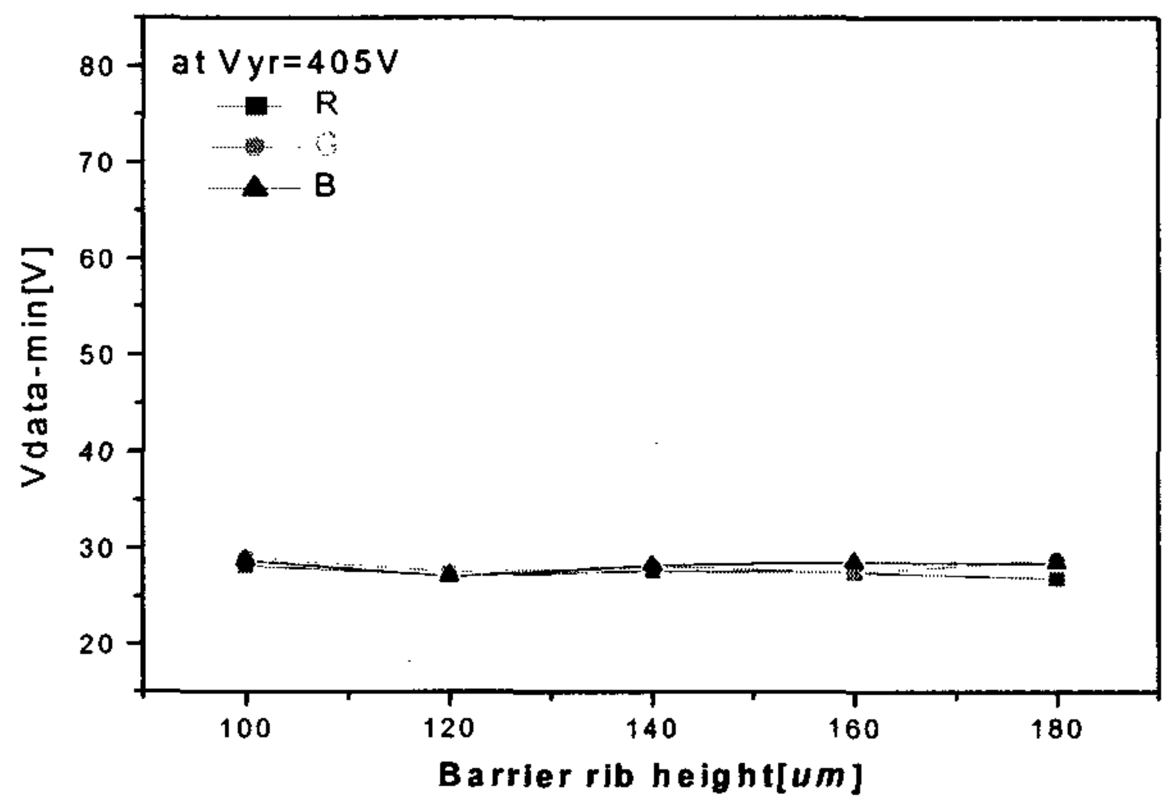
Figure 7. Vt close curves of R, G and B cell in 140um barrier rib height

Address voltages (Vdata)

Figure 8 (a) and (b) show the variation of the minimum address voltage when a definite ramp-reset voltage was applied. Figure 8 (a) shows the measured result when ramp-reset voltage is 375V. In this case, all of R, G and B cells have almost the same minimum address voltage up to 140um barrier rib height in spite of difference of the required minimum ramp-reset voltages and the measured firing voltages according to various barrier rib heights and phosphors. It is to well show the role of ramp-reset that is to make the same condition of address discharge for each cell by eliminating differences of the discharge characteristics between cells.



(a) At the ramp-reset voltage (Vyr) = 375V



(b) At the ramp-reset voltage (Vyr) = 405V

Figure 8. Change of minimum address voltage according to barrier rib height

For G cell with 160um barrier rib height and B, G cells with 180um barrier rib height, the minimum address voltages are higher. Its reason is that the ramp-reset voltage is not high enough for those cells. At this time, if the ramp-reset voltage is applied higher than 375V, those cells will also have the same minimum address voltage as other cells have. Figure 8 (b) shows the measured result when the ramp-reset voltage is 405V. From the result in figure 8 (b), we realized that, if ramp-reset voltage is enough for all cells, the minimum address voltage for all cells is almost the same regardless of the difference of barrier rib height and phosphor.

4. Conclusion

In this paper, we showed that the surface and opposed firing voltages varied by the change of barrier rib height and phosphor, using Vt close curve. In addition, we also showed that the variation of the firing voltage brought the ramp-reset voltage into change. Moreover, it was also proven that the condition of address discharge could be almost the same by proper ramp-reset.

As the results, it is certain that the ramp-reset must be appropriately adjusted according to a cell structure. If design the ramp-reset waveform after understanding this principle exactly, we could secure a wider margin in the driving of AC-PDP.

5. References

[1] K.Sakita and et al, “Analysis of a Weak Discharge of Ramp-Wave Driving to Control Wall Voltage and Luminance in AC-PDPs”, SID’00, 10-3 (2000)

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[3] K.Sakita and et al, “High speed Address Driving Waveform Analysis Using Wall Voltage Transfer Function for Three Terminals and Vt Close Curve in Three-Electrode Surface-Discharge AC-PDPs”, SID’01, P37-1 (2001).

[4] K.Sakita and et al, "Analysis of cell operation at Address period Using Wall voltage Transfer Function in Three-electrode Surface-Discharge AC-PDP", IDW’01, PDP5-1 (2001).