Effects of Cell Structure on the Contrast Ratio in AC PDP

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Abstract

Luminance and contrast ratio is one of the most fundamental and important parameters of plasma display panel. Understanding the effects of cell design parameters on the display and background luminance is inevitable for improving the contrast ratio. We report the experimental results on the relationships between cell parameters and contrast ratio of the ac PDP driven by ADS scheme. It was found that the contrast ratio is the most significantly affected by rib height and optimum range of the rib height simultaneously affects the facing discharge during the reset periods, diffusion loss of plasma and shadowing of the visible light emitted from phosphor.

1. Introduction

Although the plasma displays are now entering into the markets, further improvement still needed from the picture quality point of view. [1][2] Contrast ratio is one of the main parameter that indicates the picture quality. Especially, for the use of home theater, high contrast is very important. The contrast ratio is generally defined as the ratio of the white luminance called display luminance to the black luminance called background luminance of the image, including light reflected from the display. Primarily, the background luminance determines dark room contrast ratio. To improve the contrast ratio we have to understand the effects of the cell design parameters on the display and background luminance. In this paper, we report the effects of cell parameters such as rib height, electrode gap, cell pitch and width of the address electrode on the contrast ratio. The characteristics of addressing and sustain discharge are also investigated as a function of these parameters.

2. Experimental

PDP is a flat panel display that utilizes gas discharge. Fig. 1 shows the principle structure of a discharge cell in ac PDP. The size of a discharge cell is about 0.3mm × 1mm× 0.12mm(height). The tri-primary colors(R, G, B) are obtained from RGB phosphors excited by vacuum ultra-violet photons emitted from gas discharge. Table 1 shows the specification of 4-inch model PDP used in this study.[3]

Fig. 2 shows the schematic diagram of discharge test chamber and driving circuit for measuring the electrical and optical characteristics. The vacuum system has a cylindrical vacuum chamber of 200mm diameter and 80mm height and a molecular pump system. The chamber has a quartz view-window to investigate the optical characteristics. The test samples are installed in this chamber. The firing voltage, the sustain voltage, the luminance and the discharge current waveform for the test panels are measured. The luminance of the samples is detected by the luminance colorimeter (BM-7, Topcon Co.).

Fig. 3 shows the driving waveforms used in this study. The total period is 1.63ms. This is the same with the conventional 40 inch PDP[4]

3. Results and a Discussion

Fig. 4 shows the display luminance and back-ground luminance as a parameter of the barrier rib height. As shown in Fig. 4, the maximum display luminance was obtained between 130㎛ and 140㎛ of rib height. It is found that the increasing rates of the display luminance is 8%/10㎛ as the rib height increases from 100㎛ to 140㎛. However, the display luminance decreases as the ratio of 4%/10㎛ over 140㎛ rib height. Then, the background luminance is opposed to the display luminance. The minimum luminance was obtained at the rib height 140㎛. In case of low rib height, the background luminance may mainly depend on the facing discharge between the scan and address electrode compared with the surface discharge between the sustain electrodes in reset period. Because the lower rib height means the closer the distance and the stronger the facing discharge. In case of the range over rib height 140㎛, the surface discharge can be activated due to wide discharge area whereas the facing discharge can be a little weaken caused by increasing of electrode gap. As a result, the background luminance might be increased, but the

display luminance that depends on the conditions of only surface discharge might be a little decreased because of the quenching and self-absorption of Xe eximer in large discharge area.

Fig. 5 shows the contrast ratio as a parameter of rib height. The maximum contrast ratio is obtained at the rib height 140㎛.The increasing rates of the contrast ratio is 15%/10㎛ as the rib height increases from 100㎛ to 140㎛ and the decreasing rate is 13%/10㎛ over 140㎛ rib height.

Fig. 6 shows the display luminance and background luminance as a parameter of the barrier rib width. The display and background luminance decreased as increase of the rib width. The discharge area decreased as increase of the rib width. When the discharge area decreased, the luminance decreased because of increasing of the plasma diffusion loss.

Fig. 7 shows the contrast ratio as a parameter of rib width. The maximum contrast ratio was obtained at the rib width 60㎛. However, there was little difference because the display and background luminance decreased together as increase of the rib width.

Fig. 8 shows the display luminance and background luminance as a parameter of the address electrode width. The display and background luminance increases as increase of the address electrode width. The maximum display luminance was obtained between 110㎛ and 120㎛ address electrode width, and it was saturated over 120㎛. From Fig. 8, it is found that the increasing rate of display and background luminance is about 9% /10㎛ and 5%/10㎛ as increase of the electrode width from 70㎛ to 100㎛. It is considered that the background luminance increased by reason of increasing intensity of the facing discharge in the reset period, and the display luminance also increases because the more wall charges which affect the intensity of the sustain discharge is generated in the address period as increasing of the address electrode width.

Fig. 9 shows the contrast ratio as a parameter of the address electrode width. The maximum contrast ratio was obtained at the address electrode width 100㎛. From Fig. 9, it is found that the increasing rate of the contrast ratio is about 9% /10㎛ as increasing of the address electrode width from 80㎛ to 100㎛. However, the contrast ratio decreased very little because the increasing rate of the background luminance was larger than that of display luminance in the range over 100㎛.

Fig. 10 shows the display luminance and background luminance as a parameter of the phosphor thickness. The maximum display luminance was obtained at 30㎛ phosphor thickness. The background luminance decreases as the phosphor thickness increases Because the higher phosphor thickness, the weaker the facing discharge. On the other hand, the display luminance caused by surface discharge increases as the phosphor thickness increase up to 30㎛.

Fig. 11 shows the contrast ratio as a parameter of phosphor thickness. The increasing rate of contrast ratio is about 18%/10㎛as the phosphor thickness increase from 10㎛ to 30㎛

Fig. 12 shows the display luminance and background luminance as a parameter of the sustain electrode gap on the front glass. The discharge path increases as the sustain electrode gap increases. Therefore, many excited and meta-stable particles are generated in long discharge path during the sustain discharge, consequently, the display and background luminance increases as the sustain electrode gap increases.

Fig. 13 shows the contrast ratio as a parameter of the sustain electrode gap. The maximum contrast ratio was obtained at electrode gap 80㎛. However, there was little difference in contrast ratio as the electrode gap increases.

4. Conclusion

In this paper, it was investigated that the relationships between the cell specification and the contrast ratio in ac PDP.

As a result, it can be noticed that the contrast ratio is mainly affected by the rib height and phosphor thickness. However, the contrast ratio is little affected by the rib width, address electrode width and discharge gap because the display and background luminance increase or decrease together as those sizes are varied. Consequently, the maximum luminance and contrast ratio were obtained at 140㎛ rib height, 100㎛ address electrode width and 30㎛ phosphor thickness.

5. References

[1] Larry F. Weber, "The Promise of Plasma Display for HDTV". Information Display (SID), vol. 16, no.12, pp16-20, 2000

[2] A. Sobel, "Big, Bright, and Beautiful", Information DISPLAY (SID), vol. 14, no. 9, pp.26-28, 1998

[3] T. Shinoda et al, "High Level Gray Scale for AC Plasma Display Panels Using Address-Display Period-Separated Sub-Field Method", *Trans. of IEICE C-2*, no. 3, pp349-355, 1998

[4] Tsutae Shinoda, "Research & Development of Surface Discharge Color Plasma Display Technologies", Asia Display, pp1065-1070, 1998

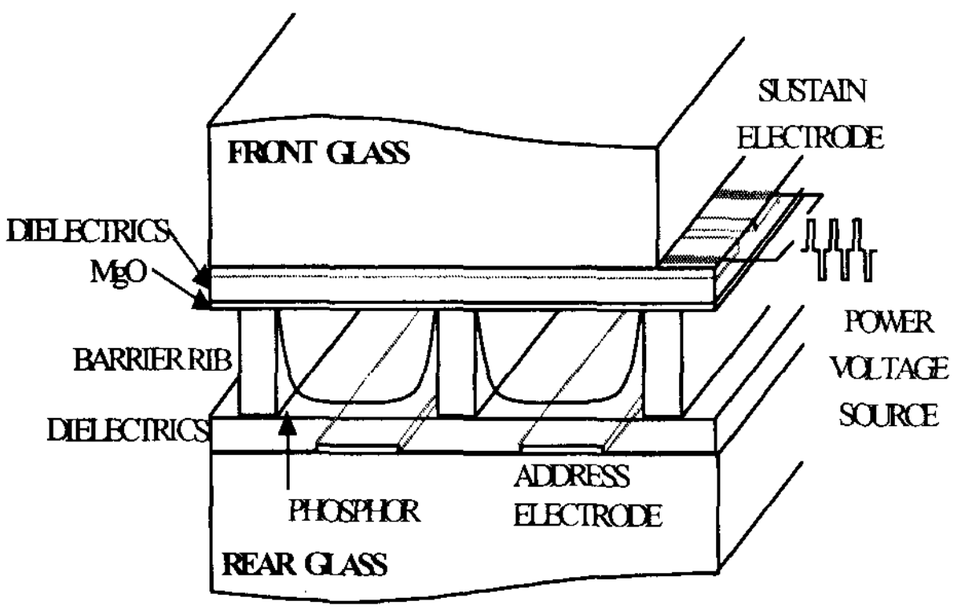

Fig. 1 The schematic diagram of AC PDP

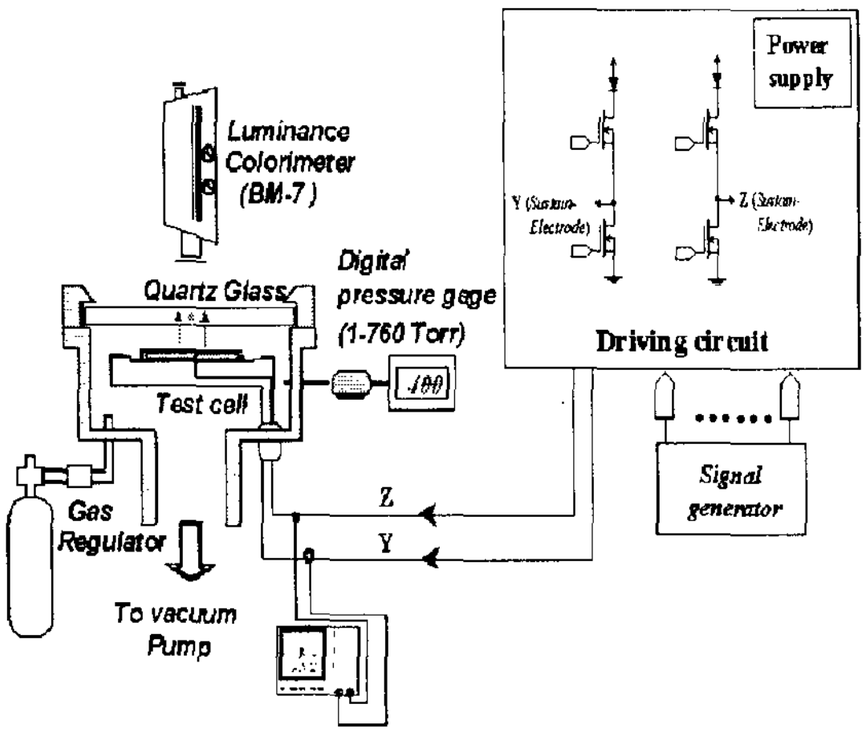

Fig. 2 Schematic diagram of experimental setup

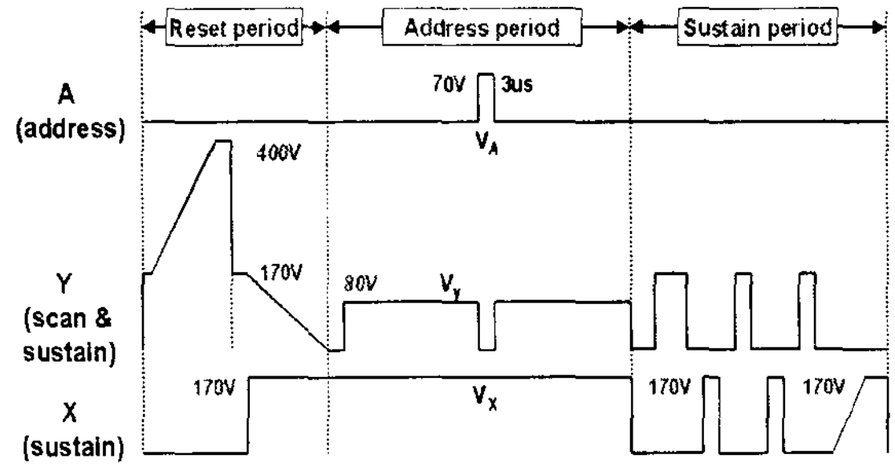

Fig. 3 Schematic diagram of driving waveform

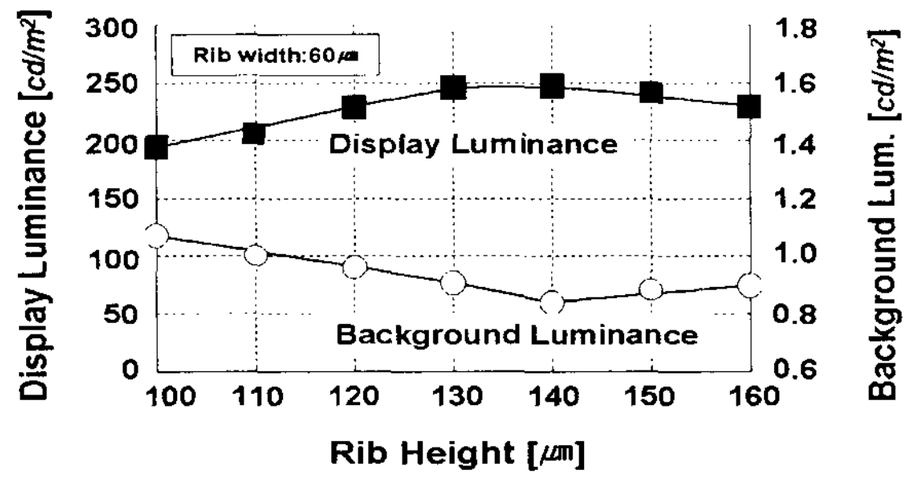

Fig. 4 Background and display luminance as a parameter of rib height

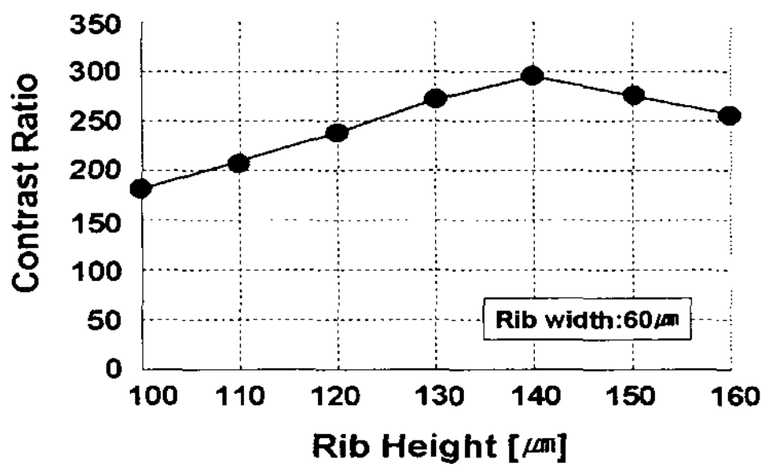

Fig. 5 Contrast Ratio as a parameter of rib height

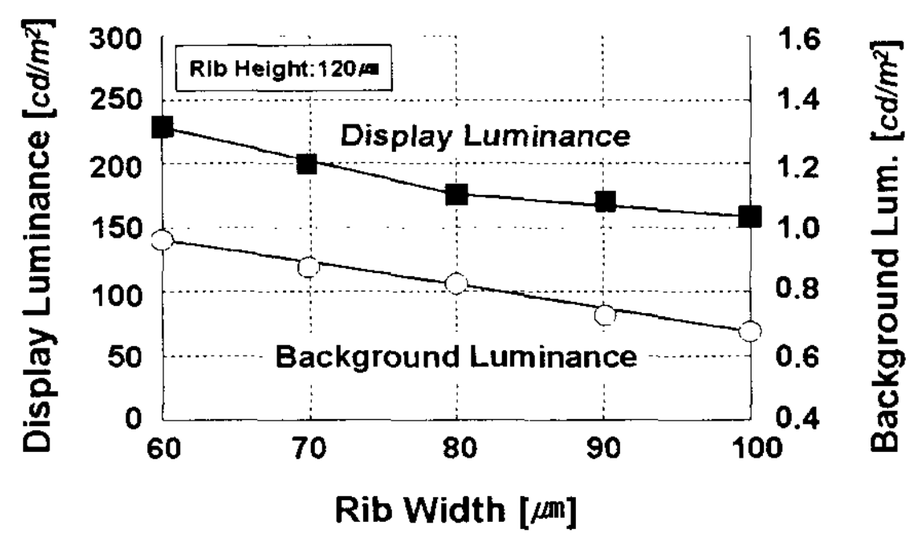

Fig. 6 Background and display luminance as a parameter of rib width

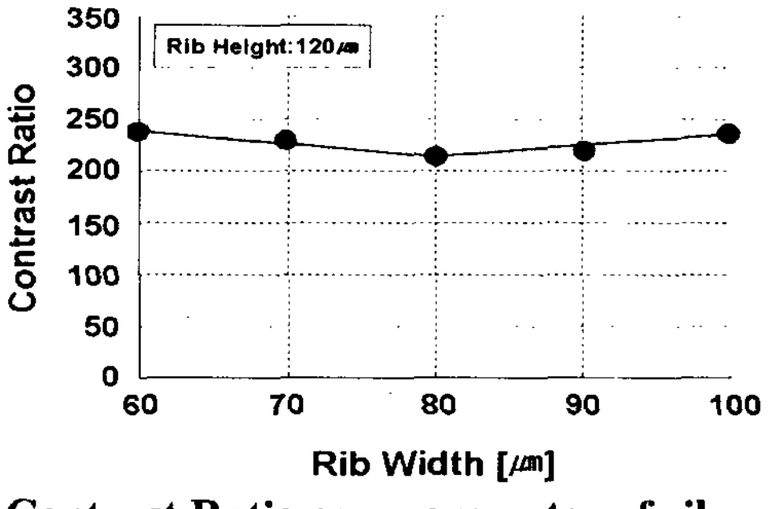

Fig. 7 Contrast Ratio as a parameter of rib width

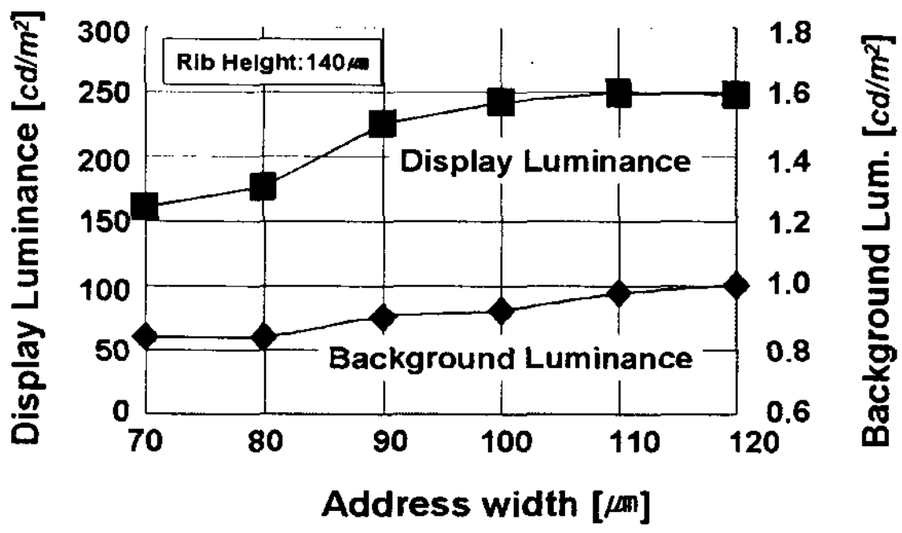

Fig. 8 Background and display luminance as a parameter of address electrode width

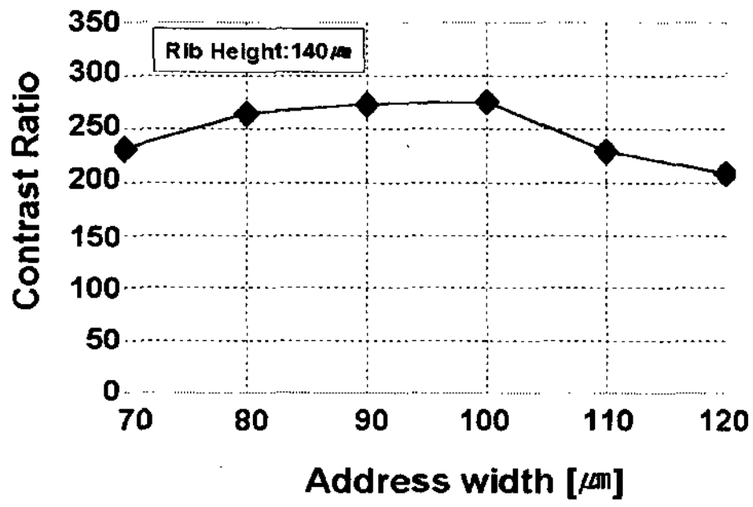

Fig. 9 Contrast Ratio as a parameter of address electrode width

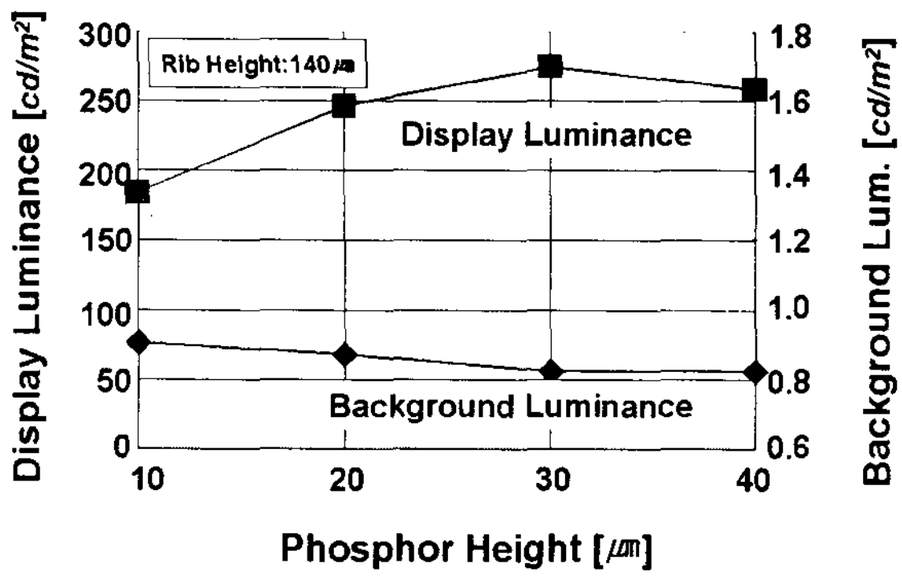

Fig. 10 Background and display luminance as a parameter of phosphor thickness

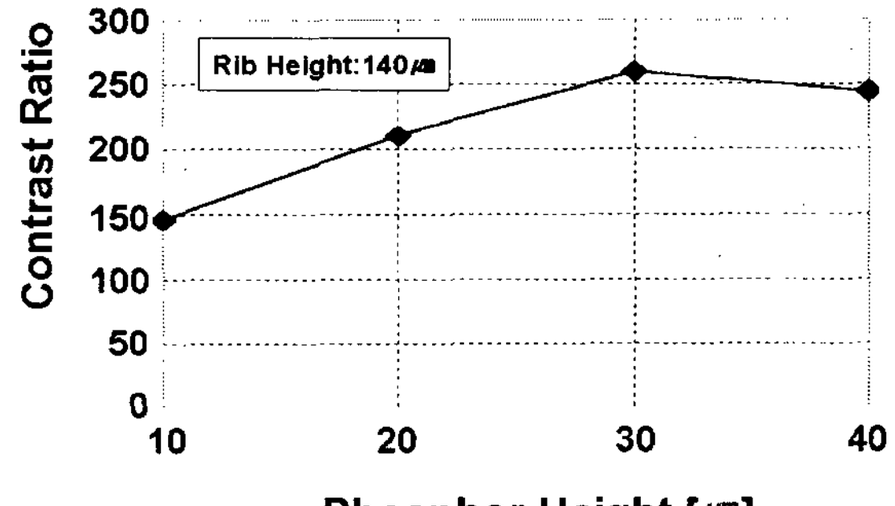

Fig. 11 Contrast Ratio as a parameter of Phosphor thickness

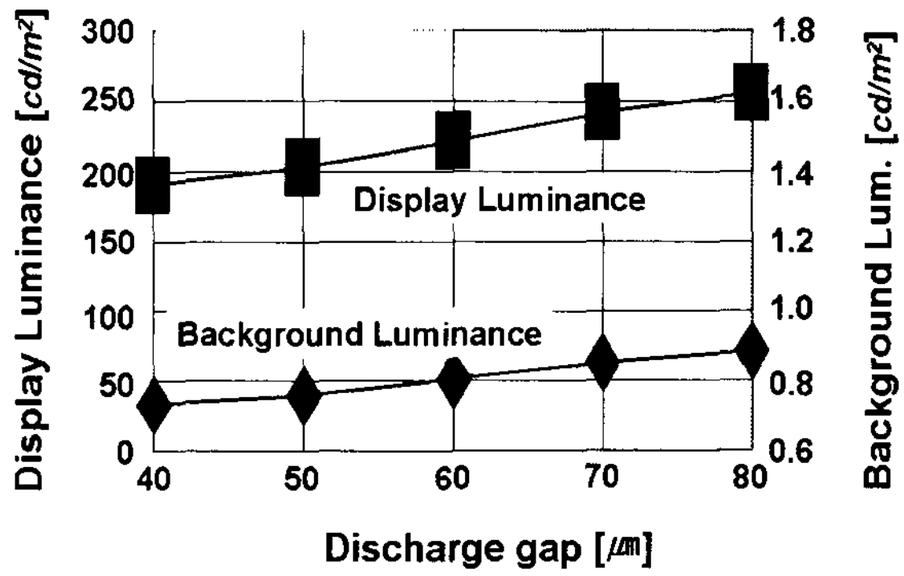

Fig. 12 Background and display luminance as a parameter of sustain electrode gap

Table 1. Specification of 4-inch ac PDP.

Front panel		Rear panel	
ITO width	310㎛	Address electrode Width	100㎛
ITO gap	60㎛	White back thickness	15㎛
Bus width	100㎛	Rib height	150㎛
Dielectric thickness	25㎛	Rib pitch	360㎛
MgO thickness	5000Å	Rib width	70㎛
He+Ne(30%)+Xe(4%) 400[Torr]		Phosphor thickness	20㎛