The Effect of Phosphor Thickness and Discharge Space on the Luminance and Addressing Time in ac PDP

Gi-Bum Lee, Jeong-Eun Heo, Gyu-Seup Kim, Young-Kee Kim,
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Abstract - In this study, the luminance, luminous efficiency and address time of an ac PDP as a parameter of the phosphor thickness and the size of discharge space are investigated. The maximum luminance and luminous efficiency are obtained at the phosphor thickness of 30 ㎛ for the rib height of 110 ㎛. For the rib height of 120 ~ 160 ㎛, the maximum values are obtained at the thickness of 50 ㎛ regardless of the kind of R, G and B phosphor. These results do not affected by the variation of discharge space. The average decrease rate of the total charge to the phosphor thickness is about 3.35pc/cell/10 ㎛ and the average increase rate of the addressing time is about 0.027 ㎲/10 ㎛.
Key Words - ac PDP, Phosphor thickness, Luminance, Luminous efficiency, Address time

1. Introduction

A large-area color flat panel display which can display image and information is expected to be used for a wall-hanging television and a multimedia displays. Plasma display is a most promising candidate for large-area wall-hanging displays because of the features of a simple panel structure and a good display quality.

However, because of its relatively low brightness, it is important to find out the optimum phosphor thickness to obtain high luminance. In addition the effect of phosphor thickness on the driving conditions should be discussed.

In this paper we investigated the effect of the phosphor thickness and discharge space on the luminance and address time in ac-PDP.

2. Experimental

Fig. 1 shows a typical discharge cell of a surface-discharge-type ac-PDP fabricated in this study, whose model is well-known as 3-electrode reflection type. Table 1 shows the spec. of 4-inch test panel. The tested ac PDPs in this study are fabricated by the flowchart of Fig. 2. On the front glass of Fig. 1 or Fig. 2, the transparent sustain-electrodes(ITO) are formed with narrow metallic bus electrodes on the ITO. Bus electrodes are introduced due to lowering electrode resistance. A dielectric layer is coated by thick film printing method on the electrodes. MgO

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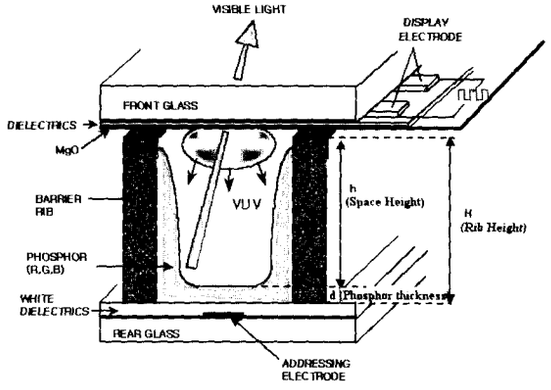

Fig. 1 The schematic diagram of model ac PDP

Table 1 The spec. of 4-inch test panel

Phosphor	Red	$(Y,Gd,Eu)BO_3$
	Green	$(Zn,Mn)SiO_2$
	Blue	$(Ba,Eu)MgAl_{14}O_2$
ITO electrode	gap	60 ㎛
	width	310 ㎛
Bus electrode	width	120 ㎛
Dielectric layer	thickness	20 ㎛
MgO	thickness	5000 Å
Barrier rib	width	80 ㎛
	height	110 ㎛~170 ㎛
Address electrode	width	120 ㎛
Sustain pulse	Voltage	185 V
	Frequency	50 kHz
	Duty ratio	0.5
Cell pitch		0.36mm × 1.08mm
Number of cells		6 × 100
Gas component		He-Ne(30%)-Xe(2%)

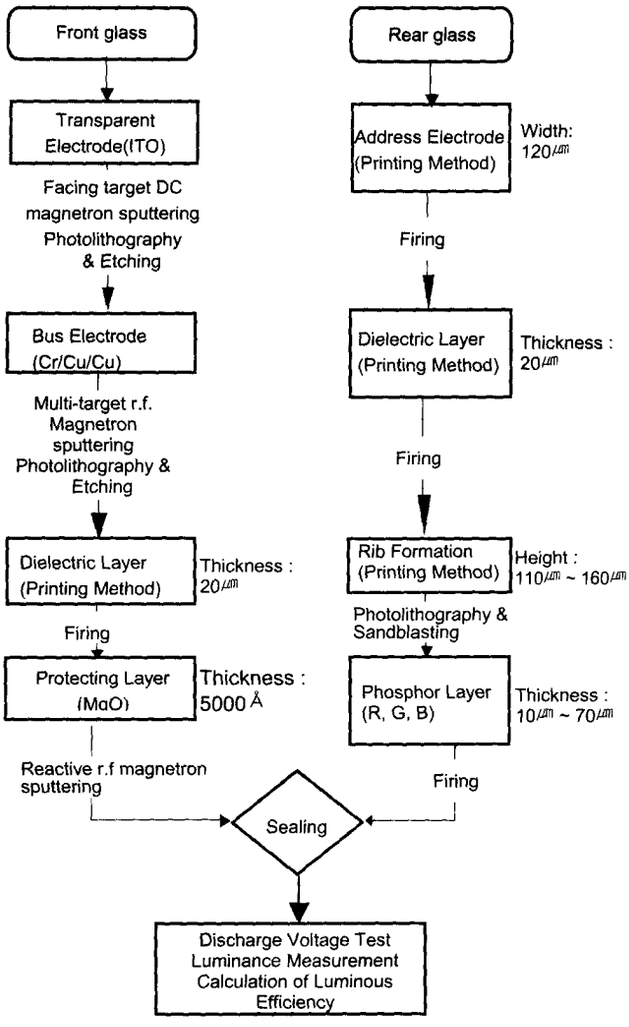

Fig. 2 Manufacture flowchart of the test ac PDP

protecting layer is evaporated on it. On the rear glass, the addressing electrodes are formed orthogonal to the sustain-electrodes. The stripe type barrier ribs are located between these electrodes to maintain discharge space and separate discharge cells each other. These ribs are formed by sandblast method [4]. Rib height was varied in the range of 110 ㎛~160 ㎛, which is widely. Actually trio-primary

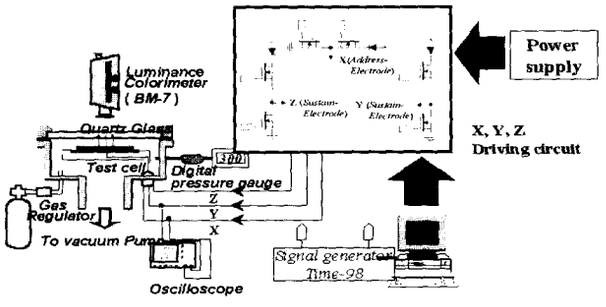

Fig. 3 The schematic diagram of discharge test chamber

color phosphors (Red, Green and Blue) are formed in each groove.

Fig. 3 shows the schematic diagram of discharge chamber to test the characteristics of discharge. This test chamber has a working gas feeding system, pressure controller and digital pressure display. About 10^{-8}torr can be attained with the turbo and rotary pump system. He-Ne(30%)-Xe(2%) penning gas was filled to working pressure[Torr] in the chamber. The luminance of samples is measured by the luminance colorimeter (BM-7). The method used for calculating the luminous efficiency is as follows.

$$\textit{Luminous Efficiency} = \frac{\pi \times \textit{Luminance [cd/m}^2\textit{]} \times \textit{Area [m}^2\textit{]}}{\text{Power Consumption [W]}}$$

In this study, the ADS (Address- Display- Separation) driving method is adopted to measure address characteristics. Fig.4 shows the driving scheme in this work to drive the 4-inch panel with only one addressing pulse. The conditions of applied voltages of three electrodes are shown in Table 2. A previous image is to be cleared in reset period. In address period, address discharge is occurred between scan and address electrode. The generated charges are distributed on the three kinds of electrodes. The well-distributed wall charge makes the exact good image in sustain period. The sum of reset and address period is 1.2 ㎳ and one subfield time is 2 ㎳. The distributed charges at each electrode are detected from the current of each electrode after an address discharge. Addressing time means the time required from the peak of applied voltage to termination of discharge current and total charge means the sum of the charges on the address electrode and sustain electrode in address period.

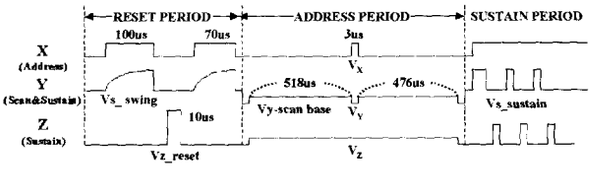

Fig. 4 The schematic diagram of driving waveform in the address experimental (ADS method)

Table 2 The conditions of applied voltages in address experimental

Vy	-155V
Vy_scan base	-50V
Vx	110V
Vz	60V
Vz_reset	370V
Vs_sustain & swing	160V

3. Results and Discussion

Figs. 5, 6 and 7 show the effect of green phosphor thickness on the luminance and luminous efficiency as a parameter of barrier rib height. For the rib height of 110 ㎛, the maximum luminance and luminous efficiency are obtained at the phosphor thickness of 30 ㎛. For the rib height of 130 ㎛ and 150 ㎛, the maximum value are obtained at the thickness of 50 ㎛. The maximum luminance and efficiency for the rib height 110, 130 and 150 ㎛ were 810, 888 and 960cd/㎡, respectively. The maximum luminous efficiency were 1.18, 1.31 and 1.37 lm /W, respectively.

Figs. 8 and 9 show typical results for the effects of red and blue phosphor thickness on the luminance and luminous efficiency under the condition of constant rib height 130 ㎛. From many experiments, it is found out that the optimum R, G and B phosphor thickness showing maximum luminance and luminous efficiency is all the same for a given rib heights Although these optimum thickness are obtained as a parameter of phosphor thickness under the condition of constant rib height, the same results are obtained when the experiment is conducted as a parameter of phosphor thickness under the condition of constant space height as shown in Fig. 1.

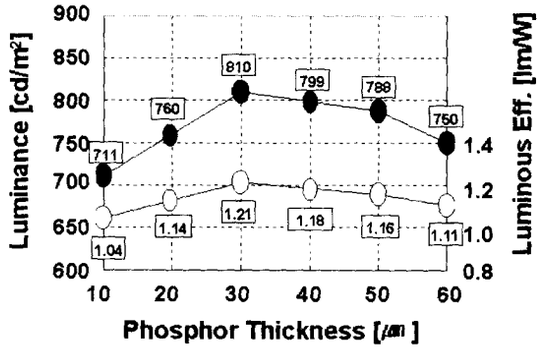

Fig. 5 Effect of the green phosphor thickness on the luminance and luminous efficiency for the rib height of 110 ㎛

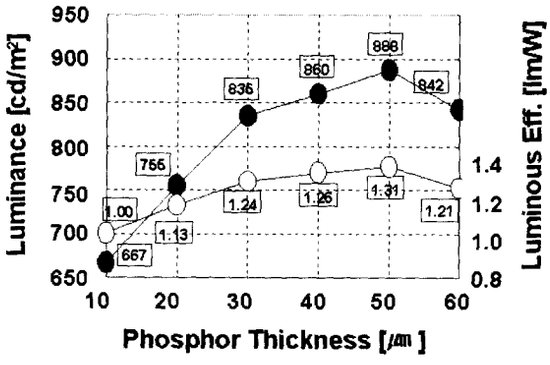

Fig. 6 Effect of the green phosphor thickness on the luminance and luminous efficiency for the rib height of 130 ㎛

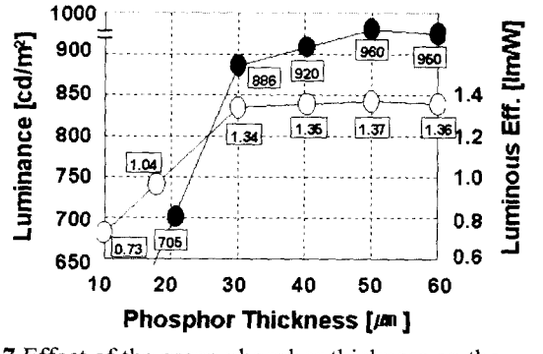

Fig. 7 Effect of the green phosphor thickness on the luminance and luminous efficiency for the rib height of 150 ㎛

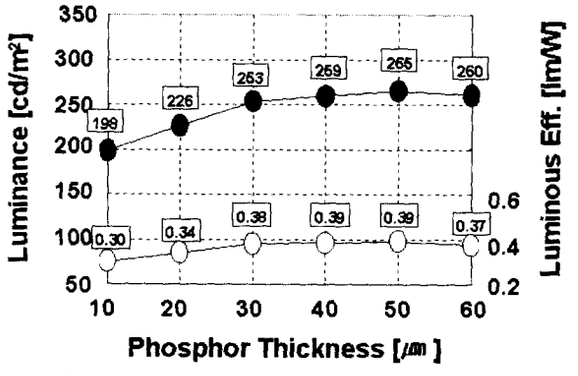

Fig. 8 Effect of the blue phosphor thickness on the luminance and luminous efficiency for the rib height of 130 ㎛

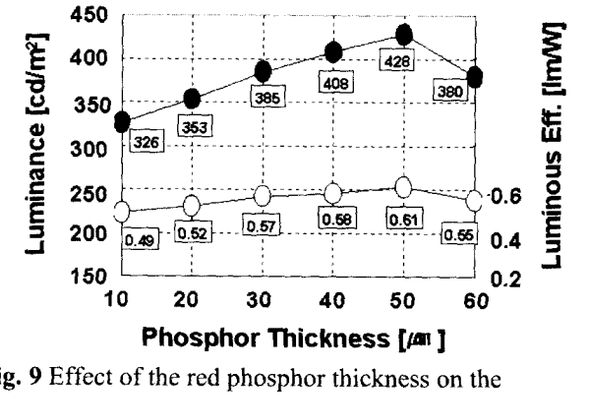

Fig. 9 Effect of the red phosphor thickness on the luminance and luminous efficiency for the rib height of 130 ㎛

Fig. 10 shows the current waveform of address electrode during an addressing discharge as a parameter of green phosphor thickness. The first part of current waveform is the displacement current and 2nd part corresponds to discharge current of address electrode during address period.

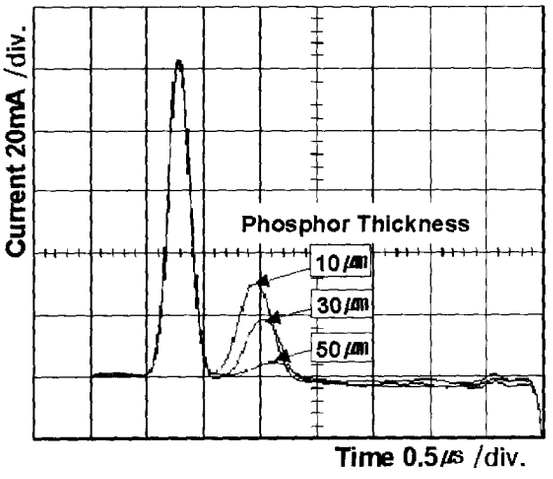

Fig. 10 The current waveform of address electrode during an addressing discharge as a parameter of green phosphor thickness

Figs. 11, 12 and 13 show the effects of R,G and B phosphor thickness for a given rib height on the total charge and addressing time. The charge is decreased with increase in the phosphor thickness for a given rib height, whereas the addressing time is increased. The decrease in the charge on the address and sustain electrode may be due to the electrification of phosphor by the electron or ion in the process of discharge in the discharge cell, because the total charge in the discharge cell is the sum of the charge on the sustain electrode and the charge on the phosphors. The increase in the addressing time may be due to the dielectric properties of phosphors, that is, the phosphor acts like as increase in the dielectric thickness on the address electrode. Therefore the effective gap voltage in the addressing process decrease and the address time is increases. The average decrease rate of the charge is about 3.35pc/cell/10 ㎛, regardless of the R, G, B and the rib height in these test. The average increase rate of the addressing time is about 0.027 ㎲/10 ㎛.

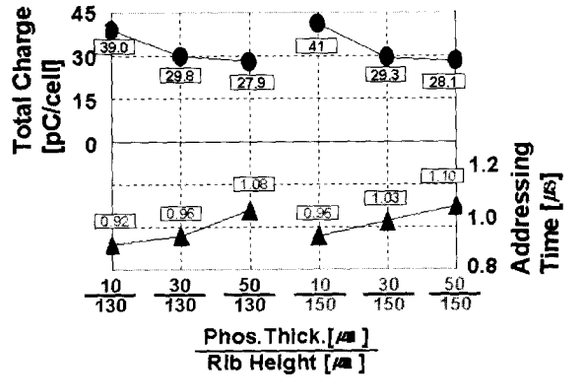

Fig. 11 Effect of green phosphor thickness on the charge and addressing time for the rib height of 130 ㎛ and 150 ㎛

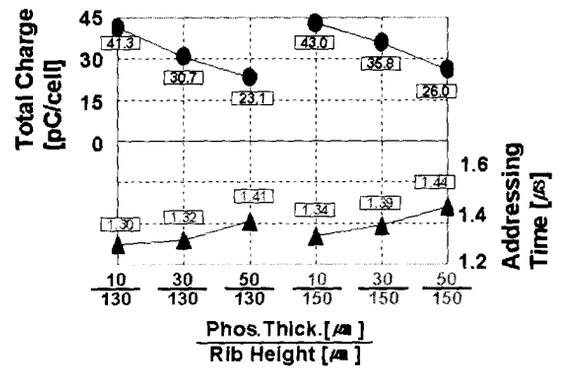

Fig. 12 Effect of blue phosphor thickness on the charge and addressing time for the rib height of 130 ㎛ and 150 ㎛

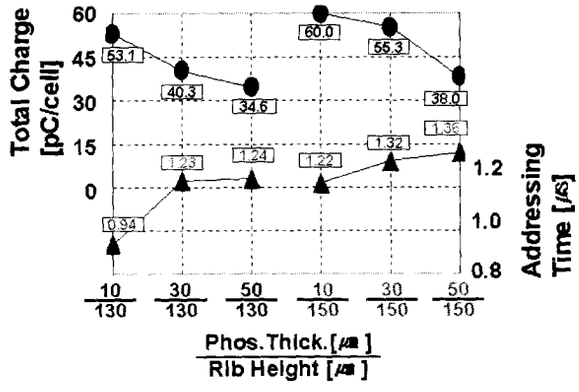

Fig. 13 Effect of red phosphor thickness on the charge and addressing time for the rib height of 130 ㎛ and 150 ㎛

4. Conclusion

In this paper, the optimum thickness of phosphor to obtain high luminance and luminous efficiency in ac PDP is investigated in the range of 110 ㎛~160 ㎛.

(1) For the rib height of 110 ㎛, the optimum phosphor thickness was 30 ㎛. However, for the rib height of 120~160 ㎛ the optimum thickness was 50 ㎛ regardless of the kind of R, G and B phosphor. These results do not affected by the variation of discharge space is this experimental condition.

(2) The average decrease rate of the total charge to the phosphor thickness in address period is about 3.35pc/cell/10 ㎛, regardless of the R, G, B and the rib height in these test. The average increase rate of the addressing time is about 0.027 ㎲/10 ㎛.

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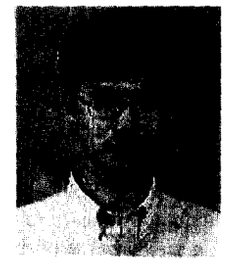

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