

Effects of Phosphor Layer Morphology on Discharge Characteristics of Red, Green, and Blue Cells in AC-PDP

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Abstract

This paper presents the effects of the phosphor layer morphology related to the discharge volume on the discharge and radiation characteristics of the Red, Green, and Blue cells in an AC-PDP. As the thickness of the phosphor layer increases and the corresponding discharge volume in the cells decreases, the voltage margin decreases due to an increase in the sustain voltage. In contrast, the IR(Infrared) emission, discharge current, and luminance characteristics remain almost unchanged, regardless of any changes in the phosphor layer morphology.

Keywords : phosphor layer morphology, discharge volume, voltage margin, IR(Infrared) emission, discharge current.

1. Introduction

AC-PDPs(Plasma Display Panels) are one of the most promising candidates for next generation large-area full-color high-definition display devices[1]. However, problems related to low luminance and luminous efficiency continue to be major issues in current PDP technology.

The phosphor layer morphology related to the discharge volume and phosphor layer thickness may also be a factor that affects the luminance and luminous efficiency of an AC-PDP. Although research on the optimal thickness of the phosphor layer for a high luminance and luminous efficiency has already been reported[2], the optimal phosphor layer morphology related to the discharge volume for improving the luminance and luminous efficiency has not yet been clearly determined.

Most previous researches related to discharge characteristics had focused on the characteristics of the VUV emission, aimed at improving the luminous efficiency of an AC-PDP.[3] As such, the effects of changes in the height of the barrier rib and changes in the discharge characteristics due to changes in the discharge volume surrounded by the barrier rib and phosphor layer had been neglected.

In the present work, the effects of the phosphor layer morphology on the discharge characteristics of the R, G, and B cells in an AC-PDP test panel are examined using a 7-inch AC-PDP test panel with four different R, G, and B phosphor layer patterns. Accordingly, the current study focuses on the effects of the phosphor layer morphology relative to the discharge volume on the discharge characteristics of the R, G, and B cells in an AC-PDP.

2. Experiments

Fig. 1 shows the 7-inch AC-PDP test panel with four different R, G, and B phosphor layer patterns. The

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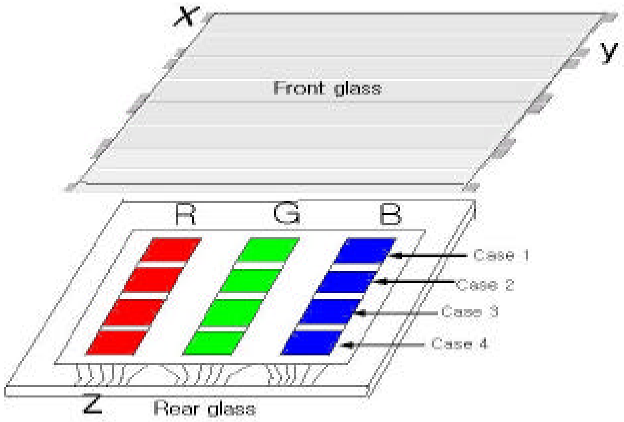

Fig. 1. Schematic diagram of 7-inch AC-PDP test panel with four different phosphor layer patterns.

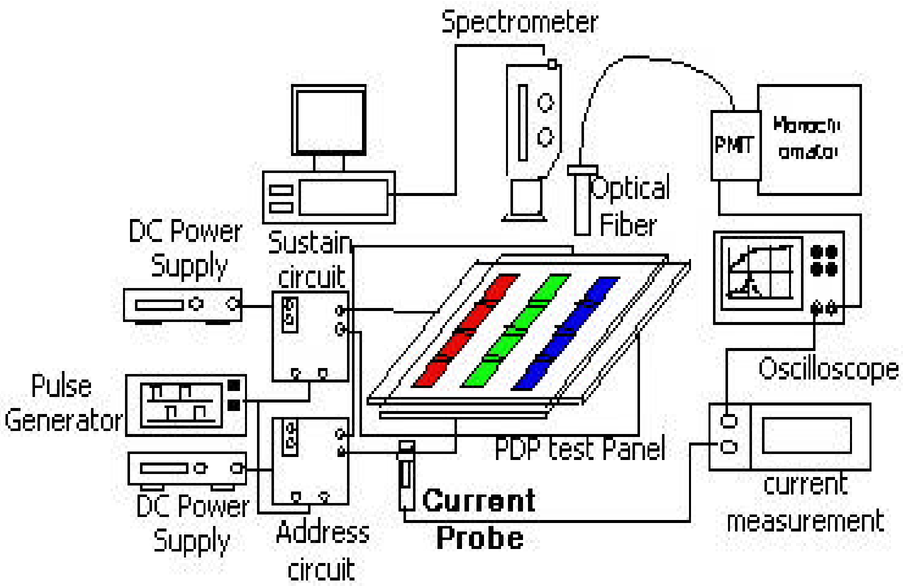

Fig. 2. The schematic diagram of measurement equipment.

R, G, and B phosphor layers were deposited in the three regions shown in Fig. 1, respectively. Separating the number of printing times from 1 to 4 produced the four different phosphor layer patterns(case 1, 2, 3, and 4). The firing temperature of phosphor layer was 450 ?C. In Fig. 1, X and Y are the sustain electrodes, while Z is the address electrode. Fig. 2 shows the schematic diagram of measurement equipment. The circuits of driving pulses consisted of sustain pulse circuits and address pulse circuits. The pulse generator generated the pulse signal to change frequency and pulse width. The discharge current measured flowing current in address electrode. Table 1 shows the discharge conditions employed in the experiment. The other driving conditions were a voltage of 180 V, frequency of 10 KHz, and duty ratio of 40 %.

Table 1. Discharge conditions employed in current study.

Gas	Ne+He(9:1)+Xe(4 %)
Gas pressure	**400 Torr**
Sustain voltage	180 V
Pulse frequency	10 KHz
Duty ratio	40 %

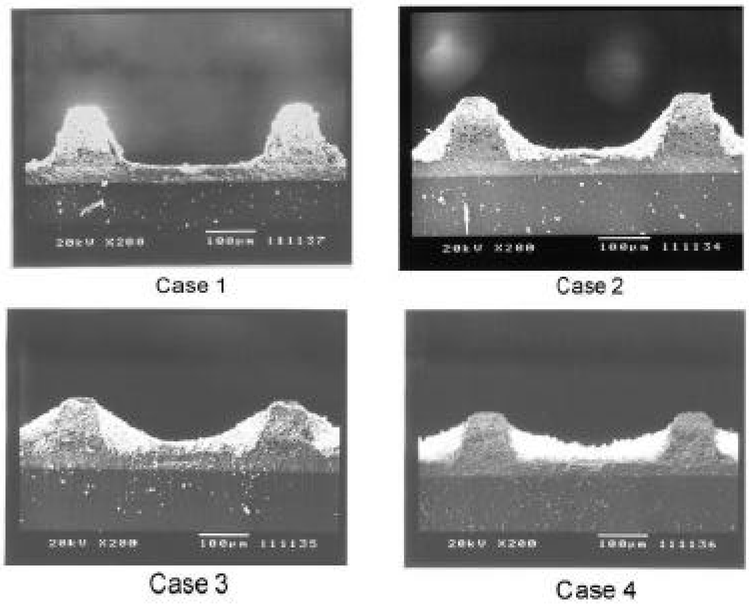

Fig. 3. SEM images of four different phosphor layer patterns.

3. Results and Discussion

Fig. 3 shows SEM(Scanning Electron Micro-scope) images of the R, G, and B cells with four different depth profiles for the deposited phosphor layers. The thickness of the phosphor layers shown in Fig. 3 is as follows; about 10 ?m for case 1, 25 ?m for case 2, 35 ?m for case of 3, and 50 ?m for case 4. The height of barrier rib is fixed in this paper. So, if the thickness of phosphor increased, the corresponding discharge volume decreases. In this paper, dischargd volumes in the cases of 2,3, and 4 decreased by about 15 %, 30 %, and 40 % respectively, compared with that of case 1(the pitch of barrier rib : 350 ?m, the height of barrier rib: 130 ?m, ITO width : 320 ?m, ITO gap : 60 ?m)

3.1. Voltage margin

Fig. 4 shows the change in the voltage margin measured from the 7-inch AC-PDP test panel with four different phosphor layer patterns. As shown in the SEM image in Fig. 3, as the thickness of the phosphor layer increased, the corresponding discharge volume in the cells decreased. Irrespective of the reduction in the discharge volume, even though the firing voltage remained almost constant, the sustain voltage increased with the decrease in the discharge volume (particularly in case 4). Such increase in the sustain voltage was presumably due to a reduction in the mean free path of the particles within the cells. Accordingly, this experimental result indicates that as the discharge volume decreased with an increase in the thickness of the phosphor layers, the sustain voltage increase, thereby decreasing the voltage margin, as shown in Fig. 4.

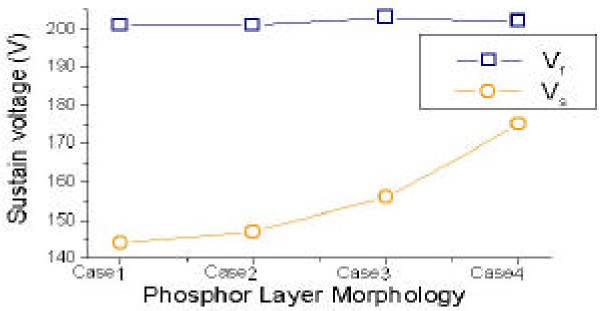

Fig. 4. Changes in firing voltage V_f and sustain voltage V_s relative to phosphor layer.

3.2. IR emission

Fig. 5 shows the IR emission(828 nm) measured from the R, G, and B cells in the 7-inch AC-PDP test panel with four different phosphor layer patterns. The IR emission(828 nm) characteristics did not change much, regardless of changes in the phosphor layer morphology, relative to the discharge volume. For the R and G cells in the 7-inch AC-PDP test panel, the maximum IR intensity values were obtained with case 2 phosphor layer patterns, although the IR intensity did not change much, see Fig. 5. Meanwhile, for the B phosphor layers, the maximum IR intensity value remained almost unchanged, regardless of any change in the phosphor layer pattern. This result indicates that the different phosphor layer patterns had no affect on the IR emission characteristics.

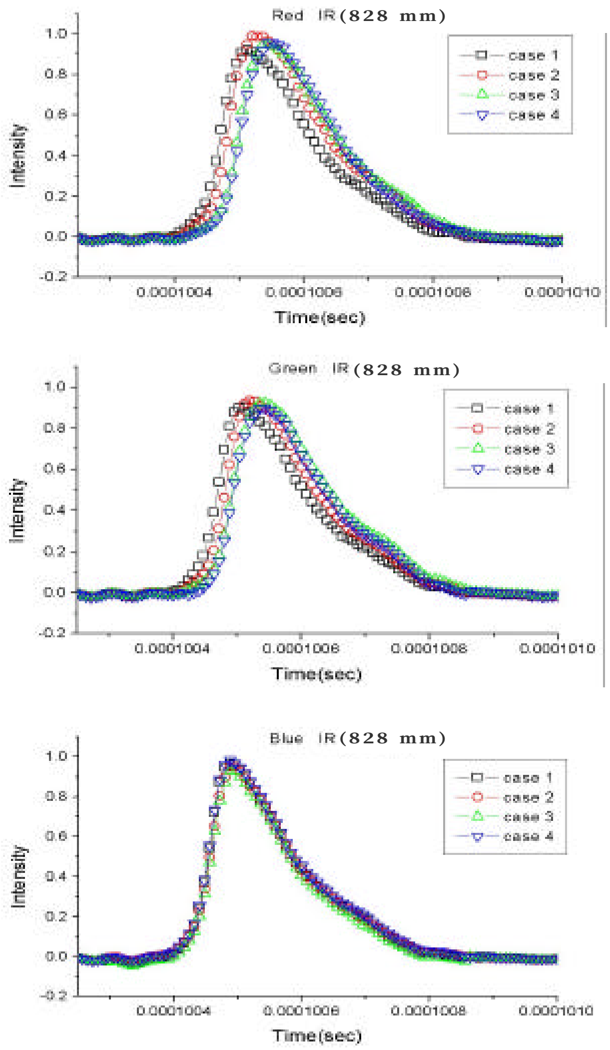

Fig. 5. Changes in IR emission (828 nm) relative to phosphor morphology pattern for R, G, and B phosphor layers.

3.3 Address voltage and corresponding discharge current

Fig. 6 shows the change in the address voltage, i.e. the firing voltage between the address electrode and the sustain electrode, with the four different phosphor layer morphology patterns. The address voltage varied from 218 V to 316 V. As the thickness of the phosphor layer increased and the corresponding discharge volume decreased, the address voltage increased. In particular, in the case of the blue phosphor layer, the difference of the address voltage between case 1 and case 4 was about 100 V, indicating that the different phosphor layer patterns had the strongest influence on the blue phosphor layer among the R, G, and B phosphor layers.

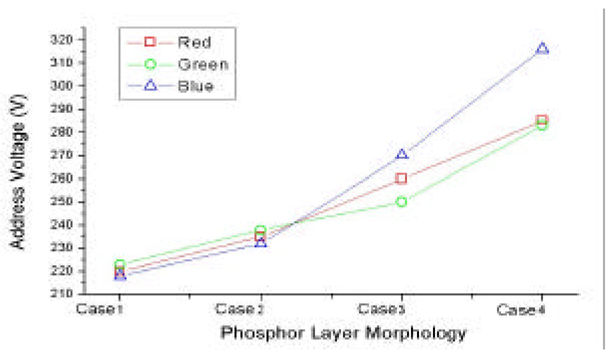

Fig. 6. Address voltages with four different phosphor layer patterns.

Fig. 7 shows the changes in the discharge current waveforms with the four different phosphor layer morphology patterns. As shown in Fig. 7, as the thickness of the phosphor layer increased and the corresponding discharge volume decreased, the peak intensities of the discharge current in the R, G, and B cells gradually decreased. Especially, in the case of the R and B cells, the discharge initiating time was delayed as the thickness of the phosphor layers increased and the corresponding discharge volume decreased. Such delay characteristic was presumably due to a change in the wall charge accumulation process resulting from the reduction in the discharge volume [4].

3.4 Luminance

Fig. 8 shows the luminance measured from the R, G, and B cells in the PDP test panel with four different phosphor layer patterns. The driving condition at each case is the same with that shown in Table 1. Only the sustain electrodes used in discharge. The address electrode was floating. The maximum luminance for the R, G, and B phosphor layers was obtained with case 2, although there was not much change in the luminance. Accordingly, as shown Fig. 8, the changes in the phosphor layer morphology resulting from depositing phosphor layers with different thicknesses did not affect the luminance characteristics of the R, G, and B cells.

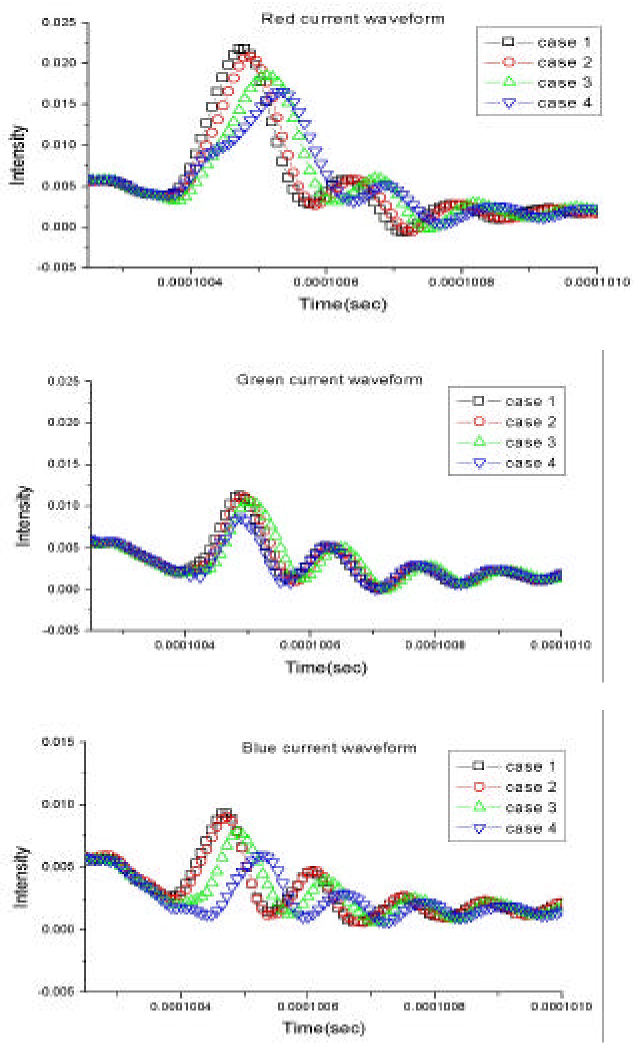

Fig. 7. Changes in discharge current waveforms.

4. Conclusions

In the present study, the effects of the phosphor layer morphology on the discharge characteristics of R, G, and B cells were examined using a 7-inch AC-PDP test panel with four different phosphor layer patterns. The voltage margin, address voltage, and discharge current were all found to be strongly dependent on the phosphor layer morphology, whereas the IR emission and luminance characteristics of phosphor layer remained almost unchanged, regardless of any changes in the phosphor layer morphology related to the discharge volume.

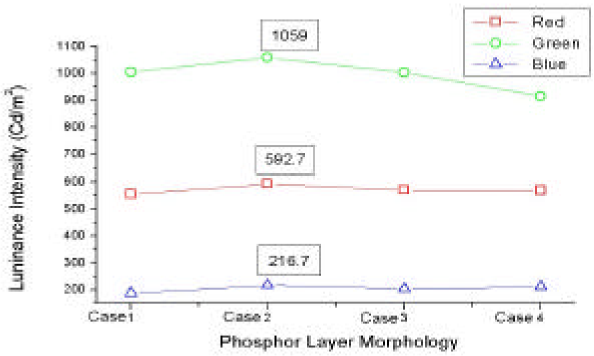

Fig. 8 . Changes in luminance of R, G, and B cells.

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