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An in-situ Study on Discharging Characteristics of an Alternative Current Plasma Display Panel Varied with Discharging Space

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An *in-situ* Study on Discharging Characteristics of an Alternative Current Plasma Display Panel Varied with Discharging Space

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An in-situ experimental was carried out to analyze how the gap between a front and rear panel influenced on the discharging properties of an AC Plasma Display Panel (PDP). Initial firing voltages showed almost constant values except at the position of near the barrier rib as the gap increased. The fluctuations of sustain voltages became smaller dependent on the gap, and seemed to have a linear relation to the filtered IR at 828 nm. Observation on the Infra-red indicated the excited or the metastable species could be greatly affected by the rear panel regardless of the gap. Based on these results, we discussed a new method to evaluate dimensional fluctuation of an AC PDP.

Keywords: firing voltage; gap; infrared; plasma display panel; sustain voltage

INTRODUCTION

Continuous and considerable interests in optimizing of AC PDP cell structures have been giving occasion to many reports on the analysis of the structures of AC PDP using computer simulations [1–6]. Reports using a two-dimensional fluid code showed a non-negligible part of the xenon excitation in a PDP discharge occurs in the anode region. Veronis and Inan discussed the effect of floating electrodes in the dielectric layer within a coplanar discharge structure [4].

The barrier ribs in various AC PDP structures are used to separate cells and to prevent a discharging of non-selected cells. According to

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the report of Boeuf, Pitchford, and Punset showed that barrier ribs were essential for avoiding cross-talks between adjacent cells [5].

Manufacturer of AC PDP have their unique cell structures based on their driving schemes or materials. Each cell in AC PDP has a slightly different discharging space owing to the height fluctuation between cells caused by the non-uniformity of barrier rib or packaging. However, there exist few experimental reports on the influence of the fluctuation of discharging space except some computer simulation results.

In this study, we introduce an *in-situ* experimental facility to investigate how the gap fluctuation between a front and rear panel influences on the discharging properties of an AC PDP. The infra-red from discharging state of test panel was filtered and measured to analyze the behavior of charged particles or eximers dependent on the gap.

EXPERIMENTAL

In this study, we prepared the 2-inch test PDP sample with PD-200 glass substrate. Figure 1 shows the structure of test PDP sample and its specifications are summarized in Table 1. The MgO protective layer was deposited using E-beam evaporation method. During MgO deposition process, the base vacuum was kept at 3×10^{-6} Torr and the temperature was set at 300°C. The deposited rate was 0.5 nm/s, and the deposition thickness was about 500 nm.

The prepared front panel and rear panel were set in the measuring chamber as shown in Figure 2. The rear panel can be moved up and down through rotating the handle, which could be precisely controlled by 10 μm. After setting of panels, the vacuum chamber was pumped to 1.0×10^{-6} Torr and annealing has done at 300°C for 1 h. And then the

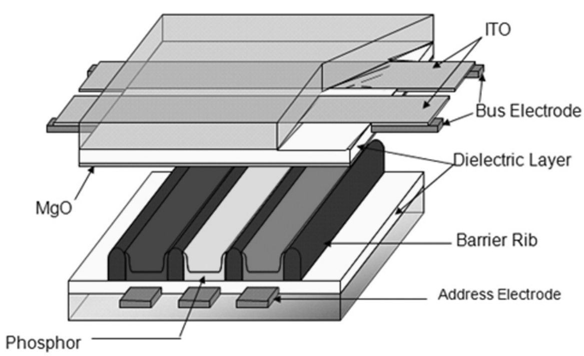


FIGURE 1 Specifications of a test panel used in this experiment.

TABLE 1 Specifications of a Test Panel

Front Panel	ITO width	320 μm
	ITO thickness	130 μm
	Bus electrode width	80 μm
	Dielectric layer thickness	24 μm
	MgO thickness	500 μm
	Address electrode width	200 μm
Rear Panel	Dielectric layer thickness	24 μm
	Barrier rib height	130 μm
	Barrier rib pitch	300 μm
	Phosphor (Green) thickness	10 μm

mixed gas of Ne + Xe (4%) was injected and maintained at 400 Torr. The bus electrodes were connected to the square pulse (3 μs, 50 kHz) and the address electrodes were floated. The gap between a front and rear panel was varied as a parameter to analyze discharge characteristics of ac-PDP as shown in Table 2. The initial firing voltage (V_f), the highest sustain voltage (V_{s1}), the lowest sustain voltage (V_{sn}) were measured with a current probe (Tektronix, TCPA300) and an oscilloscope (Tektronix, TDS-540C). At the same time, the infrared (IR) light generated in discharging was detected by a PMT (Photo Multiplier Tube, ACTON, PD438) with band pass filers of 820 nm and 830 nm.

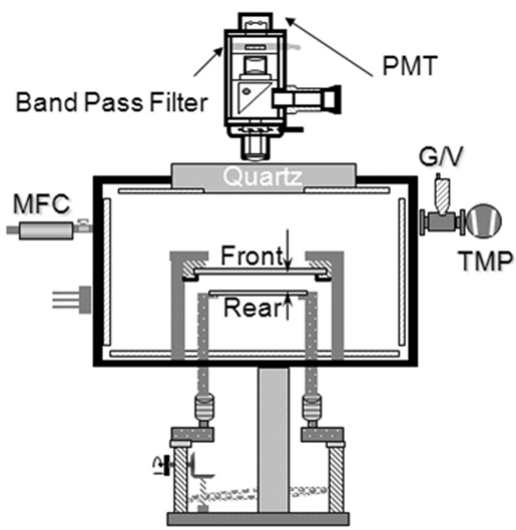


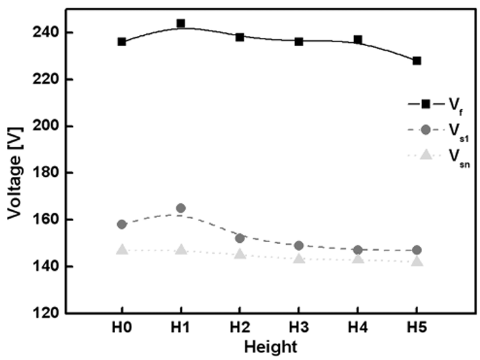
FIGURE 2 A Schematic diagram of test chamber and IR detector used in this experiment.

TABLE 2 Gap between a Front Panel and Rear Panel

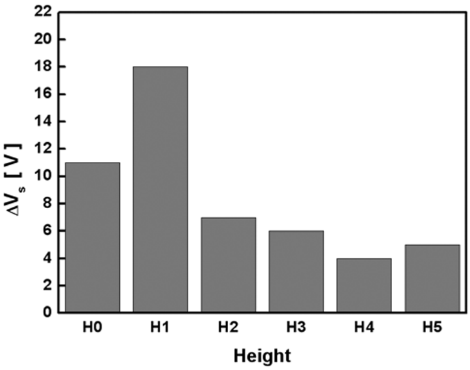
	Distance
H0	130 μm
H1	140 ~ 170 μm
H2	260 μm
H3	370 μm
H4	480 μm
H5	1100 μm

RESULTS AND DISCUSSION

Figure 3 shows discharging characteristics of the test panel dependent on height. As shown in Figure 3, the firing voltages at every position



(a)



(b)

FIGURE 3 (a) Operational voltages and (b) ΔV_s of test panel dependent on a gap between a front and rear panel.

are almost same values except at H1 under our test condition. The V_s is much more sensitive to varied gaps than that of V_f as shown in Figure 3(a). According to the simulation results of the reduction of charged particles near the barrier ribs [1], we expected the increasing of charged particles as the gap increasing, and thus a visible change in discharge property. The test panel, however, has similar values of $V_{fmax.}$ and $V_{smax.}$ dependent on the gap except some experimental error under our test condition. Instead of that the trend of ΔV_s $(V_1 - V_n)$ shows quite interesting result and indicates clearly the

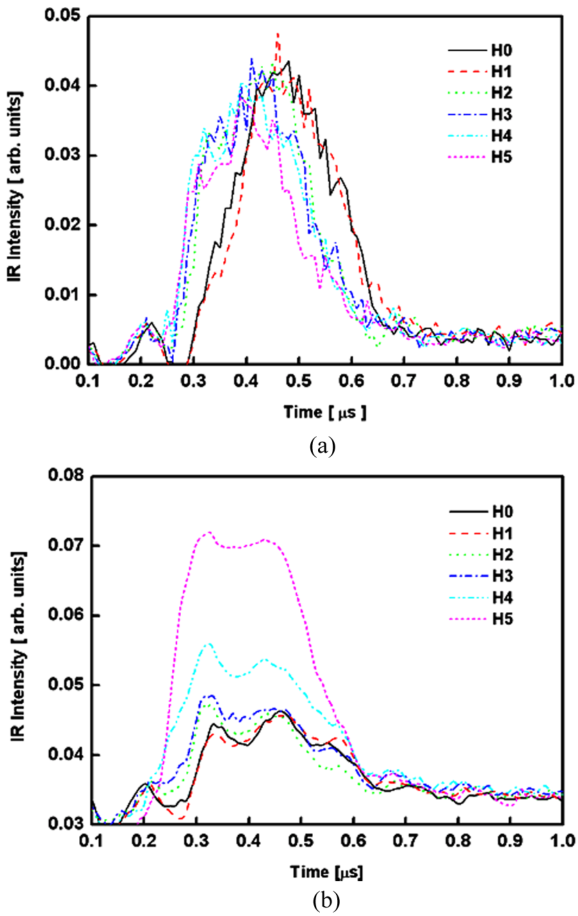


FIGURE 4 IR intensity of test panel at 180 V; (a) with a band pass filter of 830 nm, and (b) without filter.

cross-talk phenomenon occurs seriously where the gap between a front and rear panel is increased.

Basically the variation of the operational voltage is made of the dimensional fluctuations of the each layer in an AC PDP, the distance of the ITO electrodes, and the height of barrier rib between the cells in the same panel. Upper about the twice of the height of the barrier rib the ΔV_s is constant or slightly reduced. This result may suggest a method to analyze precisely the PDP panel by a simple comparison of ΔV_s between H1 (the lowest gap) and H6 (the highest gap).

Figure 5 shows the IR intensity of the test panel discharging at 180 V. The total IR intensity of the panel is linearly increased and the filtered 828 nm emission shifted to shorter response time as the gap between a front and rear panel is increased. This result implies that cells at the same lines in a test panel were equalized due to the cross talk. Basically the variation of the operational voltages are made of the dimensional fluctuations between the cells, such as the distance of ITO-electrodes, the height of barrier ribs, the thickness of protective layer, dielectric layer, and phosphors in the same panel. Upper about the twice of the height of the barrier rib the ΔV_s is constant or slightly reduced as shown in Figure 4. The discharging current and the IR indicates all the cells in a test panel have almost same discharge environmental where the gap between a front and rear panel is high enough to cause cross-talk completely. Considering the uniformity of cells is followed by a normal distribution, the dimensional fluctuation when the cross-talk occurs completely was mainly caused by the fluctuation of ITO-electrodes, if panels are made of same materials.

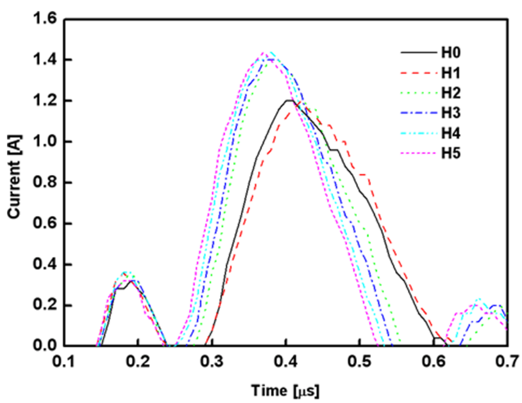


FIGURE 5 Discharging current of test panel at 180 V dependent on a gap between a front and rear panel.

This may allow us to analyze the variations from both of a front and rear panel separately, and thus lead to estimate the variation of bus-electrodes on a front panel precisely, even though there may exist unknown fluctuations in a dielectric and protective layer. The simulation result of the reduction of charged particles near the barrier ribs well explains this result [1]. This also, indicates the excited or the metastable species can be greatly affected by the rear panel regardless of the gap in this experimental range.

CONCLUSIONS

We introduce an *in-situ* experimental facility to determine how the gap between a front and rear panel influences on the discharging properties of an AC PDP. The firing voltages of a test panel dependent on height were hardly changed except at the position of near of the barrier rib. The variation of V_s became smaller as the height increased, and seemed to have a linear relation to the filtered IR at 828 nm. We also, observed the excited or the metastable species can be greatly affected by the rear panel regardless of the gap in this experimental condition.

REFERENCES

[1] Ding, K., Deng, B., Gu, C. X., Wu, Z. W., & Sun, Q. (2006). *Contrib. Plasma Phys.*, *46*, 301.
[2] Shon, C. H. & Lee, J. K. (2001). *Phys. Plasmas*, *8*, 1070.
[3] Lee, J. K., Dagsteer, S., Shon, C. H., Hur, M. S., Kim, H. C., & Cho, S. (2001). *Japan. J. Appl. Phys.*, *40*, L528.
[4] Veronis, G. & Inan, U. S. (2002). *J. Appl. Phys.*, *91*, 9502.
[5] Rauf, S. & Kushner, M. J. (1999). *J. Appl. Phys.*, *85*, 1.
[6] Punset, C., Boeuf, J. P., & Pitchford, L. C. (1998). *J. Appl. Phys.*, *83*, 1884.