Influence of Sustain Pulse-width on Electrical Characteristics and Luminous Efficiency in Surface Discharge of AC-PDP

Yong-Whan Jeong[a], Jin-Man Jeoung, and Eun-Ha Choi
Charged Particle Beam and Plasma Laboratory, Department of Electrophysics, PDP Research Center, Kwangwoon University, 447-1 Wolgye-dong, Nowon-gu, Seoul 139-701, Korea

[a]E-mail : yjeong@paran.com

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Influences of sustain pulse-width on electrical characteristics and luminous efficiency are experimentally investigated for surface discharge of AC-PDP. A square pulse with variable duty ratio and fixed rising time of 300 ns has been used in the experiment. It is found that the memory coefficient is significantly increased at the critical pulse-width. And the wall charges and wall voltages as well as capacitances are experimentally measured by Q-V analysis method along with the voltage margin relation, in terms of the sustain pulse-width in the range of 1 μs to 5 μs under driving frequency of 10 kHz to 180 kHz. And the luminous efficiency is also experi-mentally investigated in above range of sustain pulse-width with driving frequency of 10 kHz to 180 kHz. It is noted that the luminous efficiency for 10 kHz and 180 kHz are 1.29 lm/W and 0.68 lm/W respectively, since the power consumption for 10 kHz is much less than that for 180 kHz. It has been concluded that the optimal sustain pulse-width is in the range of 2.5 ~ 4.5 μs under driving frequency range of 10 kHz and 60 kHz, and in the range of 1.5 ~ 2.5 μs under driving frequency range of 120 kHz and 180 kHz based on observation of memory coefficient, and wall voltage as well as luminous efficiency.

Keywords : Wall voltage, Memory coefficient, Luminous efficiency, AC plasma display panel (AC-PDP)

1. INTRODUCTION

In ac plasma display panel (AC-PDP), sustain pulse-width plays an important role of improvement on the operating margin and luminous efficiency. It is therefore of great importance to investigate experimentally the influence of sustain pulse-width on the electrical characteristics and luminous efficiency in AC-PDP to determine the optimal sustain pulse-width. Thus, the operating margin and the luminous efficiency as well as wall charges and wall voltages are experimentally measured in terms of the sustain pulse-width in the range of 1 μs to 5 μs.

2. EXPERIMENTAL CONFIGURATION

Figure 1 shows the cross sectional view of AC-PDP cell structure. In surface discharged AC-PDP with three electrodes system, the X and Y electrodes that are covered with dielectric layers of 30 μm in thickness are parallel to each other in front glass. A MgO protective layer is deposited on the dielectric layer by the electron beam evaporation method with 0.5 μm thickness[1]. The cell pitch is fixed to be 1080 μm and the width and gap of the electrode are kept to be 260 μm and 100 μm, respectively. On the rear glass the address electrodes of 100 μm in width and barrier rib of 120 μm in height are located perpendicular to the two sustaining electrode[2]. Three capacitances Co, Cp and 2Cg, shown in Fig. 1, are for gas-filled discharge space, for intergap dielectric region, including the front glass medium which is parallel to the discharge region, and for dielectrics, respectively. The number of discharge cells for three paired XY-line is 834. In this experiment a square driving voltage pulse with rising time of 300 ns is applied, while the address electrode has been floated. The filling gas is a mixture of Ne(96 %) and Xe(4 %), and total pressure is kept to be at 400 Torr [3].

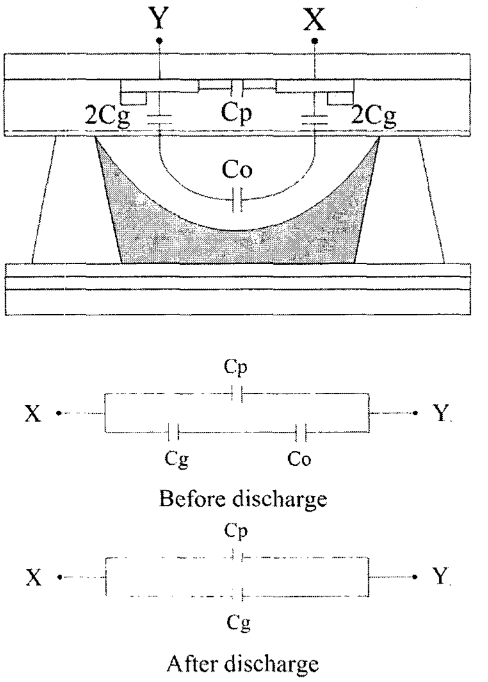

Fig. 1. Cross sectional view of AC-PDP cell.

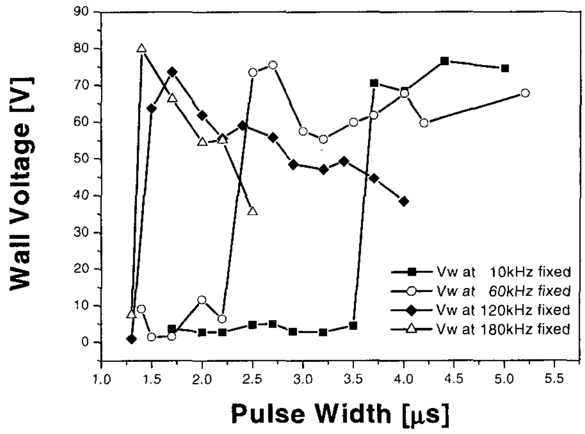

Fig. 2. Wall voltages with respect to sustain pulse-width.

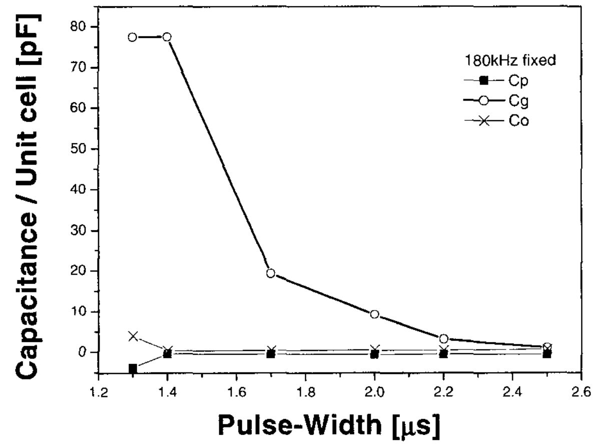

Fig. 3. Capacitances Co, Cp, and Cg per unit cell.

3. EXPERIMENTAL RESULTS AND DISCUSSION

Figure 2 shows the maximum wall voltages induced by accumulated wall charges between the gas-filled space, which is experimentally determined by dividing the wall charge Qw accumulated on the dielectric surface by capacitance of discharge space Co. If the sustain pulse-width is around 1 or 2 μs with frequency ranges from 10 kHz to 60 kHz, it is noted that the wall voltage has relatively small values, since it is too short to accumulate the enough wall charge on the dielectric material. It is also noted that the pulse-width possessing maximum wall voltages is significantly shortened to be 1.3 μs, 1.7 μs, 2.7 μs, and 3.6 μs for driving frequencies of 180 kHz, 120 kHz, 60 kHz, and 10 kHz, respectively.

Figure 3 shows measured capacitances Co, Cp, and Cg per unit cell versus sustain pulse-width for driving frequencies of 180 kHz. These capacitances can be determined from charge-voltage(Q-V) characteristic curve along with voltage margin relation. It is found that Cg decreases significantly from 76 pF/cell to 0.8 pF/cell as sustain pulse width increases from 1 μs to 2.5 μs for driving frequency of 180 kHz while Co is almost unchanged at 0.3 pF/cell. Also found is that the capacitance Cp has a negative capacitance characteristics, which means that the amount of charge increment Δ Qp with respect to voltage increment Δ V in Cp is negative. The characteristics of negative capacitance is caused by wall charge accumulated on the dielectric surface in previous pulse[4].

Figure 4 shows the memory coefficient versus sustain pulse-width. It is noted that the memory coefficient versus sustain pulse-width has the similar characteristics to those of wall voltage, as shown in Fig. 2, for several driving frequencies used in this experiment. These characteristics are caused by both the wall charge quantities accumulated on the dielectric surface and capacitance Co. It is noted that the memory coefficient is significantly increased from 0.05 to 0.63 at pulse-width of 3.6 μs, 2.2 μs, 1.7 μs, 1.3 μs for driving frequencies of 10 kHz, 60 kHz, 120 kHz, 180 kHz, respectively. These characteristics shows the existence of optimal sustain pulse duration occupying memory coefficient greater than 0.6.

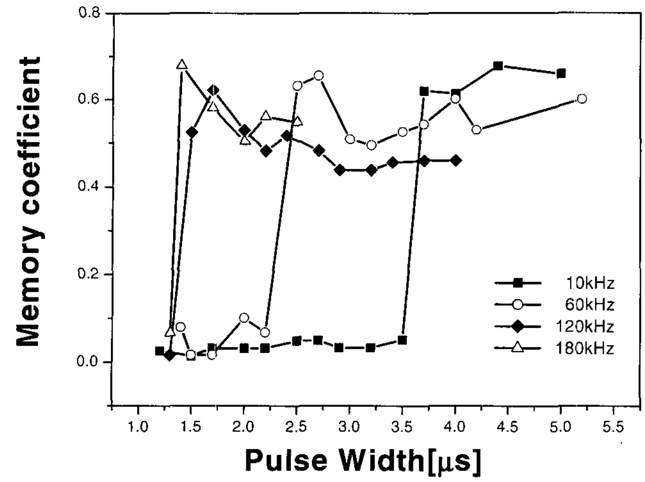

Fig. 4. Memory coefficient versus sustain pulse-width.

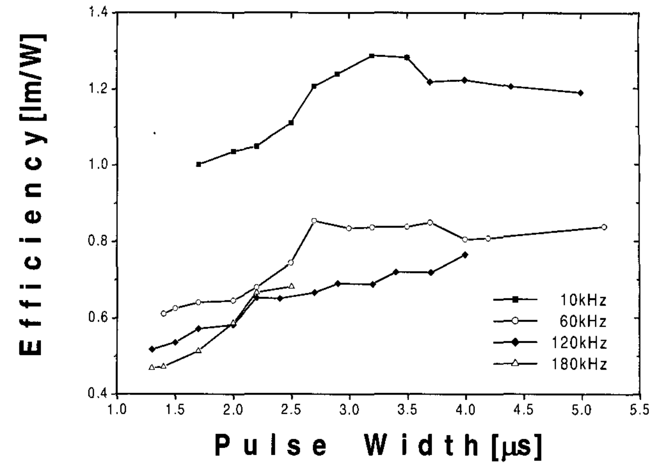

Fig. 5. Luminous efficiency versus sustain pulse-width.

Figure 5 shows the luminous efficiency for various sustain pulse-width ranged from 1 μs to 5 μs at fixed driving frequencies of 10 kHz, 60 kHz, 120 kHz and 180 kHz, respectively. The luminous efficiency is defined as following.

Efficiency = (π × lighting area × brightness) / (power consumption of discharge)

The power is calculated from voltage and current waveforms. It is noted that the luminous efficiency shows the slight increment in all sustain pulse-width region. It is noted that the luminous efficiency for 10 kHz and 180 kHz are 1.29 lm/W and 0.68 lm/W respectively, since the power consumption for 10 kHz is much less than that for 180 kHz as shown in Fig. 5. It has been concluded that the optimal sustain pulse-width is in the range of 2.5~4.5 μs under driving frequency range of 10 kHz and 60 kHz, and is in the range of 1.5~2.5 μs under driving frequency range of 120 kHz and 180 kHz based on observations of wall voltage and memory coefficient as well as luminous efficiency. It is also noted that the higher brightness is obtained for higher driving frequencies for given pulse-width[5].

4. CONCLUSION

It is found that the brightness has been nearly unchanged by pulse-width for given driving frequencies. Influence of sustain pulse-width on the electrical characteristics and luminous efficiency have been experimentally investigated to determine the optimal sustain pulse-width in the surface discharge of AC-PDP. It is noted that the wall voltage versus pulse-width has the similar characteristics to that of memory coefficient. These characteristics are caused by both the wall charge quantities accumulated on dielectric surface and the measured capacitance Co. It has been found that the capacitances Cp are found to be negative capacitance characteristics which is originated from wall charge deposited on the dielectric material. It has been also found that the memory coefficient is significantly increase from 0.05 to 0.63, at respective sustain pulse-width region between 1 μs and 5 μs for respective driving frequencies. Consequently the optimal pulse-width is existed. If the pulse-width is in optimal value, then the operating margin is enlarged because of the wall voltage increment induced by the more accumulated wall charge. It is noted that the luminous efficiency for 10 kHz and 180 kHz are 1.29 lm/W and 0.68 lm/W respectively, since the power consumption for 10 kHz is much less than that for 180 kHz.

It has been concluded that the optimal sustain pulse-width is in the range of 2.5~4.5 μs under driving frequency range of 10 kHz and 60 kHz, and is in the range of 1.5~2.5 μs under driving frequency range of 120 kHz and 180 kHz based on the observations of wall voltage, and memory coefficient as well as luminous efficiency.

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