Influence of Sustain Pulse-Width on the Electrical and Optical characteristics in AC-PDPs

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Influence of sustain pulse-width on electro- luminous efficiency is experimentally investigated for surface discharge of AC-PDP. A square pulse with variable duty ratio and rising time of 300 ns has been used in the experiment. It is found that the firing voltage is decreased as the pulse-width is increased from 2 μs to 8 μs with sweeping frequency range of 10 kHz to 50 kHz. It has been found that the optimal sustain pulse-width is in the range of 3 ~ 4 μs under driving frequency range of 30 kHz and 50 kHz, based on observation of memory coefficient, wall charge, and wall voltage as well as luminous efficiency.

Keywords : AC-PDP, wall charge, wall voltage, memory coefficient, electro- luminous efficiency

1. Introduction

In AC plasma display panels (AC-PDPs), sustain pulse-width play an important role in improvement on the operating margin and luminous efficiency. It is therefore of 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 2 μs to 8 μs. We have developed a simple nice method, which was already reported, to measure the wall charges and wall voltages resulted from the measurements of all capacitances in AC-PDP[1][2].

2. Experimental Configurations

Figure 1 shows the cross-sectional view of AC-PDP cell structure. In surface discharge 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 in thickness. The cell pitch is fixed to be 1080 μm and the width and gap of the electrode are respectively kept to be 260 μm and 100 μm. On the rear glass the address electrodes of 100 μm in width and barrier rib of 120 μm in height are located. 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.

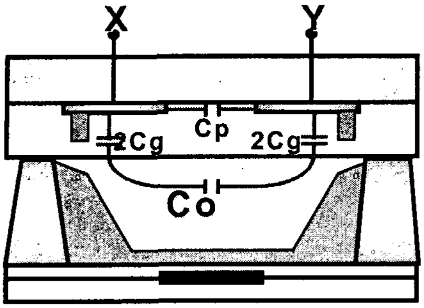


Fig. 1. Cross-sectional view of AC-PDP cell

3. Experimental Results & Discussions

Figure 2 shows the variations of firing voltage for various sustain pulse-width ranged from 2 ㎲ to 8 ㎲. It is noted that the firing voltage decrease as the sustain pulse-width increases from 2 ㎲ to 8 ㎲. These characteristics are same as all frequency regime between 10 kHz and 50 kHz. These characteristics may originate from the reason that the seed electrons gain more energy for gas breakdown and then the ionization rate becomes to be high as the sustain pulse-width increases. And these characteristics shows that the firing voltage is affected by both the sustain pulse-width and the driving frequency.

Figure 3 shows the memory coefficient, defined by 2 (Vf -Vs) / Vf, versus sustain pulse-width. It is noted that the memory coefficient is significantly increased from 0.16 to 0.71, as the sustain pulse-width is increased from 3 ㎲ to 4 ㎲ and beyond which it maintains constant value 0.8 up to sustain pulse-width 8 ㎲. These characteristics are originated from the amount of wall charge accumulated on dielectric surface. These characteristics shows the existence of optimal sustain pulse-width for the driving frequency, with which priming particles in gas-filled discharge space make the enough margin for stable operation. In this experiment the optimal sustain pulse-width for stable operation with enough margin is above 5 ㎲ in the frequency range of 10 kHz and 20 kHz, and above 4 ㎲ in the frequency range of 30 kHz and 50 kHz, respectively.

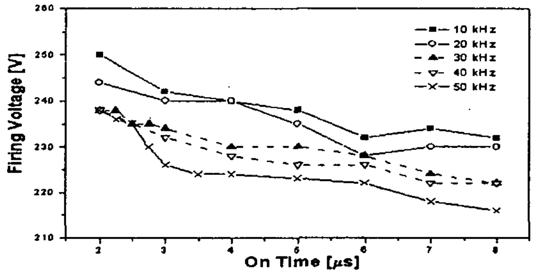


Fig. 2. Variations of firing voltage for various sustain pulse-width

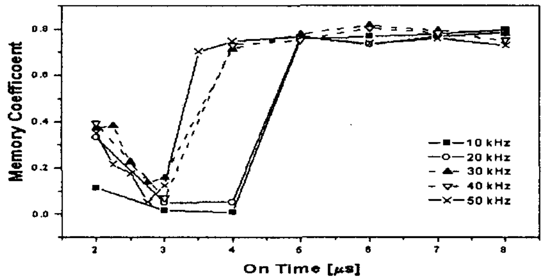


Fig. 3. Memory coefficient versus sustain pulse-width

Figure 4 shows the maximum wall charges per unit cell accumulated on the dielectric surface versus sustain pulse-width at driving frequencies 30 kHz and 50 kHz. It is noted that the wall charges increase from 21.5 pC/cell to 36.2 pC/cell as the sustain pulse-width is increased from 2 ㎲ to 6 ㎲ and beyond which the wall charge is slightly decreased to 35.3 pC/cell at sustain pulse-width 8 ㎲ in the case of 30 kHz driving. These increase in the wall charge are attributed to the longer pulse-width, which results in more amount of wall charges accumulated on the dielectric surface, but the excessively long sustain pulse-width has no more effect on charge accumulation.

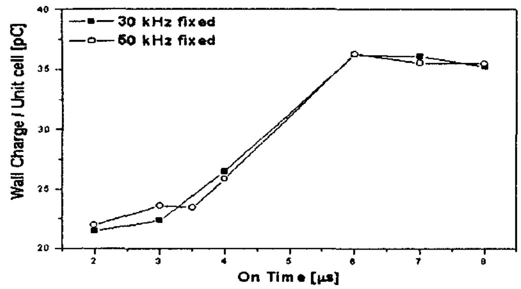


Fig. 4. Maximum wall charges per unit cell

Figure 5 shows capacitances Co, Cp, and Cg per unit cell versus sustain pulse-width. These capacitances can be determined by Q-V analysis method along with the margin relation[1][2]. It is found that Cg decreases significantly from 91.9 pF/cell to 4.59 pF/cell, while Co is almost unchanged at 0.5 pF/cell, as sustain pulse-width is increased from 2 μs to 8 μs. Also found is that the capacitance Cp between the gap electrodes in the dielectrics has a negative capacitance characteristics, which means that the amount of charge increment ΔQp with respect to voltage increment ΔV in Cp is negative. These characteristics of negative capacitance is caused by wall charge accumulated on the dielectric surface in previous pulse.

Figure 6 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. The wall voltage is significantly increased in the sustain pulse-width region of 3 μs and 4 μs. These characteristics are caused by the wall charge quantities accumulated on the dielectric surface, as shown in fig. 4. If the sustain pulse-width is 2 or 3 μs with frequency range of 10 kHz to 50 kHz, the pulse-width is too short to accumulate sufficient wall charge to induce the wall voltage, then the wall voltage has relatively small as shown in Fig. 6 and the memory coefficient also has relatively small values as shown in Fig. 3.

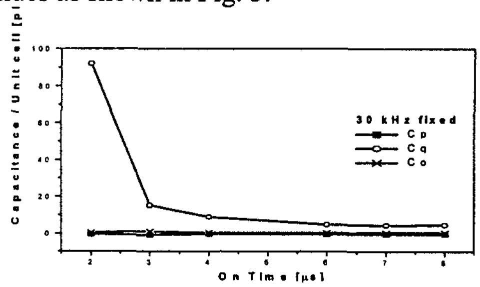


Fig. 5. Capacitances Co, Cp and Cg per unit cell

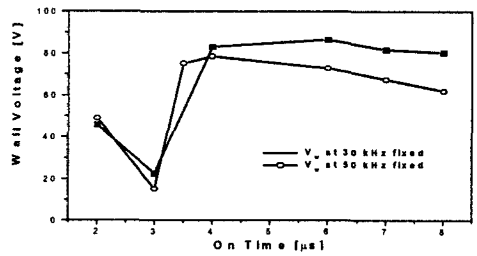
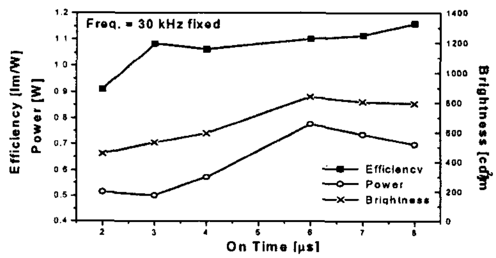


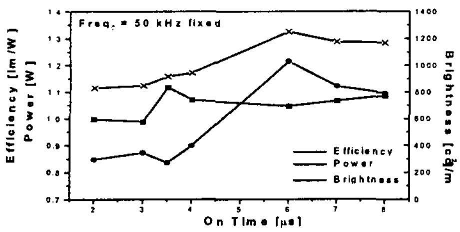
Fig. 6. Maximum wall voltages induced by accumulated wall charged

Figure 7 shows power, brightness and the luminous efficiency for various sustain pulse-width ranged from 2 μs to 8 μs at two fixed frequency of 30 kHz (a) and 50 kHz (b), respectively. The luminous efficiency is defined as following.

Efficiency = ($\pi \times$ lighting area$\times$ brightness) / power consumption of discharge



(a) Freq. =.30 kHz



(b) Freq. = 50 kHz

Fig. 7. luminous Efficiency versus sustain pulse-width

The power is calculated from voltage and current waveform and brightness is measured in dark room. As the sustain pulse-width is increased up to 6 μs, the power consumption of discharge and the brightness are increased, and are decreased as the sustain pulse-width region of 6 μs to 8 μs. It is also noted that the luminous efficiency show the slight increment in all sustain pulse-width region. It is noted that the luminous efficiency for 30 kHz and 50 kHz are 1.16 lm/W and 1.09 lm/W respectively, since the power consumption for 30 kHz is much less than that for 50 kHz. It has been concluded that the optimal sustain pulse-width is in the range of 3 ~ 4 μs under driving frequency range of 30 kHz and 50 kHz, based on observation of memory coefficient, wall charge, and wall voltage as well as luminous efficiency

4. Conclusion

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. The firing voltage decreases as the sustain pulse-width increases and these characteristics are the same as for all frequency regime between 10 kHz and 50 kHz. It has been also found that the memory coefficient is significantly increase from 0.16 to 0.71, as the sustain pulse-width is increased from 3 μs to 4 μs and beyond which it maintain constant values at sustain pulse-width 8 μs. The wall charges increase from 21.5 pC/cell to 36.2 pC/cell as the sustain pulse-width is increased from 2 μs to 6 μs and these wall charge increment are attributed to the longer pulse-width, which results in more amount of wall charges accumulated on the dielectric surface. It has been also found that the capacitances Cp are found to be negative capacitance characteristics which is originated from wall charge deposited on the dielectric material. The wall voltage is significantly increased in the sustain pulse-width of 3 μs and 4 μs. Consequently the critical pulse-width, about 4 μs in this experiment, is existed. If the pulse-width is in optimal value, then the margin is enlarged because of increment of the wall voltage induced by more accumulated wall charge. It is noted that the luminous efficiency for 30 kHz and 50 kHz are 1.16 lm/W and 1.09 lm/W respectively, since the power consumption for 30 kHz is much less than that for 50 kHz.

It has been concluded that the optimal sustain pulse-width is in the range of 3 ~ 4 μs under driving frequency range of 30 kHz and 50 kHz, based on observation of memory coefficient, wall charge, and wall voltage as well as luminous efficiency.

ACKNOWLEDGMENTS

This work was supported by G7 project of plasma display panel at 2000 under Korea Government.

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