Electro-Optical characteristics with dielectric thickness of AC-PDP

K. B. Jung, J. H. Choi, S. B. Kim, Y. Jung and E. H. Choi
Charged Particle Beam and Plasma Lab./PDP Research Center
Department of Electrophysics, Kwangwoon UniversitySeoul 139-701, Korea
Phone: +82-2-940-5236, E-mail: lightkool@hotmail.com

Abstract
In AC PDP, since charges generated by gas discharge are accumulated on the dielectric. The dielectric is a major factor to determine cell capacitance and its memory effect is a play an important role in PDP driving. In this experiment, we have investigated the electro-optical characteristics with dielectric thickness and we have analyzed wall charge and wall voltage by Q-V energy diagram. The dielectric thickness was varied from 20 um to 50 um. As results, according to the dielectric thickness increase,cell capacitance and power consumption is reduced.

1. Introduction and Experimental Setup

In AC plasma display panel, it is very important to quantity the wall voltage induced by the wall charge accumulated on the dielectric surface. Fig.1 shows the cross-sectional view of the AC-PDP cell structure. The surface-discharge scheme of AC-PDP with a three-electrodes system is widely used.

The X and Y electrodes in AC-PDP that are covered with 20um~50um thickness dielectric layers are parallel to each other in the front glass. A 0.5um-thick MgO protective layer is deposited on the dielectric layer using the electron beam evaporation method. The sustaining discharge in AC-PDP occurs between the parallel-sustaining electrodes of X and Y which are separated by 120um. The electrode width is maintained at 260um and the cell pitch is set at 1080um.

On the rear glass, the address electrodes of 100um in which and barrier rib of 130um in height are located perpendicular to the two sustaining electrodes.

Three capacitances Co, Cp and 2Cg shown in Fig.1 are for the gas-filled discharge space, for the intergap dielectric region, including the front glass medium, which is parallel to the discharge region, and for the dielectrics, respectively.

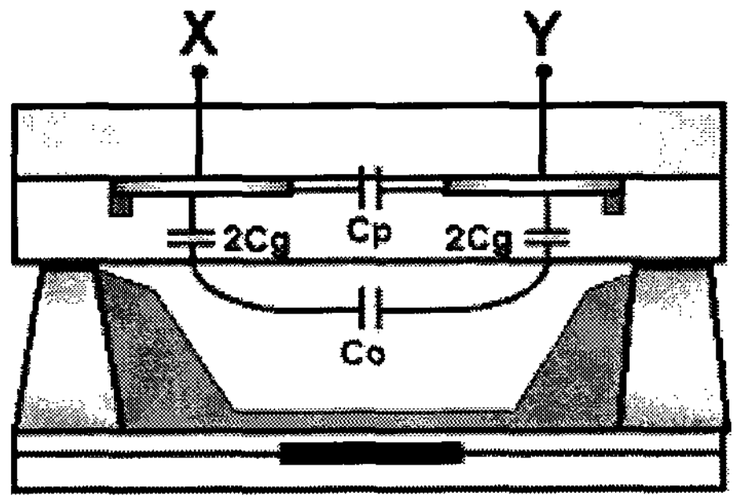

Fig. 1. Cross-sectional view of AC-PDP structure.

Figure 2 shows the equivalent circuit of AC-PDPs before and after the surface discharge. The equivalent capacitance before the discharge is given by Cp+CgCo/Cg+Co, as shown in Fig.2 (a). Following the discharge, the equivalent capacitance is represented by Cp+Cg, which is the parallel connection of Cp and Cg, as shown in Fig.2 (b).

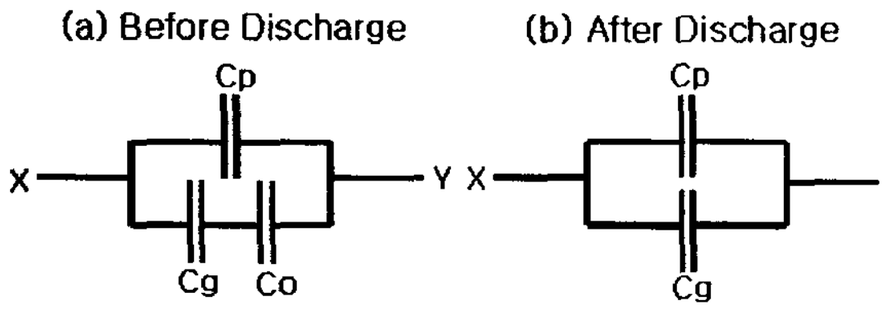

Fig. 2. Equivalent circuit of AC-PDP before and after surface discharge

2. Results and discussion

The influence of dielectric thickness on the electrical characteristics luminous efficiency was experimentally investigated to determine the optimal dielectric thickness in the surface discharge of AC-PDP.

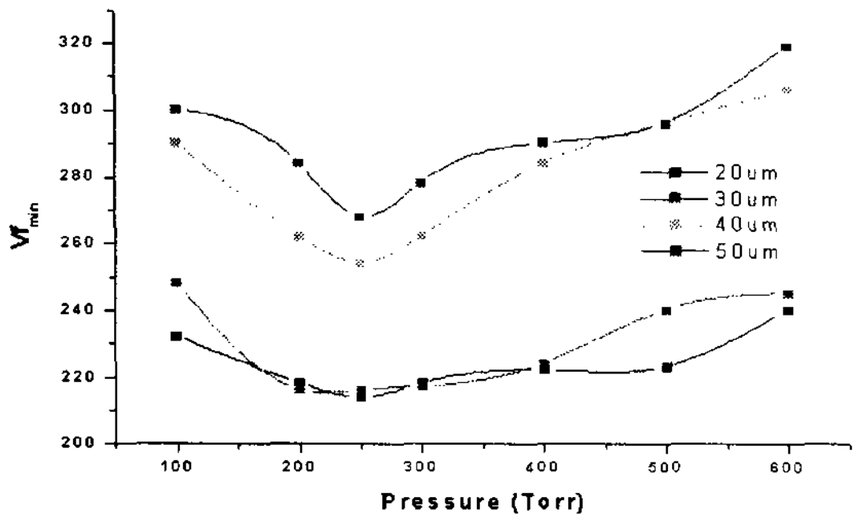

Fig. 3. Paschen Curve

Fig.3 shows the plots of the Minimum firing voltage line Vf versus P for four different dielectric layers as thickness 20,30,40,50um. In the case which the dielectric substance uses same dielectric constant, a firing voltage and sustain voltage rise according to a dielectric thickness increases in fig.3.
As the dielectric thickness is increased, the width of a static margin expands. Figure 4 shows measured static margin.
We have developed a simple method to measure the wall charges and voltages resulting from the measurements of all capacitances in AC-PDP.

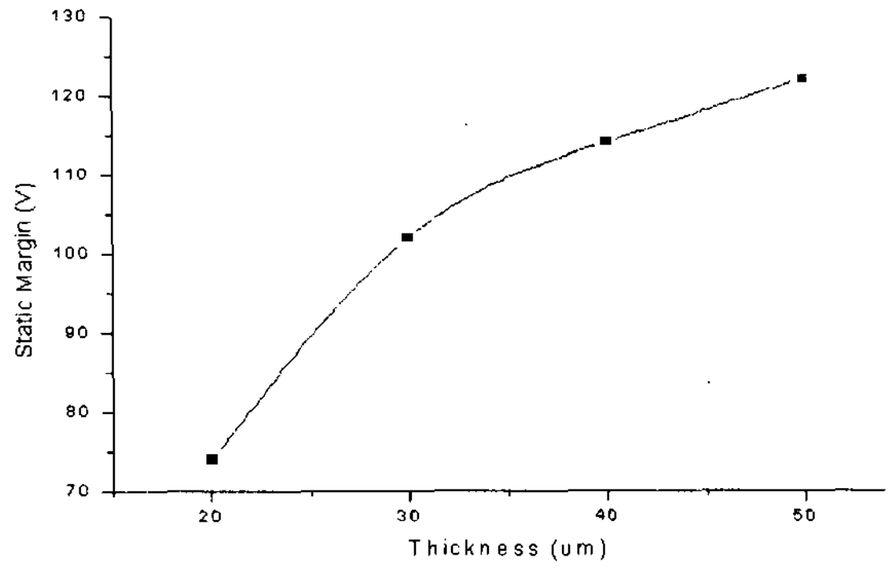

Fig. 4. Static Margin vs Thickness

These values are based on charge-voltage (Q-V) characteristic curves in Fig.5. Before and after the discharge, along with the voltage margin relation to the wall voltage and to dielectric-gap voltage induced by wall charge.

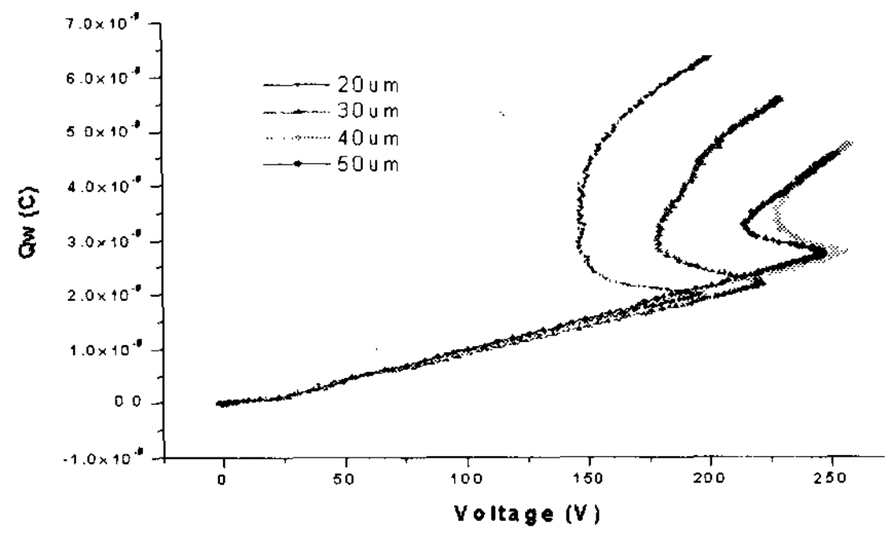

Fig. 5. Q-V Lissajous Curve

Figure 6 shows the capacitances Co, Cp and Cg per unit cell versus dielectric thickness for a fixed driving frequency of 50kHz. These capacitances, as shown in Fig1, can be determined by Q-V analysis, along with the voltage margin relation, $V_f - V_s = V_w + 2V_g$ ($V_w = Q_w/C_o$ and $2V_g = Q_w/C_g$)

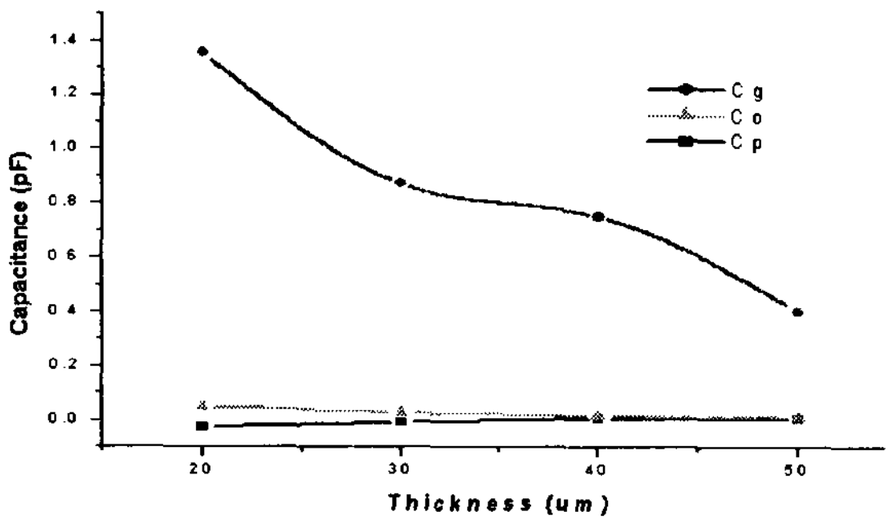

Fig. 6. Capacitance (Cg,Co and Cp) vs Thickness

As shown in the figure 6, the current is reduced according to a dielectric thickness increase because the capacitance and current has the related proportion.
Figure 7 shows the results of the brightness got low due to a current reduction.

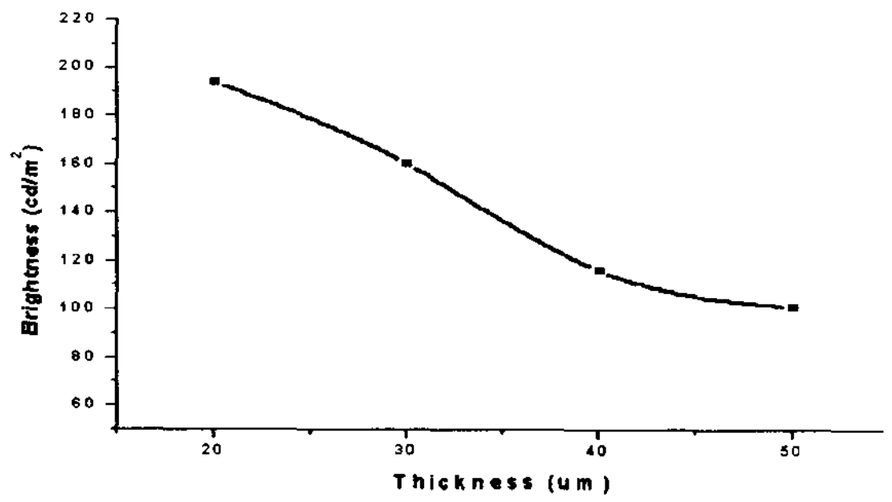

Fig. 7. Brightness vs Thickness

Figure 8 shows the efficiency had few influence along with the thickness increases of the dielectric layer. The transmitted light is reduced because of the increase of dielectric thickness.

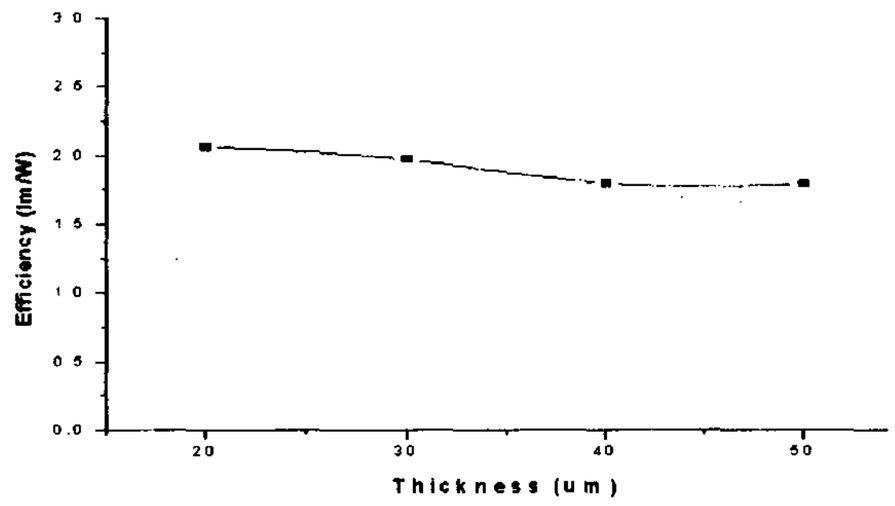

Fig. 8. Efficiency vs Thickness

3.Conclusions

In this experiment, we have investigated the electro-optical characteristics with dielectric thickness and we have analyzed wall charge and wall voltage by Q-V energy diagram. A firing voltage and sustain voltage rise as a dielectric thickness increases,the capacitance is reduced as a dielectric thickness increases. The brightness gets low according to a dielectric thickness increases. However, power consumption is the reduced. As the dielectric thickness is increased, the width of a static margin expands. The current is reduced because the capacitance is reduced to a dielectric thickness increases. The efficiency had few influence.
To find out optimal condition of dielectric thickness in AC-PDP, we make an experiment in the variety of dielectric layer thickness.

4. References

1. M. Busio and O. Steigelmann, Glastech. Ber. Glass Sci. Technol. 73 (2000) 319
2. JP Patent, 2001-195989
3.Young-Guen Kim, Young-Sam Kim, Dai-Geun Joh, Jae-Jun Ko, Dae-Il Kim, Eun-Ha Choi, Yoonho Seo and Guangsup Cho, Jpn. J. Appl. Phys. Vol. 37(1998) Pt. 2d, No.12B