The characteristics of wall charge on the dependence of aging time in an AC Plasma Display Panel

Bhum Joon Kim, Hyung Joon Cho*, Seung Hun Lee, Bhum Jae Shin, Kyung Cheol Choi
Department of Electronics Engineering, Sejong University, Kwangjin-gu, Seoul,143-747, Korea
*** PDP Div, LG Electronics Inc, Gumi, 730-032, Korea**
Tel : +82-2-3408-3904 , Fax :+82-2-3408-3902
E-mail :kyungcc@sejong.ac.kr

Abstract

The wall charge is major factor to determine the discharge characteristics. The minimum sustain voltage related to the wall charge decay were investigated as a function of aging time in AC plasma display panel. For the long time scale, the wall charge decay time is dependent on the aging time. The inverse time scale of the wall charge decay has the maximum value at around 3 hours aging time and then fell down.

1. Introduction

PDPs (Plasma Display Panels) are one of the most promising candidates for the next generation large area, flat information displays. From the late 1990's, many companies have been attempted to commercialize them exploiting various advantages, such as the large screen size, thin, and excellent picture qualities. Because of the recent innovations of technology, the image quality and performance of ac PDPs are compatible with those of CRT or projections. However, the luminous efficiency is still low and the cost is still expensive. Therefore, many studies are focus to improve the luminous efficiency and reduce the cost. There have been many attempts to improve the luminous efficiency. One of the most important topics is the understanding of discharge characteristics of PDPs for improving luminous efficiency. Most of all, understanding of the wall charge is very important issue [1]. However, the behavior of the wall charge was not easy to understand. Furthermore, the characteristics of the wall charge connected with MgO surface is very difficult to understand [2,3].

Aging process is one of the difficult manufacture processes in PDPs. The main purpose of aging process is the stabilizing display characteristics related to MgO [4,5,6,7]. The aging studies were undertaken to understand the characteristics of the discharge voltage, discharge currents, gas pressure, and variables driving conditions [5]. We have been reported that the wall charge decay time was measured by indirect method which is based on the measurement of the minimum sustain voltage [8,9]. In this work, the relationship between the wall charge decay time and the aging time was investigated.

2. Experiment

The reflection type three-electrodes surface-discharge structure is most widely used for an ac PDP. Fig.1 shows the schematic diagram of the 2.54 inch test plasma display panel used in this work. The feature of this structure is a stripe barrier rib with an aspect ratio (defined as the vertical pixel pitch relative to the horizontal pixel pitch of a sub-pixel) of 1 to 3. The paired parallel display electrodes and scan electrodes are located on the front plate and covered with the transparent dielectric layer and the protecting layer (MgO). The address electrodes are located on the back plate and covered by the dielectric layer and phosphors. The sustain electrodes were formed with the gap of 80μm. He+Ne+Xe gas-mixture was used as discharge gas and the pressure was 400 Torr.

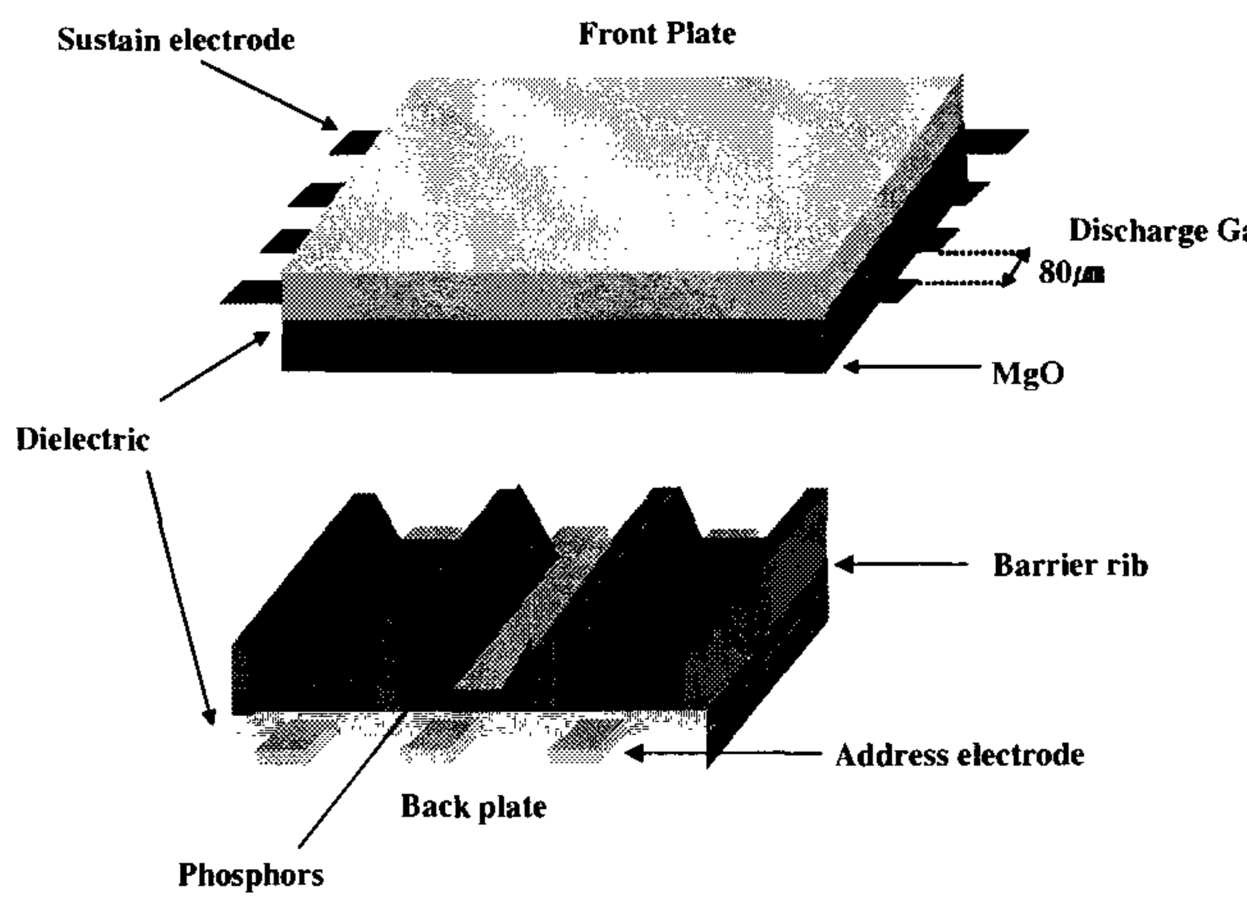

Fig.1 Schematic diagram of cell structure

Fig.2 shows the pulse waveform used in this experiment. This pulse is applied to the sustain electrodes. The width of sustain pulse was 4μs and the interval of sustain pulse was 1μs. The $\triangle$t1 denotes the time of after glow ranging from 1μs to 1ms in this experiment.

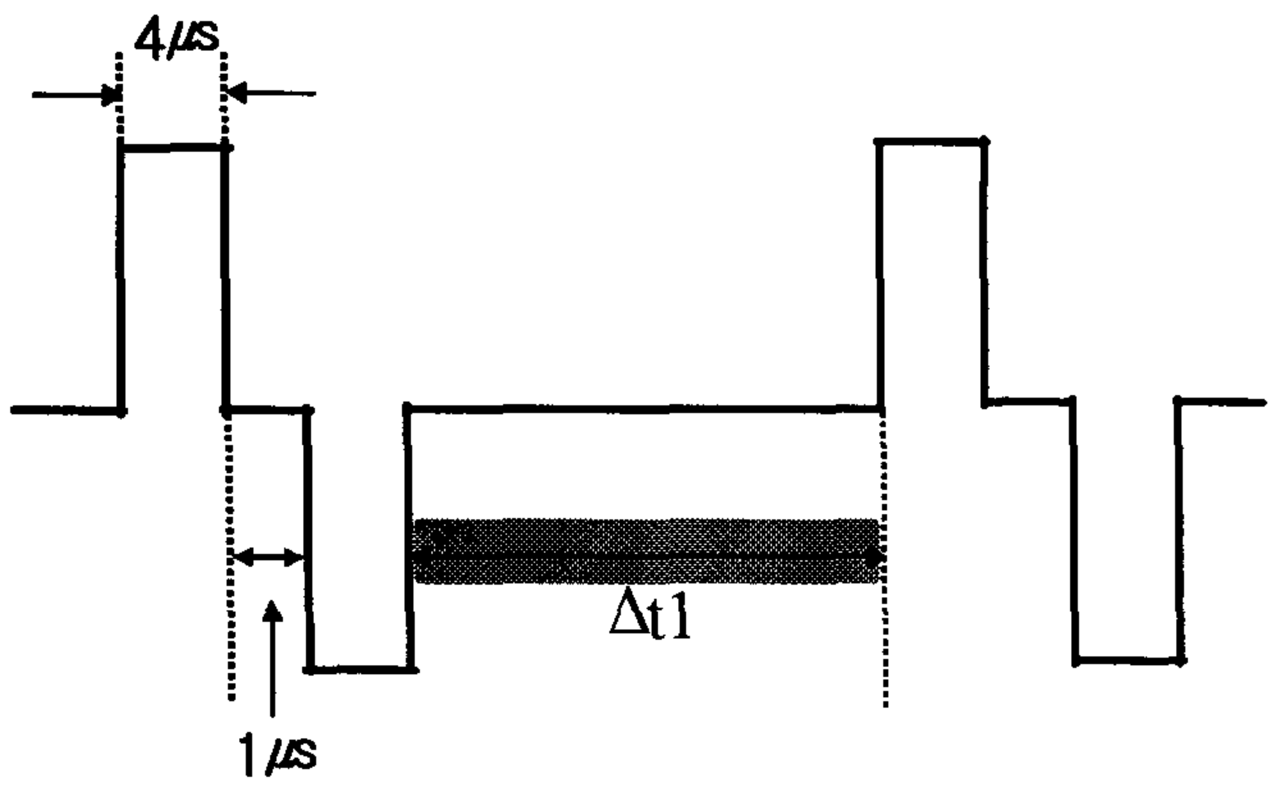

Fig.2 Pulse waveforms applied to the sustain electrodes

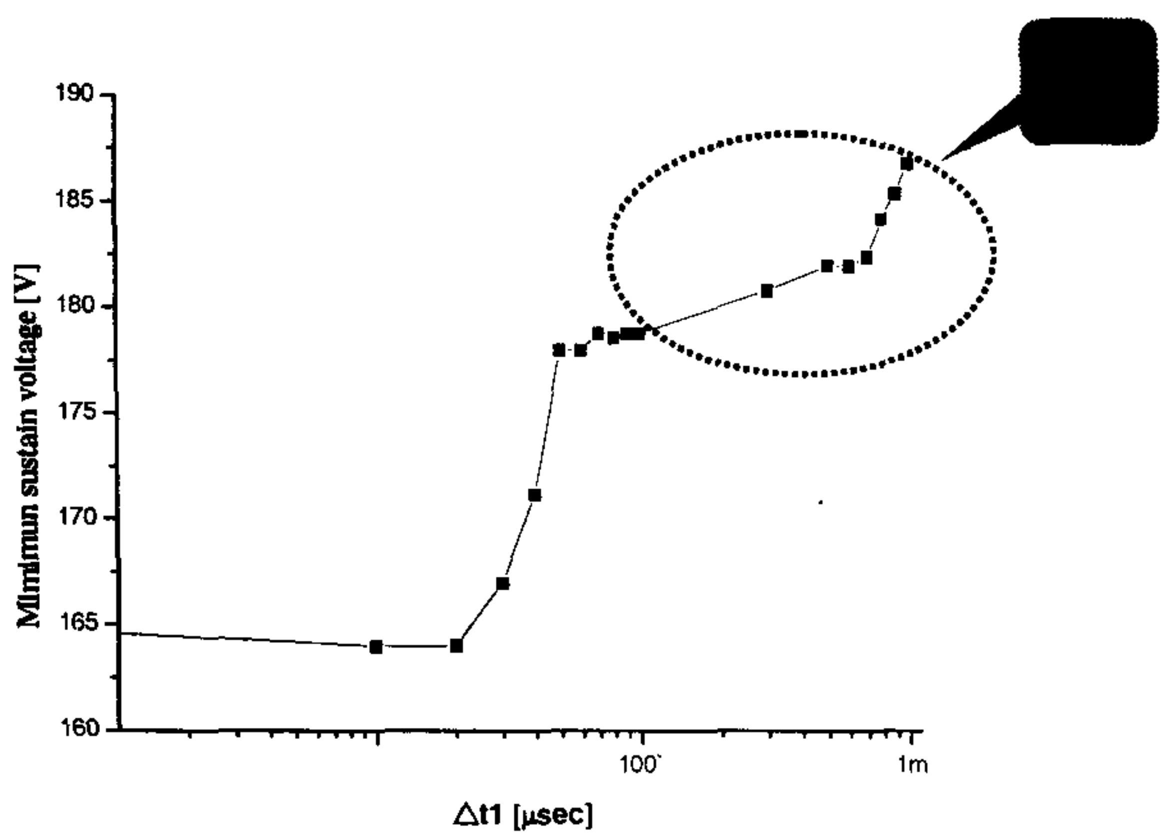

Fig.3 Measurement method for wall charge decay time

Fig.3 shows the characteristics of minimum sustain voltage as a function of the $\triangle$t1. The minimum sustain voltage is sharply increased around 30μs and then the minimum sustain voltage is slowly increased after 50μs. The abrupt change of the minimum sustain voltage is caused by the reduction of meta-stable particles. Increasing the minimum sustain voltage after 100μs might be resulted from the reduction of wall charge. To investigate the wall charge decay time, the variation of the minimum sustain voltage was measured as a function of $\triangle$t1. The γ is defined as the average slope which is the ratio of the change of the minimum sustain voltage to 100μs time step after 100μs. Therefore, 1/γ could be the time scale related to the wall charge decay [8]. The lower γ means that the wall charge decay time is longer.

3. Results and Discussion

To investigate the characteristics of the wall charge decay time on the dependence of the aging process, we measured the minimum sustain voltage(V_{smin}) as a function of $\triangle$t1 for the conditions of the various aging time.

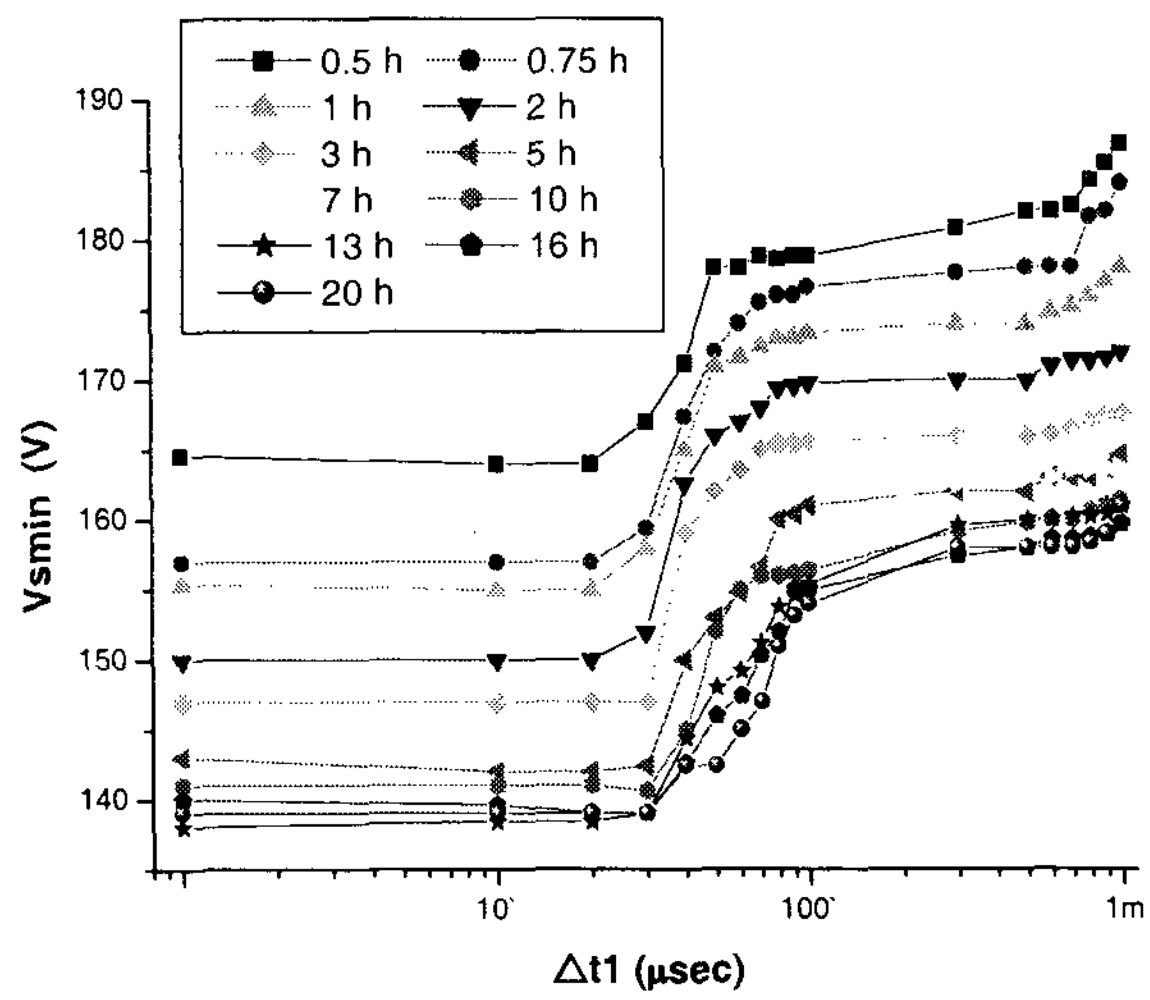

Fig.4 Minimum sustain voltage as a function of the Δt1 on the dependence of the aging time.

Fig.4 shows the minimum sustain voltage on the dependence of the aging time. As shown in Fig. 4, the minimum sustain voltage decreased with increasing the aging time. The variation of the minimum sustain voltage shows the similar tendency for all aging time below around 600μs. However, the variation of the minimum sustain voltage is somewhat different as the change of the aging time after 600μs. Below the 1 hour of aging time, the panel shows the large variation of the minimum sustain voltage. It might be the large loss of the wall charge due to the insufficient of aging time.

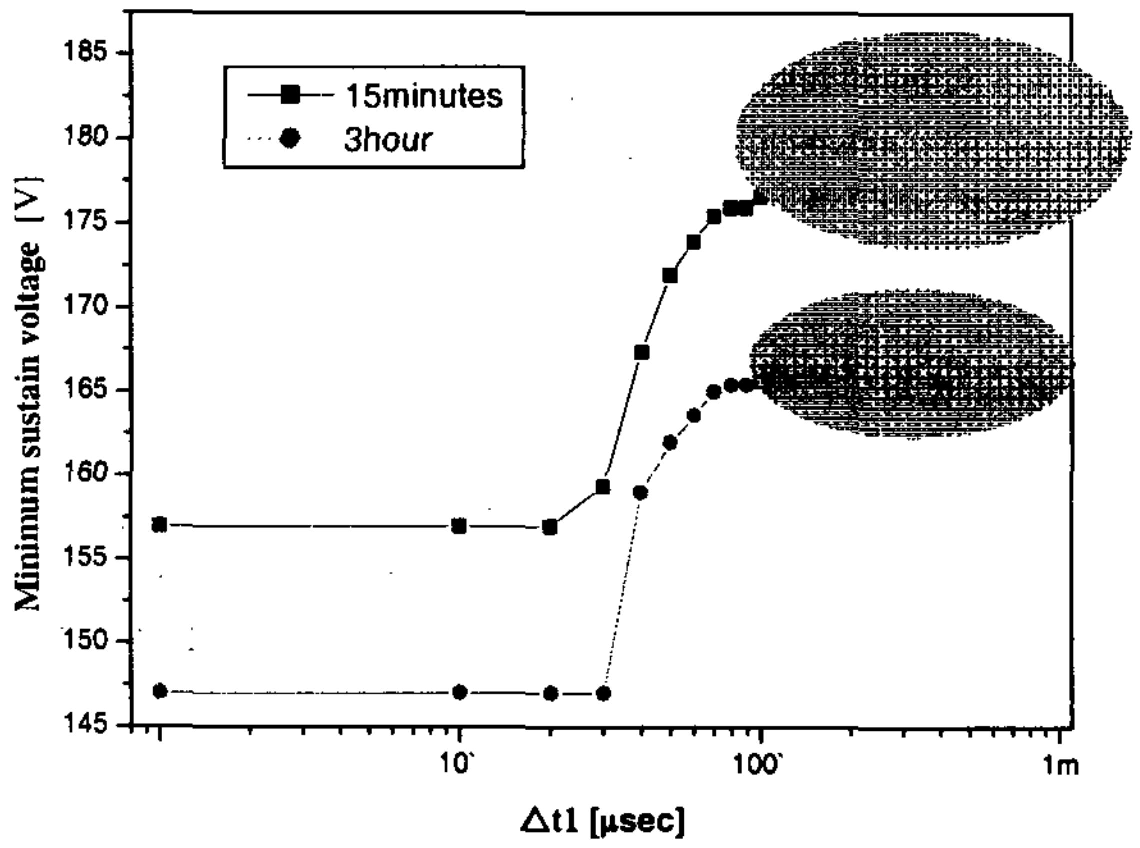

Fig.5 Minimum sustain voltage as a function of the Δtl for 15 minutes and 3 hours aging time.

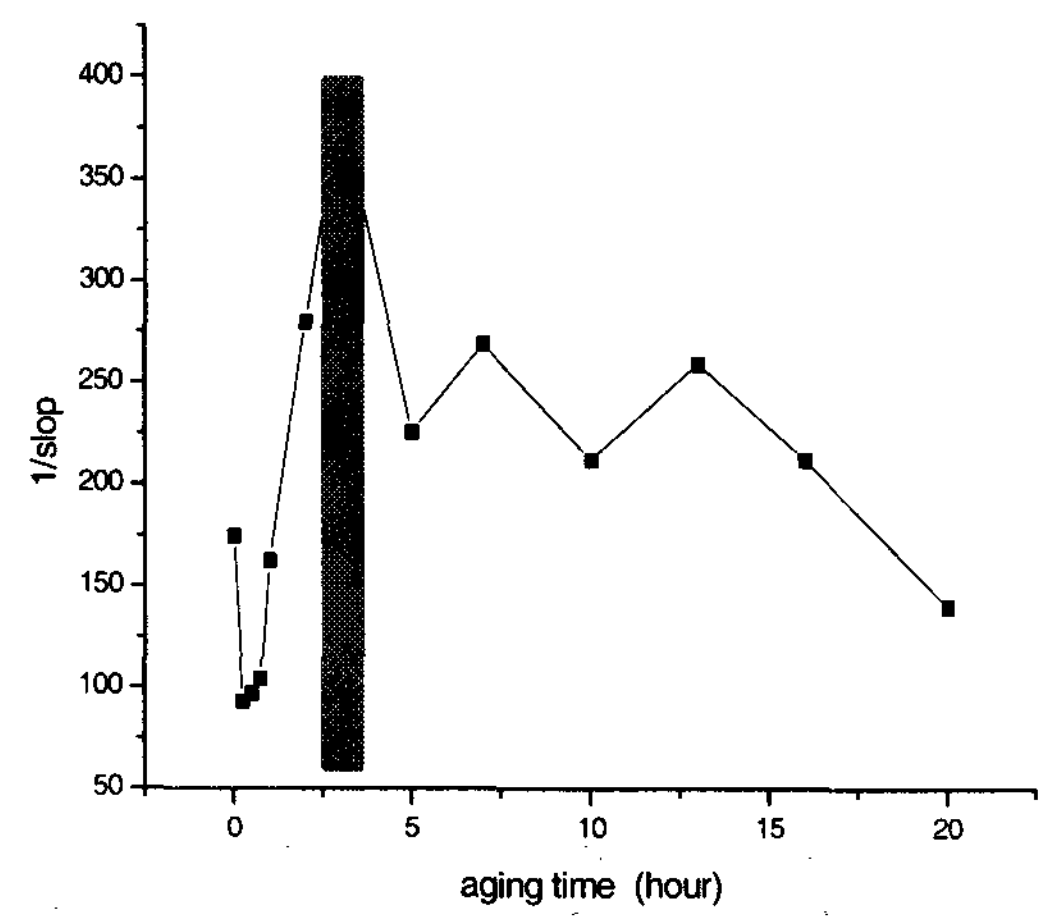

Fig.6 1/γ as a function of aging time

For the clear representation of the variation of the minimum sustain voltage, Fig. 5 shows the two different aging time which shows the large difference in change of the minimum sustain voltage. In the case of 15 minutes aging time, the minimum sustain voltage is increased 10 volt from 100μs to 1msec. However, in the case of 3 hours aging time, the minimum sustain voltage is increased only 2 volt during the same time. Therefore we might conclude that insufficient aging time is resulted in the increasing the wall charge loss. It is well known that the aging mechanism of MgO films is manly caused by the changes in surface properties due to the ion bombardment during discharge [7]. Fig.6 shows the 1/γ as a function of aging time. As shown in Fig. 6, the 1/γ is maximum value in the case of 3 hours aging time. After 3 hours aging time, the 1/γ is decreased with increasing △t1.

4. Conclusion

In this work, we investigated the characteristics of the minimum sustain voltage on the dependence of the aging time as a function of the after glow time (△t1). In the short time scale(below 100μs), the variation on the minimum sustain voltage is governed by the priming particles. However, in the long time scale (above 600μs), the minimum sustain voltage is dependent on the aging time. Therefore, the minimum sustain voltage is sharply increased for the insufficient aging time. The aging time is mainly determined by the characteristics of the discharge voltage, currents, and stability of luminance. However, in this work, it is found that the wall charge decay time is also one of the possible factors which determine the discharge characteristics.

5. References

[1] K.W Whang, D.C Jeong, "Observation of the Spatiotemporal Variation of Wall Charge Distribution in an ac PDP Cell", SID'03, pp32~35, 2003.

[2] D.I.Kim, J.J Ko, Y Guon, E.H Choi, G Cho, "Influences of Applied Writing Pulses on the Wall Charge Distribution and Light Output in AC Plasma Display Panel",SID'00, pp706~709, 2000.

[3] M.S Kim, J.D Yi, T.H Shin, J.G Han, K.H Bu, S.J Moon, Y.W Seo, Y.D Joo, B.K Kim, J.K Lee, J.D Kim, "Novel Measurement of Wall Voltage in AC-PDPs ", IDW'00, pp719~722, 2000.

[4] H.J Kim, K.C Choi, "The relationship between the discharge characteristics and the superficial layer of MgO in AC PDP", IMID'02, pp224~227, 2002.

[5] Peter Pleshko, "AC Plasma Display Aging Model and Lifetime Calculations", IEEE Trans.on Electron Devices, VOL.ED-28, No.6, pp654~658, 1981.

[6] C.H Park. Y.K Kim, B.E Park, W.G Lee, J.S Cho, "Effects of MgO annealing process in a vacuum on the discharge characteristics of AC PDP", Material Science & Eng..B60, pp149~155, 1999.

[7] M.O Aboelfotoh, Omesh sahni, "Aging Characteristics of AC Plasma Display Panels", IEEE Trans.on Electron Devices, VOL. ED-28, NO.6, pp645~653, 1981.

[8] B.J Rhee, H.N Lee, K.C Choi, "Temporal behaviors of the charged and metastable particles in an AC Plasma Display Panel", IDW'99, pp619~622, 1999.

[9] K.C Choi, H.J Cho, B.J.Kim, J.H Lee, "Control of the Wall Charges by Applying Pulses to Address electrode in an AC Plasma Display Panel", Euro'02, pp731~734, 2002.