The relationship between the discharge characteristics and the superficial layer of MgO in AC PDP

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Abstract
The relationship between the discharge aging time and the superficial layer thickness of MgO thin film was investigated in an AC PDP. The discharge characteristics of an AC PDP with the various aging time were evaluated by discharge aging experiments. We find the presence of a superficial lay which is related to the discharge characteristics during aging process. The superficial layer of MgO thin film was observed by Transmission Electron Microscope (TEM). It was found that the superficial layer thickness of MgO was dependent on discharge aging time.

1. Introduction

An AC Plasma Display Panel (PDP) is now on mass production. However, low luminous efficient and high manufacturing cost are still problem to be solved. Especially, the aging process, which usually last 8hours ~ 24hours, is a kind of obstacle for PDP mass production. This is because that there is no exact understanding of aging process. Plasma interacts with protecting layer intensively during aging process. One of the main purpose of the aging process is the stabilization of discharge. Something happens to the surface of protecting layer during aging process because of the interaction with Plasma. The end point detection of aging process should be related to the surface properties of the protecting layer. Also, the display characteristics and the reliability are dependent on the surface properties of the protecting layer, which was mainly prepared during the aging process and the actual display period [1,2]. Up to now, MgO is the best material for the protecting layer in AC PDPs. In this work, the relationship between the discharge characteristics and the surface properties of MgO film was investigated.

2. Experiment

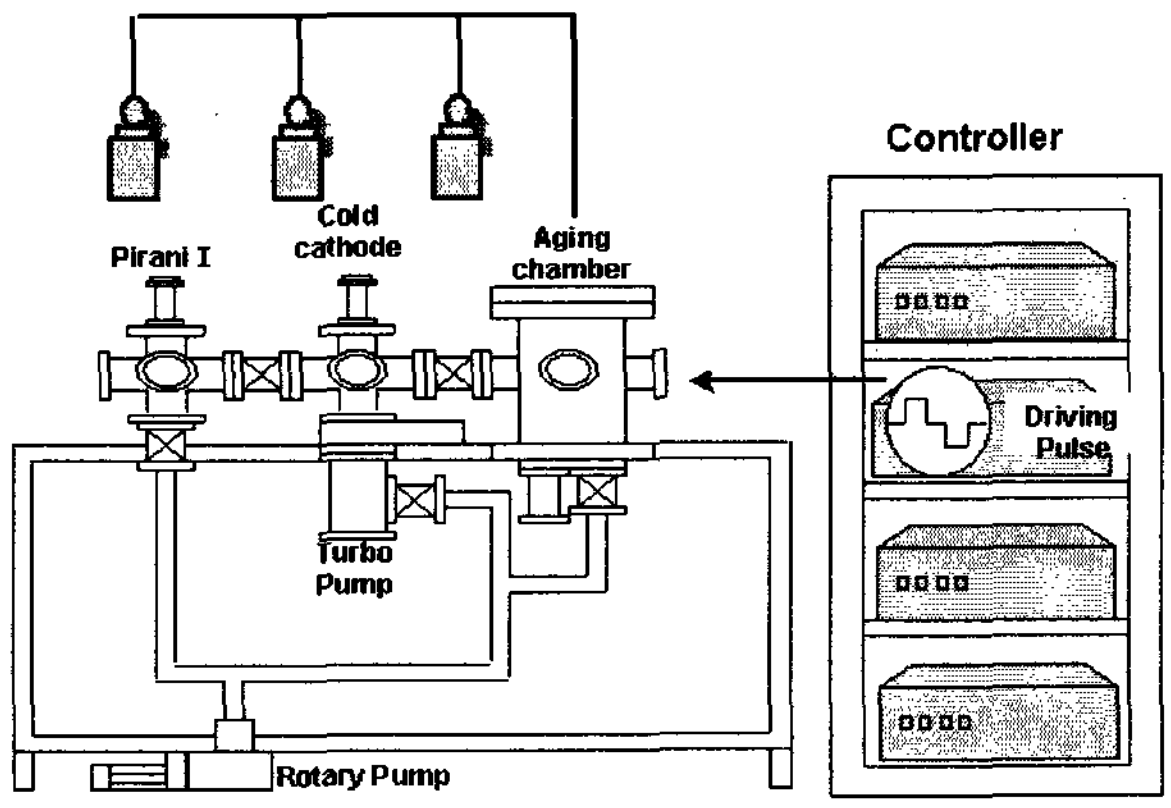


Fig. 1.The schematic diagram of discharge aging chamber

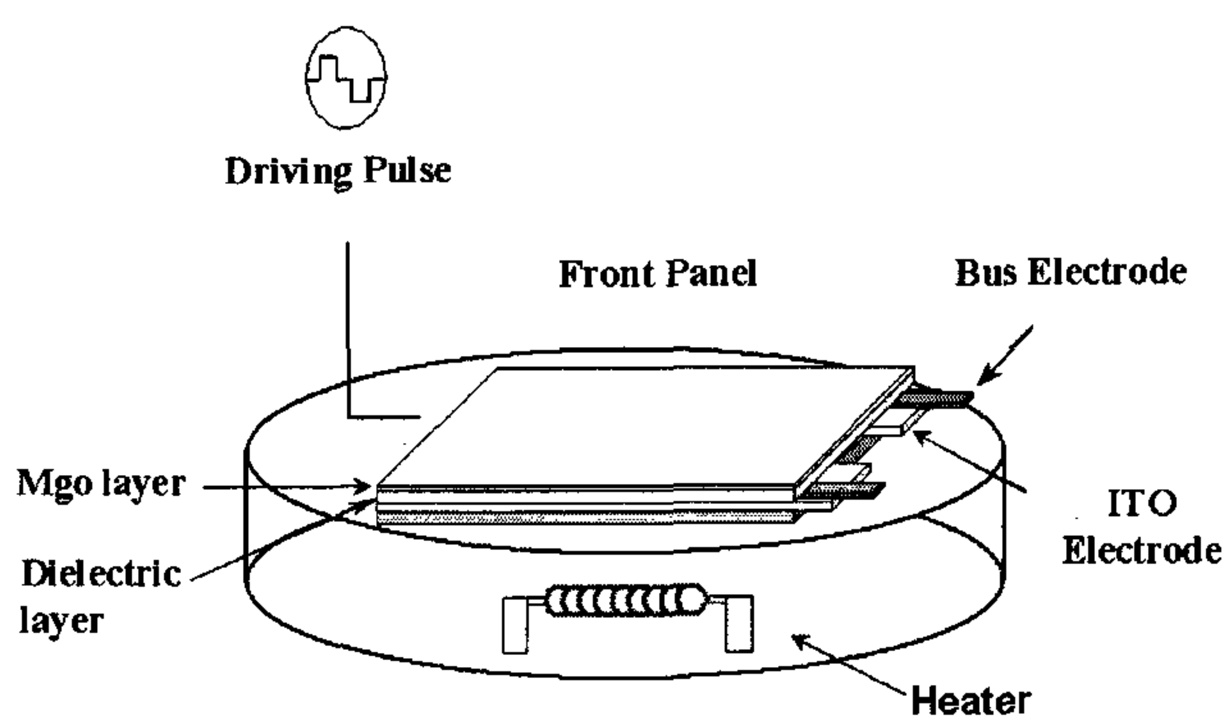


Fig.2 The front plate is placed substrate, which can be annealed in the aging chamber

We used a 4-inch test panel to investigate the relationship between discharge characteristics and the surface properties of MgO. The 4-inch experimental panel was made as follows: On glass, sustain electrode were made of a transparent material, Indium Tin Oxied(ITO), and patterned by photolithography. Bus electrodes were then formed on the transparent electrodes using the screen print method. Next, a transparent dielectric layer was applied with a 30um thickness, and a 6800Å thick MgO film was deposited using electron-beam method. For the aging process, the experimental panel was placed in an aging chamber. Fig. 1 shows a schematic diagram of the discharge aging test chamber. The experimental panel was subjected to thermal annealing in aging chamber for 2hours with a vacuum degree of about 1.0×10^{-6}Torr at a temperature of 300°C to activated the MgO surface. As shown in Fig.2, the front plate was placed on the substrate which could be heated in the aging chamber. The aging chamber was filled with Ne+Xe(4%)gas mixture at a pressure of 435torr. The pulsed of 220V and 25 KHz were applied to the sustain electrodes for aging process.

3. Results and discussion

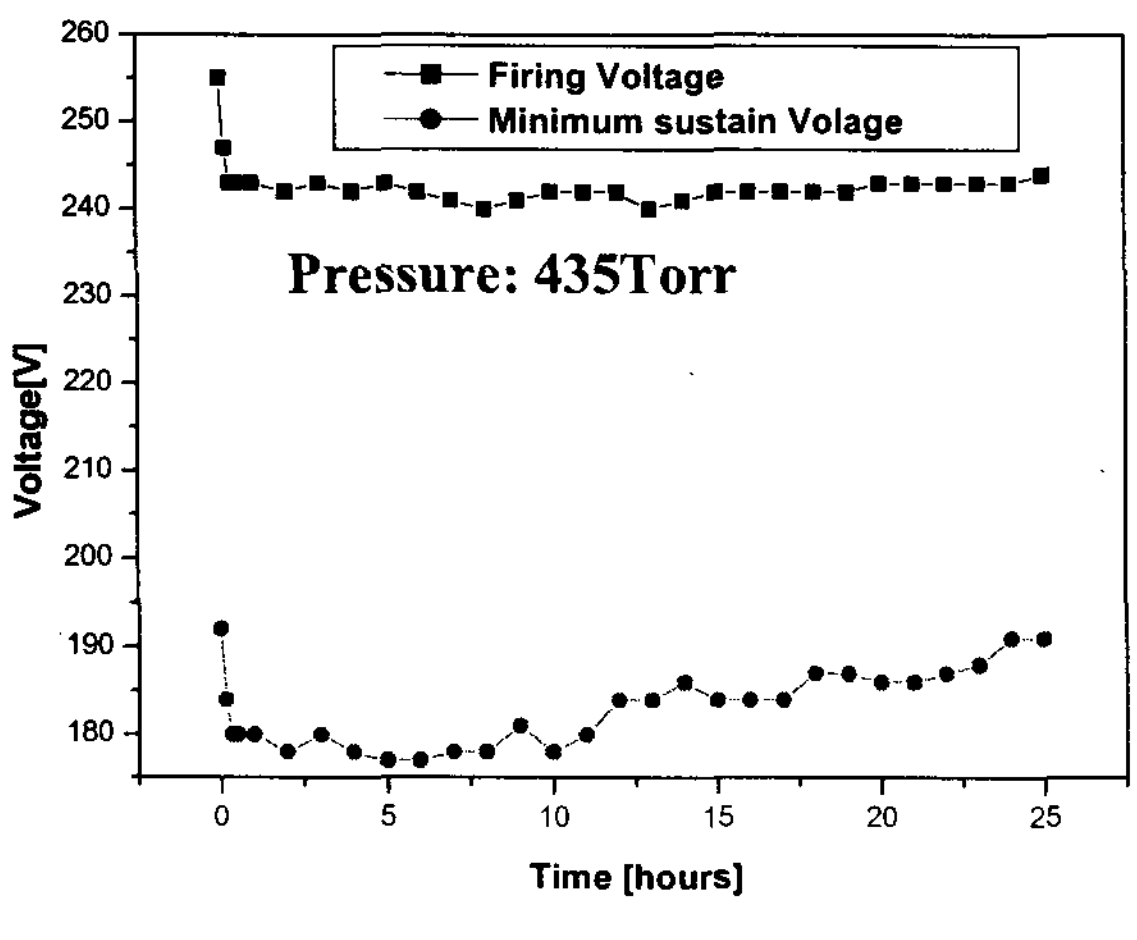


Fig.3 Firing and Minimum sustain voltage as a function of aging time

The firing and the minimum sustain voltage were measured by using sustain pulses with 25 KHz. The square mark plots as shown in Fig.3 shows the firing voltage as a function of discharge time. The firing voltage decreased drastically within 30 minutes and was stabilized. The minimum sustain voltage as shown by the circular mark in Fig.3 decreased within 30 minutes as the firing voltage did. And then, the minimum sustain voltage went up high gradually. Generally, the minimum sustain voltage is related to meta-stable particle during short time and the surface properties of MgO during long time. There were something changed on the surface of MgO during aging process.

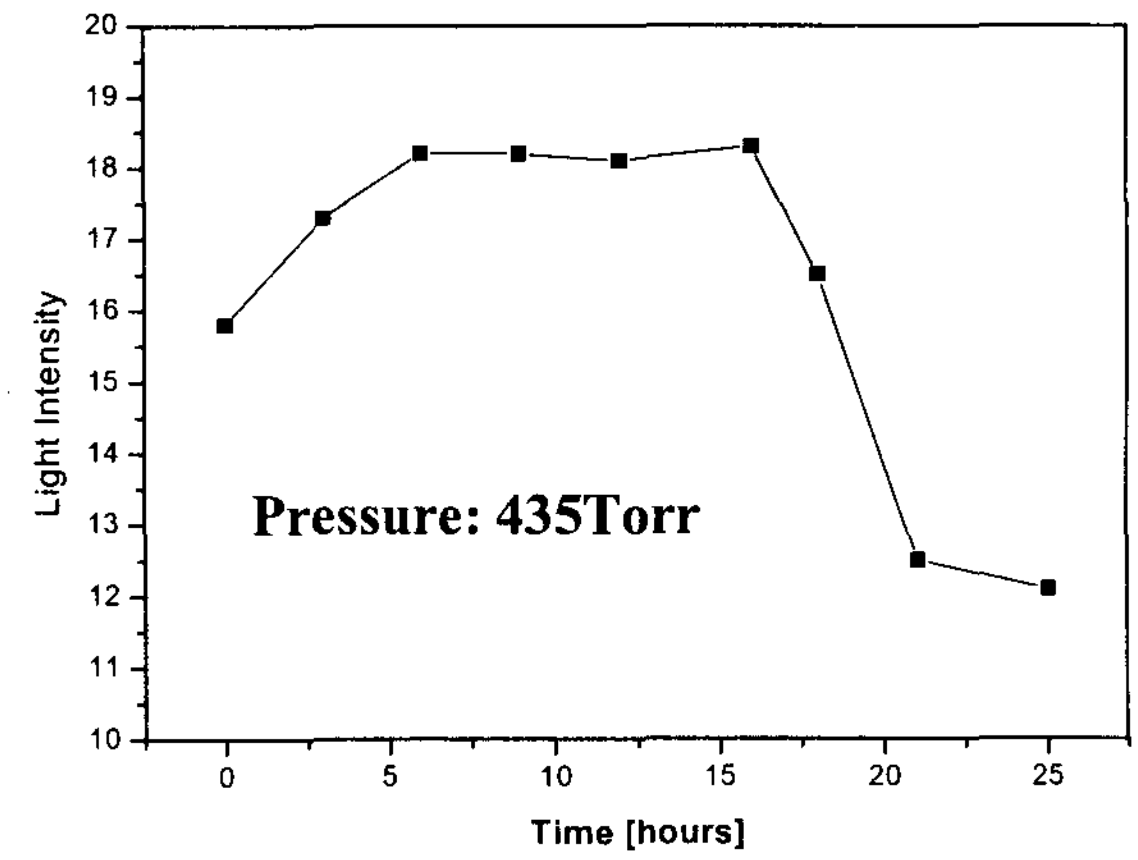


Fig.4 Light intensity of Ne+Xe(4%) gas mixture discharge as a function of aging time

Fig.4 shows the light intensity emitted from the Ne+Xe(4%) gas mixture discharge as a function of discharge aging time. This figure shows that the discharge state is related to the surface properties of MgO. The light intensity slightly increased until 16hours and then suddenly decreased. We could expect that there were something happened to the Ne+Xe(4%) discharge and the MgO surface.

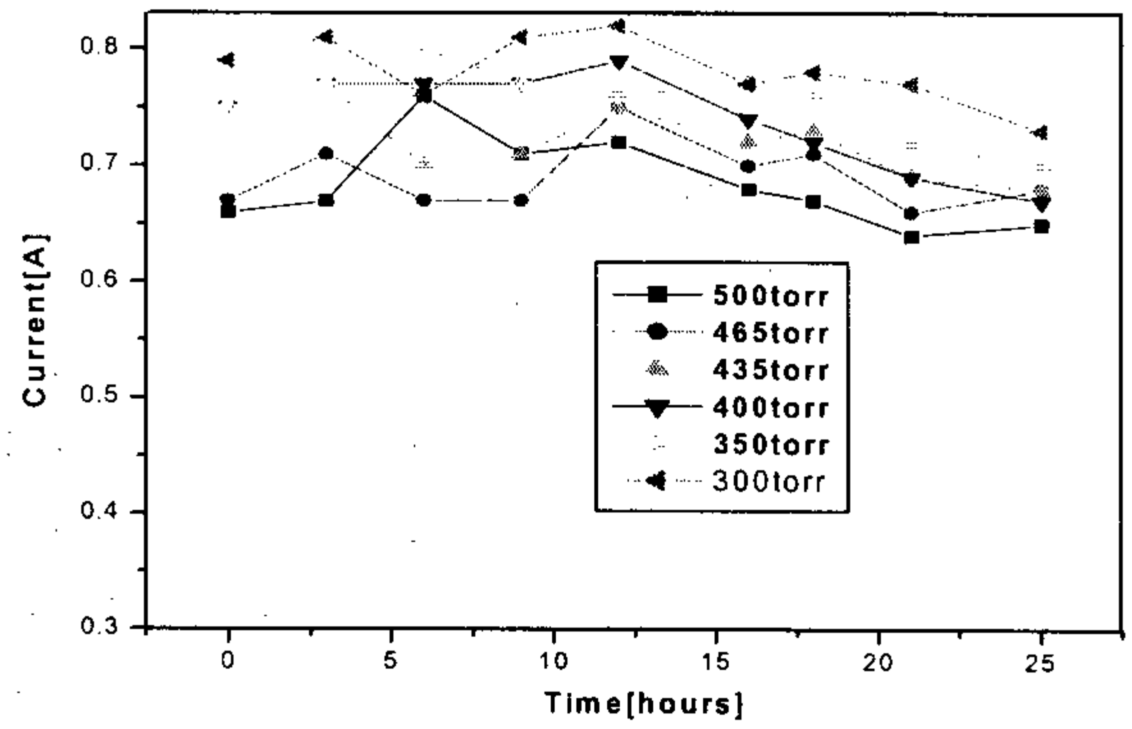
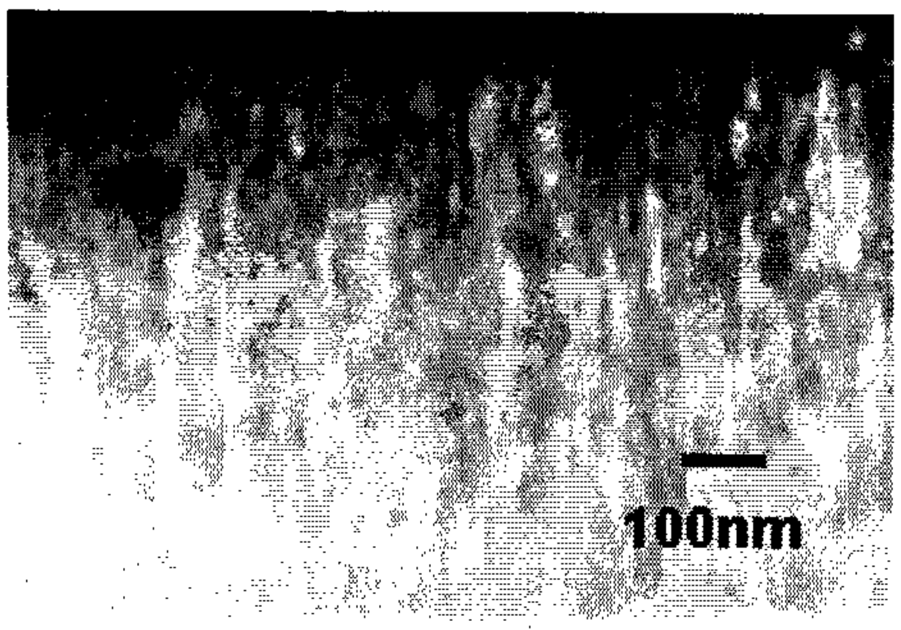
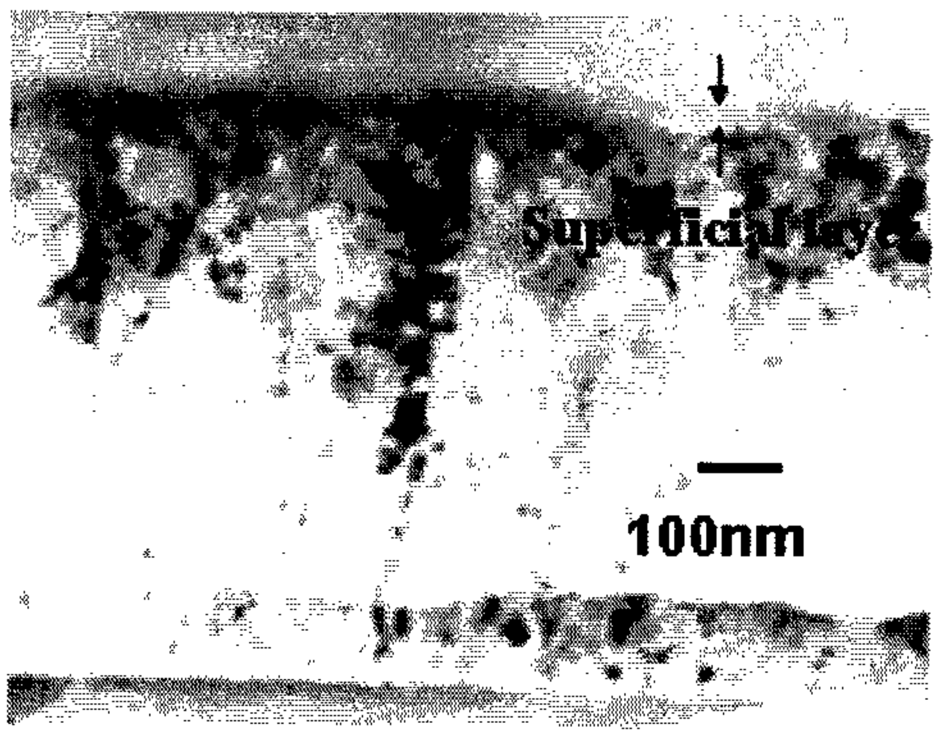


Fig.5 Discharge current of Ne+Xe(4%) gas mixture as a function of aging time

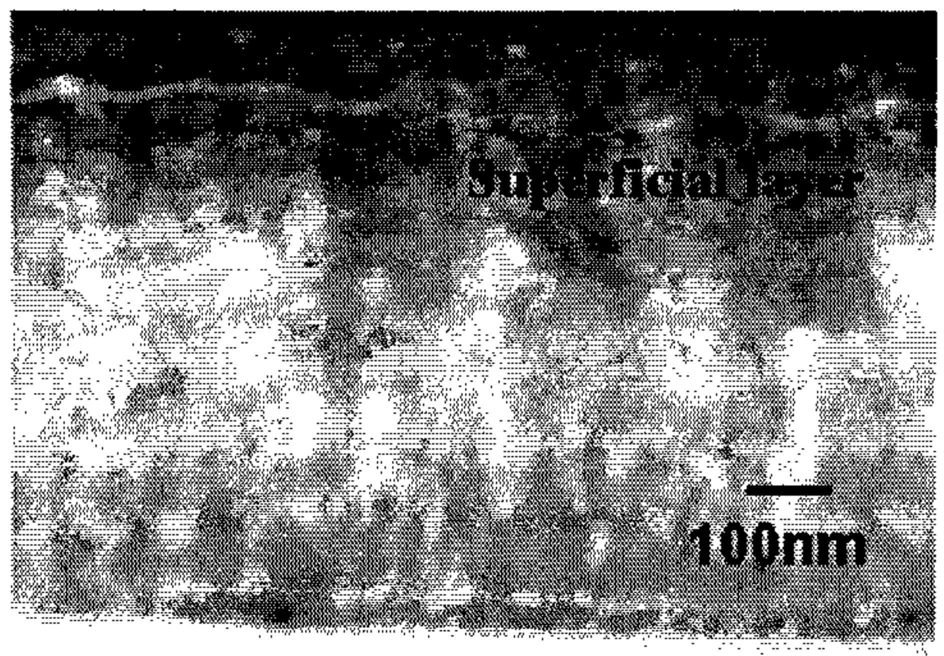
Fig.5 shows the discharge current of Ne+Xe(4%)gas mixture as a function of discharge aging time. As shown in Fig.4, the discharge current was dependent on the aging time. At around 12hours, the discharge current started to decrease.



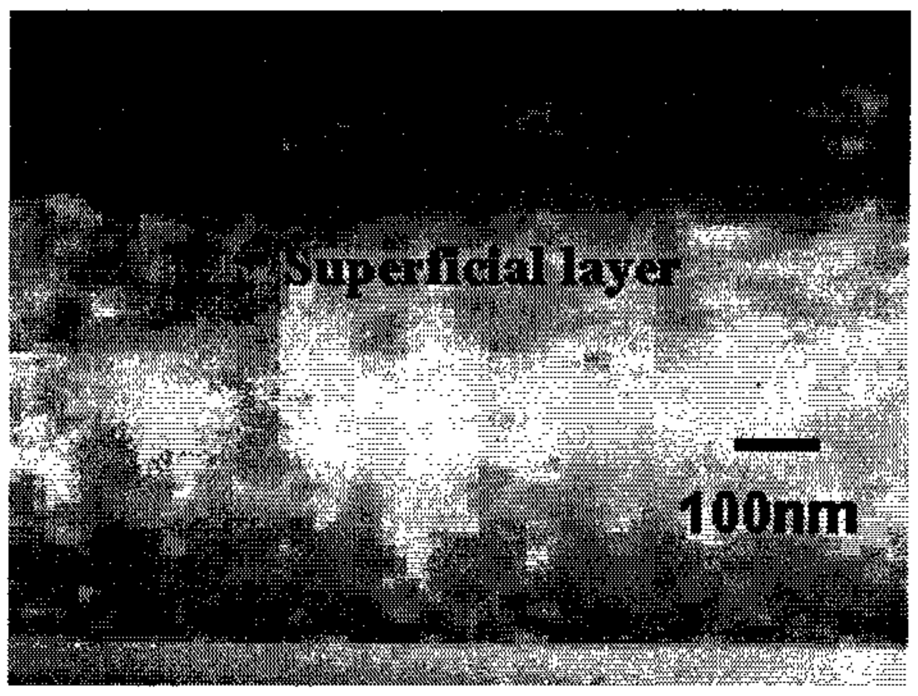
(a) 0hours



(b) 12hours



(c) 16hours



(d) 25hours

Fig.6 Cross sectional view of MgO film after (a) 0hours, (b) 12hours, (c) 16hours, (d) 25hours aging process

Table1. superficial layer thickness of MgO film

Aging time	0hours	12hours	16hours	25hours
Superficial layer thickness	0nm	50nm	80nm	200nm

Fig.6 shows the TEM cross-sectional images of the MgO film as the aging time passes. It was found that superficial layer thickness of MgO thin films are dependent on discharge aging time. During discharge aging process in an AC-PDP, MgO thin films are bombarded by ions in the gas discharge. The mean energy of these ions is quite low (about 3eV) but some species have an high energy[3].These superficial layer in the MgO thin films may be the cause of bombardments by these kinds of ions. It is thought that the bulk layer in the MgO thin film has different structure from the bulk layer. In Fig.3 and 4, it is expected that the minimum sustain voltage starts to increase after 10 hours and the light intensity decrease after 16hours. Also, the time averaged currents decrease after 12hours from differential pressures. The variation of the minimum sustain voltage, the light outputs and discharge current is related to the superficial layer thickness which increase during aging process as shown in Fig.6 and Table 1.

4. Conclusion

The appearance of a nano-scale superficial layer on the MgO film in an AC PDP was found in this work. The superficial layer thickness was related to the minimum voltage, the light intensity from the plasma, and the discharge current. The superficial layer thickness was proportional to aging time. The growth rate of the superficial layer was about 5nm/hour until 16hours and 8nm/hour until 25hours. This result can be used to control the aging process time improve the reliability.

5. Acknowledgement

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6. References

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