Nano-porous Al_2O_3 used as a protecting layer of AC Plasma Display Panel

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Abstract

Nano-porous alumina was investigated as a protecting layer in an AC Plasma Display Panel. A 2 μm thick nano-porous Al_2O_3 layer inserted with MgO was formed on the dielectric layer instead of the conventional 500 nm-thick MgO thin film. Both nano-porous Al_2O_3 layer and inserted MgO were prepared by wet process. The luminance and luminous efficiency of 3-inch test panel adopting nano-porous Al_2O_3 was higher than that of the conventional PDP.

1. Introduction

The protecting layer in an ac plasma display panel plays an important role in generating gas discharge and making the display images. MgO is usually used as protecting layer in an ac PDP. Recently, nano-porous dielectrics have attracted special interests in the nano and microelectronics industry because of novel physical, chemical properties and availability. The merits of this structure are special stability, robustness and relatively simple fabrication process compared to MgO treatment. Also, discharge characteristics and efficiency are controllable by structural modification of nano-porous alumina. The conventional plasma display panel adopting MgO thin film has a lot of problem related to the reliability and the manufacturing cost. There were a lot of efforts to replace MgO thin film with other material for the protecting layer in an AC PDP[1,2,3]. Up to now, any material as protecting layer could not beat the MgO [4,5]. In this work, nano-porous Al_2O_3 was proposed as one of candidates for the protecting layer and investigated the influence of the new protecting layer on the luminous efficiency of the AC PDP.

2. Experiment

We have fabricated transparent nano-porous alumina layer instead of MgO thin film of the conventional PDP cell. The MgO thin film was deposited by the electron-beam evaporation method or sputtering deposition. Thin film nano-structured alumina was formed through the deposition of aluminum and electrochemical anodization of this aluminum layer in acidic solution. Figure 1 shows nano-porous alumina layer has regular honeycomb like porous structure. The nano-porous Al_2O_3 layer partially filled with MgO on the dielectric layer of an ac PDP.

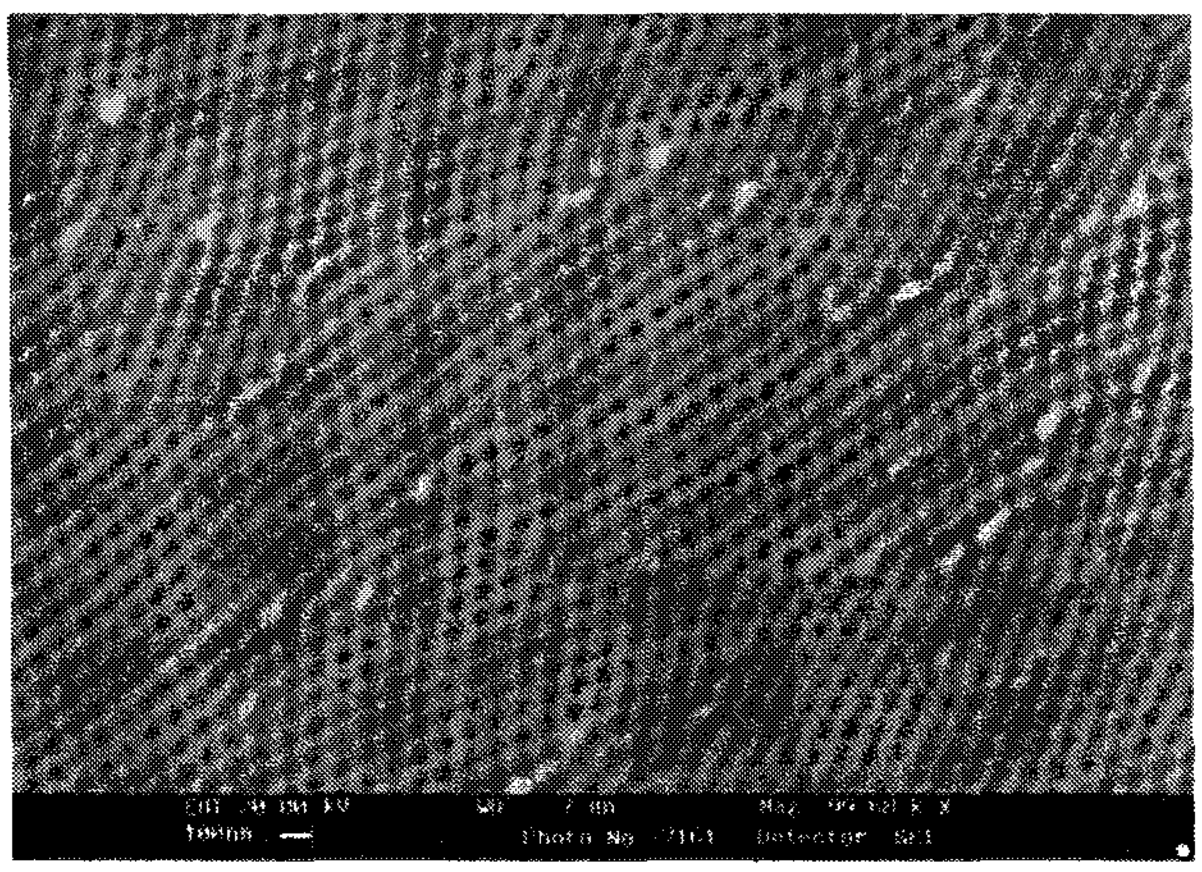

Fig. 1 SEM image of nano-structured alumina layer

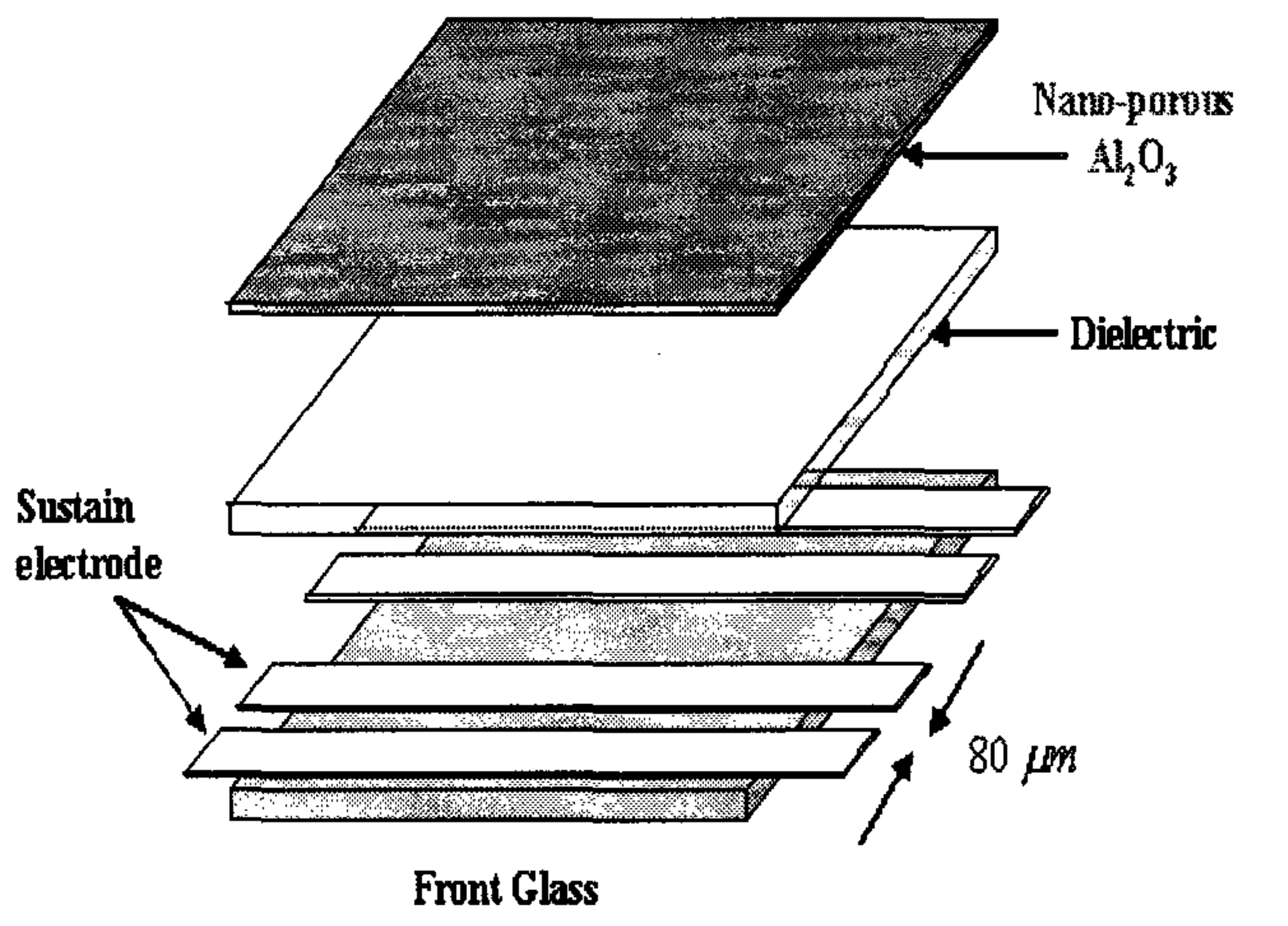

Fig. 2 A 3-inch front panel with nano-porous Al_2O_3

Figure 2 shows a 3-inch front panel adopting nano-porous Al_2O_3 layer. The thickness of the Al_2O_3 layer and pore diameter were simply controlled by the wet anodization conditions. Also we have inserted MgO into the nano-pore to improve the discharge characteristics of the AC PDP. By the incorporation of MgO with Al_2O_3, the efficiency was improved more than 30% in previous report[6]. The 3-inch experimental panel was made as follows: Two sustain electrodes were formed on the glass substrate using the screen print technique. The distance between two sustain electrodes was 80 μm. And then, a transparent dielectric layer was coated with a 30 μm thickness using the screen printing technique. After that, a 2 μm-thick nano-porous Al_2O_3 layer was formed by anodization in 0.3 M oxalic acid. The mean pore diameter was about 30 nm. To insert MgO into the nano-pores, precursor solution ($Mg(acac)_2$:PEG) was spin-coated on the Al_2O_3 layer and baked at 350 °C under oxygen or air conditions. Ne+4% Xe gas-mixture was filled up to 400 torr. The sustain pulses with the frequency of 25 kHz were applied to the sustain electrode.

3. Results and Discussion

Figure 3 shows the discharge current of the 3-inch test panel as a function of the sustain voltage. The operating voltage of the proposed panel with nano-porous Al_2O_3 was higher than that of the conventional panel with 500 nm-thick MgO. However, the discharge current of the proposed panel was lower than that of the conventional panel.

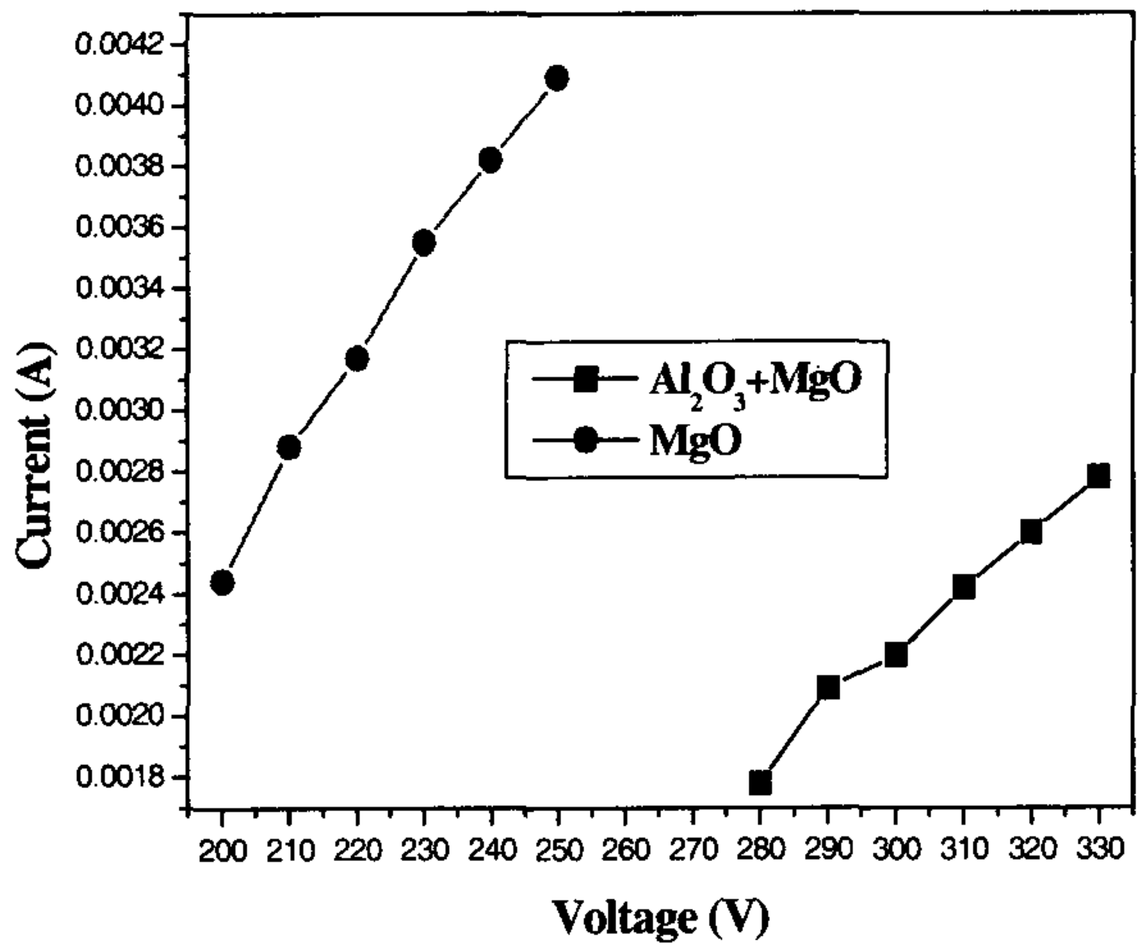

Fig. 3 Discharge current as a function of the sustain voltage

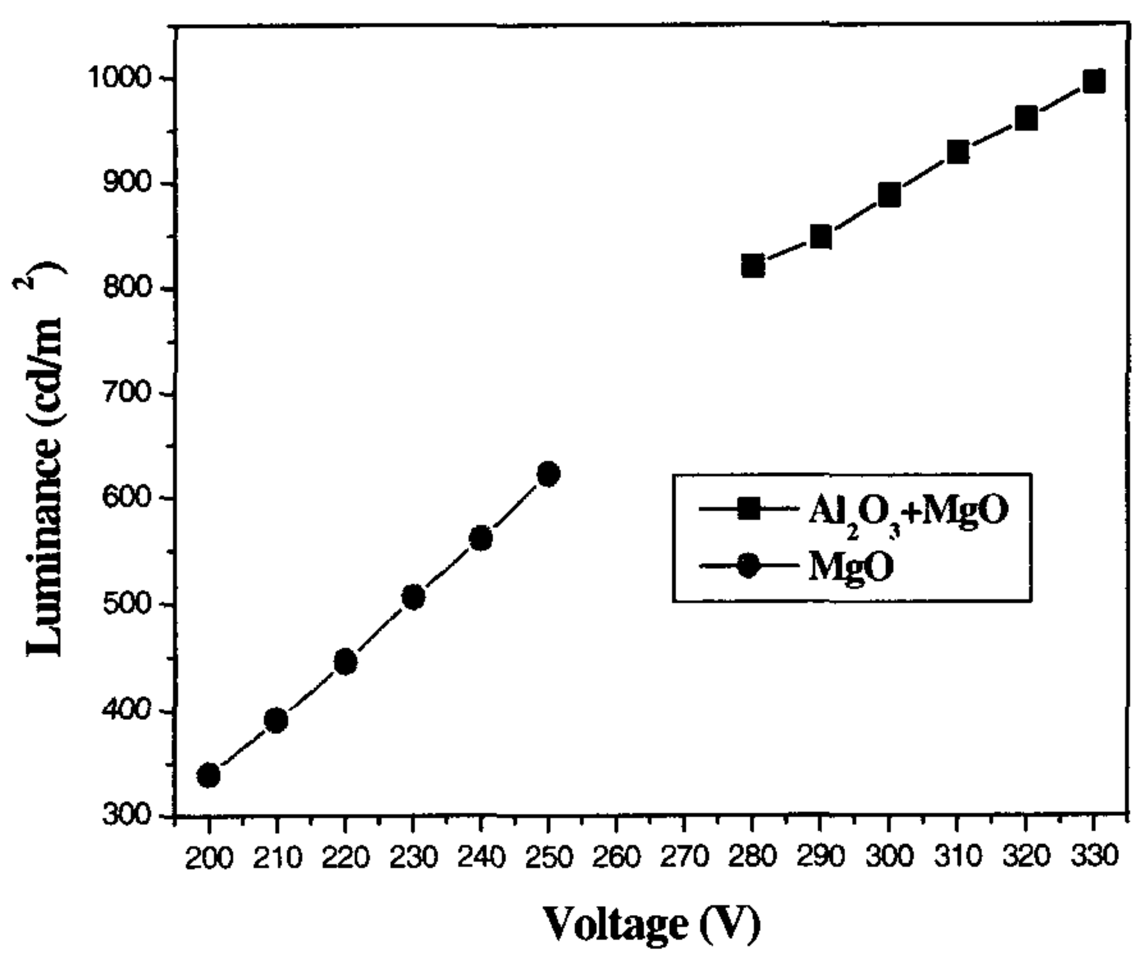

Fig. 4 Luminance as a function of the sustain voltage

Figure 4 shows the luminance as a function of the sustain voltage. The luminance increased with increase of the sustain voltage as expected. The luminance of the proposed panel was still higher than that of the conventional panel even if the discharge current of the proposed panel was lower than that of the conventional panel.

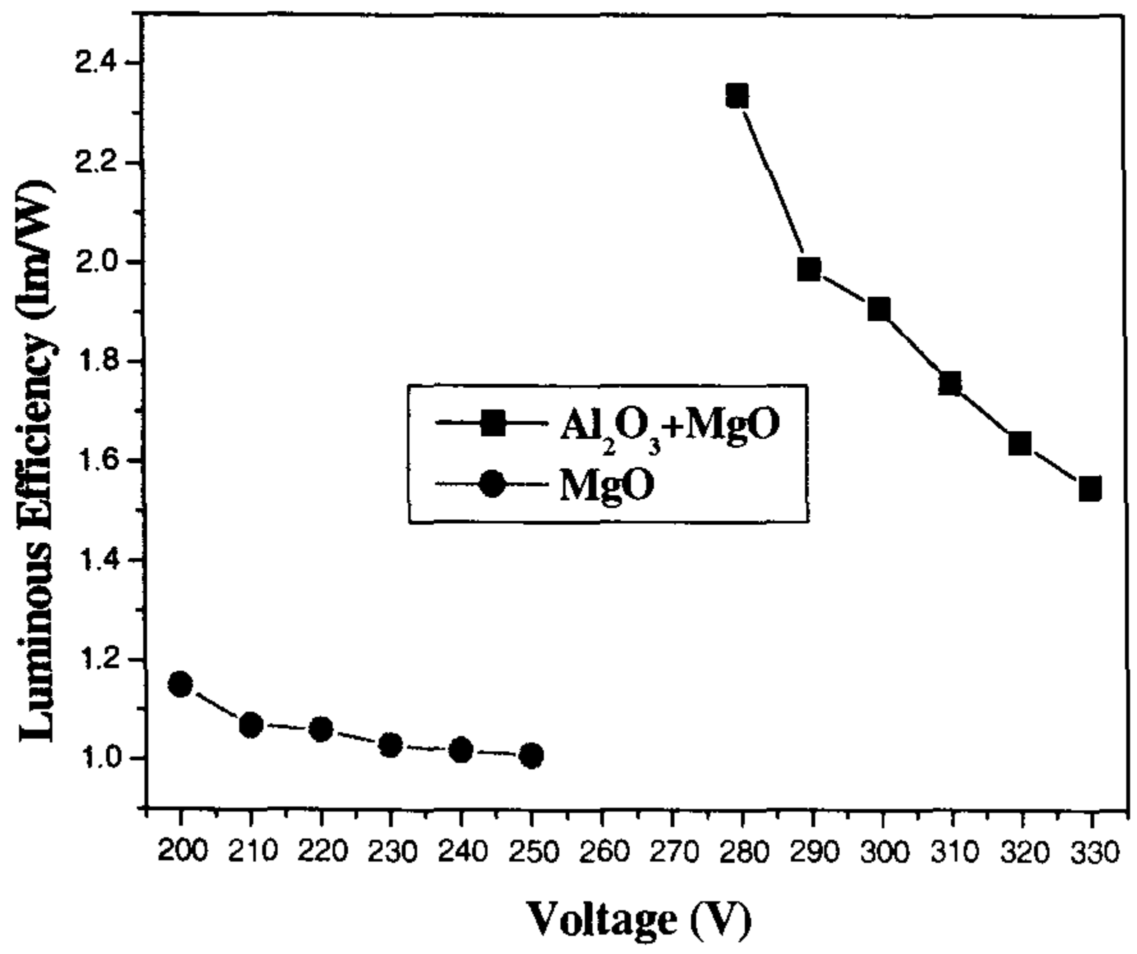

Fig. 5 Luminous efficiency as a function of the sustain voltage

Figure 5 shows the luminous efficiency as a function of the sustain voltage. The luminous efficiency of the conventional panel was about 1 lm/W in the range of the voltage of 200 ~ 250 V. The luminous efficiency of the proposed panel was 2.3 lm/W at 280 V. Of course, the operating voltage of the proposed with nano-porous Al_2O_3 layer was higher than that of the conventional type PDP. If the operating voltage would be lowered, the luminous efficiency will be much higher.

4. Conclusion

The discharge characteristics of the ac PDP adopting nano-porous alumina layer were investigated in this work. It is pointed out that nano-porous alumina layer can be used as the protecting layer in an AC PDP. It is found that the luminous efficiency of the panel adopting nano-porous Al_2O_3 thin film which was coated with MgO is higher than that of the conventional type PDP.

5. References

[1]K.Machida, H.Uchiike, H.Sasaki, and E.Munemoto, "Vacuum-Evaporated and Thick film Print-Dielectric Materials for protecting layer in AC Plasma Displays", Japan Display '92, pp613~616, 1992.

[2]T.Hirakawa, H.Uchiike, and Shuxiu Zhang, "Secondary Electron Emission Charateristics of MgAl2O3 as Protecting Layer ac PDPs", IDW '00, pp691~694, 2000.

[3]T.j. Vink, R.G.F.A. Verbeek, G.Oversluizen, P.K. Bachmann, and V.Van Elsbergen, "Effect of protective coating materials on the performance of PDPs", IDW '01, pp949~952, 2001.

[4]T.Hirakawa, S.Goto, S.Zhang, and H.Uchiike, "Influence of Evaporation Conditions on Physical Properties of MgO Thin Film", IDW '02, pp749~752, 2002.

[5]Sean J. Yoon, Insook Lee, and Sun C. Choi, "Calculation of Lifetime of the MgO Protecting Layer in AC-PDPs", IDW '01, pp941~944, 2001.

[6]S.J. Park, J.H. Cho, S.S. Kim, and K.W. Lee, "Nanoporous Plasma Electrodes for Flat Lamp", ICOPS 2003, 2PA30, 2003.