Characteristics of an MgO Green Sheet as a Protective Layer of AC-PDP

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Abstract

The protective layer of AC-PDP was fabricated by laminating an MgO green sheet. The MgO green sheet was made by coating MgO solution composed of solvent, dispersant, binder, and MgO nano-powder. The MgO solution was coated by the die casting method on the base film. We fabricated three kinds of MgO green sheets of which thicknesses were 20, 28, and 40 μm, respectively. The MgO nano-powder showed lower CL intensity and γi than the e-beam MgO. The MgO green sheet applied panels showed low luminance and current density. The efficiency was almost same as the conventional e-beam MgO panel.

1. Introduction

The MgO protective layer has a great role in a plasma display panel (PDP) because it protects the dielectric layer against plasma damage and decreases the firing voltage by emitting secondary electrons. All the PDP module makers use the vacuum evaporation method to fabricate the MgO protective layer. The vacuum evaporation method is one of the most cost-consuming processes in the PDP fabrication. Therefore, non-vacuum method to fabricate the MgO protective layer is needed to reduce the fabrication cost.

There have been many efforts to develop the atmospheric process such as screen-printing [1, 2], sol-gel [3] and bar coating [4] methods. However, none of these methods are more efficient than the conventional e-beam deposition method in terms of the properties of the protective layer.

In this paper, we fabricated the MgO green sheet with MgO nano-powder. The MgO green sheet was applied to 7.5 inch panel as a protective layer. The characteristics of the panels were compared to the conventional e-beam MgO panel.

2. Experiments

The MgO green sheet was made by coating MgO solution composed of solvent, dispersant, binder, and MgO nano-powder. The average particle size of MgO nano-powder was about 50 nm. Figure 1 shows the HR-TEM images and SADP of the MgO nano-powder. The TEM images and diffraction pattern show that the MgO nano-powder are single crystals. The BET specific surface area of MgO nano-powder was 31 m^2/g.

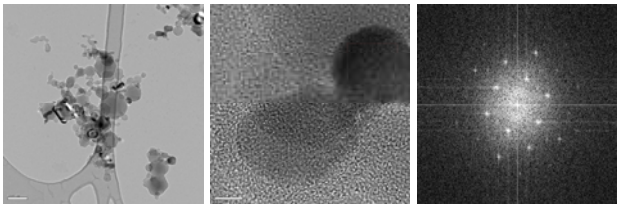

Figure 1. HR-TEM images and SADP of MgO nano-powder.

The MgO solution was prepared by mixing the solvent, the dispersant, and MgO nano-powder. The Poly Glycol Methyl Ether Acetate (PGMEA) was mainly used as a solvent. The MgO nano-powder were dispersed into the solvent with a dispersant. Then, the organic binder was added to the previous solution to increase the viscosity. The viscosity of the MgO solution was 300 cps.

The MgO solution was coated by the die casting method on the base film. We fabricated three kinds of MgO green sheets of which thicknesses were 20, 28, and 40 μm, respectively. The MgO green sheets were applied to 7.5 inch panels as a protective layer. The MgO protective layer was formed by laminating and firing the MgO green sheet. The firing temperature was controlled below 550 ^oC to avoid the MgO cracks due to the thermal stress of the panel. Finally, Ne-Xe (10 %) mixture gas was injected as discharge gas.

3. Results

Figure 2 shows the SEM images of the 1.244 μm thick MgO green sheet after the firing process at 520^oC. During the firing process, an organic binder was burned out, and only MgO nano-powder remained forming a protective layer. The thicknesses of the MgO protective layer before and after the firing process are summarized in Table 1. The thickness

uniformity was very poor. This might be resulted from the non-uniformity of the MgO powder dispersion in MgO solution.

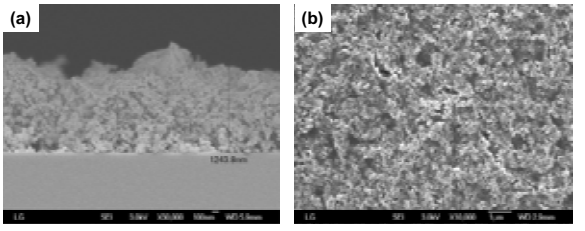

Figure 2. FE-SEM images of 28 μm thick MgO green sheet after firing process; (a) cross-sectional view, (b) planar view.

Table 1. The thicknesses of MgO green sheets before and after the firing process at 520 °C.

Before (μm)	20	28	40
After (μm)	0.925	1.244	1.434

The electrical property of MgO nano-powder was examined by cathodoluminescence (CL) measurement. Figure 3 shows the CL spectra of MgO films fabricated by e-beam evaporation and MgO nano-powder. The CL spectra were measured with Jeol JSM-820 scanning microscope with Gatan's Mono CL system. The MgO film and MgO nano-powder were coated with Pt film of 3.5 nm thickness to avoid an electron charging. The CL measurement was conducted with 20 kV acceleration voltage and 10,000 magnifications at room temperature.

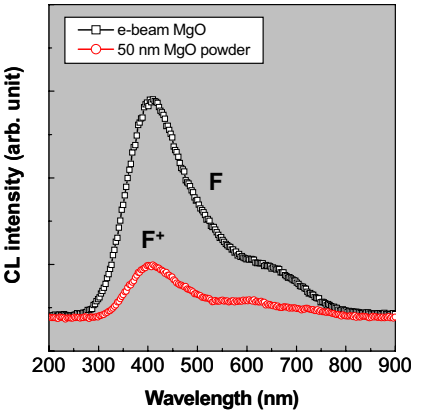

Figure 3. CL spectra of the e-beam evaporated MgO film and the MgO nano-powder.

The CL peak appeared at 400 nm, and this wavelength was conformed to F^+ center. The CL peak of F center was expected to appear at 520 nm, but was not seen clearly. The CL intensity of the MgO nano-powder was smaller than that of the e-beam MgO. This result indicates that the MgO nano-powder has the small amount of F and F^+ centers.

The secondary electron emission coefficient (γ_i) of the MgO film and MgO nano-powder were measured by a focused ion beam (FIB) method at the PDP research center at Kwangwoon University. Neon ion was used to extract the secondary electron from the MgO surface.

Figure 4 shows the γ_i of the e-beam MgO and MgO nano-powder as a function of acceleration voltage. The γ_i of MgO nano-powder was smaller than that of the e-beam MgO. Recently, we have reported about the relations between the CL characteristics and the γ_i of MgO film [5]. The increase of γ_i after the aging process was explained by the creation of the F and F^+ centers. We think that the surface band bending induced by F and F^+ centers resulted in the increase of γ_i. In this experiment, the result, that the MgO nano-powder showed low CL intensity and γ_i, well coincided in our previous report.

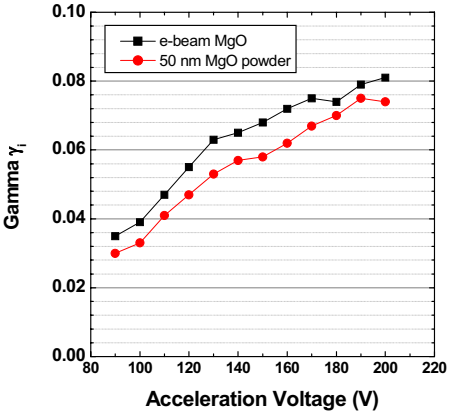

Figure 4. The secondary electron emission coefficients (γ_i) of the e-beam evaporated MgO film and MgO nano-powder.

The discharge voltages of the e-beam MgO and the MgO green sheet applied panels are shown in Table 2. The discharge voltages of the MgO green sheet applied panels were higher than those of the e-beam MgO panel. This may be contributed from the low CL intensity and γ_i of MgO nano-powder.

Table 2. The discharge voltages of the e-beam MgO and the MgO green sheet applied panels.

Sample / Voltage	e-beam MgO	MgO green sheet (μm)		
		20	28	40
full on voltage	242	272	263	264
1st on voltage	239	258	255	255
1st off voltage	158	168	169	167
full off voltage	155	164	165	164

The full on voltage of the panel with 20 μm thick MgO green sheet was relatively high, compared to the panels with 28 and 40 μm thick MgO green sheets. This indicates that the thickness of MgO green sheet is important to obtain a low discharge voltage.

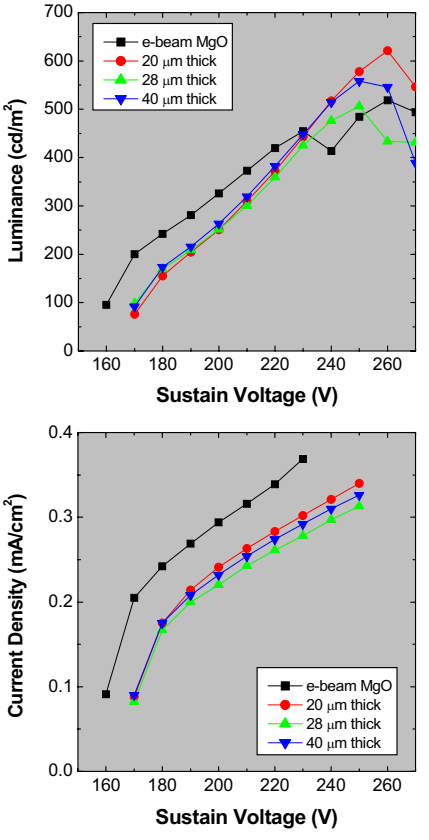

Figure 5. The luminance and the current density characteristics of the e-beam MgO and the MgO green sheet applied panels as a function of sustain voltage.

Figure 5 shows the luminance and the current density characteristics of the e-beam MgO and the MgO green sheet applied panels as a function of sustain voltage. The MgO green sheet applied panels showed lower luminance than the e-beam MgO panel up to the sustain voltage of 220 V. The current density of the MgO green sheet applied panels was also lower than that of the e-beam MgO panel. The low luminance of the MgO green sheet applied panels was due to the low discharge density which was expressed as a current density. Beyond 220 V, MgO green sheet applied panels showed high luminance even though the current density was low.

Figure 6 shows the efficiency of the e-beam MgO and the MgO green sheet applied panels as a function of sustain voltage. Before 200 V, the efficiency was almost same, except the panel with 20 μm thick MgO green sheet. After 200 V, however, the MgO green sheet applied panels showed higher efficiency than the e-beam MgO panel. This was because the increment of the current density was lower than that of the luminance for the MgO green sheet applied panels. The thickness of MgO green sheet is important to obtain a high luminance as in the case of the discharge voltage. The luminance, the current density, and the efficiency are summarized in Table 3 at the sustain voltage of 200 V .

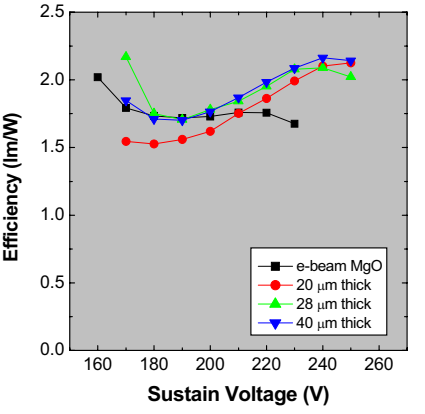

Figure 6. The efficiency of the e-beam MgO and the MgO green sheet applied panels as a function of sustain voltage.

Table 3. The luminance, the current density, and the efficiency of the e-beam MgO and the MgO green sheet applied panels at the sustain voltage of 200 V.

	e-beam MgO	MgO green sheet (μm)		
		20	28	40
Luminance (cd/m^2)	326	251	252	263
Current Density (mA/cm^2)	0.294	0.241	0.220	0.232
Efficiency (lm/W)	1.73	1.62	1.78	1.77

4. Conclusion

We have developed the MgO green sheet by coating MgO solution composed of solvent, dispersant, binder, and MgO nano-powder. The MgO solution was coated by the die casting method. The thickness of MgO green sheets were 20, 28, and 40 μm, respectively. The MgO nano-powder showed the low γ_i and the small amount of F and F^+ centers. The MgO green sheet applied panels showed lower luminance and current density than the e-beam MgO panel. The efficiency was almost same at around 200 V. This indicates that MgO green sheet could be a good candidate as a protective layer of AC-PDP using non-vacuum fabrication method.

5. References

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