Fabrication of transparent dielectric mono layer green sheet for plasma display panel

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Abstract

To fabricate mono layer green sheet (MLGS) of transparent dielectric for PDP front panel, dispersion of transparent dielectric slurry and various properties of green sheets were examined as a function of amount and kinds of organic additives. Sedimentation height and viscosity of slurry were measured to determine proper types and amount of dispersant in non-aqueous system transparent dielectric slurry. Many MLGS having various ratios of the transparent dielectric glass frit, binder and plasticizer were fabricated. Finally we got the transparent dielectric layer of high transparency and free from residual pore might be remained in the gap between the electrodes.

1. Objectives and Background

In recent years, flat panel display (FPD) is attracting public attention as man-machine interface as information society develops. The Plasma Display Panel devices has the characteristic that it is simple structure and easy to make large screen. A lot of makers are producing over 42~102 inch plasma display panel as for as wall tapestry television and HDTV. The transparent dielectric layers for PDP front panel have function of capacitor for current limit control and function of charge memory. Originally, screen printing method used to formation of transparent dielectric layer in PDP process. The screen printing methods have defects of dielectric properties for easy to come into existence pores and bad surface roughness. The defects result from repeated printing process.[1] Several additive methods have been suggested to the take place screen printing method. One of the Solutions for this problem is dry film method in using ceramic green sheet on tape casting process.[2,3] Tape casting produces a thin layer of green sheet by coating a carrier surface with a ceramic suspension using the doctor blade technique. But existing green sheet is applied after the gap which exist between the electrodes is filled with the dielectric paste by printing method to preventing the residual pore in the gap. So we studied fabrication for mono layer green sheet of transparent dielectric for PDP front panel to eliminate the printing process filling the paste between the electrodes. For this, dispersion of transparent dielectric slurry and various properties of green sheet were investigated as a function of amount and types of organic additives. As a result, we found that the amount and composition of organic additives were main variables to affect of transparent dielectric green sheet for PDP.

2. Experimental

2.1 Preparation of MLGS Slurry

MLGS was fabricated using commercialized Pb free Bi_2O_3-B_2O_3-ZnO based transparent dielectric powder in non-aqueous slurry system. The solvent used was an azeotropic mixture of 66% toluene and 34 % ethanol. And acrylic binder was chosen considering binder burnout in PDP process. The standard composition of the transparent dielectric slurry is shown in table 1.

Table 1: Standard compositions of normal type transparent dielectric green sheet slurry (wt%)

Powder	Solvent	Binder	Dispersant	Plasticizer
60~62	22~23	6.2~7.7	0.8~0.9	0.5~8.6

The plasticizer is the key component in making MLGS. It gives the adhesive property and softness to the green sheet so that it can stick to glass substrate and cover the gap between the electrodes. If the amount of plasticizer is insufficient, adhesive property can not be anticipated. But if the amount of plasticizer is excessive, the workability of laminating dropped drastically as the plasticity increased even though the flexibility and adhesive property also raised.[4,5] After the solvent, binder and powder were mixed, the slurry was subjected to ball milling for 4hr which process was effective in reducing the agglomerate size. After the first ball milling process, the plasticizer and binder were added and the slurry was subjected again to the same process for 24hr. [6]

2.2 Fabrication and characterization of MLGS

Green sheet was fabricated by comma blade which has the strong point in making thin green sheet. Thickness of green sheet showed 70~80μm with the variance ±4μm. Green sheet was kept after laminated with lubricant coated cover film at 80℃ for preventing the deterioration of adhesion and contamination. Figure 1 shows the green sheet fabrication process and laminating process.

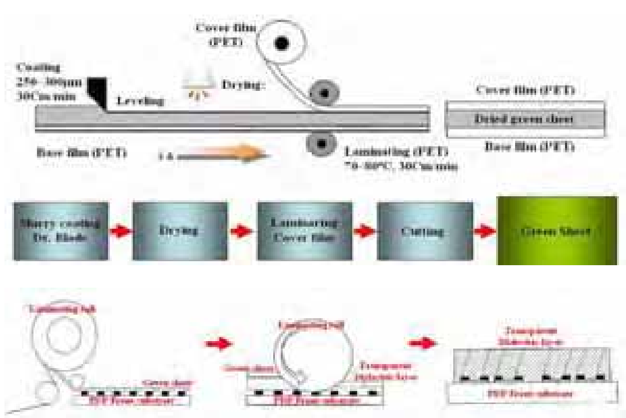


Fig. 1 Green sheet forming process & laminating process

The viscosity of slurry was measured by Brookfield rotor type viscometer (HBDV-II+, USA). Thermal behavior of green sheet was measured by TG-DSC (STA409C/3/F, Netzsch, Germany). Mechanical characteristics of green sheet was measured by UTM (Instron 4465, UK). Manufactured green sheet was coated on the PD-200 and electrode formed PD-200 and fired at 560℃, 570℃, 580℃ respectively. The transmittance of dielectric layer was measured by UV/VIS/NIR Spectro-photometer(V-570, JASCO, Japan).

3. Results and discussion

3.1 Properties of MLGS

To optimize the dispersion of transparent dielectric slurry, we compared the sedimentation height of Bi_2O_3-B_2O_3-ZnO based slurry system with the variation of dispersants and their amount. Figure 2 shows the result of sedimentation test method. Dispersant H was chosen from the result.

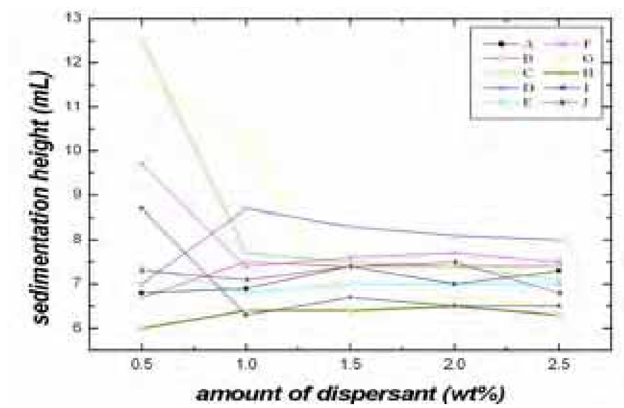


Fig. 2 Dispersion characteristic of various kind of dispersant in Bi_2O_3 based slurry

Figure 3 showed the viscosities of normal green sheet slurry measured after second ball milling. These showed the viscosity range from 200 to 800 cp and also showed pseudo-plastic behavior.

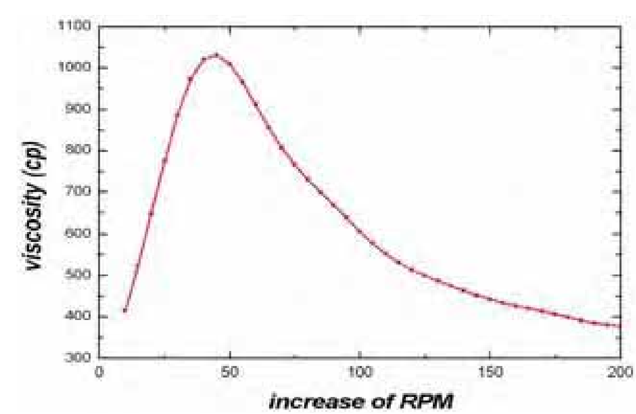


Fig. 3 Viscosity of normal green sheet slurry (temp : 25℃ , SSA-21)

Table 2 showed the variation of the contents of plasticizer and characteristics of green sheet. The contents of plasticizer was controlled to give a optimum properties for MLGS.

Table 2. Variation of the contents of plasticizer and characteristics of green sheet

No	Plasticizer (wt%)	Thickness (μm)	Thickness Variance (μm±)	Shrinkage (%)	Stickiness
1	0.90	78	± 4	49.8	X
2	1.79	76	± 4	50.2.	X
3	2.67	75	± 3	50.4	O
4	3.52	80	± 4	50.7	O
5	4.37	78	± 4	51.2	O

The stickiness of green sheets was varied with the contents of plasticizer. If the content of plasticizer was insufficient, below 2wt%, the green sheet didn't stick to PD-200 when laminating it with roll laminator at 80℃. But the stickiness was improved with the content of plasticizer raised from 2.67% to 4.37%.

Figure 4 showed the TG-DSC graph of composition 5. Exothermic peak was found at 368°C, and final weight loss was about 14.83 wt%. Binder burn out was completed relatively low temperature for using acrylic binder. So it can be expected to reduce the residual carbon in fired dielectric layer.

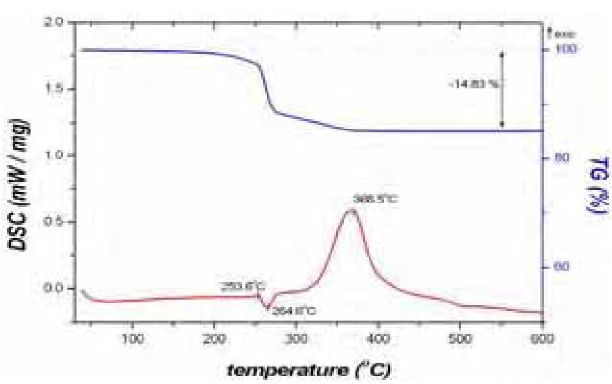
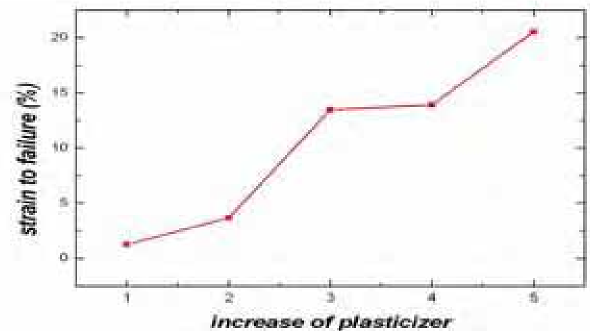
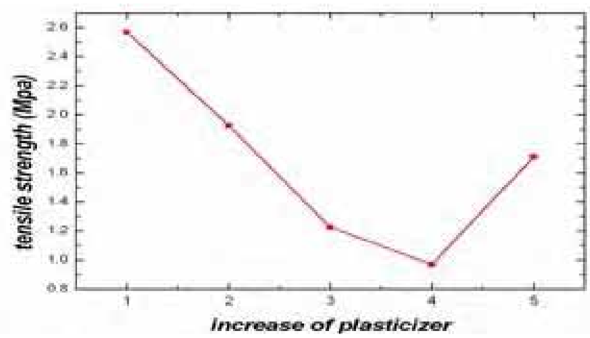


Fig. 4 TG-DSC graph of the MLGS green sheet

Figure 5 showed strain to failure and tensile strength of green sheet made of standard composition in Table 2. Strain to failure was increased from 0.55% to 1.25% with the content of plasticizer. Tensile strength showed minimum value at composition 4 in table 2. From these results, composition 5 in table 2 was chosen for MLGS slurry system.



(a)

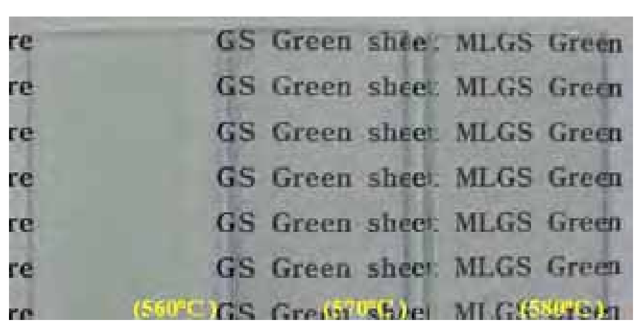


(b)

Fig. 5 Mechanical properties of MLGS green sheet as a function of the Plasticizer contents (a) Strain to failure (b) Tensile strength

3.2 Properties of transparent dielectric layer

Figure 6 showed transparency of dielectric layer coated PD-200 and electrode patterned PD-200 and Figure 7 also showed the transmittance of dielectric layers with the variation of firing temperature. The dielectric layer showed opaque characteristic fired at 560℃ but the transmittance was increased with the temperature raised from 570℃ to 580℃. The maximum transmittance was 76% fired at 580℃.



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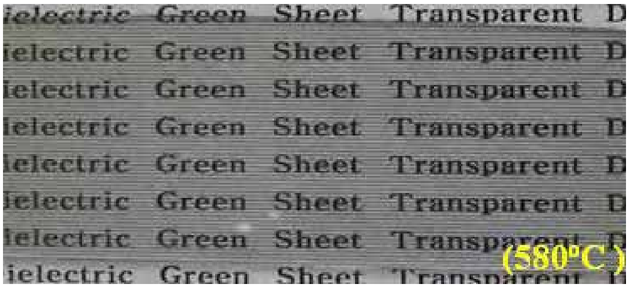


(b)

Fig. 6 The transparency of dielectric layers
(a) PD-200 (b) Electrode patterned PD-200

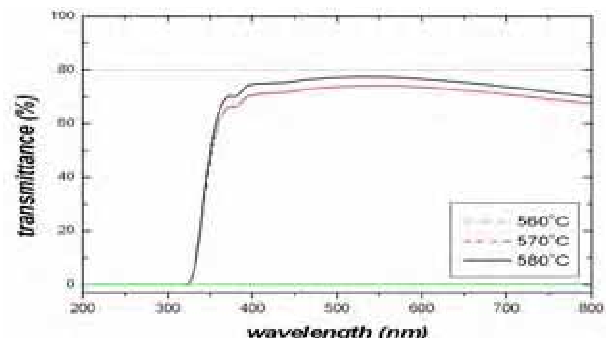
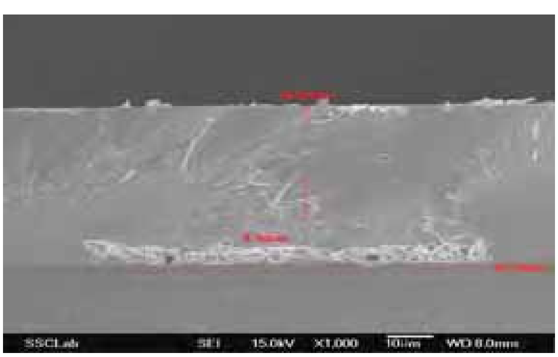


Fig. 7 Optical transmittance in visible range as a function of firing temperature

Figure 8 shows the cross section of fired dielectric layer which was laminated on the electrode patterned glass substrate and sintered at 580℃ at which optimum sintering temperature of transparent dielectric glass frit. MLGS dielectric layer showed the shrinkage of about 50% and good quality had no pore around the electrode on the glass substrate.



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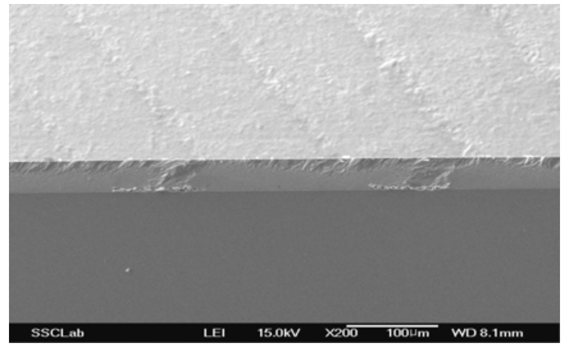

(b)

Fig. 8 SEM image of fired dielectric layer
(a) Cross section of dielectric layer on the electrode (b) Low magnification image of dielectric layer on the electrode

4. Conclusion

We studied fabrication of mono layer green sheet of transparent dielectric for PDP front panel which reduced the number of process in forming transparent dielectric layer with the green sheet. We examined the dispersion of transparent dielectric slurry and various properties of green sheets as a function of amount and kinds of organic additives. Through this, we found that the types and amount of dispersant and plasticizer were main factor to realize MLGS for transparent dielectric layer in PDP. Finally we got the transparent dielectric layer of high transparency and free from residual pore might be remained in the gap between the electrodes.

5. References

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