Interaction Between Transparent Dielectric and Bus Electrode for Heating Profile in PDP

Sangwook Lee*, Dongsun Kim, Mikyung Park,

Seongjin Hwang and Hyungsun Kim

School of Materials Engineering, Inha University, Incheon, Korea, 402-751
TEL:82-32-860-7545, e-mail: kimhs@inha.ac.kr

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Abstract

In PDP, bus electrode should have low resistance for high efficiency. The transparent dielectric affects the shape change of bus electrode during the firing. These are related with the electrical property of the electrode. In this study, the shape of electrode was controlled by firing schedules of the transparent dielectric and the bus electrode.

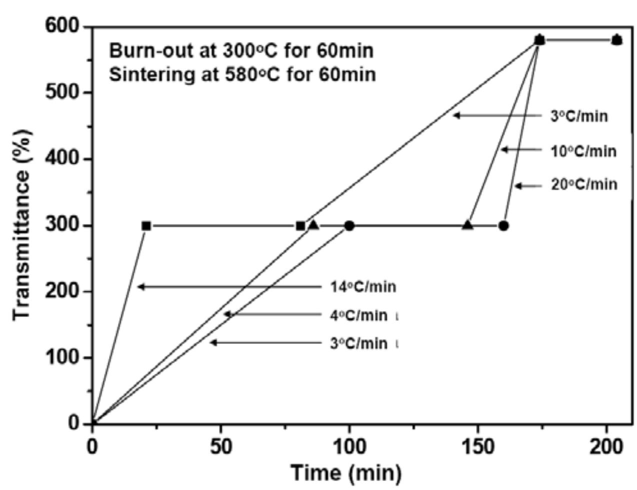
1. Introduction

Flat panel display (FPD) is rapidly growing, however, the FPD industry has many problems that need to be resolved from the viewpoint of the environment and related devices. Now, glass frit is actively investigated to substitute a lead glass for a lead-free glass. However, there are many problems to use alternative materials. Especially, in PDP, there are problems related with the transparent dielectric and the bus electrode such as yellowing phenomenon, edge-curl and bubbles around the electrode. Yellowing phenomenon occurred by a reaction between Ag colloids within the electrode and the transparent dielectric composition [1, 2]. Recently, addition of the transition metals such as Cu, Ce and Co in transparent dielectric has been presented as one of the solutions [3]. So far, researches have emphasized the adverse effects of bus electrode toward transparent dielectric such as yellowing phenomenon.

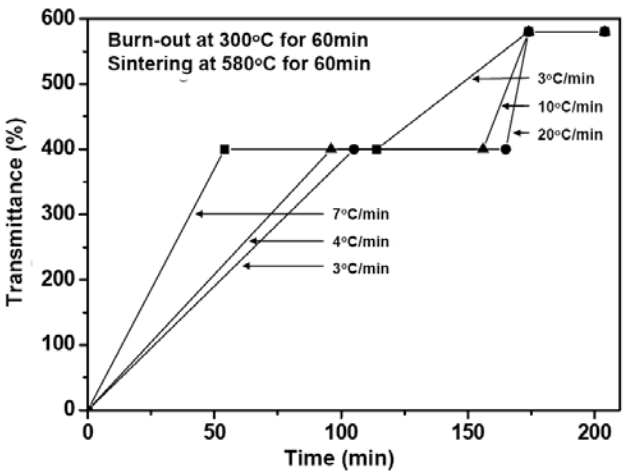
In this study, we investigated the shape change of bus electrode for the firing of transparent dielectric with firing schedule of bus electrode and transparent dielectric. Bus electrode changes its shape due to shrinkage or expansion of glass frits and sliver powders within itself. We suppose that the transparent dielectric affects the shape change of electrode because it covers the electrode and its thickness unfired is above ten times as large as the bus electrode. Besides, its shrinkage is about 30~50% during the firing. Therefore, it is our aim to investigate different thermal behaviors of the bus electrode and the transparent dielectric with the firing schedules. The shape change of electrode affects the cohesion between the substrate and the electrode. This can cause the increase of the electrode resistance.

2 Experimental

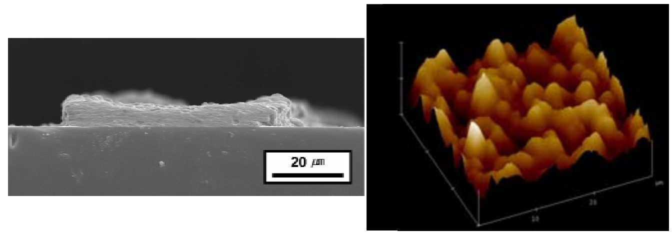
In this study, commercial sheets for the transparent dielectric were used to get reliability of results. The bus electrode and the transparent dielectric were sintered under 3, 10 and 20^{o}C/min of heating rate after binder burn-out. After firing, we observed the difference of the shape of electrode using a scanning electron microscope (S-4300SE, Hitachi, Japan). The surface morphology of sintered electrode was measured using atomic force microscope (Multimode IV, Veeco Instruments, USA). Transmittance of samples was measured using UV-visible spectrometer (UV-2450, Shimadzu, Japan).



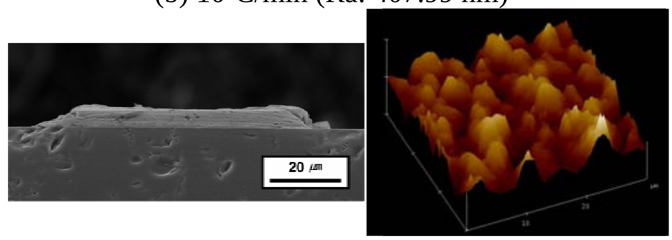
(a) Bus electrode



(b) Transparent dielectric
Fig. 1 Firing schedule of bus electrode and transparent dielectric



(b) 10°C/min (Ra: 407.99 nm)

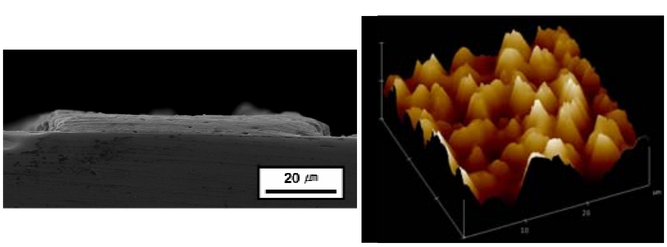


(c) 20°C/min (Ra: 402.30 nm)
Fig. 2 Shape and surface roughness of electrode with heating rate during the sintering

3. Results and discussion

The bus electrode was sintered by several heating rates: heating rates are 3, 10 and 20°C/min after binder burn-out. The heating rate controls the sintering time of glass frits within the electrode. Thus, the shape of the electrode was different with heating rates. This is due to the thermal behavior(s) of glass frits and silver powders within the electrode. Especially, glass frit could flow to bottom of the electrode because the glass transition point (Tg) of frit for the electrode is low temperature comparing to the sintering temperature (580°C).

In case of the electrode sintered 3°C/min after binder burn-out, its surface was the roughest among three samples having different heating rate as shown in Fig. 2. In each sample, the value of surface roughness (Ra) was 473.58, 407.99 and 402.30 nm and firing time was 93, 28 and 14min, respectively. The sample with the heating rate of 3°C/min has longer firing time than others after burn-out. This result means that the firing time after binder burn-out has influence on the thermal behaviors of frits within the electrodes.



(a) 3°C/min (Ra: 473.58 nm)

The dielectric was coated on the electrodes sintered by different heating rate (3, 10 and 20°C/min). The electrode coated with the dielectric was also fired at three heating rate (3, 10 and 20°C/min). Fig 3 shows the height of edge-curl with heating rates of the dielectric. The height of edge-curl was different with the heating rate of the electrode and the dielectric. In case of the electrode fired by the heating rate of 3°C/min, the height of edge-curl with firing of dielectrics was lower than that of others as shown in Fig 2 (a). That is why frits within electrodes flew into the bottom of the electrode and were strongly adhered to the glass substrate. Thus, the edge-curl of the electrode was not increased by shrinkage of dielectric during sintering.

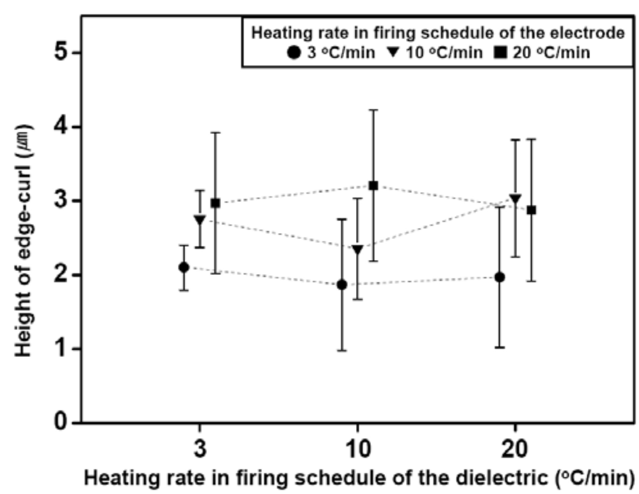


Fig. 3 Height of edge-curl with heating rate in firing schedule of the dielectric

The result shows that the slower firing rate of electrodes is, the lower the height of edge-curl is after firing. Therefore, the occurrence and increase of edge-curl can be controlled by firing temperature or heating rate during firing the electrodes.

The transmittance was measured with the heating rate of the electrodes and the transparent dielectric. The transmittance with firing schedule of electrode was almost the same. However, in case of firing after coating with the dielectric, the yellowing phenomenon could occur in the electrodes fired by the heating rate of 3^{o}C/min. The hump around the 420nm is fingerprint of yellowing phenomenon as shown in Fig. 4.

In general, the glass frits within the electrode are used to improve cohesion of Ag powders and cohesion between the electrode and the glass substrate. Ag particles placed in upside of the electrode had weak cohesion because frits flow into the bottom of the electrode. Ag particle placed in upside of the electrode can easily diffuse into the transparent dielectric due to the weak cohesion of Ag particles. However, in case of electrodes sintered by the heating rate of 10 and 20^{o}C/min, the yellowing phenomenon did not occur.

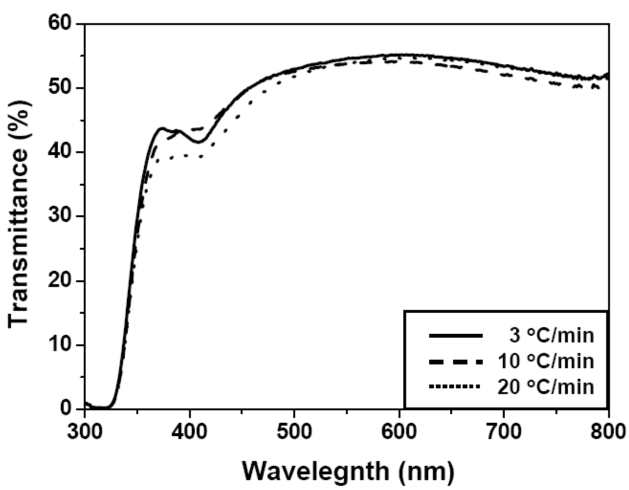


Fig. 4 Transmittance of dielectric for different heating rates

4. Summary

The shape of the bus electrode was different with the heating rate. Especially, the surface roughness of the electrode was rougher with decreasing heating rate. This is due to the thermal behaviors of glass frit within the electrode. In case of the electrode sintered by slow heating rate, the height of edge-curl was low but yellowing phenomenon easily occurred after sintering the dielectric. Thus, the heating rate should be properly controlled to prevent problems occurred in the electrode such as the edge-curl and the yellowing phenomenon.

5. Acknowledgement

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6. References

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