Photosensitive Black Matrix Paste for Bus Electrode of PDP

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Abstract

The bus electrode is composed of two layers. One is the black matrix(BM) and silver layer is formed on top of black layer. The BM paste is made by mixing Co_3O_4 black powder with photosensitive vehicle and rheological additives.
In this work we studied the effect of Co_3O_4 black powder and glass frit on the rheological property of photosensitive BM paste. We also examined how the size and content of black powder and glass frit affect the transmittance and reflectance of the BM layer after sintering.

1. Introduction

Plasma Display Panel (PDP) electrodes include address and bus electrode patterned on rear and front panel of PDP, respectively. The bus electrode is composed of two layers. One is the black matrix (BM) and silver layer is formed on top of black layer. These electrodes are patterned by the photolithographic method utilizing photosensitive silver (Ag) paste [1~3]. The BM paste is made by mixing Co_3O_4 black powder with photosensitive vehicle and rheological additives. The photosensitive Ag paste is composed of organic vehicle including binder polymer, UV oligomer/ monomer, photoinitiator and additives and inorganic powders of silver and glass frit. The BM paste is first screen printed and dried and then Ag paste is printed on top of it. The dried BM and Ag layer is exposured to UV light through the photomask and then developed with aqueous alkaline solution [4]. After dring the BM-Ag double layer pattern is sintered up to 580 ℃ for 30 min to give final bus electrode patter of PDP. In this work we studied the effect of Co_3O_4 black powder and glass frit on the rheological property of photosensitive BM paste. We also examined how the size and content of black powder and glass frit affect the transmittance and reflectance of the BM layer after sintering.

2. Experimental

In this study, poly(isobutyl methacrylate-co-methacrylic acid-co-2-hydroxyl ethyl meth-acrylate)s were synthesized as binder polymers which could be burnt out at relatively low temperature without residue. UV curable monomers and oligomers used include penta-erythritol triacrylate (PETA), trimethylol propane-triacrylate (TMPTA) and trimethylolpropane ethoxy-triacrylate (TMPEOTA). Photoinitiator (HSP-188) was purchased from SK-ucb Co. Ltd and used as received.

TABLE 1. Typical formulation of photosensitive BM and Ag pastes for Bus Electrode of PDP..

Component (BM Paste)	Photosensitive Vehicle				Inorganic powder	
	Binder	Solvent	Monomer	Additives[a]	Black powder	Glass frit
Composition (wt%)	12.7	38.5	12.1	6.1	9.7	21
Component (Ag Paste)	Photosensitive Vehicle				Inorganic powder	
	Binder	Solvent	Monomer	Additives[a]	Ag powder	Glass frit
Composition (wt%)	7.6	14.1	7.2	1.1	66.5	3.5

a : additives such as photoinitiator and dispersing agent

TABLE 2. Combination of Different Sources of Black Powder and Glass Frit for the photosensitive BM paste.

Sample	KB-1	KB-2	KB-3	KB-4
Black Powder d_{50} (nm)	120	100	120	120
Glass Frit d_{50} (nm)	2.5	1.0	1.2	1.2
Tg (℃)	437	457	359	381
Ts (℃)	465	491	437	407

Black powder had average size of about 100 nm (d_{50}) and glass frit about 1 ㎛ (d_{50}). These two powder was mixed in the mill for about 2 hour. Photosensitive Ag

(d_{50}=1.5 ㎛) paste was made by similar process. Typical formulations for BM and Ag paste are shown in Table 1.
The BM Paste were made with different size Co_3O_4 black powder and glass frit combination as shown in Table 2.

3. Results and discussion

3-1. Rheology of BM Paste

For the screen printing of BM paste on the glass substrate, the rheological property of the BM paste is important. Figure 1. shows the rheological curve of the BM paste (KB-1 ~ 4 and Reference sample) obtained by Phisica UDS-200 Rheometer (Paar phisica) at 24.7 ℃. The BM pastes exhibited nearly Newtonian flow in the 1 ~ 1000 S^{-1} shear rate range Except KB-1 sample.

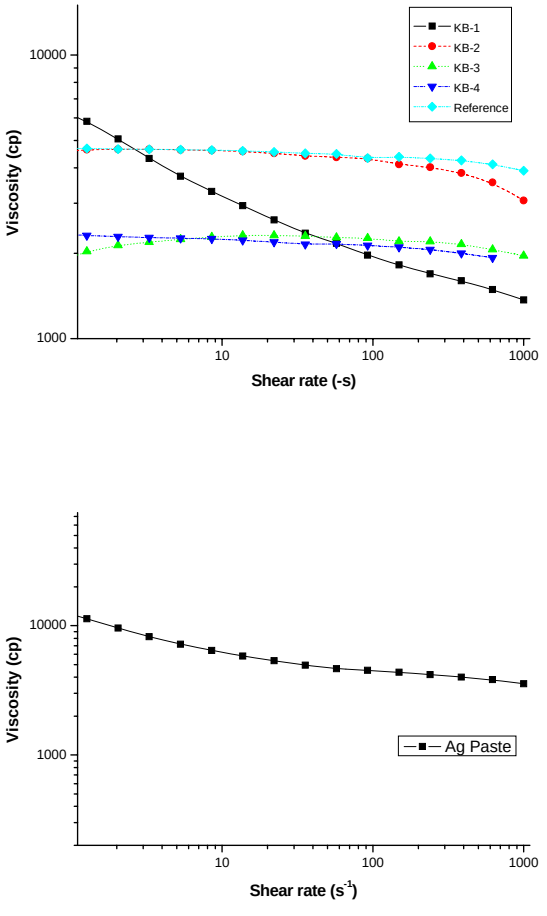

Fig 1. Rheological Curves of Photosensitive Black Matrix Pastes and Ag Paste.

The Shear thinning effect of KB-1 paste may be due association of large sized glass frit particles. The zero (1 S^{-1}) Shear viscosity of the KB-1 ~ 4 pastes were 5000, 4500, 2000, 2200 cp, respectively. It is noted that KB-2 exhibited very similar rheology to the reference BM paste. The zero (1 S^{-1}) Shear viscosity of Ag pastes were
9,000 cp, respectively.

3-2. Black Matrix Properties

The photolithographic pattering of photosensitive BM paste was printed on the glass substrate and dried. Photo mask with address electrode pattern of PDP was placed on top on the dried BM layer and then irradiated with UV lamp to a total dose of 300 ~ 500 mJ/cm^2. After UV exposure the BM layer was developed with aqueous alkaline solution at 1.0 kg/cm^2 pressure for 10 ~ 20 sec and then dried in the 110 ℃ oven for 10 min. After dry the patterned BM electrode was examined with optical microscope (Olympus STM6) to check pattern morphology. The patterned BM was finally sintered in the electric oven up to 580 ℃ for 30 min [6]. The BM pattern obtained with KB-2 is shown in Figure 2. All the BM pastes exhibited good photolithographic process properties. The transmittance and reflectance curves of the patterned BM layer often.
Sintering are shown in Figure 3. It was noted that KB-2 with smaller size Co_3O_4 black powder exhibited lower transmittance and reflectance due to increased coverage of the black pigment on the surface composed to the reference BM paste. This is shown in Figure 4 in which the SEM images of the KB-2 and reference were compared.

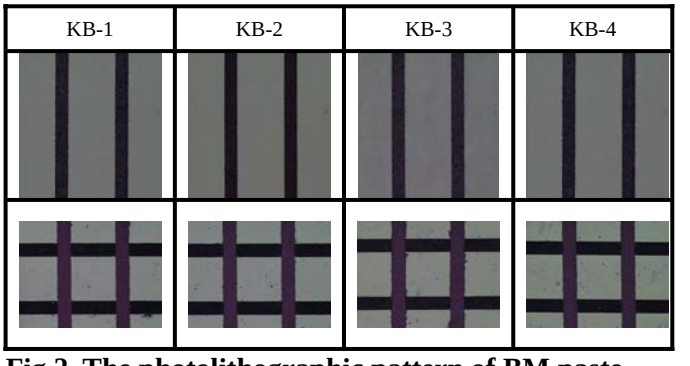

Fig 2. The photolithographic pattern of BM paste and Combination layer.

Figure 5. show the effect of sintering temperature on the transmittance of BM layer obtained with KB-2

sample. It is noted that 580 ℃ / 30min was the optimum sintering condition for the KB-2 photosensitive BM paste.

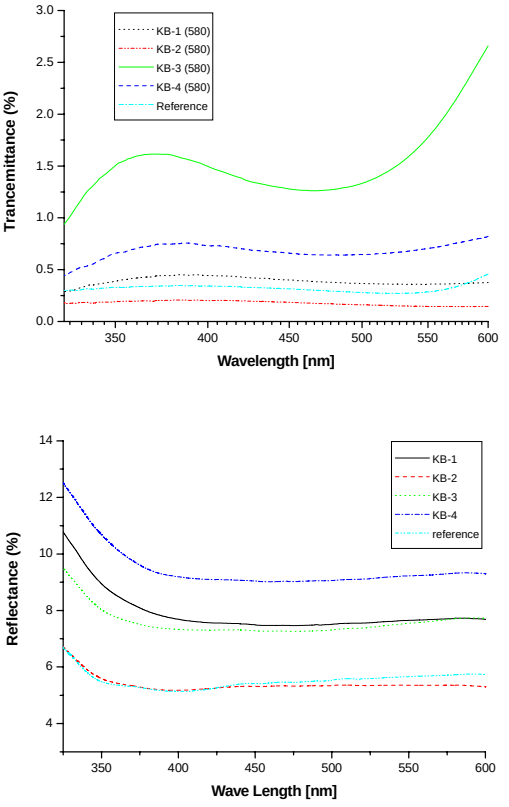

Fig 3. Transmittance and Reflectance of BM layers.

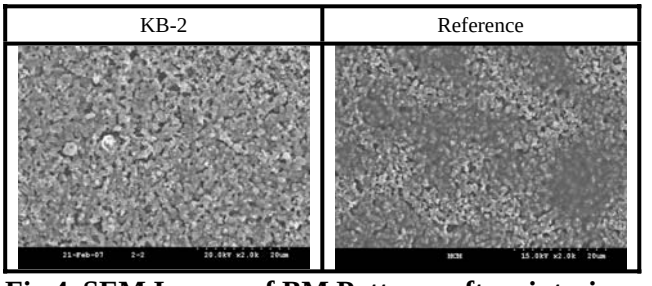

Fig 4. SEM Images of BM Patterns after sintering

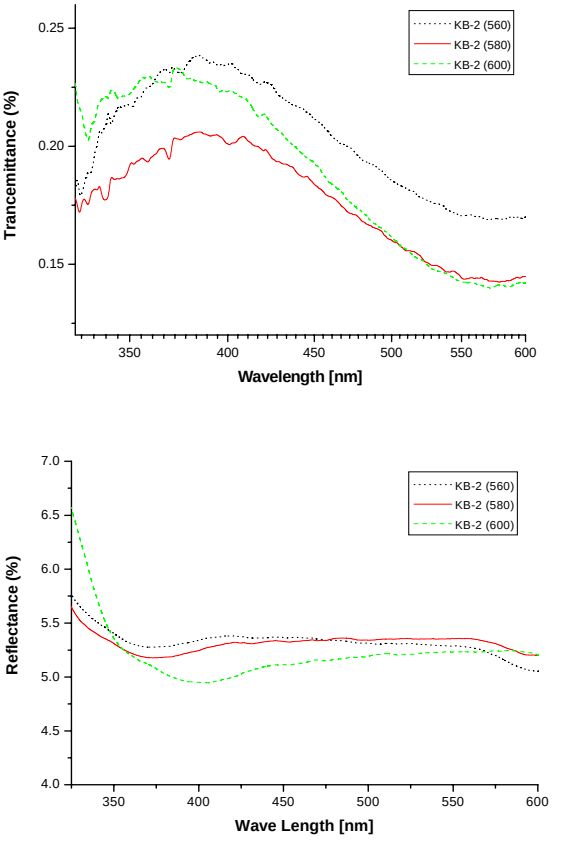

Fig 5. Effect of Sintering Temperature on the Transmittance and Reflectance of BM Layer after Sintering.

4. Summary

The black matrix layer is formed for both the bus electrode and BM pattern dried at same time on the front panel of PDP. Since the BM layer is formed as thin as possible (less than 1 ㎛ thickness) for the bus electrode area, it is very important to have transmittance and reflectance of BM area with this thin layer of BM pattern. It was found that the optical (transmittance / reflectance) pattern was strongly dependant on the size of the black pigment / glass frit combination and Tg / Ts of the glass frit.

5. References

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