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PHOSPHOR PASTE PROPERTIES IN INK-JET PATTERNING OF PHOSPHORS FOR HIGH RESOLUTION PDP

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A novel ink-jet printing method with the precision nozzle ($\phi = 0.2$ mm and $L = 1.0$ mm) for fine pattening of phosphor layer in PDP was investigated. In order to optimize the rheological properties of the phosphor paste for the precision nozzle, the composition of the paste was developed by proper combinations of binder polymer, solvnet, dispersant, phosphor powder and additives. It was found that combination of hydroxypropylcellulose and poly(methylmethacrylate-co-methacrylic acid) as binder polymer and 50 wt% of phosphor powder in the paste resulted in suitable processability to the ink-jet printing with the precision nozzle and produced phosphor layers with 29 μm of thickness after sintering process.

Keywords: ink-jet printing; phosphor paste; plasma display panel; precision nozzle

1. INTRODUCTION

The phosphor pattern on the plasma display panel (PDP) has been fabricated by several methods including screen printing, electrodeposition and photolithographic methods. Although screen printing and photolithographic methods are currently used widely for patterning of phosphor layer in PDP, those methods are disadvantageous in that they are relatively intricate processes and suffer extra loss of phosphor material. In addition as both high resolution (XGA grade) and large screen size (over 60 inches)

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of PDP are recently preferred, ink-jet printing with the precision nozzle is considered to be the method of choice for phosphor patterning in manufacturing of high resolution PDP.

In this work we present ink-jet method of patterning phosphor layers in PDP. Formulation of phosphor paste consisting of binder polymer, solvent, dispersant, phosphor powder and characteristics of phosphor paste on the ink-jet process were discussed.

2. EXPERIMENTAL

2.1. Materials

Hydroxypropyl cellulose (HPC, Aldrich Chemical Co., MW 80,000) which is soluble in water was used as a polymeric binder for phosphor paste. 3-Methoxy-3-methyl butanol (3MMB) was used as solvent ($T_b = 175^{\circ}C$) to dissolve HPC binder polymer. Poly(methylmethacrylate-*co*-methacrylic acid), Poly(MMA-*co*-MAA), which can be developable in aqueous alkaline solution, was synthesized by free radical polymerization as another binder polymer. Phosphor powder (LG Co.) had mean diameter of $2 \sim 3\,\mu m$. BYK-180 and BYK-354 (BYK-Chemie. Co.) were used as a dispersant and a leveling agent, respectively.

2.2. Formulation of Phosphor Paste

Formualtion process of phosphor paste is shown in Figure 1. Binder polymers (poly(MMA-co-MAA) and HPC) was first dissolved in organic

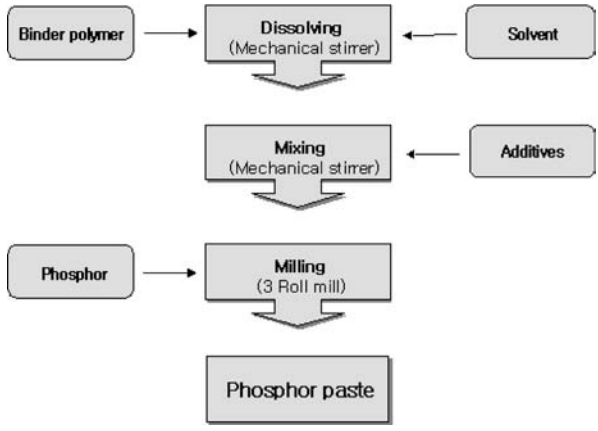

FIGURE 1 Formulation process of phosphor paste.

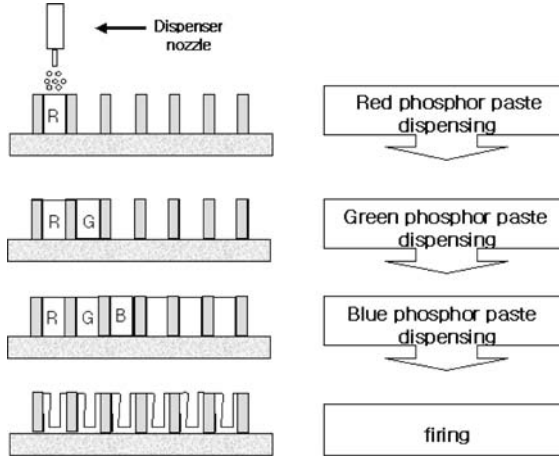

FIGURE 2 Ink-jet printing process with precision nozzle.

solvent. To this solution was added the additives such as dispersant, leveling agent, and wetting agent. Phosphor powder was added to this mixture solution and then the whole mixture was mixed well with mechanical stirrer and finally in the three roll mill.

2.3. Ink-jet Printing Process with Precision Nozzle

The phosphor paste was printed on the area between barrier ribs by the ink-jet printing process with precision nozzle and then dried in the infrared (IR) oven at 110°C for 10–15 min. The phosphor layer patterned rear panel of PDP was sintered in the electric furnace up to 560°C for 30 min. The resulting phosphor layer was examined with SEM. This process is shown graphically in Figure 2.

3. RESULTS AND DISCUSSION

Three different formulations of phosphor paste were prepared, as shown in Table 1.

The viscosity of phosphor paste was increased with the content of phosphor powder in the paste, resulting in the decreased amount of extruded paste through the precision nozzle. As observed by SEM photographs in Figure 3 the thickness of phosphor layer after sintering was measured to be around 11 μm at 70 wt% of phosphor powder in the paste. However,

TABLE 1 Formulation of Phosphor Paste

	PIJ-1(red 30 wt%)	PIJ-2(red 50 wt%)	PIJ-1(red 70 wt%)
BP	4.0 g	3.0 g	2.0 g
BCA	6.0 g	4.5 g	3.0 g
HPC	1.0 g	0.75 g	0.5 g
3MMB	4.0 g	3.0 g	2.0 g
Dispersant	0.193 g	0.338 g	0.525 g
Leveling agent	0.193 g	0.338 g	0.525 g
Phosphor powder	6.429 g	23.175 g	17.5 g

BP: Binder polymer(poly(MMA-co-MAA)), BCA: Butyl Carbitol Acetate,
HPC: Hydroxy propyl cellulose, 3MMB: 3-methoxy-3-methyl butanol.

the paste with 50 wt% of phosphor powder gave phosphor layer thickness of 29 μm after sintering. It is generally accepted that excellent luminescence could be obtained at 25–30 μm of thickness of phosphor layer on barrier ribs.

Luminescence characteristics of the phosphor in PDP is known to be adversely affected due to thermal decomposition of phosphor itself, when the sintering process is carried out at high temperature for extented period of time. It is required, therefore, that the binder polymer in phosphor paste should be completely decompsed to allow the formation of only inorganic phosphore layer at low temperature(510°C). Thermal decomposition behavior of binder polymers was inverstigated by using TGA. Samples were

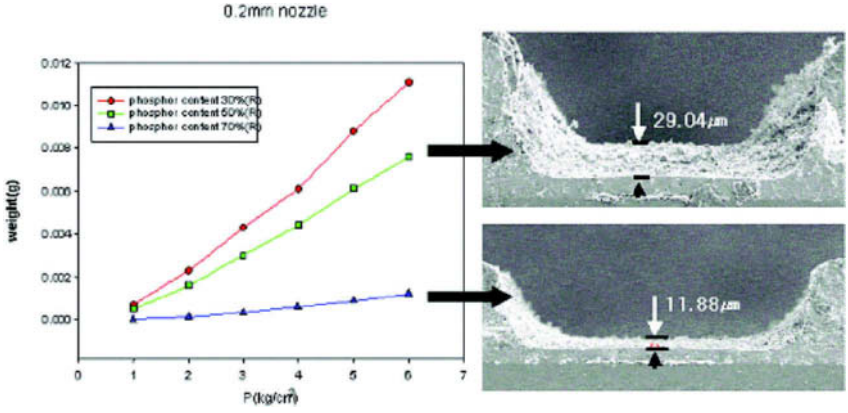

FIGURE 3 Rheology of paste and SEM photographs of resulting phosphor layer.

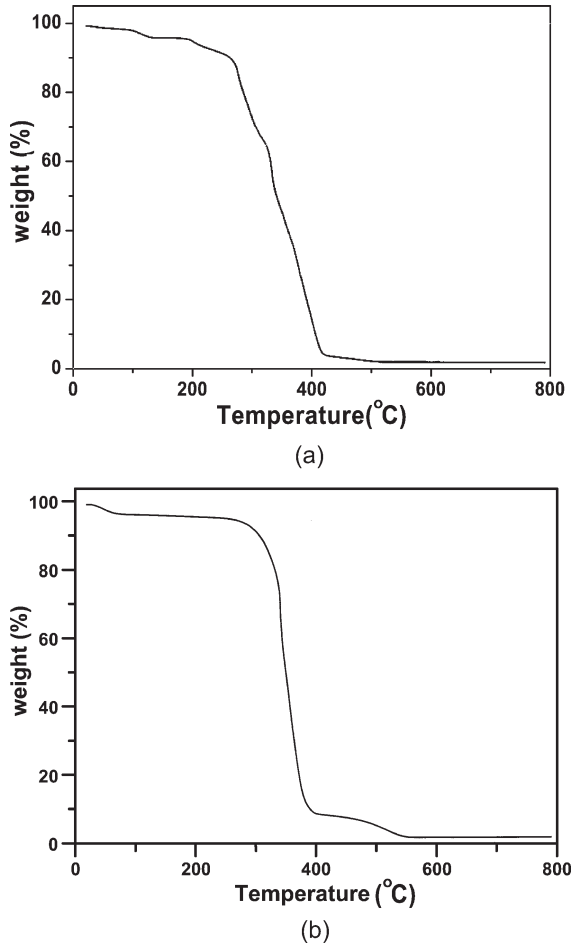

FIGURE 4 TGA thermograms of binder polymers; (a) HPC. and (b) poly(MMA-co-MAA).

prepared as follows; 25 wt% of HPC in 3MMB or 40 wt% of poly(MMA-co-MAA) in BCA solution was coated on the pretreated glass panel, dried and lifted off for sampling. As presented in Figure 4, TGA thermograms indicated that almost complete thermal decomposition of binder polymers was occurred at about 450°C.

In conclusion, optimized composition of phosphor paste applicable for ink-jet process with precision nozzle was formulated which gave phosphor layer with around 29 μm of thickness after sintering process. This clean phosphor layer obtained after sintering on the whole area including both

sides of barrier ribs were facilitated by low decomposition temperature of binder polymer.

REFERENCES

[1] Kojima, T. (1996). *Technology & Materials of Color Plasma Diplay Panel*, Shiomusi, 3–17.
[2] *Flat Panel Display*, (1997). PDP Technology, 202–207.