Width Control in the Photo patterning of PDP Barrier Ribs

Dong Ju Kim[*1], Soon Hak Kim[3], Youngjune Hur[2], Duck Gon Kim[1], Sam Jong Lee[3], Sang Kwon Jung[4], Myeug Chan Kim[4], Lee Soon Park[3, 4]

[1]Department of Sensor & Display, [2]Advanced Display Manufacturing Research Center, [3]Department of Polymer Science and [4]Mobile Display Research Center, Kyungpook National University, Daegu 702-701, Korea

Phone: 82-53-950-5627 , E-mail: lspark@knu.ac.kr

Abstract

Barrier ribs in plasma display panels (PDPs) function to maintain the discharge space between the glass plates as well as to prevent optical cross-talking. The barrier ribs currently employed are typically 300 ㎛ pitch, 110 ~ 120 ㎛ in height, with upper and lower widths of 50 ㎛ and 80 ㎛, respectively. It has been reported that barrier ribs can be fabricated by screen-printing, sand blasting, etching and photolithographic processes. In this study, photosensitive barrier rib pastes were formulated and systematically evaluated in terms of photolithographic process variables such as printing, drying, UV exposure, development and sintering. It was found that the use of UV absorbent, polymerization inhibitor and surfactant were very effective in controlling the width uniformity of barrier ribs in the photolithographic method of barrier rib patterning.

1. Introduction

The formation of barrier ribs is one of the unique processes for making PDP and has great effect on the performance of PDP. In the photolithographic process, photosensitive barrier rib paste is coated on the rear glass panel of PDP on which address electrode and white dielectric layers had been formed. After drying, UV exposure through photo mask and development, the barrier rib pattern is form. Then, the panel is subjected to firing up to 550 °C to burn out all the organic and polymer materials, resulting inorganic barrier ribs on the rear panel of PDP. In the photolithographic patterning of PDP barrier ribs, the UV dose is fairly high to ensure the penetration of UV light to the bottom of photosensitive composite barrier rib layer of which depth is about 180 ~ 200 ㎛ consisting of photosensitive organic vehicle and inorganic barrier rib powder with mean diameter of about 2.5 ㎛. The high dose of UV exposure causes the widening barrier rib pattern compared to the original mask size of barrier rib since the photopolymerization reaction is occurring isotropically to all directions [1-5].

In this work we tried to solve these problems by incorporation of UV absorbent, polymerization inhibitor and medium high HLB surfactant in the formulation of photosensitive barrier rib paste [6-7].

2. Results

2-1. Photosensitive Barrier Rib Paste and Photolithographic Process

Photosensitive barrier rib paste was made by dispersing barrier rib powder containing glass frit and aluminum oxide into liquid vehicle composed of poly(ST-*co*-BMA-*co*-AA) terpolymer binder, butylcarbitol (BC) solvent, UV functional monomers, and HSP-188 photoinitiator using a three-roll mill (Exakt 50, Germany). The viscosity of barrier rib paste was measured with Brookfield viscometer and adjusted to in the range of 20,000 ~ 29,000 cps by the addition of BC solvent. The thickness of dried barrier rib coating was varied in the range of 180 ~ 210 μm. The dried barrier rib was exposed to UV light (200 ~ 800 mJ/cm^2) through a photo-mask [8]. After UV exposure, the barrier rib panel was developed with 0.5 wt% of sodium carbonate aqueous solution. The patterned barrier rib was fired in the electric furnace at 550 °C for 30 min. to burn out organic materials completely.

2-2. Control of Barrier Rib Width

In the photolithographic patterning of barrier ribs one of major problems is the scattering of UV light through the dried photosensitive barrier rib layer of which thickness is about 220 μm. The high dose of UV light for ensuring penetration of UV light to the bottom of photosensitive barrier rib layer also causes widening of barrier rib width. The scattering is caused by the difference of refractive index between inorganic barrier rib powder and organic photosensitive vehicle. One way of solving thus problem is to make the refractive index of barrier rib powder as close as possible. However, it is desirable to adjust the components of photosensitive vehicle which could fit any kind of barrier rib powders for example lead oxide (PbO) containing barrier rib powder and lead-free barrier rib powder.
The typical formulation of photosensitive barrier rib paste for control of barrier rib width is shown in Table 1.

Table 1. Typical formulation of photosensitive barrier rib paste.

Component	Photosensitive Organic Vehicle				Inorganic Powder
Composition (Wt%)	Binder	Solvent	Monomer	Additives[a]	65
	8.2	12.3	13.2	1.3	

a : additives such as UV absorbent and photoinitiator

In order to control the width of barrier rib we tried UV absorbent, polymerization inhibitor and surfactant as additives in the photosensitive barrier rib pastes. As shown in table 2, 3, and 4, the combination of UV absorbent and polymerization inhibitor effectively reduced over widening of barrier rib pattern. SEM images of barrier rib pattern obtained with the above mentioned additives indicated barrier rib pattern with 60 μm width and 110 μm depth could be fabricated as shown in Figure 1.

Table 2. Effect of UV absorbent on the photo-patterning of barrier rib.

Sample	UVA_0	UVA _1	UVA _2	UVA _3	UVA_4
UVA content (wt%)	0	0.5	1.0	1.5	2.0
Line pitch ave. (μm)	-[a]	164	134.2	140.6	127.6
Line pitch δ	-[a]	2.75	3.48	8.08	10.48

a ; occurring the patterning loss of barrier rib

Table 3. Effect of polymerization inhibitor on the photo-patterning of barrier rib.

Sample	PMI_0	PMI _1	PMI _2	PMI _3	PMI _4
HQ content (wt%)	0	0.01	0.02	0.03	0.04
Line pitch ave. (μm)	189.6	156.4	168.2	130.2	152.2
Line pitch δ	12.01	7.55	5.87	2.63	8.35

Table 4. Effect of combination of UV absorbent and polymerization inhibitor on the photo-patterning of barrier rib.

Sample	UVA _40	UVA _41	UVA _42	UVA _43
UVA content (wt%)	2.0	2.0	2.0	2.0
HQ content (wt%)	0.0	0.01	0.02	0.03
Line pitch ave. (μm)	127.6	159.8	130.8	117.4
Line pitch δ	10.48	3.48	8.79	10.70

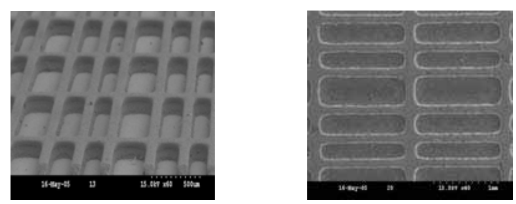

Figure 1. SEM images of barrier ribs obtained with photosensitive barrier rib paste.

3. Conclusion

The formation of barrier ribs by photolithographic method is one of the unique processes for making PDP panels.
It was found that the use of additives such as UV absorbent and polymerization inhibitor in the typical photosensitive barrier rib paste could improve both the photo-patterning yield and resolution of PDP barrier ribs.

4. Acknowledgements

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5. References

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