Ink-Jet Printing Technology for Color Filter

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Abstract

It is a revolutionary technology of making color filters by ink-jet printing. The difficult reason of this method is that it is a merger technology of many fields. There must be perfect orientation systems, designed capacity and production equipment of automatically controlled printing head. Moreover, accurate ink with modification is also needed.

1. Introduction

In recent years, the requirement of colored liquid crystal displayers increases fast as the growth of the market with notebooks, TV, automobile display and electric toys. Color filter is one of the important parts in colored liquid crystal displayers, and its demand shows that the market of the colored liquid crystal displayer grows up. One of the keys that keep market requirements grow up continuously in the future is the decreased price of colored liquid crystal screen, which stimulates the growth of the consumer market. Ink-jet printing technology shown in this study is a revolutionary method of making color filter for purposes of materials saving, process simplification and coat decrease.

2. Experimental

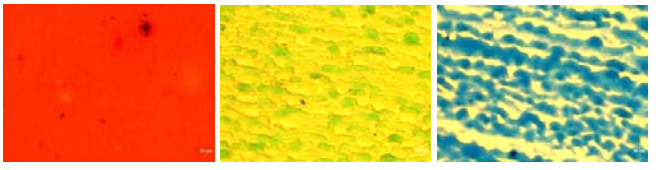
In this research, we focus on R.G.B. photo resistant modification, printing location controlling, and the component allocating, to manufacture color filters with good quality by ink-jet printing.

Two kinds of photo resistant are used to compare the results of ink-jet printing in this study. One is the photo resistant for traditional manufacture provided by ChungHwa Picture Tubes, Ltd. (CPT), and the other is the modified photo resistant which is the mixture of previous one and certain additive.

The printing equipment in this study is Dimatix Materials Printer (DMP). The accurate printing locations are controlled by different computer programs, and the printing patterns for photo resistant are also designed to fill them in the pixels completely without diffusion and mixing of them.

3. Results and discussion

After ink-jet printing on glass, the results of transmission optical microscope (OM) of traditional red, green, and blue (R.G.B.) photo resistant provided by CPT are shown in Figure 1. It is obvious found that the surfaces of green and blue photo resistant are rough and the transmitted light is not uniform which does not fit in with the requirements of color filter fabrication.



(a) (b) (c)

Figure 1 Results of transmission optical microscope of (a) red, (b) green and (c) blue photo resistant provided by ChungHwa Picture Tubes, Ltd. (CPT).

After sufficiently mixing with 10% weight of additive which has higher boiling point than that of traditional additive, the modified photo resistant are printed on glass and analysis by transmission OM. According to the results shown in Figure 2, it illustrates that the modification photo resistant has smooth surfaces and it can get more uniform transmitted light after this ink-jet printing process.

(a) (b) (c)

Figure 2 Results of transmission optical microscope of modified (a) red, (b) green and (c) blue photo resistant.

Therefore, the modified photo resistant with better optical properties after printing process is used to proceed following printing investigation.

The first step of printing investigation is the location design of printing points. After several corrections, the technology used in this study can already print the photo resistant in the accurate locations shown in Figure 3. Even in larger areas, the printing points can be still in the centers of pixels, and this avoids the deviations of photo resistant which may cause diffusion and mixture of them.

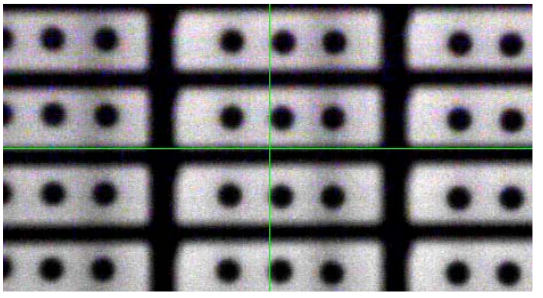


Figure 3 Transmission optical microscope of location points of modified photo resistant in pixels.

Second step of printing investigation is designing how many printing drops for filling completely in each pixel with one layer. Figure 4 and 5 show different numbers of printing drops of modified photo resistant with single and double lines in each pixel, respectively. According to the printing results, each pixel can be filled completely with 20 drops of modified photo resistant in double lines for one layer.

(a)
(b)
(c)
(d)
(e)
(f)
(g)

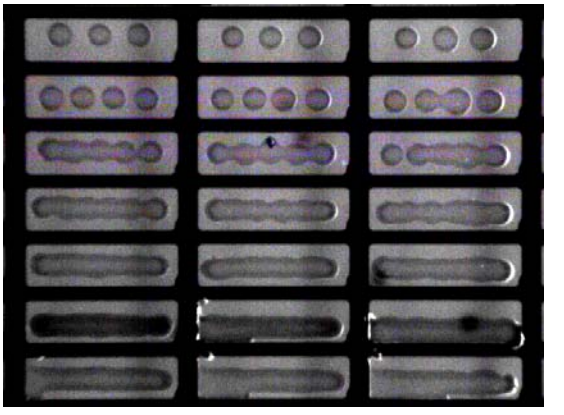


Figure 4 (a) 3, (b) 4, (c) 5, (d) 6, (e) 7, (f) 8 and (g) 9 drops of modified photo resistant with single line in pixels.

(a)
(b)
(c)
(d)
(e)
(f)
(g)

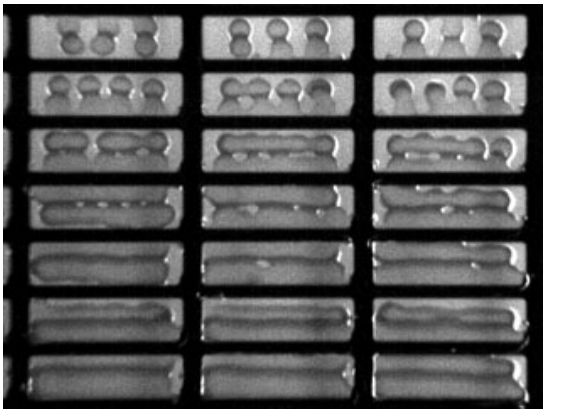


Figure 5 (a) 6, (b) 8, (c) 10, (d) 12, (e) 14, (f) 16 and (g)18 drops of modified photo resistant with double lines in pixels.

Basing on previous results, different layers, from 1 to 20, of modified photo resistant are printed in pixels to observe the diffusion of them, shown in Figure 6. According to the printing results in Figure 6, it is found that there is no diffusion of photo resistant in the color filter.

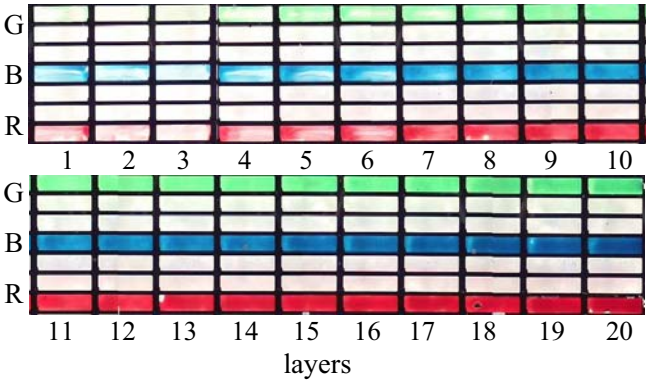
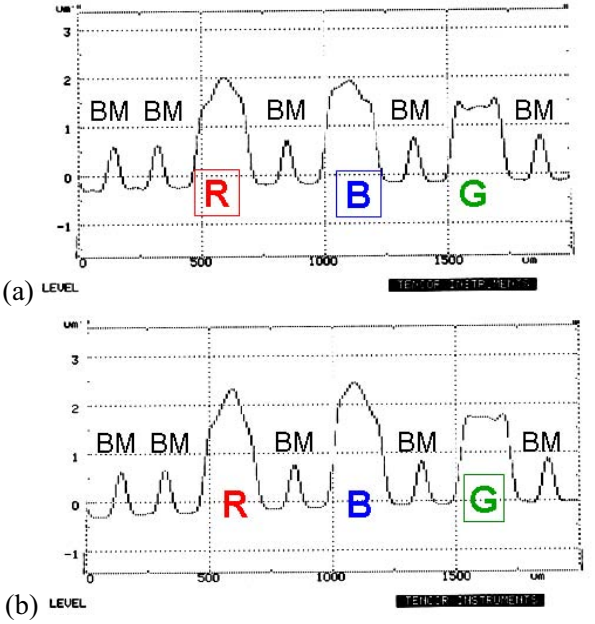


Figure 6 Results of transmission optical microscope of modified R.G.B. photo resistant with 1 to 20 layers in pixels.

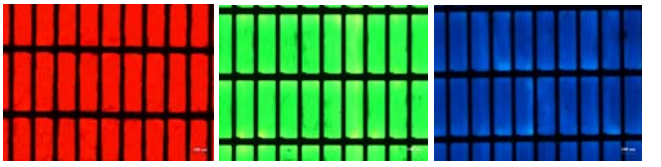
Furthermore, α-step analysis is used to decide the required layer numbers for each modified photo resistant in practical standard of 1.8 μm. Figure 7 (a) and (b) are the α-step results of 16 and 17 layers of modified photo resistant in pixels, respectively. It is found that modified red, green and blue photo resistant fit in the required standard when the thicknesses are 16, 17 and 16 layers, respectively.



(a) (b)

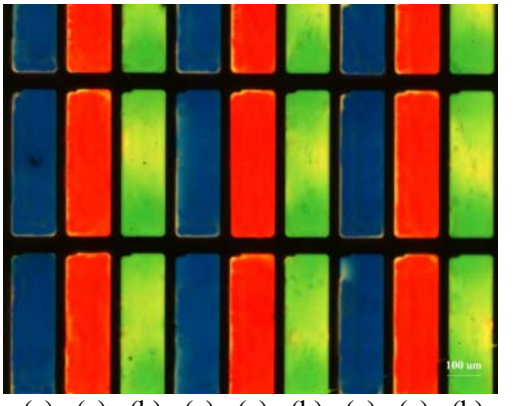
Figure 7 α-step results of modified R.G.B. photo resistant with (a) 16 and (b) 17 layers in pixels after curing and heating processes.

With the parameters obtained from previous results, ink-jet printing for completed areas of color filters is shown in Figure 8 and 9. In Figure 8, each color filter is printed with single color photo resistant. The transmission optical microscope results show that the light transmitting the modified photo resistant is uniform. In Figure 9, the modified R.G.B. photo resistant are printed alternately with 16, 17 and 16 layers, respectively, and it is found that there is no diffusion or mixing of photo resistant by ink-jet printing technology in this study.



(a) (b) (c)

Figure 8 Results of transmission optical microscope of modified (a) red, (b) green and (c) blue photo resistant with 16, 17 and 16 layers in pixels, respectively.



(c) (a) (b) (c) (a) (b) (c) (a) (b)

Figure 9 Results of transmission optical microscope of modified (a) red, (b) green and (c) blue photo resistant with 16, 17 and 16 layers in pixels, respectively.

4. Summary

Color Filter, one of the important elements in LCD, is consisted of materials with three primary colors, such as red, green, and blue, which are arranged on the glass substrate to form micro-dot matrix pattern for the purpose of full-colored displayers. Tradition manufacture of color filter includes many steps;

however, three primary colors can be sprayed directly into the micro-dot matrix pattern of color filter by ink-jet printing shown in this study. This process not only economizes the use of rotary coatings, exposed and developed procedure of three colors for decreasing the cost of manufactures, but also solves the problem of colors waste during the procedure of rotary coatings in tradition techniques by printing colors into the matrix pattern. Therefore, the ink-jet printing has more production advantage than others present methods in making color filters.

5. Acknowledgements

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6. References

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