# Core Technology for Prominent COT (Color Filter On TFT Array) Structure

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## Abstract

*To get rid of cell assembly margin and have more process room of upper substrate, we developed truly COT (Color Filter On TFT Array) LCDs in that B/M (Black Matrix) as well as C/F (Color Filter) layer is located on TFT substrate. Novel B/M material is also developed for this COT structure. Difficulty in making contact hole through C/F layer was solved by making each C/F pattern isolated from others. We think this configuration will be core technology for prominent COT LCDs.*

## 1. Introduction

As the mother glass size is getting bigger, several types of COT structures are being developed to strengthen competitive power of LCD for high light efficiency [1~4]. However, only truly COT structure that both B/M and C/F are laid on TFT array, enables us to design assembly margin free LCDs and to use bare glass for upper substrate in cell assembly process. Moreover, COT configuration that organic B/M patterns are put on upper glass is unfavorable to us because additional overcoat layer should be added on upper glass for planarization and prevention of contamination as liquid crystal can be polluted by impurity ions emerging from organic B/M.

To embody truly COT structure, some arts, such as development of B/M material, design ability for outer area of TFT array and ideas for cell process are needed. We developed truly COT-TN / COT-IPS configurations (15', XGA) that don't have any B/M patterns in upper glass to shield TFT channel area and bus-line.

## 2. COT structure and design

### 2.1 B/M

Novel organic B/M material, which can be adopted into COT, was developed. And we made sure that B/M pattern can be made as thin as 12 ㎛ width. By using it, we could shield bus-line as well as TFT channel. So it was possible to minimize surface reflection of metal bus-line.

### 2.2 C/F pattern and contact hole

Beside the B/M line patterns, C/F was laid and each C/F pattern was isolated from others. Overcoat layer of acrylic resin was used in order to block impurity ions diffusing from organic C/F layer and it also functions as a passivation layer for planarization.

Generally, when photo aligner for C/F patterning was used, making contact hole through C/F layer was so difficult that we could not form hole properly. So we made it between C/F patterns through overcoat layer. This process has great advantages of cost reduction and throughput enhancement because we don't have to use Canon equipment of higher accuracy, which is more expensive than common C/F aligner and is relatively inefficient in throughput. Figure 1 shows a schematic cross sectional view of contact hole through which drain electrode is connected with pixel electrode.

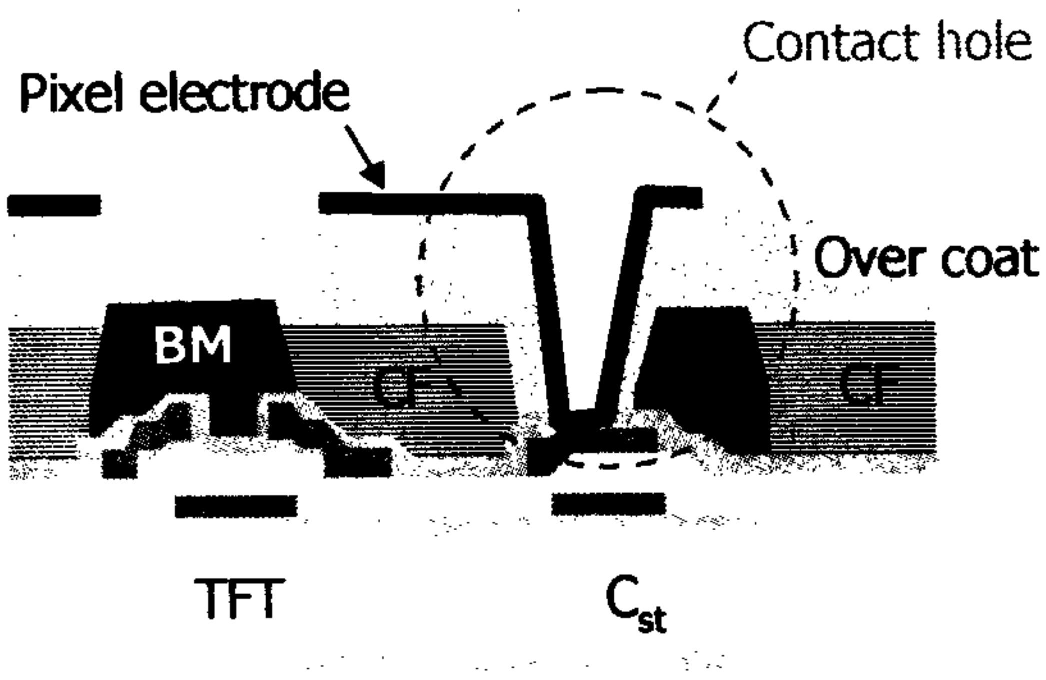


**Figure 1. Cross sectional view of contact hole.**

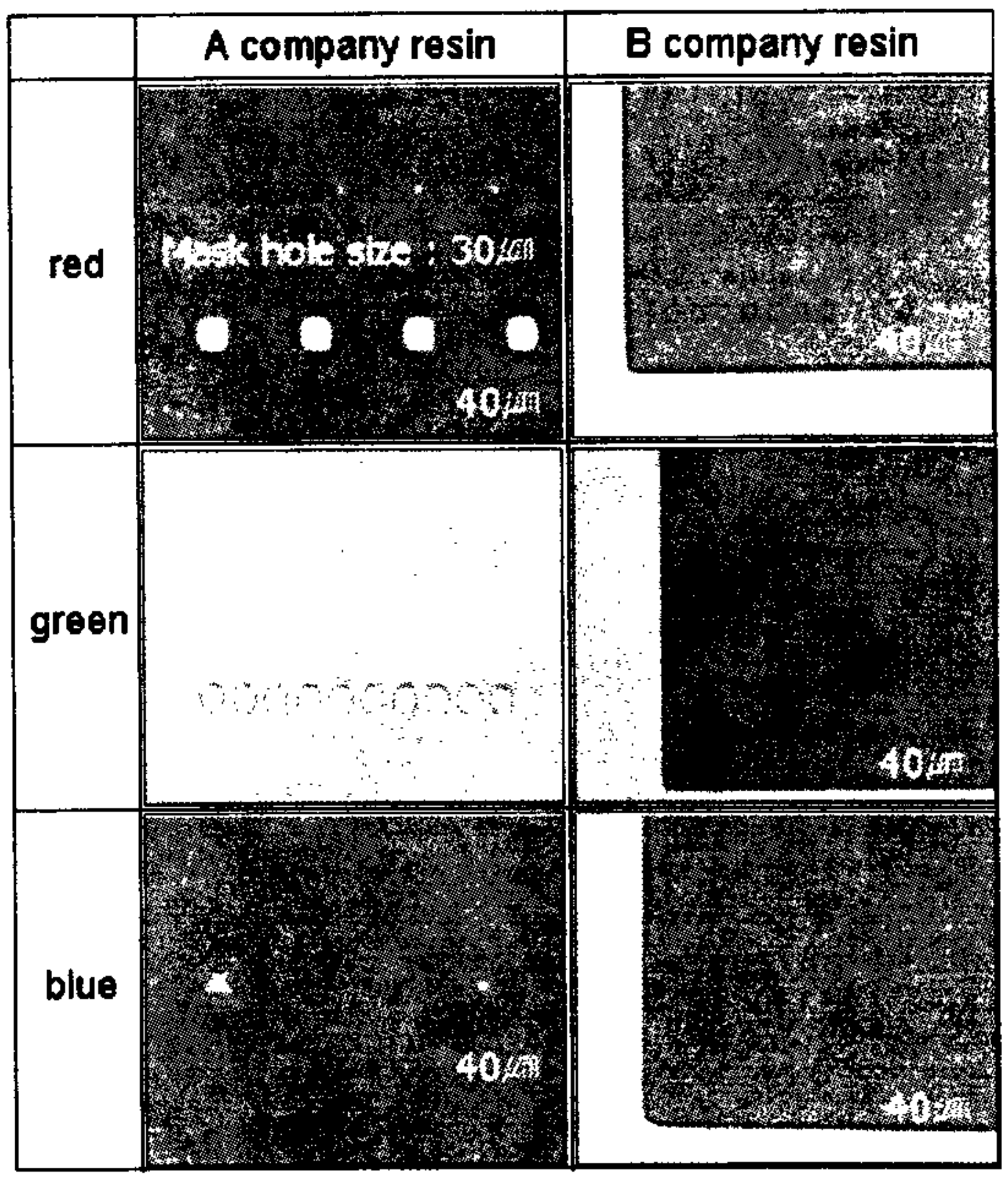


**Figure 2. C/F hole patterns for various photo mask hole size.**

Figure 2 shows the C/F hole patterns for various photo mask hole size: Common C/F aligner was used for this test. All C/F resins made by "B" company and Blue resin of "A" company didn't show clear hole pattern even if 40 ㎛ wide hole pattern was used for photo process. The cause of such difficulty is that C/F resins are nega-type and light intensity characteristic of C/F aligner differs from Canon's.

## 2.3 COT-IPS design and prototype sample

For COT-IPS feasibility test, we designed COT-IPS prototype (15', XGA). No B/M patterns were located on upper glass to shield TFT channel and bus-line, same as COT-TN. The methods of making contact hole, C/F and overcoat layer were also similar to those of COT-TN.

Figure 3 and Figure 4 show simulation results for prediction of transmission and cross talk level respectively. By covering bus line with common electrode, aperture ratio was increased.

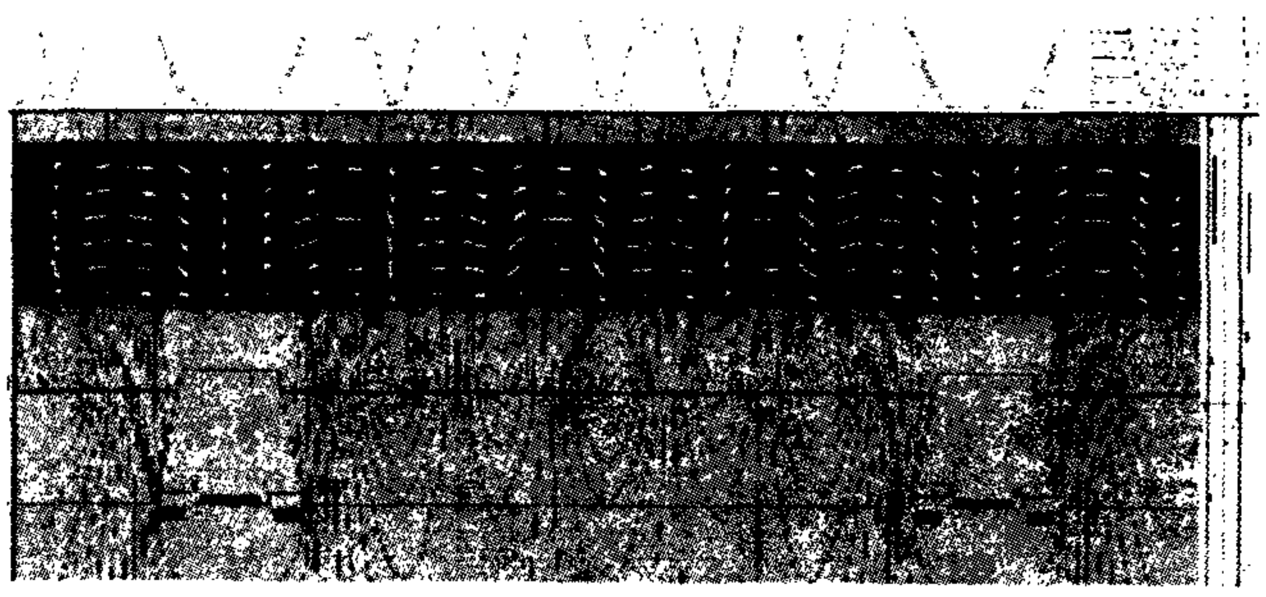

**Figure 3. Simulation result for prediction of transmission.**

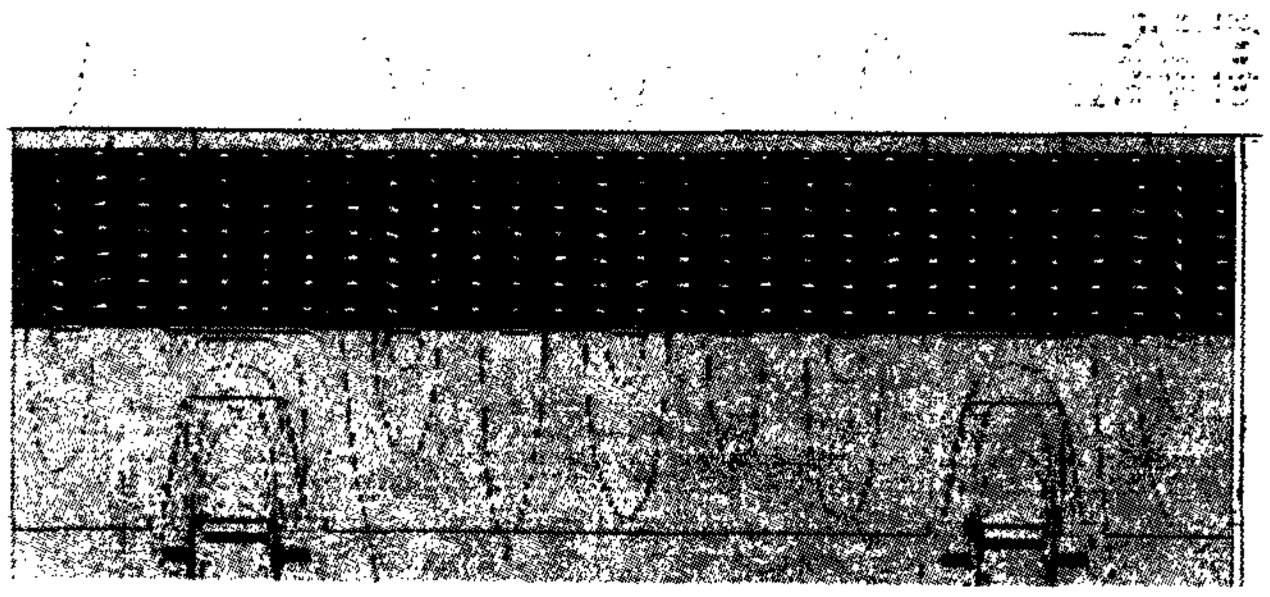

**Figure 4. Simulation result for prediction of cross talk level.**

Through pixel simulation, we could design COT-IPS structure of high aperture ratio that minimizes light leakage and cross talk level.

## 3. Results and discussion

COT-TN and COT-IPS of high aperture ratio were developed and robustness of these models was verified. Specification of prototype is shown in Table 1. In COT-IPS case, the increased rate of aperture ratio was almost 40% compared with normal IPS model of same resolution.

**Table 1. Specification of prototype COT LCDs**

| | COT-TN | COT-IPS |
|---|---|---|
| Resolution | 15', XGA | 15', XGA |
| Aperture ratio | 70% | 50% |
| Color gamut | 70%, NTSC | 70%, NTSC |

Vertical cross talk level was as low as 0.1% even though it was a high aperture structure. The reason is that common electrode that was covering data bus line and low dielectric layer contributed to signal shielding.

Novel B/M material was developed for COT structure. Ensuring process for B/M pattern as narrow as 12 ㎛ width, we could shield bus-line as well as TFT channel. In this case, we could minimize surface reflection of metal bus-line. Most of all, this configuration is essential for truly COT structure in that no B/M patterns are laid on upper substrate. As we mentioned before, it can give us more room for cell process margin and is more cost effective than other one that has B/M pattern on their upper substrate.

Exhibited method for making contact hole not only cleared difficulty of forming hole through C/F layer but excluded poor contact problem caused by C/F residues.

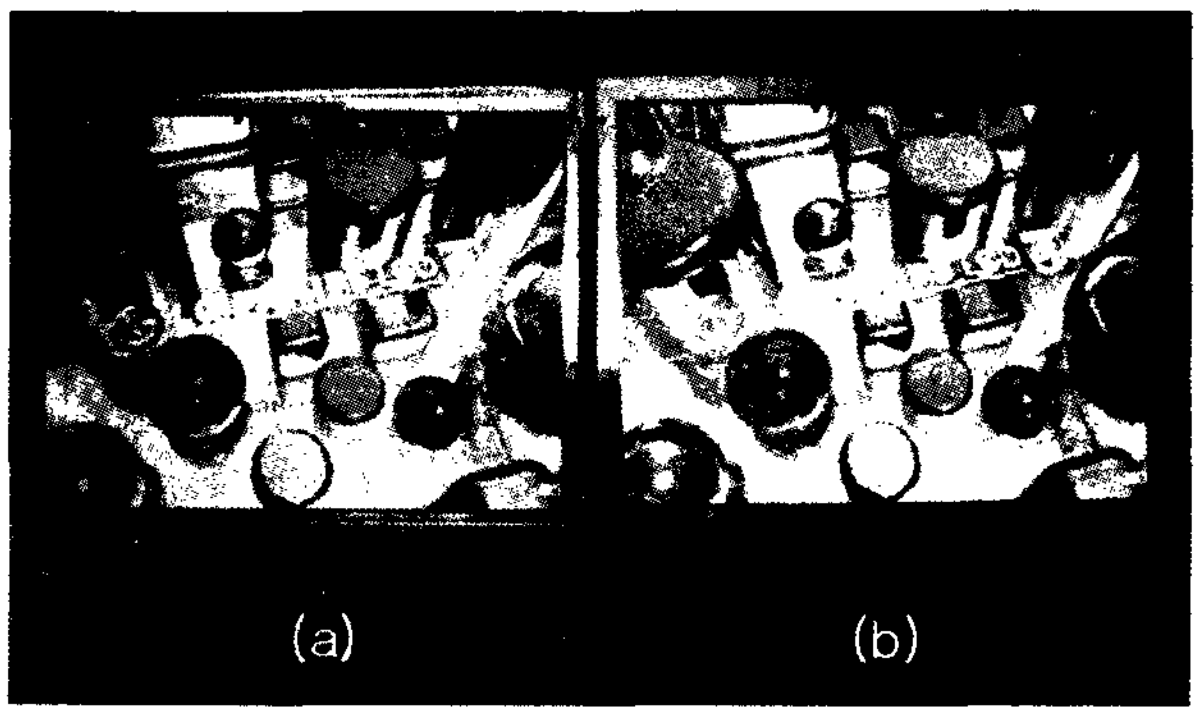


**Figure 5. Prototype module ((a) COT-TN, (b) COT-IPS).**

## 4. Conclusion

We believe COT configuration we suggest will be a promising model for next generation factory.

## 5. References


[1] 6th Annual DisplaySearch US FPD Conference "High aperture ratio technology for TFT LCD" (March 30, 2004).

[2] MunPyo Hong et al., SID'01 Digest, 1148 (2001).

[3] H. Hayama et al., SID'00 Digest, 1112 (2000).

[4] J. H. Song et al., SID'00 Digest, 1018 (2000).