A New Transflective TFT-LCD with Novel Color Filter

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Abstract

A new 10.4" transflective TFT-LCD has been developed using newly designed color filter for sunlight readable application. High transmittance and color gamut are realized by the dual color filter and dual cell gap structure in the ECB mode. The color gamut of new device provides 17% in transmissive and 18% in reflective mode. This new device provides the 125cd/m^2 of luminance, 240:1 and 27:1 of contrast ratio in the transmissive and reflective mode, respectively.

Introduction

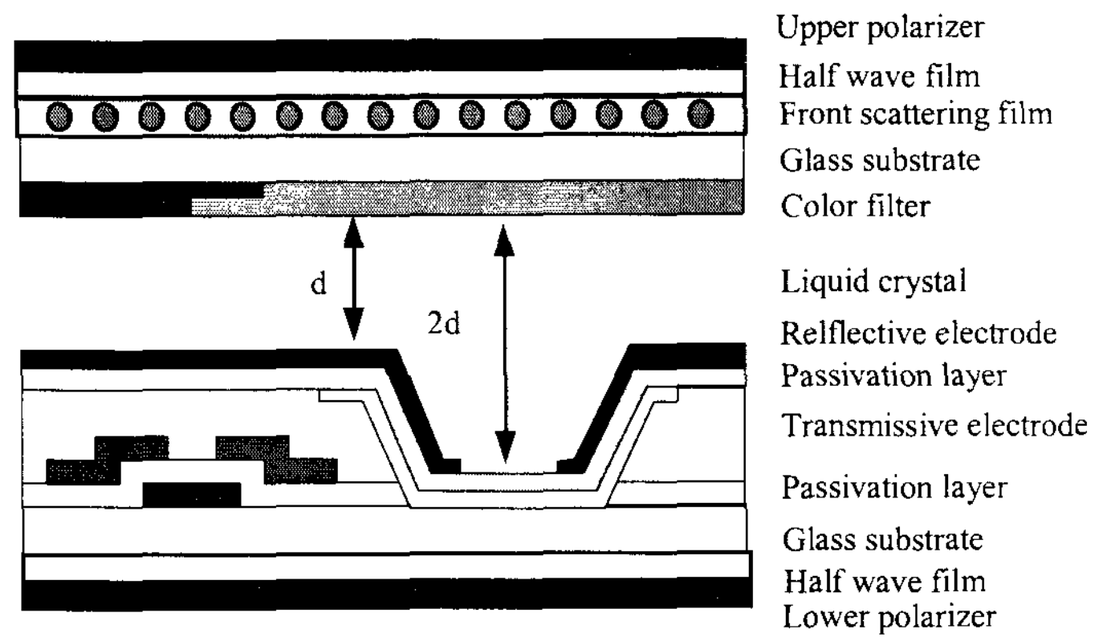
In the recent years, portable information systems with TFT-LCDs have received a lot of interest. As a result, transflective color LCDs have been used for sunlight readable application such as mobile, PDA, Web Pad, Tough Book LCD, etc. Because they have many advantages which are low power consumption, lightweight and good legibility both indoors and outdoors [1~4]. However, the characteristics of transflective LCDs are not sufficient for a wider application at indoor and outdoor environment. Especially, the color characteristics of transflective mode are not so good in the transmittance areas.

To overcome this problem, LCD manufacturers have been making an effort to develop new transflective LCD modes. They showed new design procedure for the single retardation film structure, transflective LCD of ECB (Electrically Controlled Birefringence) mode, which was based on wide-band quarter wave plate structure [5]. But, these displays have trade-off between color gamut and brightness. Also, the color gamut is not the same in both reflective and transmissive modes because the light has a single pass in the transmissive areas compared to a double pass in the reflective areas. So we need the transflective modes to separate color characteristics for reflective and transmissive modes [6].

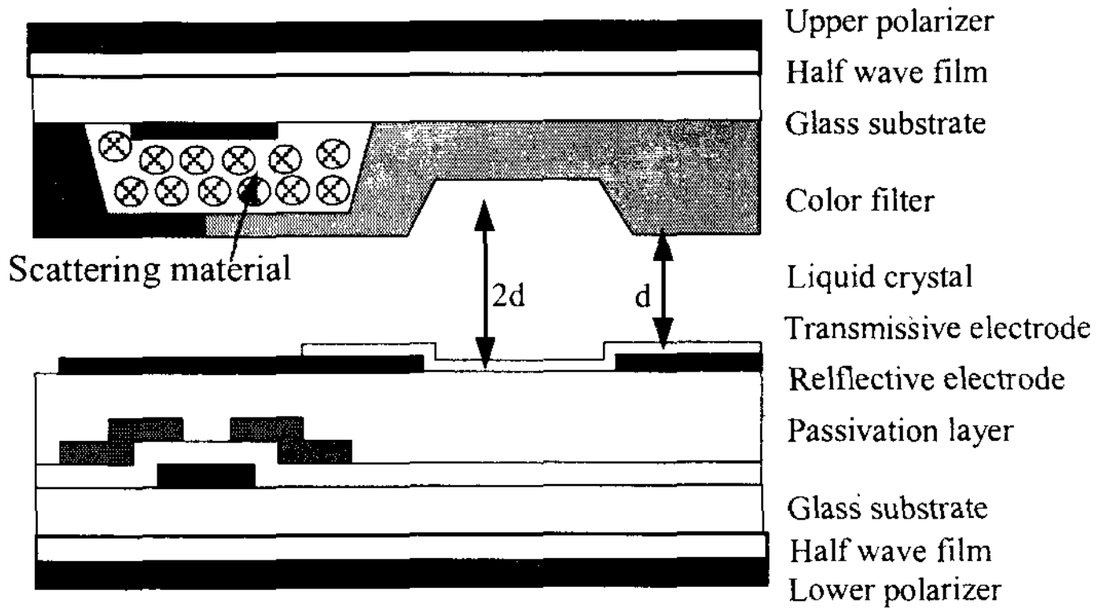
In this paper, we review the new type of transflective color TFT-LCD with a high contrast ratio and the same color gamut between reflective and transmissive areas. This mode is applied to the design concept of the ECB mode with dual cell gap, dual color filter, and scattering materials in the transflective areas.

Device structure

To realize of excellent display legibility under any environment of indoors or outdoors, it is necessary that LCDs have both of reflective and transmissive functions at the same time. In the figure 1, there are two types of cross-sectional view of transflective TFT-



(a) Conventional Transflective TFT-LCD



(b) New Transflective TFT-LCD

Figure 1. The cross-sectional view of several TFT transflective LC modes; (a)conventional structure, (b) new structure with a dual color filter and scattering areas.

LCD modes. Each pixel is divided into reflective and transmissive area. We have adopted an ECB mode in these types. To achieve maximum transmittance of the panel, the cell gap of the transmissive areas is twice as much as that of the reflective areas like as figure 1 (a) [5]. In this structure, the scattering films are used in the front side of displays instead of using Micro Reflecting Structures (MRS) which are required the additional process[3]. As the figure 1(b), we have a developed a new configuration of transflective display using novel color filter. For the forming of dual cell gap conveniently, we designed a dual thickness of color resign on the color filter substrate instead of TFT substrate. In addition, in the figure 1(b), to achieve high contrast ratio, we used novel color filter with scattering material in the reflective area. So we can get a high contrast ratio higher than the conventional transflective mode even if we do not apply the front scattering films.

Optical Characteristics

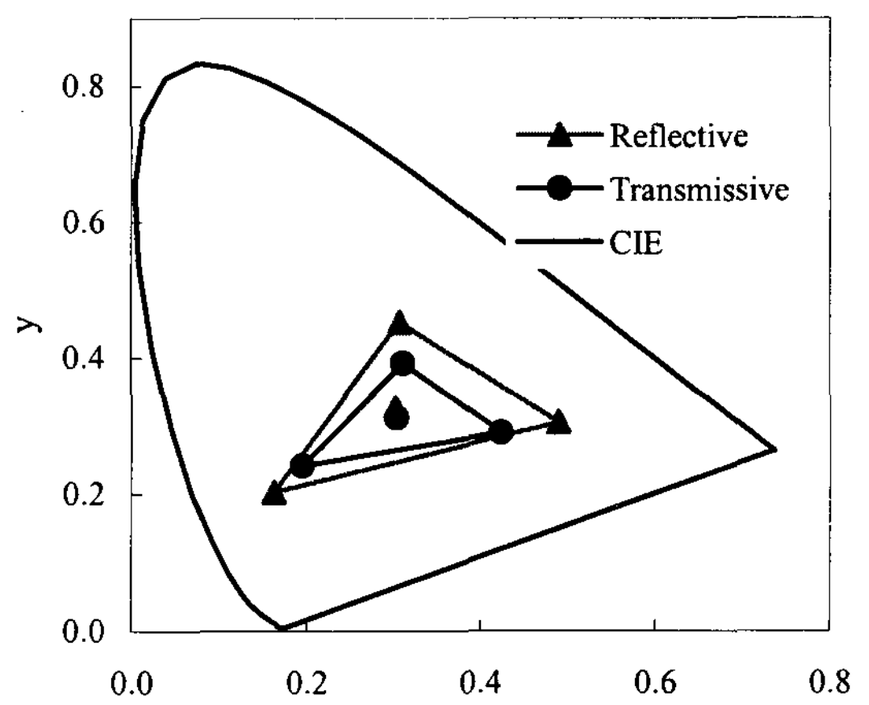
In order to achieve a good legibility of transflective mode under the indoor and outdoor ambient, good display quality are very important such as luminance, contrast ratio (CR) and color gamut. These optical characteristics of transflective TFT-LCDs are depend on the cell configurations.

Table 1. Comparisons of the transflective display modes.

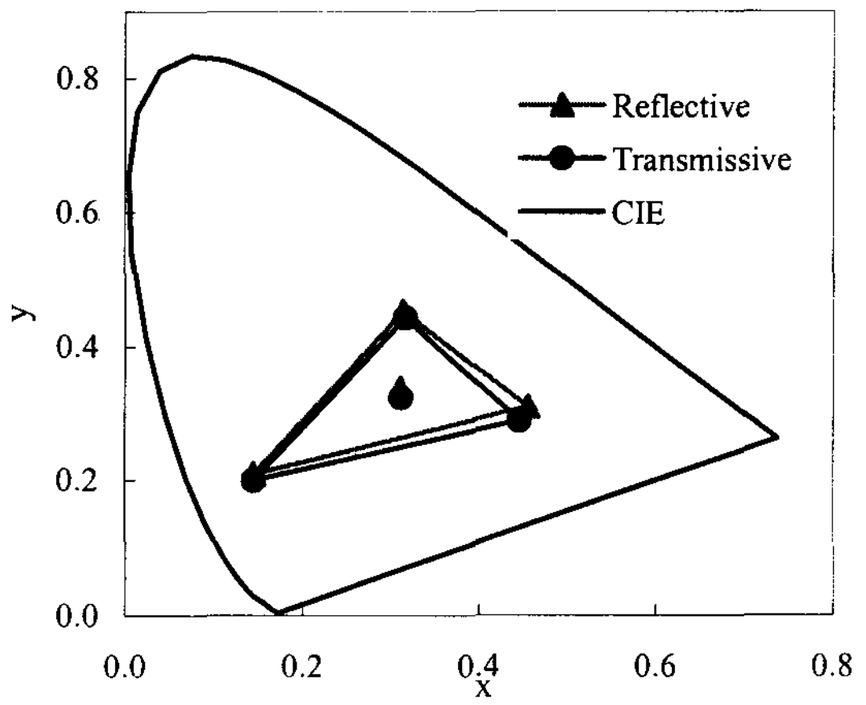
Items		Conventional type	New type
Luminance (cd/m^2)		130	125
Reflectance (%)		20	21
C/R (T-mode*)		70	240
Color Gamut	T-mode*	7	17
	R-mode**	20	18

(*T-mode: Transmissive mode, **R-mode: Reflective mode)

As shown in table 1, the new type of transflective TFT-LCD is improved in all items of the display performance compared with conventional one. The new type has three times as CR as the conventional one due to apply the scattering material within reflective area of color filter instead of front scattering film of polarizer. Reflectance is one of important parameter for low power consumption. Using the scattering materials in color filter layer instead of the front scattering film in the polarizer, more than 20% of reflectance compared to the MgO standard white was achieved at the 10 degree of incident angle.



(a) Conventional Transflective TFT-LCD



(b) New Transflective TFT-LCD

Figure 2.Chromaticity diagram of the (a) conventional and (b) new transflcective TFT-LCD.

We also improved the color gamut of color filter twice as much as that of the conventional one. As shown in the figure 2, we show the chromaticity diagram of conventional and new type of transflective TFT-LCD. We achieved almost the same as color gamut both reflective and transmissive mode using a dual color filter that are formed a different thickness of color resin in the reflective and transmissive areas. This new type can be produced 17% of color gamut through the sacrifice of transmittance of color filter.

Display Performance

We have fabricated the 10.4" SVGA transflective TFT-LCD applying the above technologies. Table 2 shows the specifications. This 10.4" SVGA transflective LCD has a luminance of 125cd/m^2, contrast ratio of 240:1 in the transmissive mode, 21% of reflectance and the same as color gamut.

(a) Transmissive mode

(b) Reflective mode

Figure 3. Photograph of the new transflective TFT – LCD .

both reflective and transmissive mode. Figure 3 shows an example of display image of the new transflective TFT-LCD.

Table 2. Specification of new type of TFT-LCD

Items	Specifications
Display Size	10.4"(diagonal 49.27mm)
Resolution	800 × RGB × 600
Luminance	T = 125nit
Reflectance	21% (at the 10 degree)
Contrast Ratio	T = 240:1, R = 27:1
Response Time	30msec
Color Gamut	T 17% / R 18%
NO. Of colors	262,000 colors

Conclusion

We have developed a new type of transflective TFT-LCD with a high contrast ratio and color gamut. We apply the dual gap on the color filter layer instead of TFT substrate and scattering material in the white resin instead of front scattering film of polarizer. As a result, this new type TFT-LCD provides a good visible display under indoor and outdoor environment.

References

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