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Recent Progress of LCD-TVs using OCB Mode

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Abstract

We have newly developed 32 inch-in-diagonal HDTV (1366×768 pixels) panels using OCB (Optically Compensated Bend) mode and low temperature p-Si TFT (LTPS) array substrates. The OCB mode can provide advantages both fast response (4ms) and wide viewing angle (>160 degrees). High performance of brightness of 600 cd/m^2 and contrast ratio of 500 : 1 was obtained. By using pseudo-impulse driving method to insert a black period between continuous two frames, moving picture quality was drastically improved [1]. Moving Picture Response Time (MPRT) of 8.4ms was achieved, which was proposed as an indicator of moving picture quality. LTPS array substrates were fabricated in our p-Si line using the largest substrates (730mm×920mm) and we realized large size and high definition(HD) panels with high performance and high uniformity. By using LTPS, peripheral circuits were integrated on glass substrates. Gate drivers and signal line selectors to reduce the number of external source drivers were integrated, resulting in huge cost reduction and high reliability.

1. Introduction

Recently the flat panel display market including LCDs and PDPs has widely and drastically grown. LCD-TV sets with 40 inches or larger have already been commercialized. And LCDs have lots of advantages of high resolution, low power consumption, light weight, flatness and so on. On the other hand, they have drawbacks of narrow viewing angle and motion blurred images, which have to be improved for TV applications.

We have been developing LTPS technology and OCB mode liquid crystal technology that succeeded in realizing the largest size LTPS panels with 32 inch -in-diagonal Our newly developed panel has excellent features of brightness, contrast ratio, wide viewing angels and fast response time.

In this paper, we report our technological advantages and higher performance of moving picture quality compared to other LC modes.

2. 32-inch LTPS HD panel using OCB mode

Table 1 and Figure 1 show specifications and photograph of the prototype 32-inch LCD (1366×768 pixels) using the OCB mode and LTPS array substrates, respectively. The OCB mode can provide advantages of both fast response (4ms) and wide viewing angle (>160 degrees). High performance with brightness of 600 cd/m2 and contrast ratio of 500 : 1 was obtained. To achieve high contrast ratio, color filter materials, cell configuration, electrode structure and process conditions were investigated. Also we have developed newly designed compensated films and cell structure to obtain a wide viewing angles of over 160 degrees both horizontally and vertically where the definition of viewing angles is viewing angle with contrast ratio of 50 : 1 or higher. Clear images can be seen in any direction. For TV application, natural color is one of the most important factors. Color shift was evaluated taking the gray levels into account. Viewing angles with color shift of ΔCu'v'<0.02 were also over 160 degrees both horizontally and vertically. The reproducibility of a natural picture is also excellent.

	Specification
Diagonal Size	31.55 inch
Pixel Format	1366×768
Brightness	600cd/m^2
Contrast Ratio	500:1
Color temp.	10000° K
Viewing Angle	Horizontal/Vertical
(CR>10)	>160° />160°
(CR>50)	>160° />160°
(ΔCu'v'<0.02)	>160° />160°
Response Time	4ms

Table 1. The specification of the prototype OCB mode LTPS panel

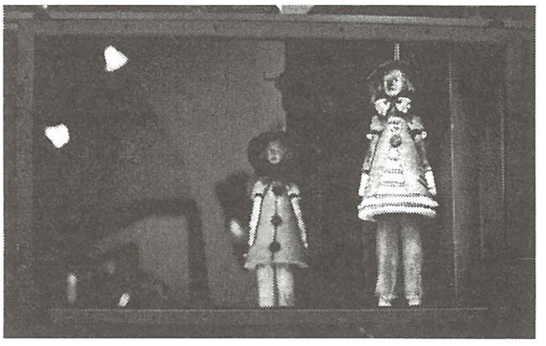

Figure 1. Photograph of the prototype OCB mode LTPS panel

3. LTPS technologies

Figure 2 shows a circuit diagram of the p-Si TFT array substrate. Gate drivers and signal line selectors to reduce the number of external source drivers by a half are integrated as peripheral circuits, resulting in huge cost reduction. Scanning circuits for black insertion driving are also incorporated in built-in gate drivers. Connection reliability is improved by minimizing the size of PCB.

Figure 3 shows a cross sectional view of the pixel structure. Minimizing the size of p-Si TFT and fabricating color filter (CF) on array substrate achieve high aperture ratio of 70% that is comparable to TN LC panel. Each pixel has a component to confirm transition of OCB mode LC from spray to bend orientation.

LTPS is suitable for high definition TV with the OCB mode. Because the OCB liquid crystal requires high-speed scanning to achieve fast response, excellent pixel charging capability of LTPS enables us to design the OCB mode HD panels, and it is much more difficult to design using a-Si TFT. We have newly developed LTPS, with which reliability of 60,000 hour continuous driving is confirmed.

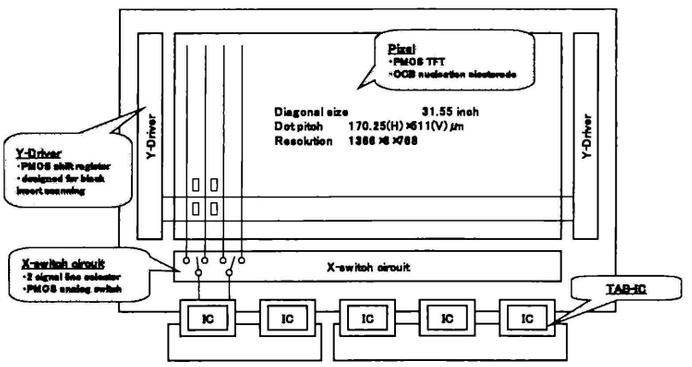

Figure 2. Circuit diagram of 32 inch-in-diagonal p-Si TFT array substrate

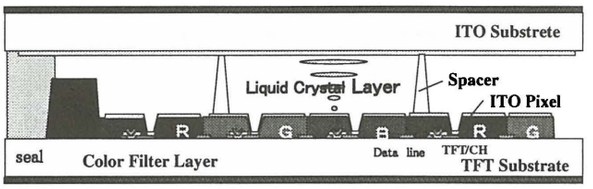

Figure 3. Cross sectional view of the panel structure

4. Motion picture quality measured by MPRT

Figure 4 shows response time data between gray levels of the OCB panel. Level 1 indicates a black state and level 8 indicates a white level. It shows that the longest response time was 4ms, which was obtained without an over driving usually used in other LCD modes, IPS [2] or VA [3]. We have achieved about twice as fast response time as those of other LCD modes.

By using pseudo-impulse driving method to insert a black period between two successive frames, we drastically improved motion picture quality. Figure 5 shows the optical response of the OCB panel by using the impulse driving and a half of every frame time was a black state, which could be obtained by the fast response (less than 4ms) of the OCB mode. Blur of moving picture was caused not only by the slow LC response, but also by hold type driving. So we used both the fastest LC response by the OCB mode and the impulse driving method, that eliminated a blur

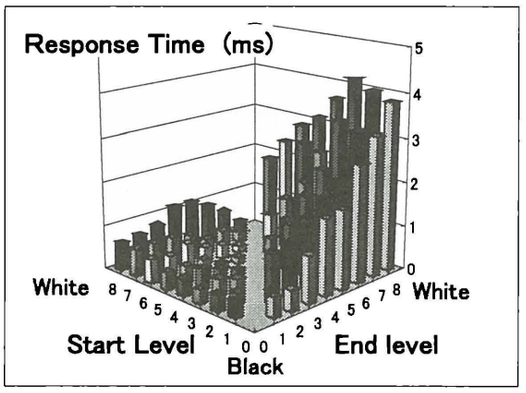

Figure 4. Response time characteristic between gray levels of the OCB-LCD

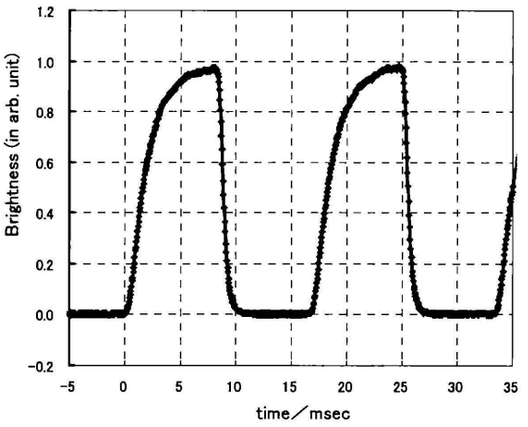

Figure 5 : Optical response of the OCB panel by using the impulse driving.

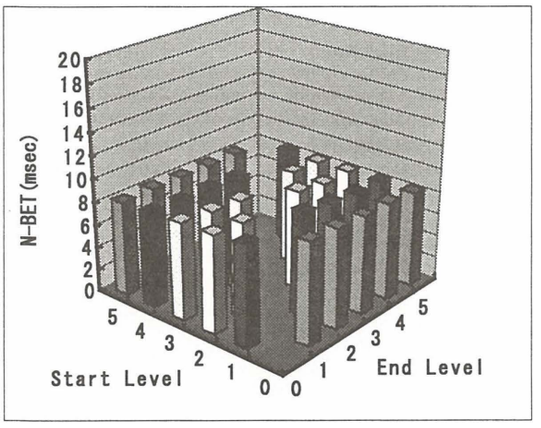

Figure 6 : N-BET (Normalized Blurred Edge Time) data of the OCB panel using the impulse driving method. (MPRT)

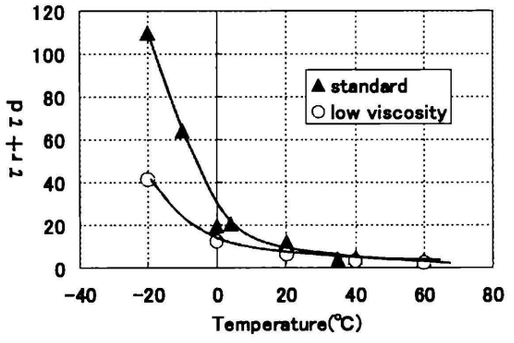

Figure 7 : Temperature dependence of response time

of moving picture.

The new method to measure a blur of moving picture has been reported and MPRT was proposed as an indicator of moving picture quality [4][5]. Figure 6 shows the N-BET (Normalized Blurred Edge Time) data of the OCB panel using the impulse driving method. The MPRT, averaged time of N-BET data, was 8.4ms, which was about half of those of other LC modes. This motion picture quality reached the level at which a blur is not felt and is almost the same as CRT.

The OCB mode shows fast response time at the wide range of temperatures[6] as shown in the Fig.7. Even at -20 ℃, the response time was 110ms. Further speed-up up to 40ms can be tried by developing new OCB liquid crystal material with lower viscosity. Dynamic scenes can be displayed not only at room temperature, but also at −20℃.

5. Conclusion

We have succeeded in developing the largest size LTPS panel with OCB mode, a 32-inch in-diagonal HD-TV panel and also realized the excellent features. As shown in Table 2, our developed panel has excellent features of brightness, contrast ratio, wide viewing angles and fast response time compared to other LCD modes, and especially has advantages in color shift and moving picture quality [7][8]. Combination of our LTPS and OCB mode gives the best solution to realize high performance HD-TV sets and also provides low cost and high reliability.

6. References

[1] K. Kumagawa et al. SID Digest '02, 1288 (2002)

[2] S. D. Yeo SID Digest '04 , p758-759 (2004)

[3] K. H. Kim et al. SID Digest '04 , p106-109 (2004)

[4] Y. Igarashi et al. SID Digest '04 , p1262-1265 (2004)

[5] K. Oka et al. SID Digest '04 , p1266-1269 (2004)

[6] K. Nakao et al. Proceeding of IDW '00, 215 (2000)

[7] J. H. Kim, et al. SID Digest '04 , p115-117 (2004)

[8] S. S. Kim SID Digest '04 , p760-763 (2004)

Mode		VA	IPS	OCB
Brightness		○	○	○
Contrast Rstio		◎	○	○
Wide Vewing Angle	CR	○	○	○
	Color Shift	△	◎	◎
Responsibility		△	△	◎

Table 2 : Comparison Table of the OCB panel with other LCD modes.

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