The development of high brightness IPS mode for LCD Monitors

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Abstract

An 18.1" Thin Film Transistor Liquid Crystal Display (TFT LCD) monitor adopting high brightness In Plane Switching (IPS) technology was realized. While conventional IPS structure used a Chromium (Cr) and Molybdenum (Mo) for a drain electrode, Indium Tin Oxide (ITO) was proposed and verified in this paper. Black sticky micropeal spacers were introduced for the reduction of light scattering phenomena, which was observed at dark room with the conventional micropeal spacers. With the proposed method, more than 10 % aperture ratio was increased and the excellent image quality was obtained.

Introduction

IPS mode [1] is becoming a core technology for the LCD monitor applications due to the wide viewing angle and excellent image quality characteristics. There are so many key issues in improving IPS technology such as high fast response time[2], color shift[3], crosstalk[4], holding ratio[5] and brightness. Recently, 25 msec response time enough to access moving pictures was reported through the optimization of liquid crystal material and cell components. Chromium black matrix was replaced by the organic black matrix to reduce crosstalk and nonlinear electrode structure was proposed to improve color shift problem. Compared to Twisted Nematic (TN) mode, IPS mode has two different design aspects, both finger electrode structure and normally black state. The finger electrode structure was attributed to lower aperture ratio and normally black state affects the image quality at a dark environment. The display with low power consumption and high brightness has been required on LCD applications market for a last decade. Although super high aperture ratio technology using low dielectric materials have been reported [6] for TN LCD, the aperture ratio of six-block IPS technology reported was less than 30 %. The conventional micropeal spacer in the normally black mode causes the image degradation named the twinkling of pixels, due to the light scattering at the surface of the spacer. In this paper, authors issued and discussed two design points on IPS mode, both high aperture ratio and the twinkling of pixels.

Design and fabrication

There are many ways on IPS mode to improve the aperture ratio such as the reduction of electrode width, the increase of the electrode space, the reduction of dead zone by the optimum design and the change of electrode materials. The change of electrode width needs a fine process technology and the increase of the electrode space requires more high driving voltage. In this paper, authors select a change of electrode materials from opaque metal to transparency metal. Figure 1 showed the cross-sectional view of the 18.1inch TFT LCD with IPS technology. Instead of Cr/Mo electrode, the ITO was selected as the drain electrode on six -block IPS structures, resulting in the 10 % increase of aperture ratio.

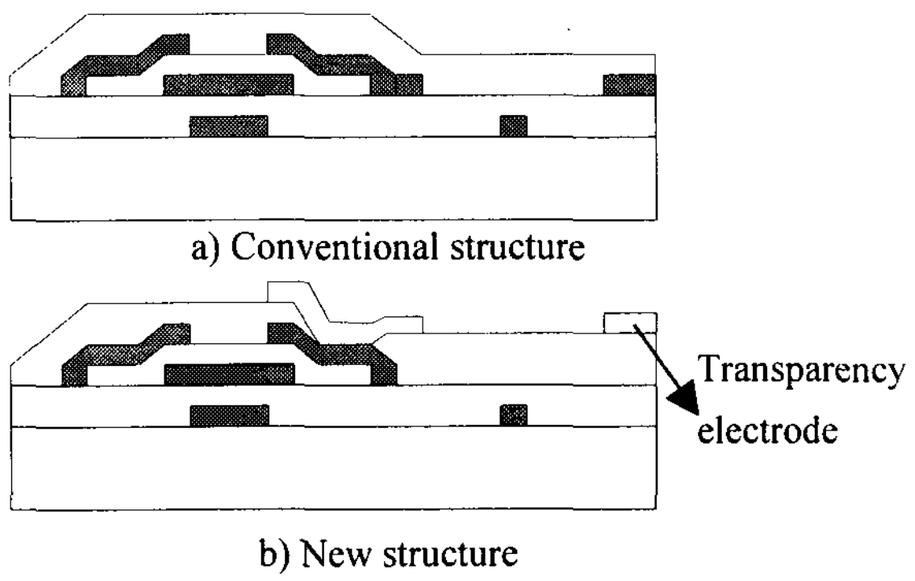

Figure 1 The cross-sectional view of IPS structure

Figure 2 showed the simulation results, transmission rate versus distance on the pixel. The transmission rate on the electrode area with 5 V applying voltage was lower than that of electrode space, especially lower on common electrode. While opaque metal screened that area, the transparency metal passed the incident light as shown in the figure, allowing the increase of the total brightness. With 1V signal condition, off state, the transmission rate was small enough, guaranteeing good contrast ratio. Figure 3 showed the horizontal view of the fabricated 18.1" pixel, both conventional and proposed structure. The new structure showed more high transmission rate.

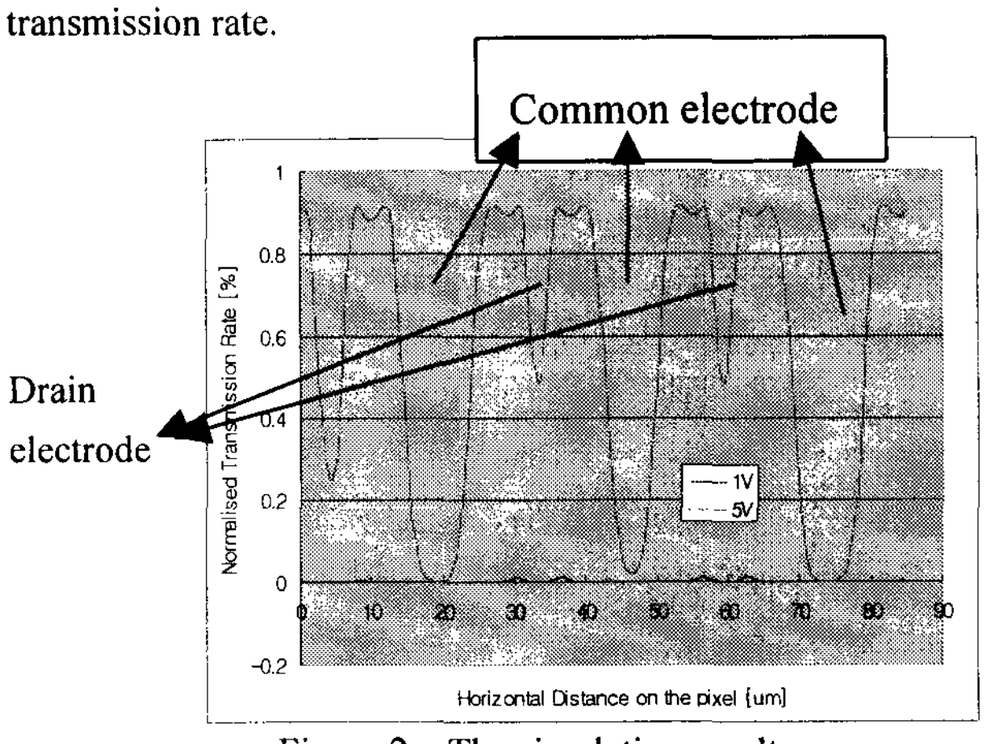

Figure 2 The simulation results

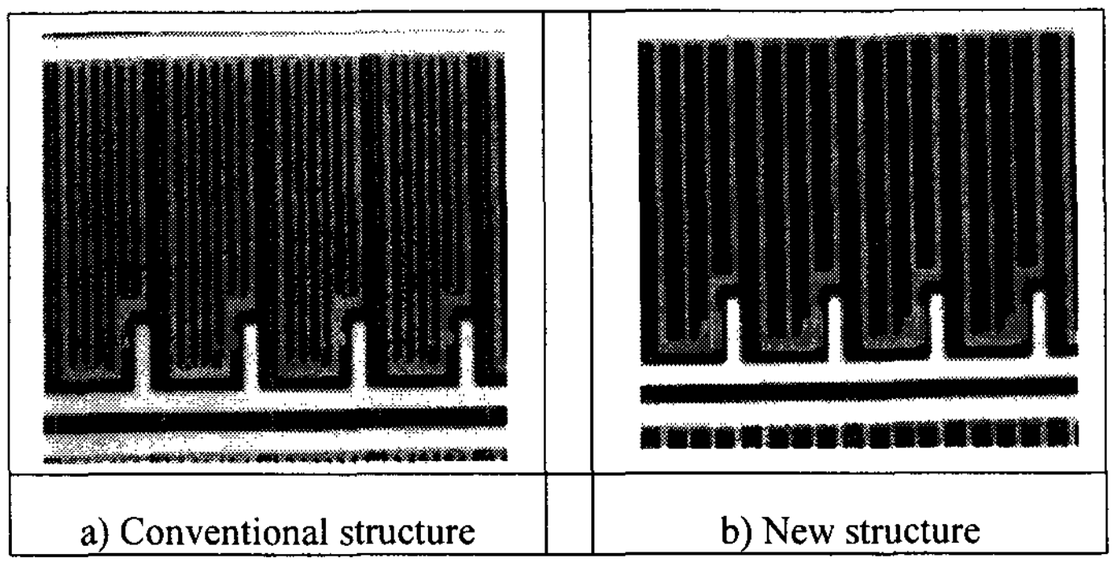

Figure 3 The microphotography of the fabricated pixels

Normal black mode causes the twinkling phenomena at the dark room environment. The scattering of the incident light at the surface of micropeal is attributed to twinkling phenomena. The micropeal is a kind of polymer that is used to keep the cell gap. Figure 4 shows the micropeal on the pixel. Authors developed a new black sticky polymer that absorbed the light, showing excellent black image quality.

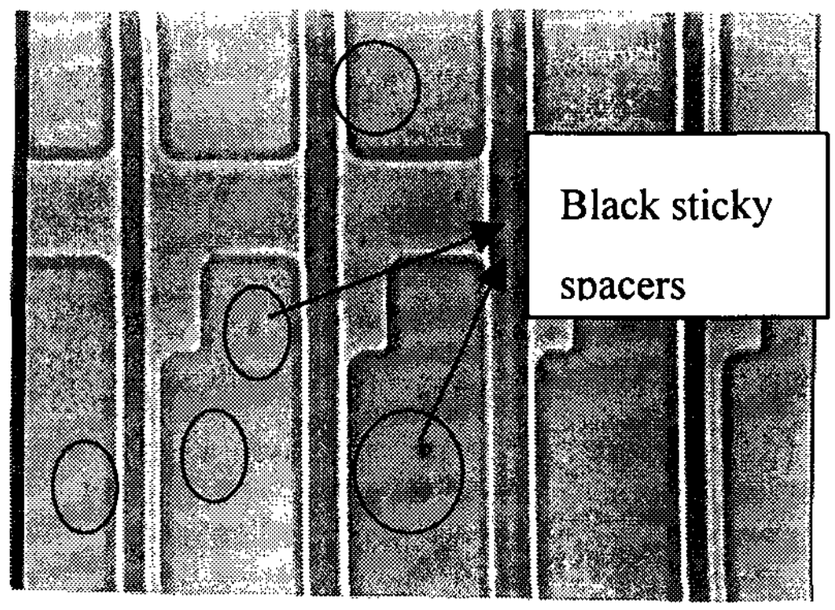

Figure 4 The microphotography of black sticky spacers

Results and discussion

Table 1 shows the comparison of electro-optical characteristics of the fabricated 18.1" LCD monitor. The new structure easily obtained 200 nit with 2 lamps due to high transmission rate. If the common electrode can be replaced with a transparency electrode, the transmission rate of IPS mode will be competent with TN LCD. Authors are under developing the structure. While the contrast ratio was a comparable with conventional structure, black image quality was better due to black sticky micropeal.

	Electrode	A/R	Brightness	Contrast
Conventional	Cr/Mo	27 %	150 nit	200:1
New	ITO	37%	200 nit	200:!

Table 1 Comparison of electro-optical characteristics

Conclusion

New IPS design concept was proposed to develop high brightness and excellent image TFT LCD monitors. Transparency drain electrode and black sticky micropeal spacers were proposed and developed. As a result of the new design, high image quality 18.1" TFT LCD display with low power and fabrication cost was realized.

References

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