Development of the new structure of transflective LCD

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Abstract

We have developed 14.1" XGA transflective panel for both transmissive mode and reflective mode. We designed new panel structure, optimized optical films and adopted pixel with high aperture and high transmittance color filter . This can be applied for mobile tool and sub-note without regard to environment.

Introduction

Reflective LCD is a promising display for mobile and outdoor application with merit of low power consumption. Makers have made an effort to develop reflective panel with high visibility under sunlight. As a result, reflectance and contrast was improved considerably. However, conventional reflective LCD has demerit of decreasing luminance in a dark place. There is a need for display which can use under various illumination circumstances.

We have developed a 14.1" XGA transflective LCD with new panel structure. We changed pixel structure and adopted transflective film. This structure leads to good-quality images for both modes, reflective and transmissive.

Cell Structure Design

Figure 1 shows the structure of the transflective LCD proposed in the study. Mirror-reflective-electrodes with holes in the center of the pixel are formed. Through the holes, the light from backlight can be passed, when they are working as transmissive mode. Transflective film can be used as reflective plate as well as transmissive polarizer with holes.

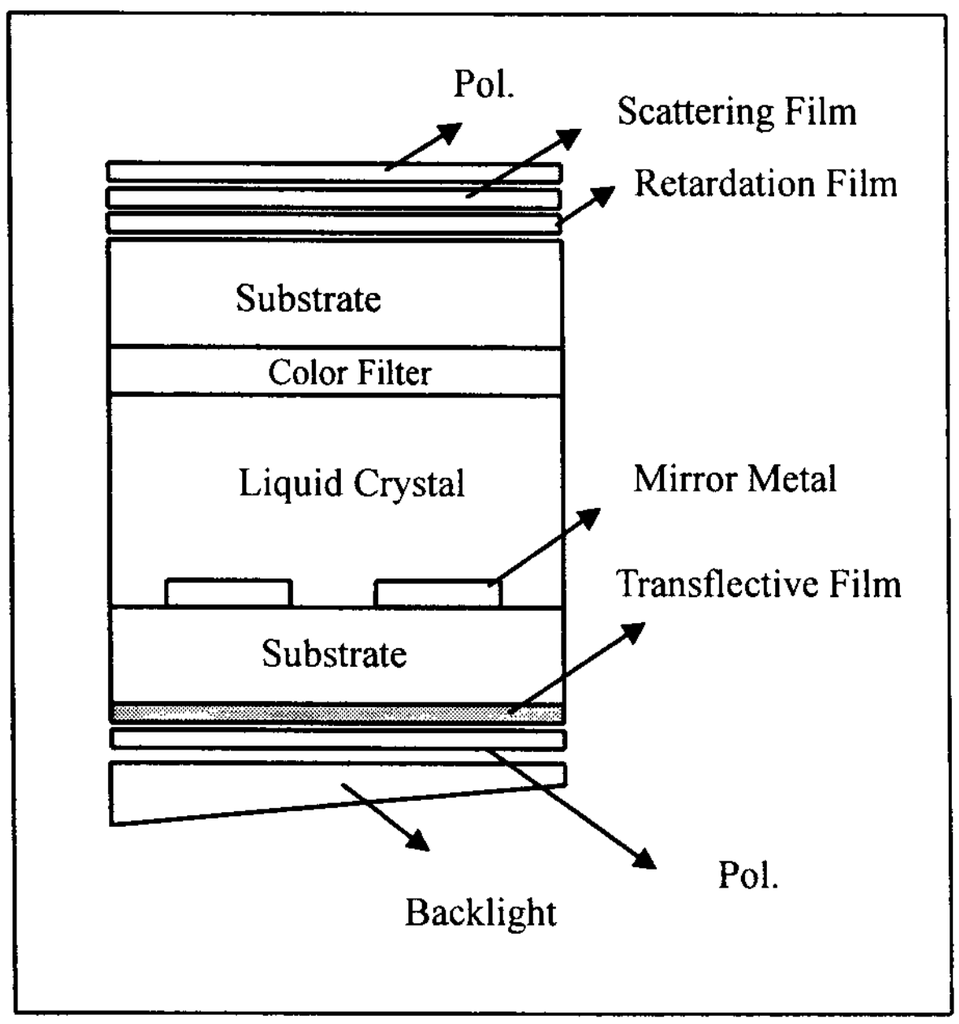

Figure 1. Structure of the Panel

Process

Figure 2 shows microphotograph and cross-sectional view of the pixel. The process is as follows. After BCB(Benzo Cyclo Butene) layer is coated, ITO(Indume Tin Oxide), pixel electrode, is overlapped on the gate line as well as data line. Then, silicon nitride layer is formed on the ITO in order to avoid the damages by the electrical interconnection between ITO and following mirror-reflective electrode, AlNd.. After silicon nitride layer, AlNd is deposited and patterned. Total aperature ratio of AlNd is 90% and that of hole is designed for 80cd/m^2.

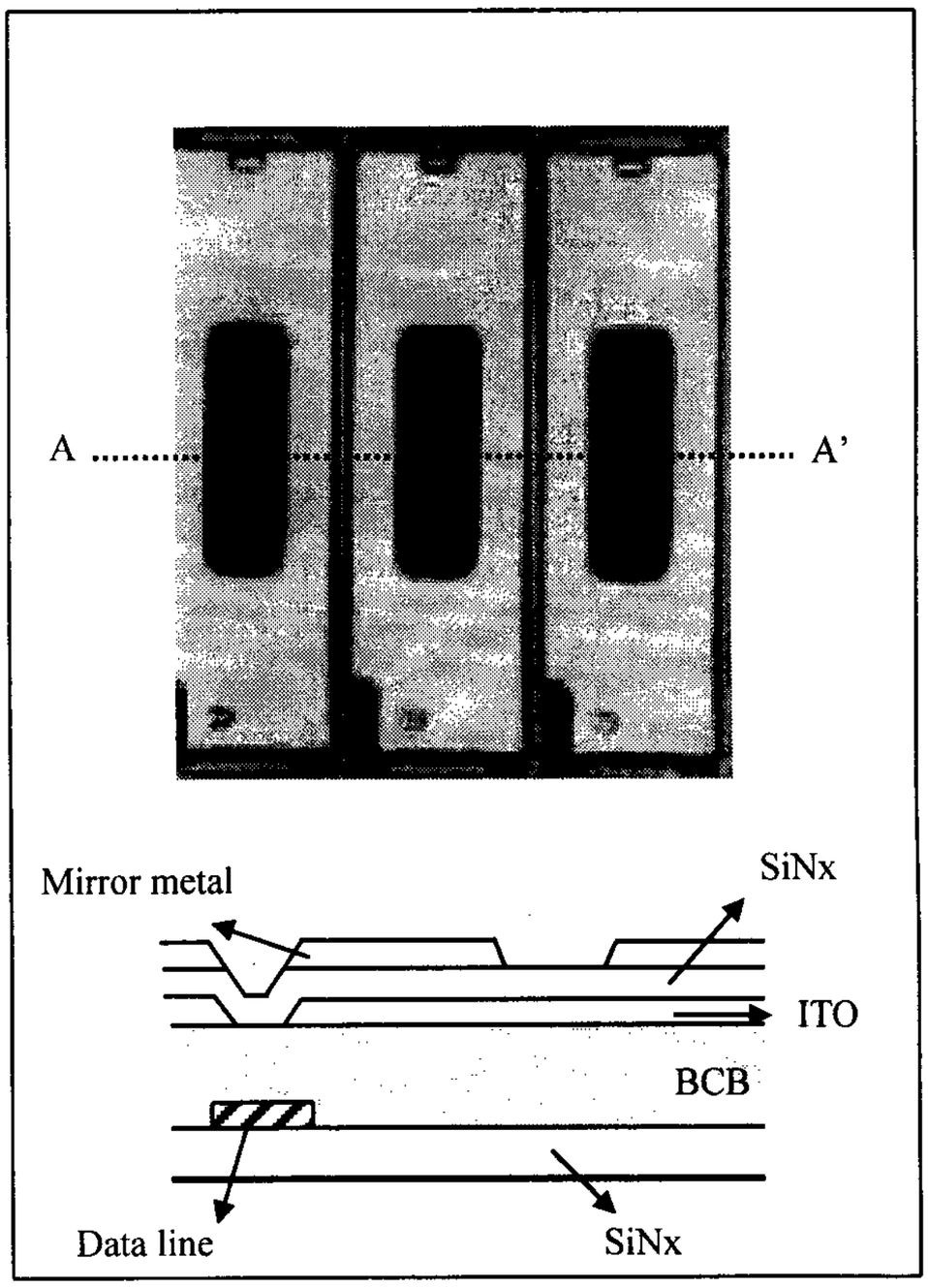

Figure 2. Microphotograph and cross-sectional view of the pixel

Scattering film and retardation film are used on the upper glass for increasing reflectance. Transflective film is used on bottom glass for reflectance of sunlight into cell at the reflective

mode and for transmission of light from the backlight at the transmissive mode. Transflective fim transmits the light which is parallel with transmission axis of the film and reflects the light which is vertical with transmission axis of the film. For increasing reflectance and realizing paper white, high purity colorfilter with high transmittance is used.

There are some problems to show two modes, reflective and transmissive, in a display. Those are color inversion between modes, color shift and decrease in contrast. At first, we calculated optimum Δ nd, optical axis of the upper films and rubbing direction for maximization of reflectance and contrast ratio at the reflective mode by simulation. Then, we decided transmission axis of the transflective film which can reflects sunlight from holes of mirror-reflective electrode and transmit light from the backlight without decreasing contrast and color inversion.

■ Result and discussion

The specification of the prototype LCD are shown in Table 1. Contrast ratio is 10:1, and the reflectance is 30% at the reflective mode. Brightness is 80cd/m^2 at the transmissive mode.

We have developed the new structure of the transflective LCD, so that this can be used without regard to outside luminance. High performance at the two modes has been obtained by means of optimized optical design. We believe that our LCD has wide application in the future.

Table 1. Specifications of transflective LCDs

Inch	**14.1" XGA**	1024*RGB*768
Color	**260K**	
C/R	**10 : 1**	MgO,-30/10deg.
Reflectance	**30%**	MgO,-30/10deg.
Viewing Angle	**UD : 130, LR : 110**	C/R > 2
Response Time	**30 msec**	Ton+Toff
Brightness	**80cd/m^2**	Transmissive mode

■ Reference

[1] Yutaka Ishii et al., Asia display '98, pp119-122(1998)
[2] T. Uchida et al., Asia display '95, pp599-602(1995)
[3] Y. Itoh et al., SID '98 Digest, pp221-224(1998)