Fabrication of the mode (Reflective and Transmissive) switchable LCD

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Abstract

The mode (reflective and transmissive) switchable LCD has been developed by using a treated SR (Selective Reflector) polarizer. We believe that our approach will be a solution to overcome weak points for a reflective and transflective mode in a dark environment and a transmissive mode in a bright environment. Therefore, this can minimize power consumption, and also be easily fabricated in a current manufacturing process, ready for large sizes.

1. Introduction

Due to the progress of wireless communications and the expansion of a Public Display (PD) market, the demands of using electronic displays in outdoor has been increasing. But, the transmissive mode liquid-crystal displays (LCD) have suffered from a low contrast ratio in a bright environment because of surface reflection. In order to solve this problem, we have increased white luminance. As a result, these displays require high power consumption and therefore the cost increases. To the some extents, outdoor visibility and power consumption have a trade-off relationship at transmissive LCDs. To increase outdoor visibility, reflective LCDs [1] have been proposed. Reflective LCDs can display a high quality image even in a bright environment but have need of external light. Therefore, transflective LCDs [2,3] was proposed for the solution to compensate the weaknesses from reflective and transmissive LCDs. However, transflective LCDs limit pixel efficiency and increase process steps. In this paper, we discuss the mode (reflective and transmissive) switchable LCD which can use a transmissive mode in a dark condition and also use a reflective mode in a bright condition. In addition, we also discuss a characteristic of this LCD.

2. Experimental

Figure 1 shows the simple cell structure of our mode switchable LCD. We fabricated a Notebook PC (X-note, R-405, LG electronics) using this configuration with a conventional 14.1 inch TN panel. Instead of a bottom polarizer, we use a SR (Selective reflector)-polarizer to realize the mode switchable LCD. The optical characteristics for this LCD were measured by using DMS-803 from Autronic Melchers.

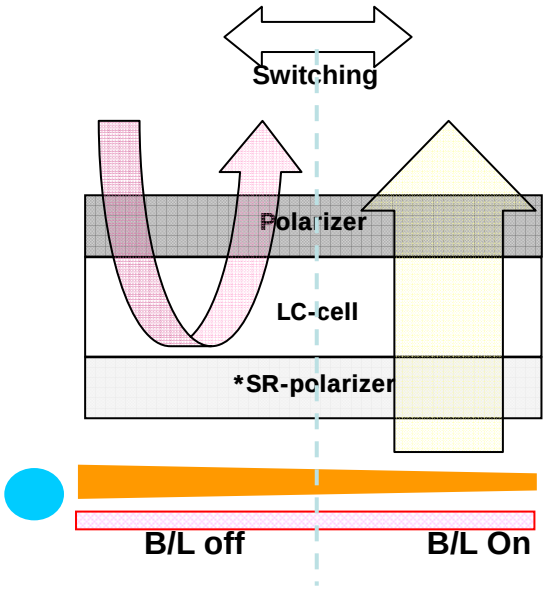

Fig. 1. Structure of the mode switchable LCD

3. Results and discussion

Table 1 shows the specifications of the 14.1 inch notebook PC, which has a mode switchable LCD panel. Figure 2 is a photograph of the notebook PC at a reflective mode in outdoor. Figure 3 is a photograph of the notebook PC at a transmissive mode in indoor.

TABLE 1. Specifications of the conventional and the mode switchable LCD

	Conventional	Mode switchable
Size (inch)	14.1	14.1
Resolution	1280 x 800	1280 x 800
Luminance (nits)	200	180
CR (@ T-mode)	500:1	300:1
Color gamut (%)	42	42
Reflectance (%)	-	~ 10*
CR (R-mode)	-	~ 8:1*
Power (W)	2.46	0.82

Fig. 2. Reflective mode in outdoor

Fig. 3. Transmissive mode in indoor

The similar type LCD was reported in 1999 [4] shown in Figure 4, as it has several problems. First, contrast ratio at a transmissive mode decreased because a reflective polarizer [5] had poor polarizing efficiency. Second, because of a gray film, luminance at a transmissive mode also decreased. Third, reflective and transmissive modes were inverted. Therefore, if the backlight is turned on at a bright environment, both reflective and transmissive images simultaneously show poor image contrast.

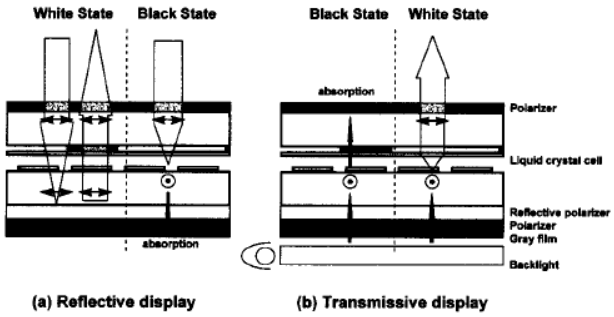

Fig. 4. Similar type LCD

To overcome the decrease of contrast ratio at transmissive mode, we have developed new reflective polarizer named a treated SR-polarizer and modified the method of polarizer attachment. Moreover, the gray film is eliminated to increase luminance. Hence we can obtain the contrast ratio of 300:1 and the luminance of 180 nits as shown in Table 1. In order to solve the third problem, reflective and transmissive images are inverted by an open-source software with a data inversion and backlight on/off functions. Two functions are merged in our notebook PC.

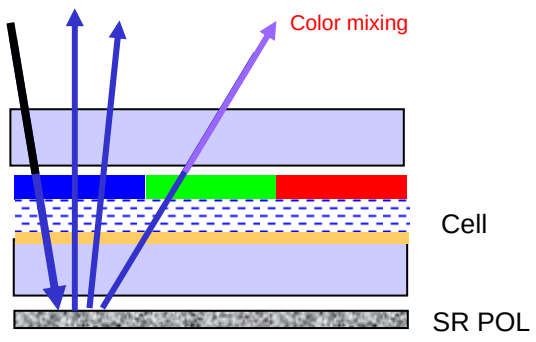

Fig. 5. Parallax effect

However, the only problem with this type of LCD is the parallax between the liquid-crystal layer and the reflector due to the positional difference by the lower glass substrate, shown in Figure 5. This leads to color mixing and may be a serious problem for a high resolution LCD. Although our LCD also has a parallax problem, it can achieve 10% reflectance and CR 8:1 which is enough to show good quality of pictures under appropriate visual angles.

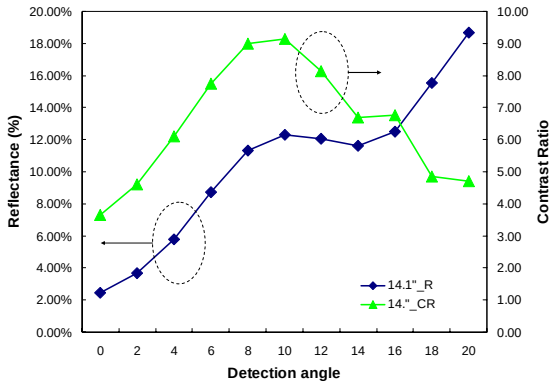

Fig. 6. Reflectance and contrast ratio at reflective mode.

4. Summary

We have fabricated a 14.1 inch notebook PC with a mode switchable LCD panel. Our mode switchable LCD has high image quality in both bright and dark conditions and can also reduce power consumption by using a reflective mode in outdoor. So, we believe this LCD can widely be used in displays for outdoor visibility and low power consumption.

5. References

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