Paper Title : Novel Optical Design of Light-Guide Plates for Transflective Liquid Crystal Displays.

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Abstract : We have proposed a novel optical design technique of light-guide plates(LGPs) which can able to improve the optical efficiency of transflective LCDs. The basic concepts of our design technique are that we make the groove-pattern of LGP pixels resemble the pixel-array-pattern of transflective LCDs in shape and size and make the surface of the groove scatter (front scattering). In simulated and measured results, we ensure that our design of LGP in backlight unit for transflective LCDs can improve the optical efficiency of LCDs.

Suggested area : Application and Systems

Oral/Poster Preference : Oral

Technical Summary

The demand for high resolution and high-contrast full-color liquid-crystal displays (LCDs) used in portable cellular phones (CPs) and personal digital assistants (PDAs) are increasing in the market. At the same time, more energy efficient illumination systems for these displays are highlighted requirements [1,2]. In general the illumination systems are divided into two categories due to the architecture of the LCDs, that is, backlighting and frontlighting systems.

Recently transflective LCDs have been widely developed for CPs and PDAs, because of their good legibility and picture quality in various illumination conditions such as indoor and outdoor [3,4]. Because transflective LCDs have adopted a half mirror method as a transflective layer previously, those must use the same backlighting system as used in the transmissive mode. But current transflective LCDs have adopted hole or slit method in which the transmittance is controlled by an area ratio of hole or slit. Therefore if the same backlighting systems are used in the transmissive mode, very low optical efficiency is obtained. So we have proposed a novel optical design of light-guide plates(LGPs) which can improve the optical efficiency of transmissive mode in transflective LCDs. The basic concepts of our design are two. The first is that we make the groove-pattern of LGP pixels resemble the pixel-array-pattern of transflective LCDs in shape and size. The second is to make the surface of the groove scatter (front scattering).

Figure 1 shows the schematic diagram of backlight unit for transflective LCDs. The smaller the ratio of transmissive part to reflective part, the higher the optical efficiency of transflective LCDs becomes. As shown in Fig. 1, our design doesn't cause total reflection but front scattering on surfaces of grooves. The reason is that the surface of the groove has a diffusive characteristic. These diffusive surfaces are formed using printing, chemical etching or laser ablation technologies [5]. We fabricated grooves with the diffusive surface as shown in Fig. 2. The groove-patterns of LGPs and the diffusive surfaces in the groove are formed well.

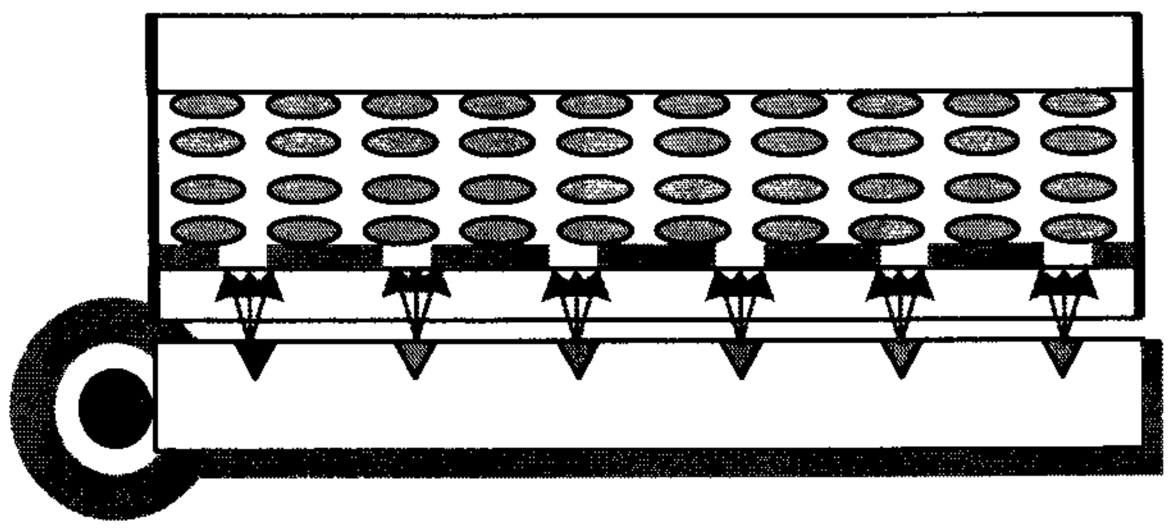

Fig. 1. Schematic drawing of backlight unit for transflective LCDs

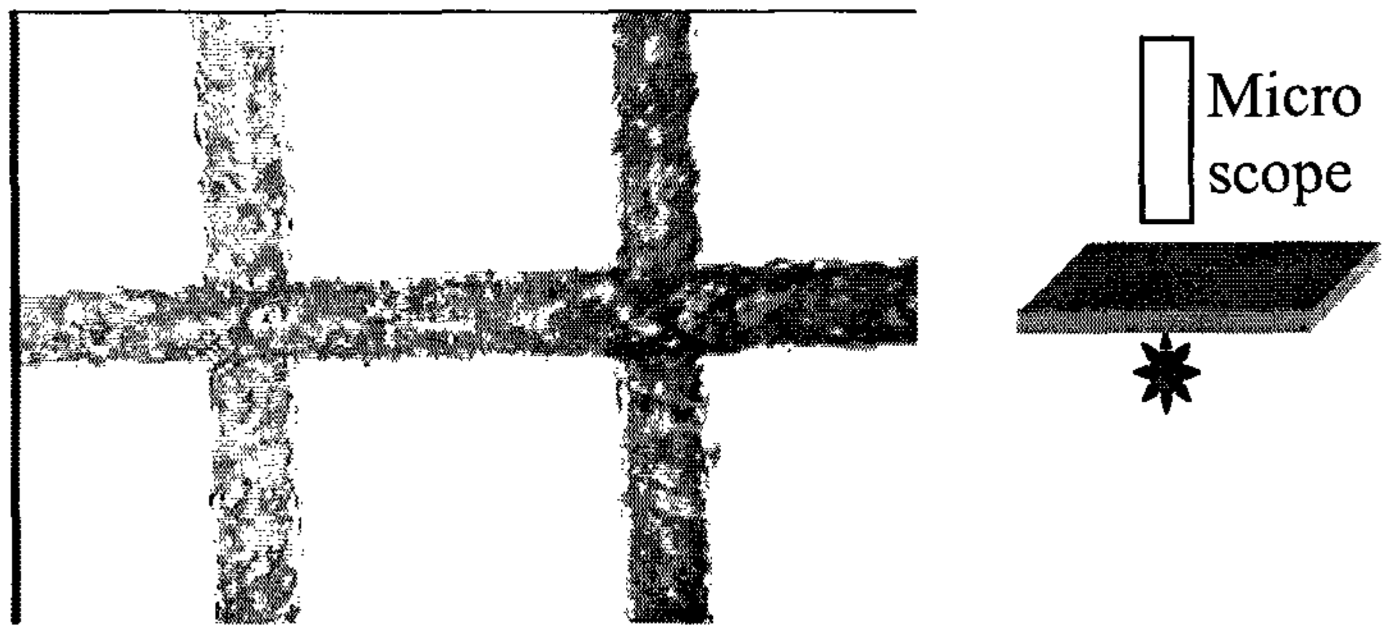

Fig. 2. Fabricated grooves with the diffusive surface

Figure 3 shows the simulated and measured results when the light of cold-cathod-fluorescent lamp (CCFL) is introduced into the LGP from its side surface. We have ensured that the light escaped from the LGP can be measure only in the groove parts.

In conclusion, we have proposed a novel optical design technique of LGPs which can improve the optical efficiency of transmissive mode in transflective LCDs. The basic concepts of our design are that we make the groove-pattern of LGP pixels resemble the pixel-array-pattern of transflective LCDs in shape and size and make the surface of the groove scatter. In the simulated and measured results, we ensure that our design of LPG in backlight unit for transflective LCDs can improve the optical efficiency of LCDs.

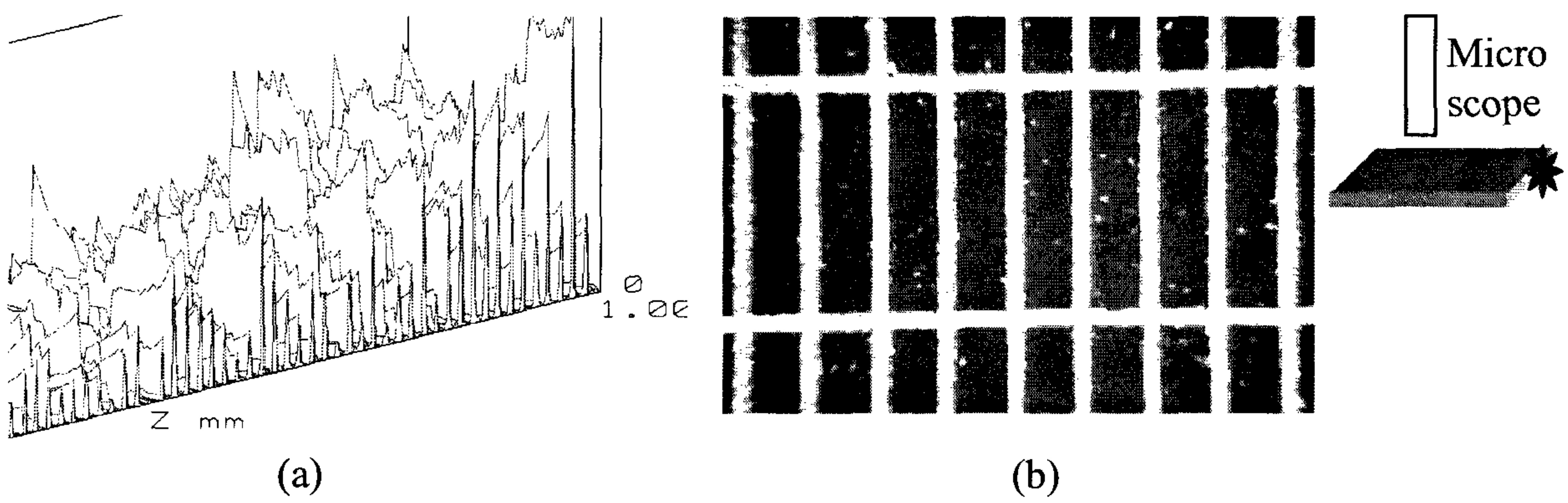

Fig. 3. (a) Simulated result and (b) measured micrograph when the light of CCFL is introduced into LGP from its side surface

Reference.

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