Backlight for TFT LCD

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Abstract

This seminar outlines the technology involved in the backlighting of TFT LCDs. It covers basic terminology, lighting requirements, lamp types and optical techniques. These will be reviewed and compared. Optical factors will be covered and related to space constraints. The spectral requirements, luminance levels, system efficacy, power requirements, lamp temperature, as well as other parameters affecting system performance will be discussed.

Introduction

Recent brilliant progress in development of liquid crystal display (LCD) demands a slim backlight (BL) with low weight and low power consumption BL, i.e. more bright and more uniform BL. The present conventional backlight can not fulfill the requirements of the new LCDs. Therefore, modification of the optical components used in backlight system such an cold cathode fluorescent lamp (CFL), CFL reflector, light guide plate, LGP reflector, light diffusing sheet and light collimation sheet is needed. In conventional backlight as CFL is used to illuminate the LGP employing edge lighting method. The incident light is guided into the LGP and diffused by white spots made of ink which are printed on the back side of the LGP and their diameters ranges from 0.25 to 1.0 mm. A diffusion of light leads to a loss of the light energy and a wavelength dispersion that causes color change over the BL. In order to use the light energy more effectively, a modification of the LGP is indispensable in the backlight system. An array of circular optical micro diffusing patterns (MDP) by curing method as minute as 100 um in diameter is designed and molded on the back surface of the LGP instead of white diffusing spots. Using internal reflection of light on each MDP element of the LGP, the loss due to diffusion, the wave length dispersion, the time consumption for printing diffusing spots and transportation between two workshops and their costs can be avoided.

Backlight Structure

Variety of backlights with light sources such as EL (Electro Luminance)., LED (Light Emitted Diode), CCFL (Cold Cathode Fluorescent Lamp) are used on the BLs of the liquid crystal display (LCD). EL of LED type BLs are mostly used in small size terminals such as cellular phones, and those with CCFL sources are used in LCD back lights of the notebook type personal computers. The CCFL used BLs are more convenient for portable LCD, because they have low weights and thin structures as shown Fig. 1. In this type of BLs, radiated lights are condensed using straight parabolic reflector, i.e. CCFL reflector, and inserted into the transparent LGP made of polymethyl methacrylate, from one of its sides. In order to obtain a proper uniformity of the emanating light on the front surface of the LGP, a gradation of ink made white spots (diameter variation), is printed on the back side of plate for diffusing guided light as shown Fig. 2. Part of the diffused light leaks out to the back or sides (except the light incident surface) of the LGP. To get back the leakage into the LGP a white reflector made of paper is set on the back near to the layer of the with spots and small parts of the LGP. The emanating light over the LGP is diffused uniformity using light diffusing sheet (diffuser) and two line-prism sheets with grooves perpendicular to each other are used to collimate the diffused light into the direction of normal to the front surface of the backlight.

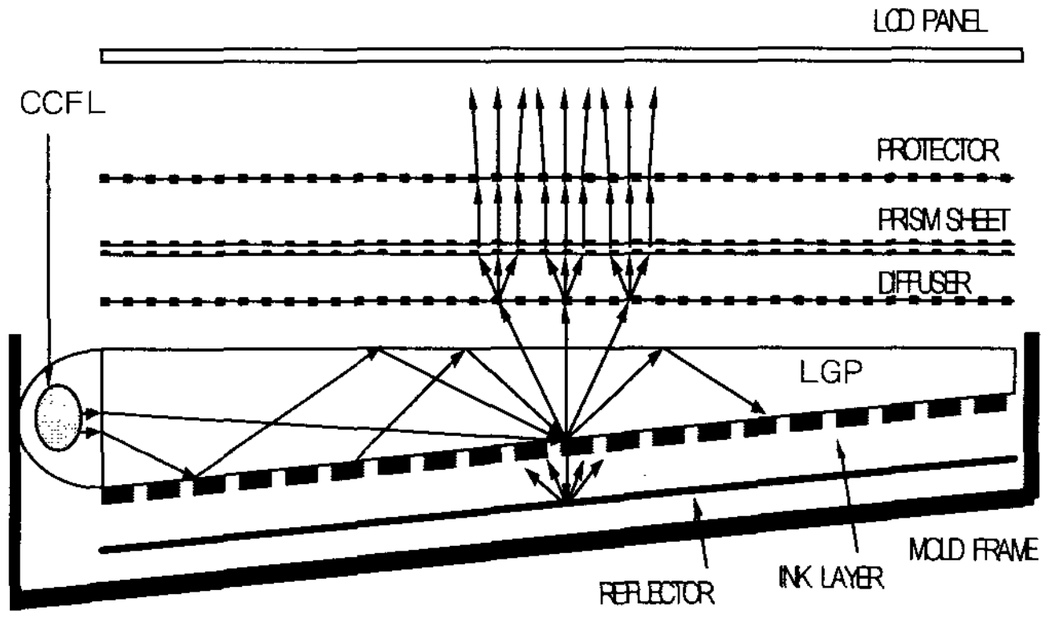

FIG. 1 Structure of edge-light type LCD back light with optical components for collimating light.

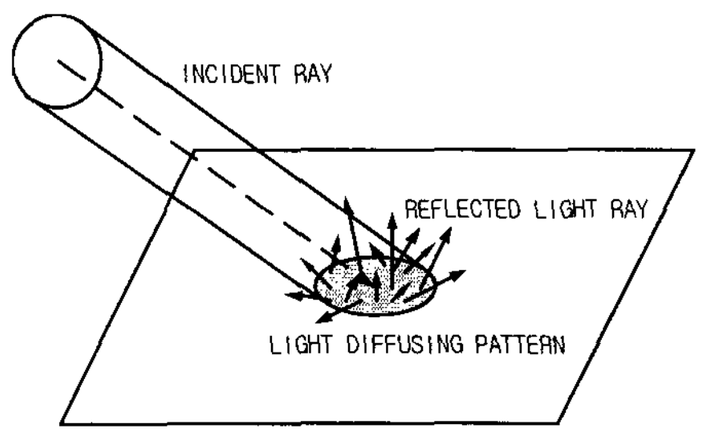

FIG. 2 Conventional ink-made white spot used to diffuse guided light in the LGP.

Light Guide Plate

Injection method is being used as a major technology in the fabrication of LGP for the BL below 307 mm(12.1") In diagonal, in our company array of light diffusing elements is etched and cured on the mold and the fabricated LGP possess diffusing characteristic. This kind of LGP is used in the assembly of the BL for the LCD. Using the cure method, we could increase the light emanating from LGP and save the time and money spending for the printing the spots on the back of the LGP. But, in principle, the etching is also leads to the diffusion of light and causes a loss of light energy in the LGP. We could modify the above process in order to obtain an optical surface for reflecting guided lights rather then diffusing lights. A chemical process is used to get the optical surface which causes an increase in emanating light. In this manner a gradation pattern of the micro diffusing patterns is designed and fabricated for the BL sizes ranges from 307 mm(12.1") to 358 mm (14.1") in diagonal. These pattern s have small sizes and can be used to control the direction of the reflected light as shown Fig. 3. A smooth surface of a MDP elements light incident on it, and few reduction of light energy and leakage light appear. Also, in BL structure ath small size of MDR elements, enables us to use thin diffusing sheets with a high transmissivity, compared with the thick and low transmissivity diffusers which are used together with the printed type LGP for hiding the spots. In general , we obtain about 6% more emanating light over the BL compared to those discussed above for 307 mm(12.1") size BL.

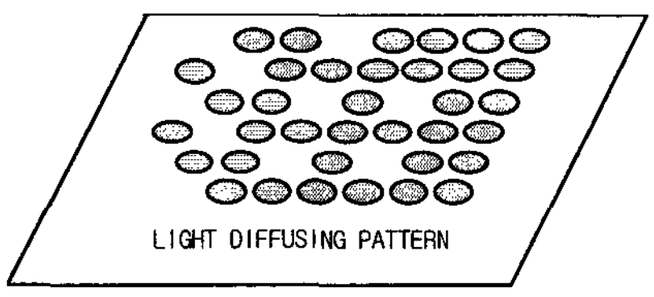

FIG. 3 Schematic diagram of the micro reflector and its array

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[3] K. Kalantar : 7th Fine Process Technology Japan '97, Comference Proceedings, No. C5, July 1997 (in Japanese)