미세 광학패턴기술을 이용한 Flexible Backlight에 관한 연구

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Investigation of flexible backlight using micro-scale optical function pattern design

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요 약

최근 휴대용 정보전자기기의 비약적인 사용의 증가는 충격에 보다 강한 디스플레이에 대한 연구를 발전시키는 계기가 되었다. 일부 제조회사에서 AMOLED를 사용한 디스플레이에서 유연한 특성을 가진 제품을 선보이고 있으나, 그 사용량에 있어서 압도적으로 많은 부분을 차지하고 있는 것은 LCD 이다. 특히 LCD는 구조적인 문제로 인하여 반드시 후면광원을 사용하여야 하는데, 면발광형식의 조광장치를 얇은 두께로 구현하는데 사용되는 것이 아크릴 재질의 도광판이다. 본 연구에서는 유연하지 않은 메틸메타아크릴레이트에 부틸 아크릴레이트 고무계열의 합성재료를 첨가하여 유연성을 유지하고, 투과율을 90%까지 상승시킨 KURARITY 라는 재질을 사용한 패턴의 설계 및 성형 결과를 통해서 유연한 후면광원의 가능성을 평가하는데 주력하였다. 평가 결과 기존의 광원과 동일한 수준의 밝기 및 휘도 균일도를 얻을 수 있었다.

Key Words : Backlight Unit, Flexible Backlight Unit, Light-guide Plate

ABSTRACT

We have designed high performance flexible prism light-guide plate (LGP) in 5 inch TFT-LCD for mobile applications. We adopted novel material such as methacrylate and butyl acrylate mixture, as it called KURARITY. It has good flexibility by addition of butyl acrylate. And it has also good transmissivity because methacrylate is a major compound. Then, we achieved good test result to embody high brightness and flexible BLU in case of LGP of base and upper surface with 5 inch, thickness 1.5mm adding prism construct, it is superior brightness improvement than previous flexible LGP. It shows significant improvement than previous printing form about some 5% and in this course to flexible embody actual material it succeeded prism LGP production by 5 inch injection form process.

I. Introduction

When the use of the TFT-LCD increases recently rapidly, the portable Note PC, tablet PC which saves the strong point of compactness and the use of the mobile applications spreads rapidly. Price of the LCD application is also important but to increasing mobility, flexible products is required mobile information terminal field such as smart phone and hand held PC application. Especially, mobile application has a potential of dropping. that is the why flexible display is needed strongly. Many peoples think the only solution is AMOLED because that is self-emissive display and it means doesn't need BLU. in the past time, many researcher made KURARITY their

Fig. 1. Transparent and elastic material.

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effort to realize flexible BLU but it has a problem of making flexible LGP. flexible transmissive materials not good for transmissivity and it cause low brightness. But we find the KURARITY(Kuraray Co. Ltd., Japan) and it is a proper material contains methacrylate and butyl acrylate. Butyl acrylate has a role of flexibility and major methacrylate increase transmissivity.And we also investigate about optical design for increasing brightness. Because the demand of the market about the BLU of the high performance, it is important to satisfaction of the product feature in the user center and the development of the high brightness product. Even though the original cost curtailment against a fundamental material arrives already to a limit in the present BLU market, the market demand of efficiency against focus parts surpasses the level of the technical development progress.

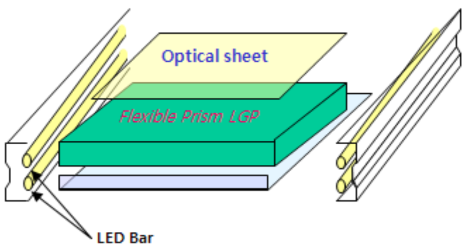


Fig. 2. Backlight unit structure

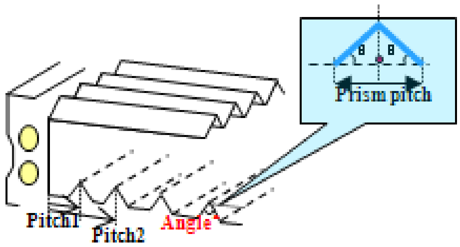


Fig. 3. Structure of upper prism and low prism

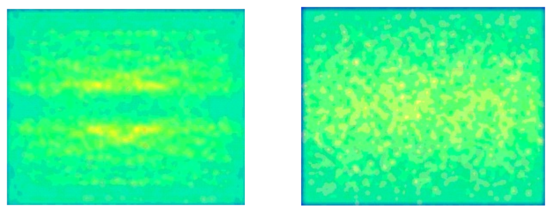
This research does not use the function characteristic optical sheet of high price like prism or the polarized prism and it uses only the diffusion sheet and as the focus parts manufactured the BLU of the high performance, it verifies probability through optical simulation for prism LGP and embodies actual material and focused on certification for reappearance of construct [2-3]. So, we estimated prediction of efficiency and realization of the object realization to architect and make of prism LGP which is the core parts using optical simulation.

Likewise Fig.2 and Fig.3, prism LGP increased efficiency of concentrate light through the arrangement of the same pitch prism on upper surface and controlled overall light density in addition to intaglio direction of lamp and horizontal prism lower surface. Also we used injection molding an engineering method order to realize of the object and achieved the cost reduction through shortening the length of the process. It compared with existing application process of printing after cutting the PMMA sheet. The optical simulation carried by SPEOS (OPTIS CO. Ltd.) and the optical simulation condition is same as before.

It predicts efficiency of LGP in construct stagethrough the optical simulation and it produced stamper using injection molding process to embody actual object. It produced metal material master reflected construct condition to produce stamper and produced stamper using this master through Ni plating processing. Injection molding used injection forming machine (Meiki Co., Ltd.) and injected after it attached stamper in both faces. It was progressed by dividing the bottom of the optical disk into relief and intaglio, in result it was able to predict the performance.

Ⅱ. Simulation and Experimental

In simulation, it accomplished the plan which leads an optical simulation assuming the bottom of the optical disk to be intaglio as shown in Fig. 2. and Fig. 3. It applied conditions such as, 20,000,000 simulation ray, 0.5m distance of detector, 5 inch LGP, against the prism form of upper or bottom part of the optical disk. With the optical simulation, there was a whole brightness distribution result as shown in the Fig.4. in BLU status.



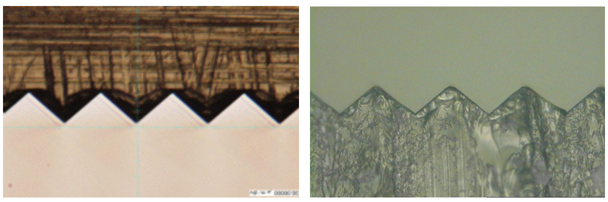
(a) (b)

Fig. 4. Result of optical simulation.
(a. in LGP status, b. in BLU status)

Figure 4(a) show which luminance result of optical simulation in the LGP. Emission light is concentrated through the center. It shows high brightness in incident plate where the lamp in top and bottom part stands. It was predicted with brightness result inline following to the center of horizontal axis in Fig. 4(a). So, Figure 4(b) show that result of optical simulation of application diffusion sheet in BLU. It shows that uniformity is increased using diffusion sheet.

On based the plan of simulation produced stamper processing Master of Stainless quality, and it embodied actual object through Injection molding using this stamper [4-8].

For complete reappearance of plan, molding product is applied to molding condition that can be formed a shape above 95 percentages in comparison of previos conventional BLU. In result, we obtain the complete molding product on based plan like fig.5. The actual object which is made by an injection molding process observed by brightness meter CA-1500(Minolta co., Ltd.), the brightness of surface is measured from the hand weaving normal direction falls from the optical disk. So, this measurement result compared with initial simulation result.



(a) (b)

Fig. 5.Vertical shape (a. in master. b. in LGP)

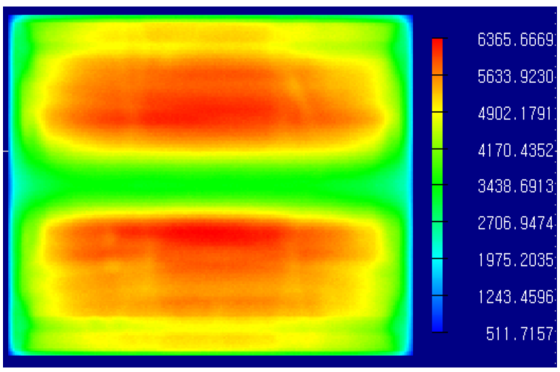


Fig. 6. Optical result of LGP surface measurement.

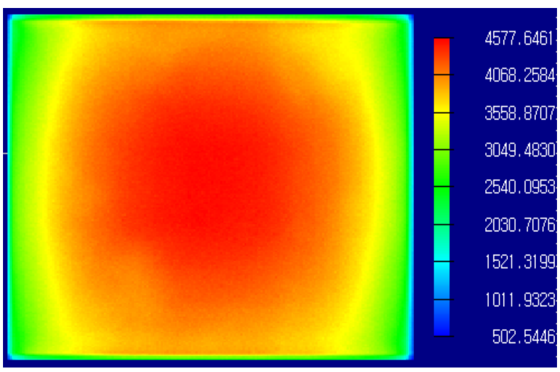


Fig. 7. Optical result of LGP surface measurement.

The result which it shows from Fig. 6 and Fig. 7, it shows the tendency which is identical with the result of optical simulation of initial design. With reference, in case when compared in priority top of brightness, there is a possibility of knowing the fact that the brightness of the case which it sets in intaglio comes out being high, in both intaglios. Thus, we accomplished of almost same luminance that is compared high brightness flexible BLU with conventional BLU.

Ⅲ. Conclusion

In this research, after achieving flexible prism LGP of 5inch, 1.5mm thickness from optical simulation to actual object embodiment, then investigated about high efficiency LGP which can be used with high brightness flexible BLU. As a test result, we could know that the prediction with using an optical simulation had a high accuracy and it was identical with the result of actual object embodiment and without using high price functional optical sheet. it was possible to manufacture low price, high efficiency BLU. And we studied a characteristics of methacrylate with butyl acrylate also.

From this cause, when accomplishing an optical simulation to reduce an expense and the hour as it follows in actual object embodiment, it was possible to predict accurate result prediction, and confirmed that it was useful to apply substantially in plan of the flexible optical material also. And in this research, by using injection molding it was successful to manufacture the LGP of ratio above 95%, it was confirmed that it could be manufactured high reliability plan with high transfer process with flexible LGP. By the actual object and optical simulation, in underneath form intaglio had advantage than relief in making effective brightness because of high output angle. When considering above result, without high price functional optical sheet, it was possible to confirm by using the actual object and optical simulation that it can be achieved brightness above 4700 nit and uniformity 75%, so hereafter we could know it possible to realize flexible prime cost curtailment and high performance of TFT-LCD for mobile applications

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