

광학시뮬레이션과 새로운 사출성형법을 사용한 TFT-LCD용 고휘도 프리즘 도광판

High Brightness Prism Light-guide Plate for TFT-LCDs Using Optical Simulation and Novel Injection Mold Process

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Abstract - We have designed high performance prism light-guide plate (LGP) in 17 inch TFT-LCD. In test result to embody high brightness BLU in case of LGP of base and upper surface with 17 inch, thickness 8mm adding prism construct. Using optical simulation, we forecast the brightness and uniformity in LGP with prism structure. And we adopted novel injection mold method and Nickel stamper to make actual evolution sample. Novel injection mold process has steady heating time zone in heat cycle time of injection mold process. For this novel heat cycle control, we achieved above 90[%] height prism structure as our design. It is superior brightness improvement than previous that of printing form about some 20[%] and in this course to embody actual material it succeeded prism LGP production by 17 inch injection form process.

Key Words : LGP (Light Guide Plate), Stamper, Prism structure, TFT-LCD, BLU(Back Light Unit)

1. Introduction

In the center of the TFT-LCD production industry the tendency of this original cost curtailment is deepened as time is past, recently the generation competition of manufacturing equipment is advanced. About the BLU occupied some 10~15[%] in manufacturing cost of the TFT-LCD, progress of the technical development for a positive original cost curtailment was delayed. 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[1].

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 [2-5].

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.

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2. Experimental

2.1 Design target and optical simulation conditions

Likewise Fig. 1 and Fig. 2., 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 on lower surface.

Also we used injection molding an engineering method in 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 stage through 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.

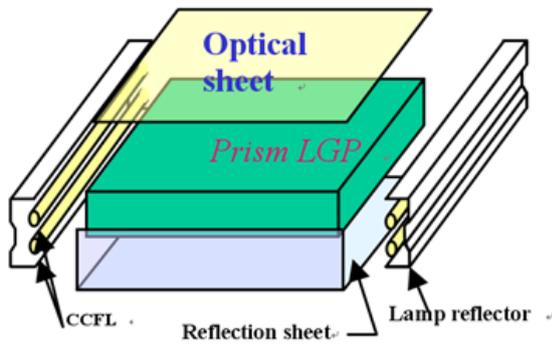


Fig. 1 Backlight unit structure.

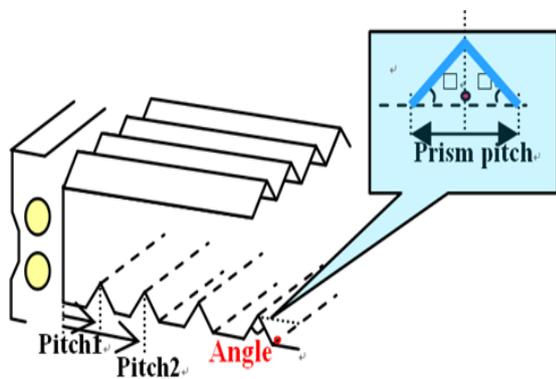


Fig. 2 Structure of upper prism and lower prism.

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. 1 and Fig. 2. It applied a condition of Table 1. against the prism form of upper or bottom part of the optical disk.

Table 1 Simulation condition.

	Width	Height	n	Thickness
LGP	345	281.4	1.49	8
Lamp	340		1.5	2.4
Prism	Upper	Angle : 90 degree		
	Lower	Angle : 80~90 degree		
Simulation Condition	Ray : 2000000, Detector : 0.5m			

2.2 Results and discussion of simulation

With the optical simulation, there was a whole brightness distribution result as shown in the Fig. 3 and Fig. 4.

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 90 percentages in comparison of plan.

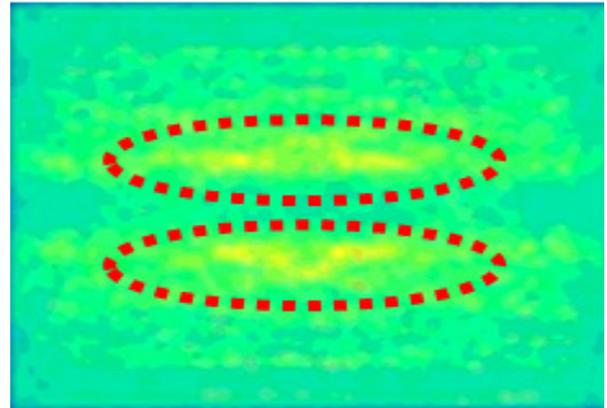


Fig. 3 Result of LGP optical simulation.

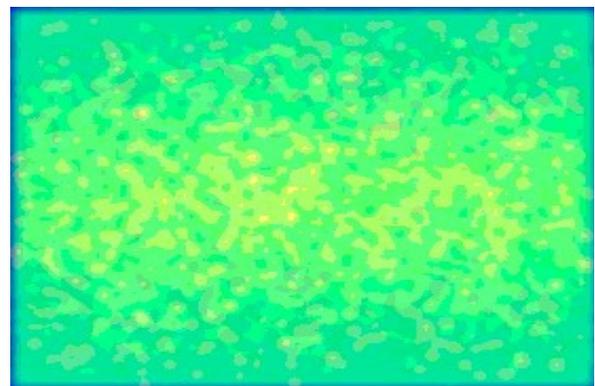


Fig. 4 Result of BLU optical simulation.

And we adopted novel injection molding method. It is based on heat cycle condition. Fig. 5 shows conventional heat cycle curve. Because it has not sufficient heating time, it is very hard to make peak shape as like prism structure. But this linear temperature control is adopted in spite of low quality. Because it is very easy to control injection machine. For this reason, prism structure is hard to make injection process. Fig. 6 shows our novel heat cycle curves. We made steady high temperature zone in one-shot and cooling process. This high temperature zone is made by very simple method as like inserting polyimide insulation film between mold and stamper. Because it is not change heat cycle condition, it does not affect any problem in actual mass production system such as long elapsed time and low output yield.

In result, we obtain the complete molding product on based plan like Fig. 7 and Fig. 8. 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.

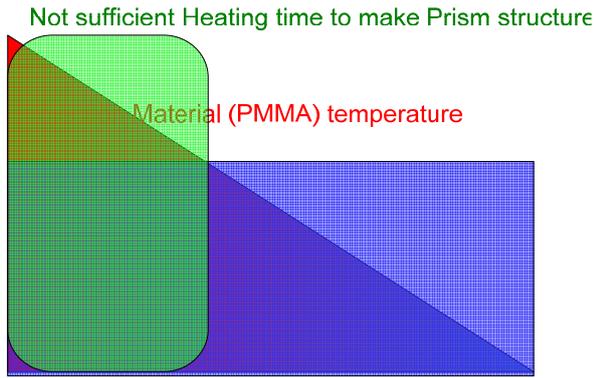


Fig. 5 Conventional heat cycle in injection mold process.

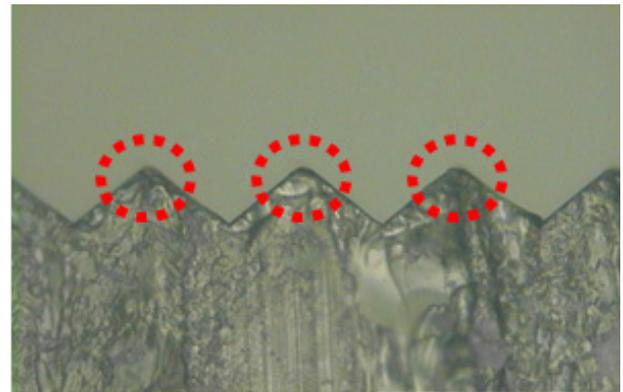


Fig. 8 Vertical shape of injected LGP.

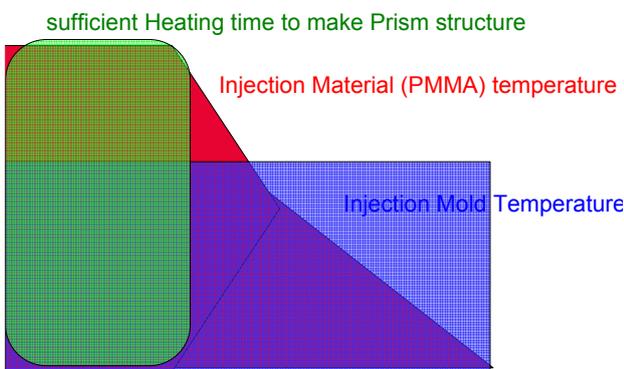


Fig. 6 Optimized heat cycle in injection mold process.

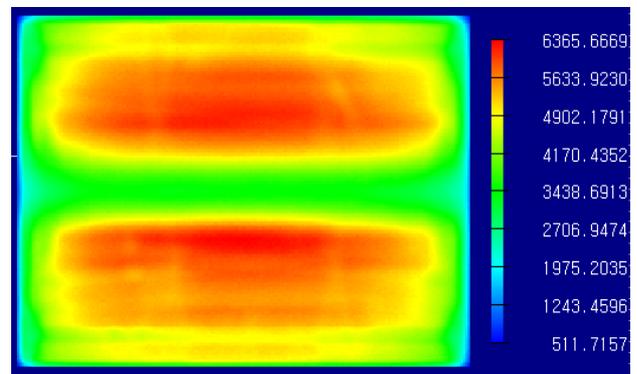


Fig. 9 Optical result of LGP surface measurement.

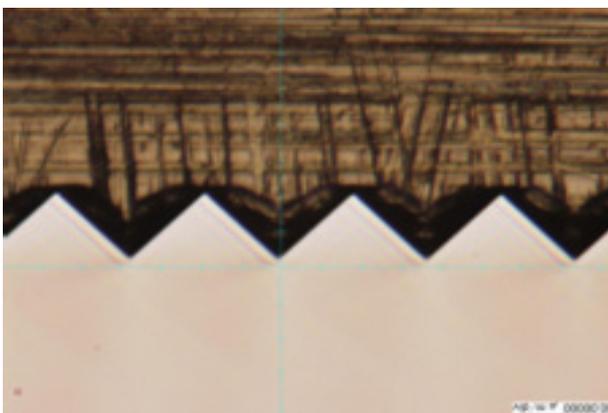


Fig. 7 Vertical shape of master stamper.

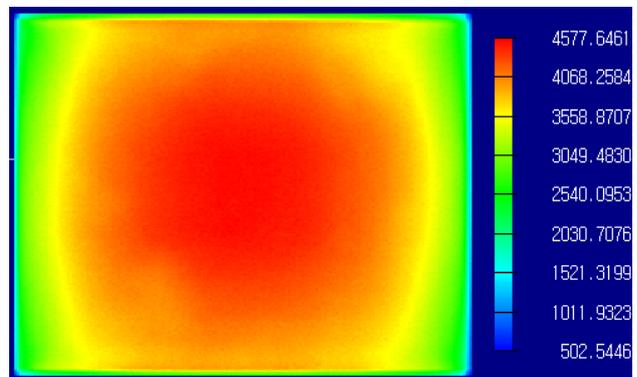


Fig. 10 Optical result of LGP surface measurement.

The result which it shows from Fig. 9 and Fig. 10, 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 same luminance that is compared high brightness BLU with existing BLU.

3. Conclusions

In this research, after achieving prism LGP of 17 inch, 8mm thickness from optical simulation to actual object embodiment, then investigated about high efficiency LGP which can be used with high brightness 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.

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 optical disk.

Also in this research, by using injection molding it was successful to manufacture the LGP of ratio above 90[%], it was confirmed that it could be manufactured high reliability plan with high transfer process. 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 prime cost curtailment and high performance of TFT-LCD for 17 inch monitor.

감사의 글

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