# The optimum simulation and real test of double prismatic Light-guide plate for a high brightness LCD backlight unit

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## ABSTRACT

*This dissertation represents method concerning high performance prism LGP design in 17 inch TFT-LCD. By means of developing LGP with total size of 8mm that has prism on both upper side and bottom side, it is superior to previous printing way in gaining high brightness. It can realize actual material simulation on prism LGP production using 17inch injection process and about 20% luminance enhancement is achieved based on such method..*

## 1. Objectives and Background

With time going on, cost down consciousness seems to have been a tendency in the main field of the TFT-LCD industry due to the advanced manufacturing equipments of various generations. LGP occupies 10~15% in manufacturing cost of the TFT-LCD but the technical development for cost down is laggard. However cost curtailment on fundamental materials has already arrived at a limit in the present BLU market and the market demand of efficiency on its main parts surpasses the level of the technical development progress.[1-5] That's why former way does not use the functional characteristic optical sheets of high price like prism or the polarized prism but adopts only diffusion sheet as the main parts for high luminance. It provides probability through optical simulation on prism LGP.

Here we can make prediction of efficiency by setting up the prism LGP structure and performing optical simulation on such main part of BLU. The basic LGP prism figure is shown in Fig. 2

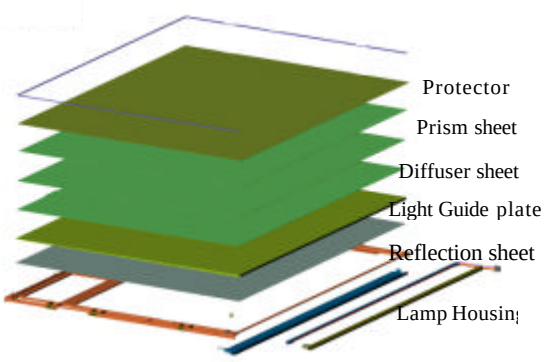



**Fig. 1 LCD Backlight unit Structure**

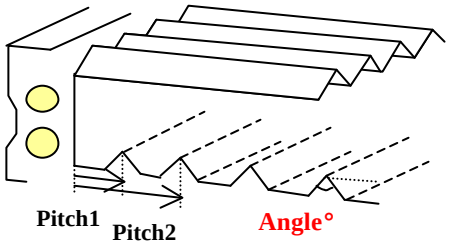



**Fig.2 LGP Structure of Upper prism and Lower prism**

According to Fig.1 and Fig.2, prism LGP increases light concentration efficiency as a result of setting prism of same pitch on upper surface and controls overall light density in intaglio direction of lamp and horizontal prism on lower surface. Also we use injection molding according to engineering method to form the entity and achieve cost reduction by shortening the length of the process compared with the existing process taking printing way after the PMMA base sheet has been made. The optical

simulation is carried out by BOE HYDIS pattern design tools and SPEOS(OPTIS co., Ltd., French) and the optical simulation condition is listed in Table.1.

Simulation estimates efficiency of LGP in construction stage and then produces stampers out of injection molding process to approach actual object. It produces metal texture on basis of construction condition to form stmapers through Ni plating processing. Injection molding is performed by injection forming machine and is formed after it has been attached stamper in both faces.

## 2. Experimental and results

Experiment is carried out by dividing the bottom optical surface into relief and intaglio so that it is most possible to predict the performance.

### 2.1 Optical simulation.

In simulation process, it touches the target which performs an optical simulation assuming that the bottom of the optical surface to be intaglio as shown in the Fig1. and Fig.2. It takes on a condition as Table 1 on prism of both upper and bottom optical surfaces.

| | | Width | Height | n | Thickness |
|---|---|---|---|---|---|
| LGP | | 345 | 281.4 | 1.49 | 8 |
| Lamp | | 340 | | 1.5 | 2.4 |
| Prism | Upper | Angle : 92 degree, H : 25 um | | | |
| | Lower | Angle : 80 degree, H : 28 um | | | |
| Simulation Condition | | Precision tolerance : ≤ 10% | | | |

**Table.1 Simulation Condition**

With the optical simulation, it brings out a wholely brightness distribution shown in the Fig.4. and Fig.5

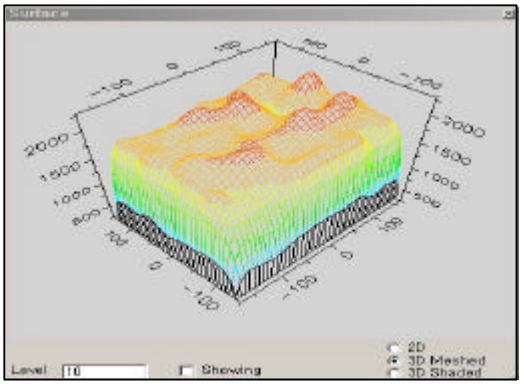


**Fig.4 Result of LGP optical simulation**

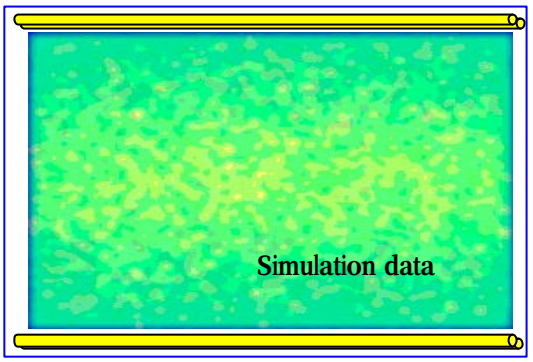
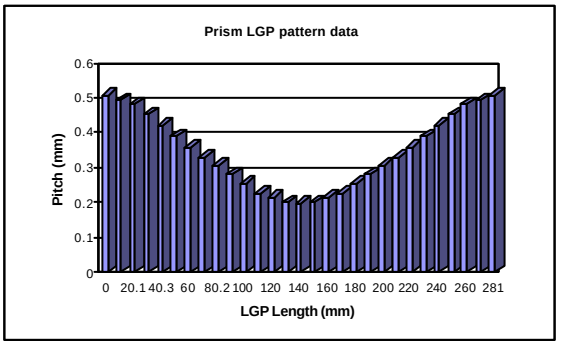



**Fig.5 Result of BLU optical simulation**

Fig.4 shows the luminance result of optical simulation in the LGP. Emission light is led to the center. It shows high brightness where the lamps are paralleled put along the incident surface. Such figure presents the brightness result along horizontal axis passing the center of the figure.

Fig.5 shows the result of optical simulation applying diffusion sheet in BLU. It shows that uniformity is enhanced due to diffusion sheet application.



**Graph.1 Optimized Prism LGP pattern data**

Graph.1 is the optimum of bottom prism pattern data of LGP. It shows the high brightness in incident surface where the lamps are paralleled put along the incident surface.

### 2.2 Experiment

Based on the idea of simulating producing stamper processing Master of Stainless quality, it realizes actual object through Injection molding using this stamper.

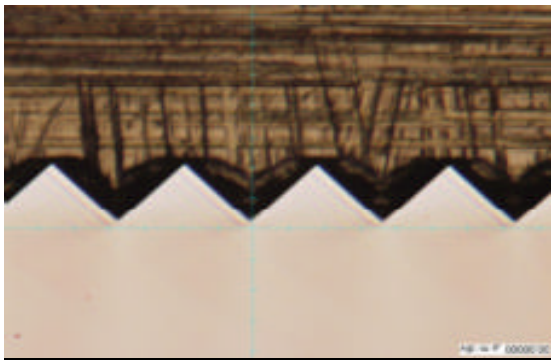


**Fig.6 Vertical Shape of Master**

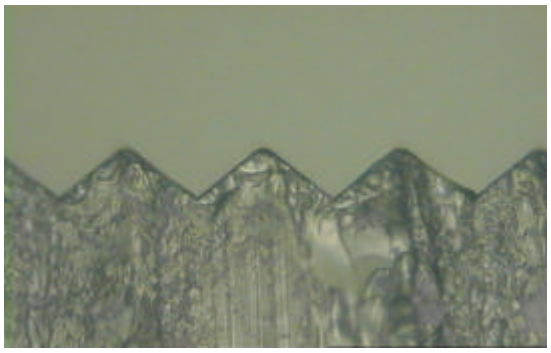


**Fig.7 Vertical Shape of LGP**

In order to complete reappearance of the plan, molding product is made under molding condition and can form a shape over 90 percentages. As a result, we obtain the complete molding product shown in Fig.6 and Fig.7. The actual object which is made by an injection molding process is observed by brightness meter CA-1500(Minolta co., Ltd., Japan), and the brightness of surface is measured from the hand weaving normal direction to the optical surface. In this way, we can compare the measuring result with the former simulation result.

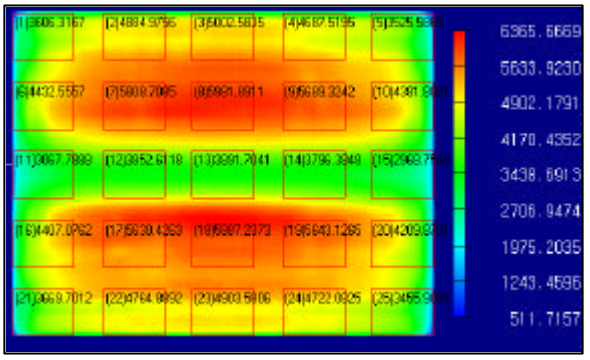



**Fig.8 Optical Result of LGP surface Measurement**

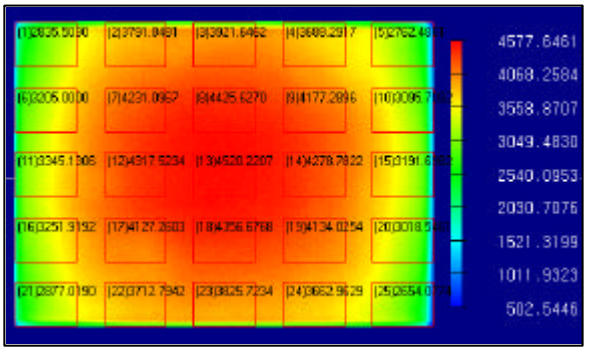



**Fig.9 Optical Result of LGP surface Measurement**

The outcome is shown in Fig.8 and Fig.9. It depicts the tendency which is identical to the result of optical simulation of the first stage design. In reference, by comparing the brightness, there is a possibility of knowing the fact that whether the outcome brightness of the case which it sets in intaglio is high or not, in both intaglios.

In one word, we accomplish of same luminance by comparing high brightness BLU with existing BLU

### 3. Summary

In this research, after achieving prism LGP of 17inch, 8mm thickness by optical simulation to actual object embodiment, then investigated about high efficiency LGP which can be used with high brightness BLU. According to the result, we can know that the prediction with using an optical simulation had a high accuracy .it is identical with the result of actual object embodiment and not

necessary to use high price functional optical sheet. It is possible to reduce the manufacturing cost, high efficiency BLU. so when it follows in actual object embodiment and accomplish an optical simulation to reduce an expense and the hour .it is possible to predict accuracy of the result prediction and confirm that it is useful to apply substantially to the plan of the optical disk .Meanwhile in this research, by using injection molding it is successful to manufacture the LGP with ratio above 90%, it is confirmed that it could be manufactured high reliable plan with high transfer process. By the actual object and optical simulation, in underneath form intaglio has more advantages than relief in making effective brightness because of high output angle. So without high price functional optical sheet, it is possible to be confirmed by using the actual object and optical simulation that it can be achieved brightness above 4700 nit and uniformity 75%, so we can know it is possible to realize prime cost curtailment and high performance of TFT-LCD for 17inch monitor.

## 4. Reference

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[3] Nakanishi, K. Kobayashi, SID01 Digest, 32, 488
[4] H. Zou, SID97 Digest, 373
[5] Y. Yamada, K. Miyachi, M. Kubo, S. Mizushima, Y. Ishii, M. Hijikigawa, Proceeding of IDW02, 203