

## Analysis of black "mura" in prism light guide plate for high brightness LCD's

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### Abstract

We have analyzed the cause of black "mura" and measured it in prism light guide plate(LGP). Properties of components used in a backlight unit(BLU) have changed by simulation tool. We get major factor of black "mura" for improvement in prism LGP. For the improvement of black "mura", removal of brightness "mura" at input light part must precede preferentially because of reflection characteristic of the prism LGP. Removal of brightness "mura" is improved by hanging of input light part in LGP and dispersion treatment.

### 1. Introduction

Conventionally, LCDs are illuminated using a backlight system.

The Brightness of BLU causes a big effect in the brightness of the whole of LCD(Liquid Crystal Display) module.<sup>1,2</sup>

Recently, according to the resolution increases and the aperture ratio comes to be low, it will not be able to show brightness well with normal BLU previously.

Also, according to the demand of more bright note PC, BLU with high brightness is developed.

General BLU composition is maintained the uniform brightness by adjustment of the dispersion degree on the LGP of wedge type with forming dot printing pattern on base side.

But the prism LGP has defecting structure. Fig. 1 shows structure of Prism LGP. The light is deflected by prism pattern on base side with perpendicular direction of lamp and is dispersed by non pattern on top side of LGP.

From the BLU of existing, there is dispersion on base side and the sheet. But the major factor of dispersion in prism LGP is the sheet.

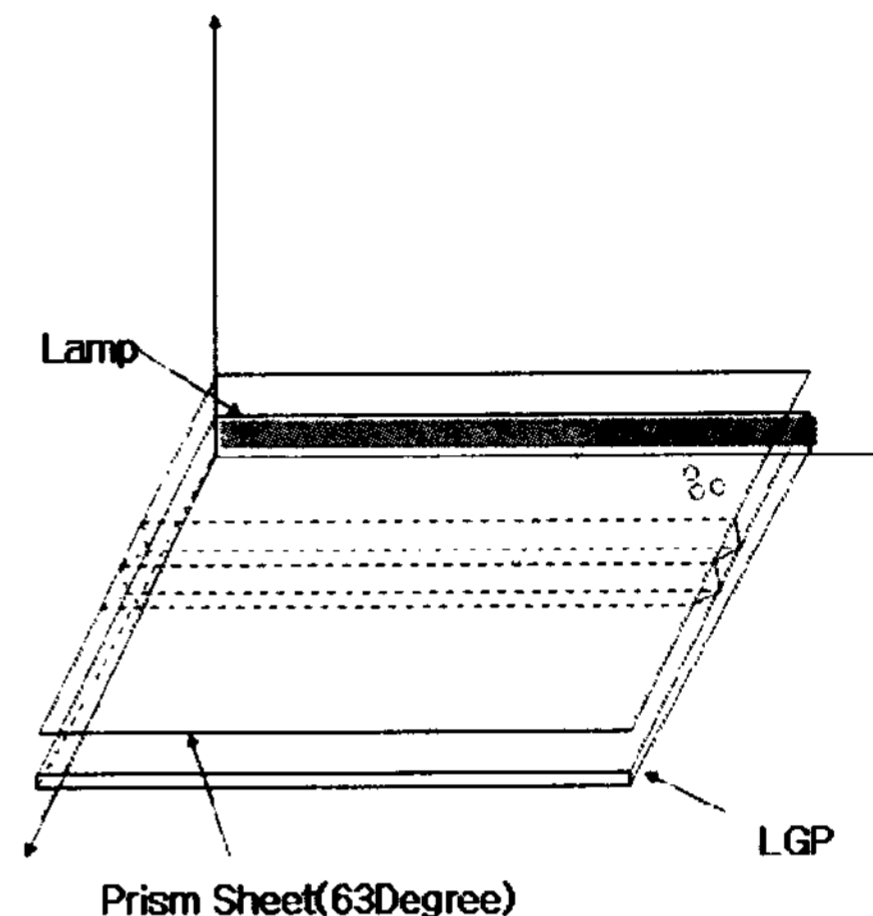


Figure 1 Structure of Prism LGP

From here, black "mura" in prism LGP is generated as shown in Fig. 2. So we have researched the cause of black "mura" and the solution plan.



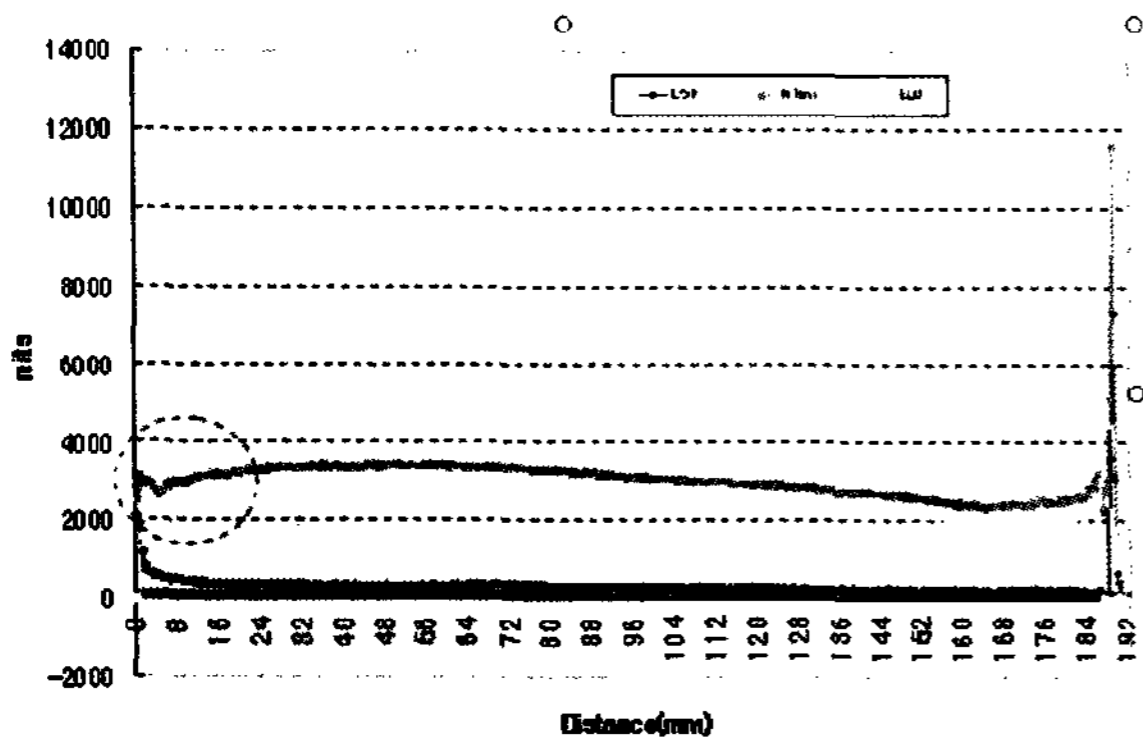
Figure 2 Black mura in Prism LGP

### 2. Measurement

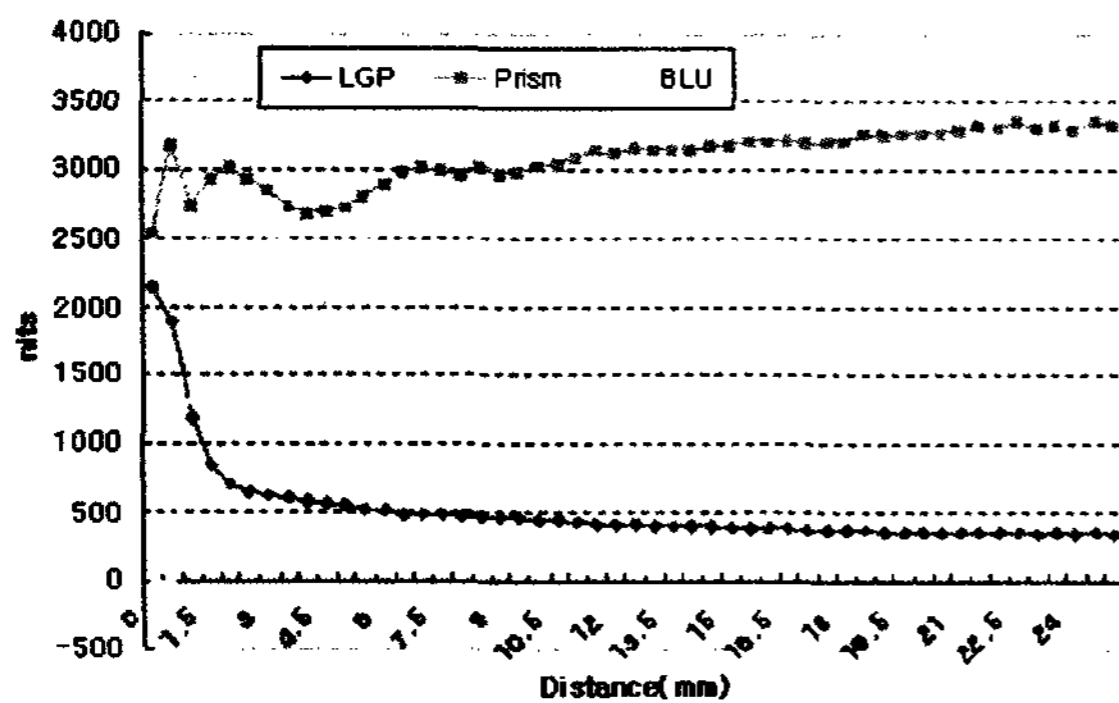
The Luminescence is measured by the BM7 of TOPCON company with perpendicular direction of lamp at 0.5mm intervals from LGP center.

Figure 3 shows the results for the measurement.

We are measured the brightness alternately by removal of protection sheet and reverse prism sheet from BLU.



(a)

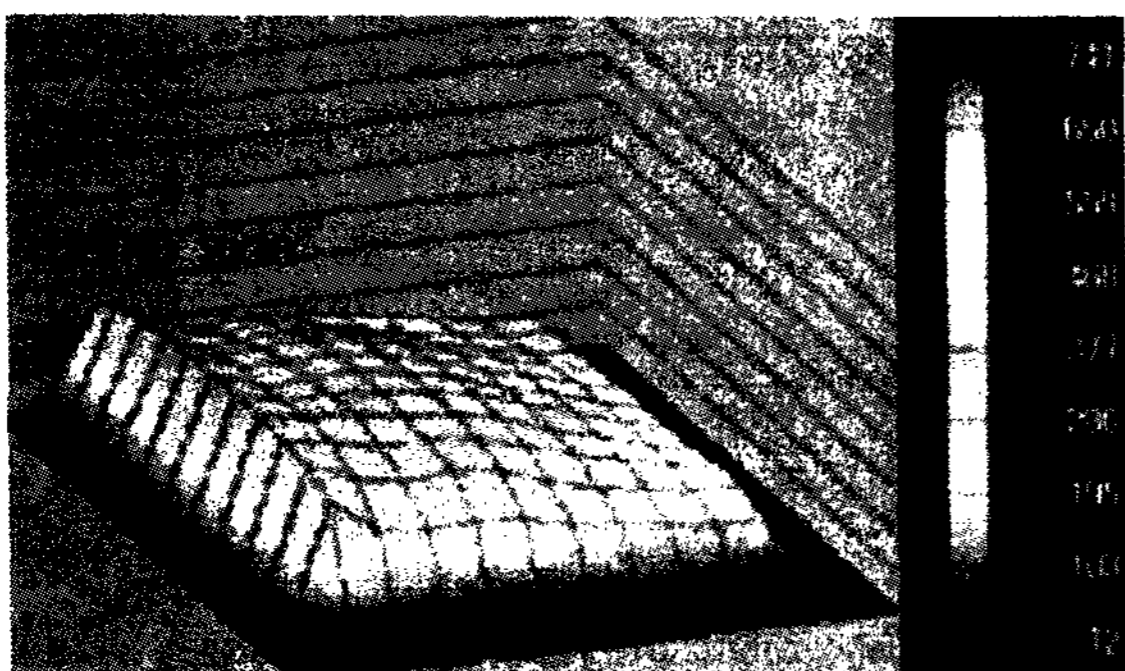


(b)

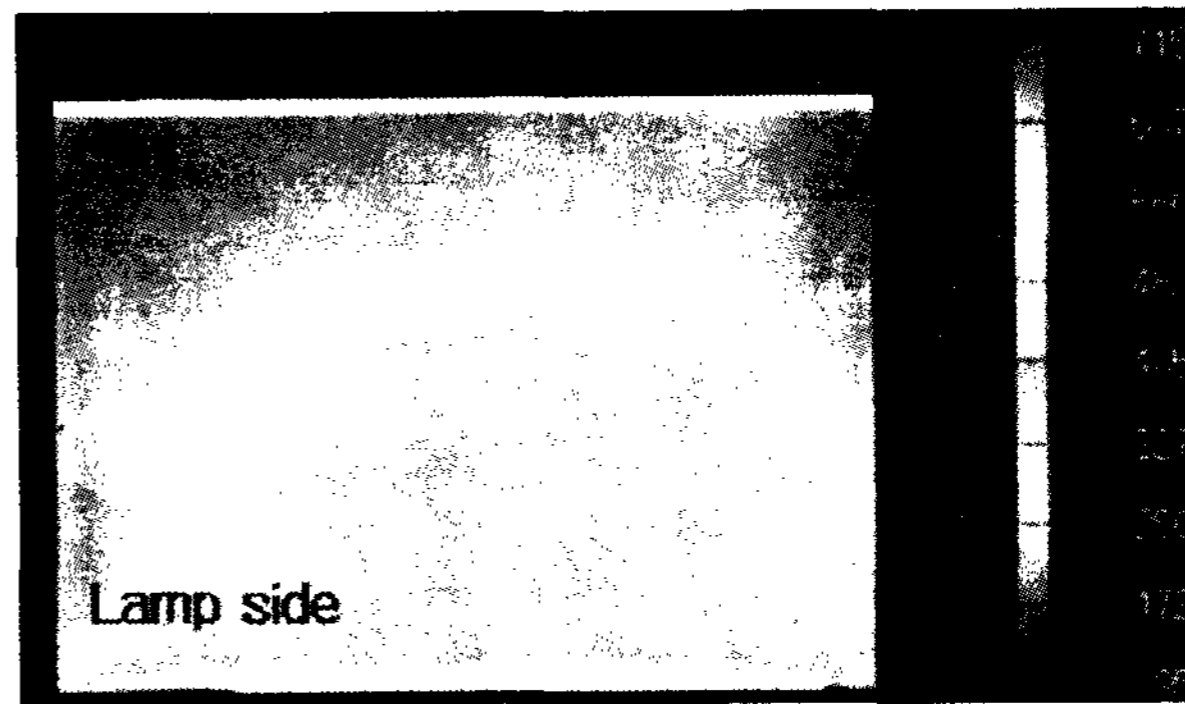
**Figure 3 (a) Full vertical Line, (b) detail vertical Line luminescence in Prism LGP**

After removal of all sheets from BLU, we are unable to see the black "mura" besides data of high brightness from the measurement data.

But black "mura" is shown certainly by add of reverse prism sheet.



(a)

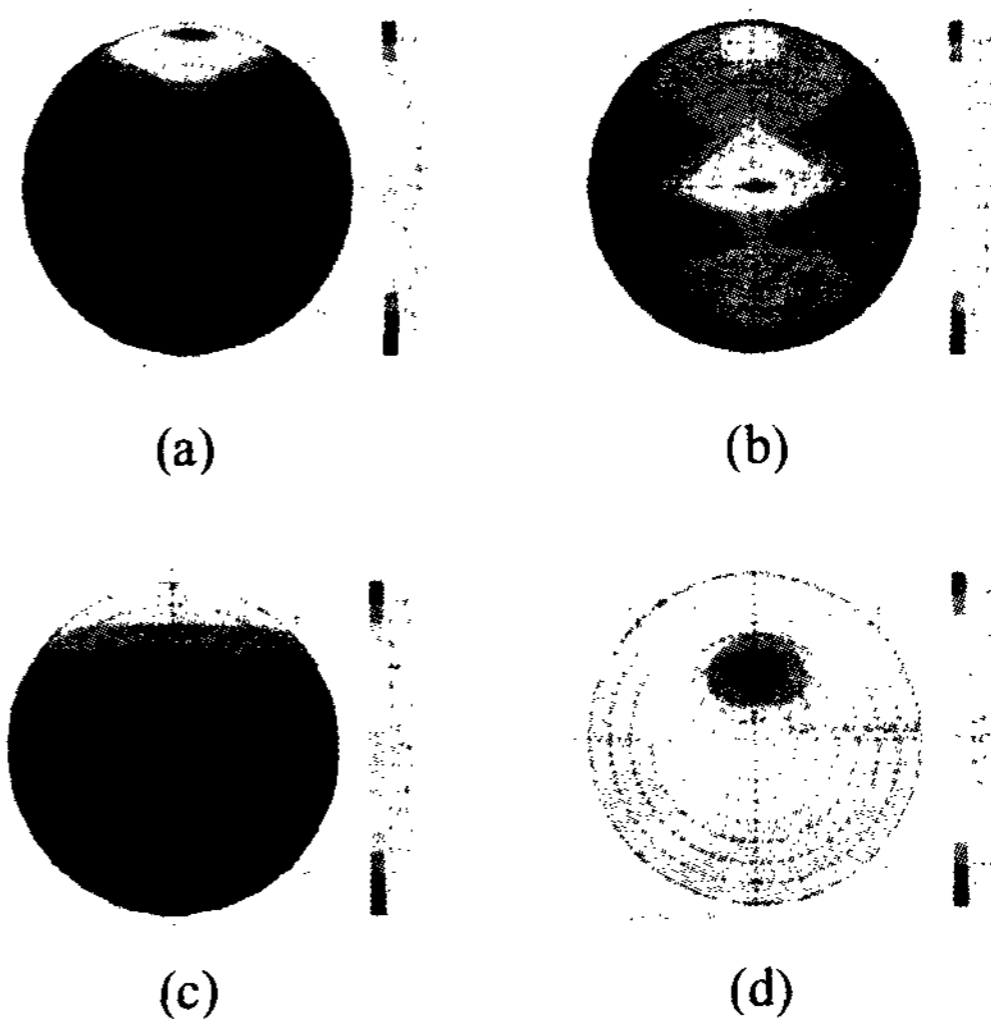


(b)

**Figure 4 (a) 2D Luminescence distribution, (b) 3D Luminescence distribution in Prism LGP**

The Brightness "mura" of light input part is split by reverse prism sheet.

And Black "mura" with crossing brightness and dark is generated by structure of reverse prism sheet. Because the light is concentrated in center point of observance.



**Figure 5 Viewing Angle in (a) Prism LGP (b) Prism LGP + Prism sheet(63degree) (c) Printed LGP (d) Printed LGP + Diffuser**

The horizontal viewing angle is wider than vertical viewing angle in prism LGP (Fig 5 (a)). But Printed LGP vertical viewing angle is wider than horizontal viewing angle (Fig 5 (c)). And BLU in prism LGP add

to prism sheet, printed LGP add to diffuser sheet show Figure 5 (b), (d). Prism LGP Vertical viewing angle is wider than printed LGP shown in Figure 6.

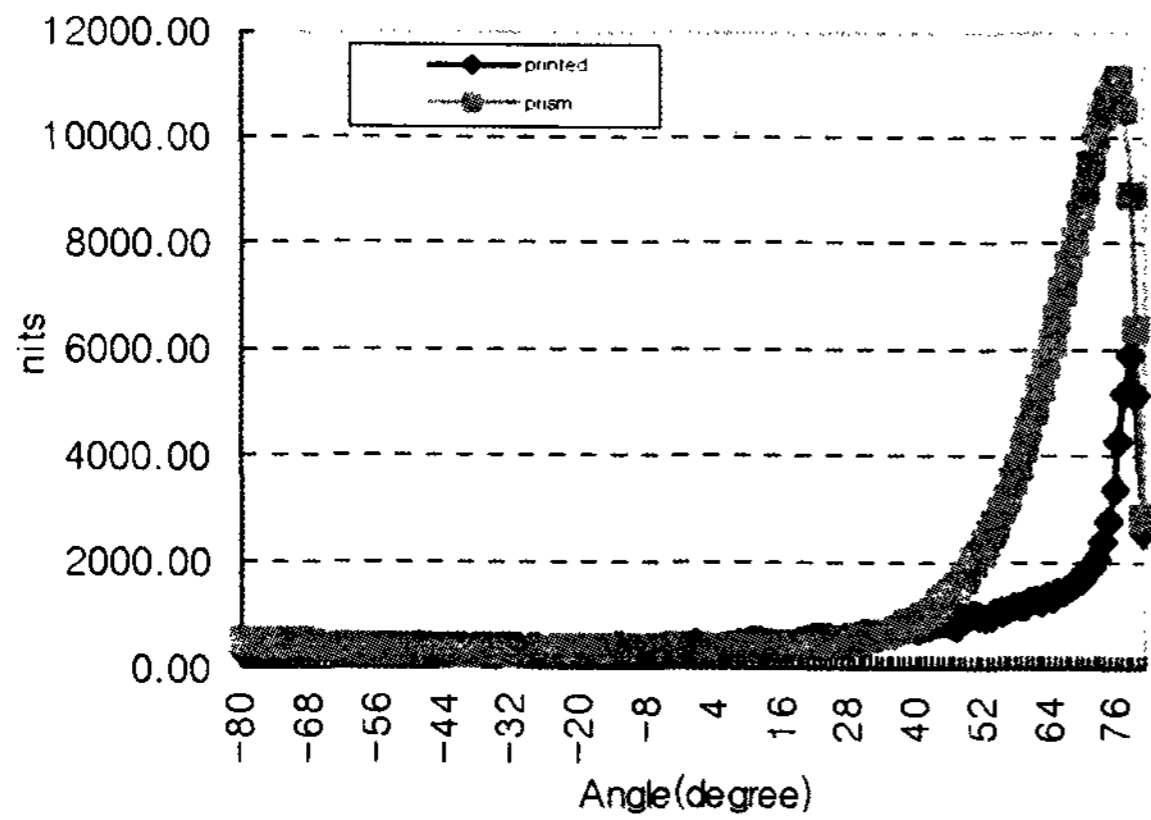


Figure 6 Vertical viewing Angle In LGP

3. Simulation

The reason of black "mura" at light input part in prism LGP is estimated at the brightness "mura" on LGP.

We can know that the fact brightness "mura" makes black "mura" at input part of BLU by Simulation like in Figure 7.

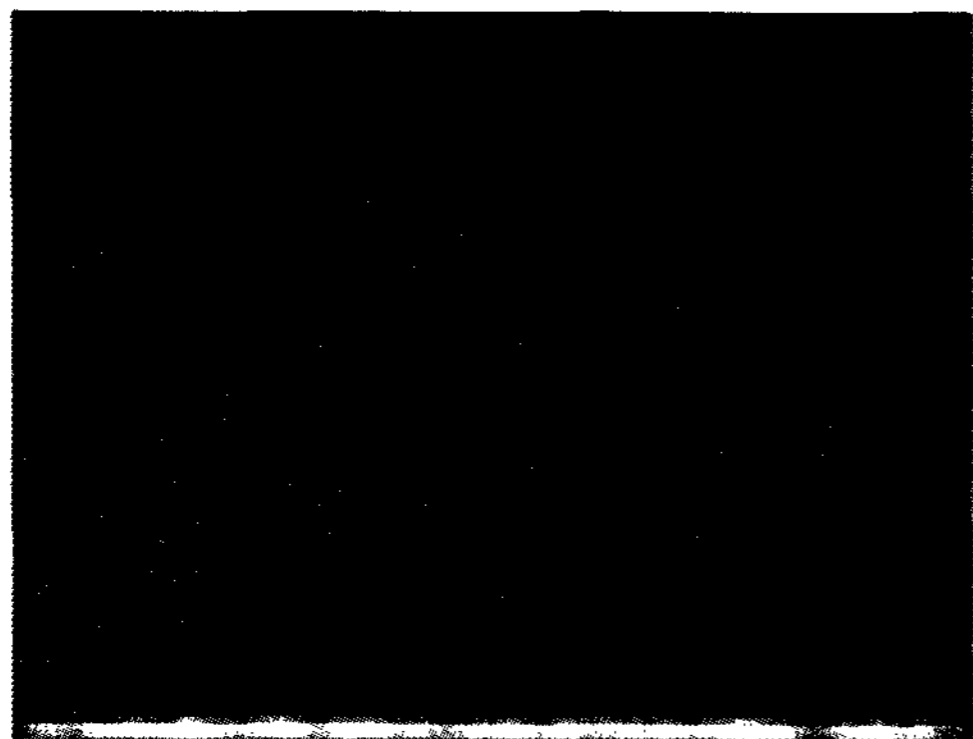
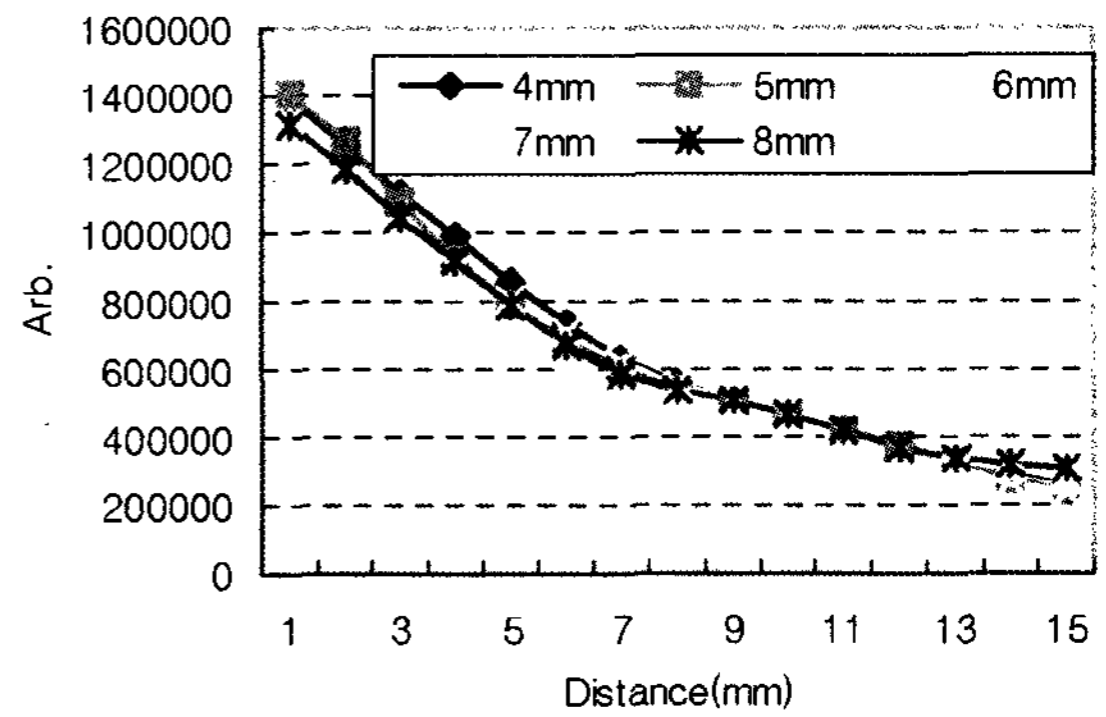
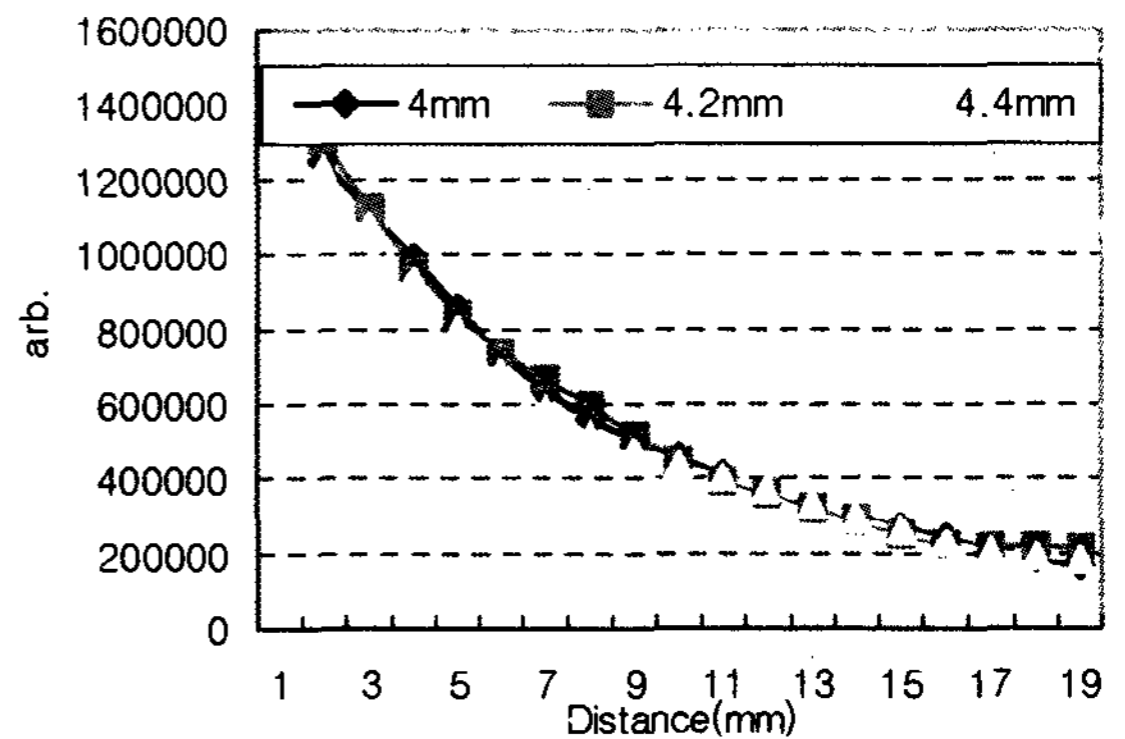


Figure 7 Brightness "mura" in input part of BLU

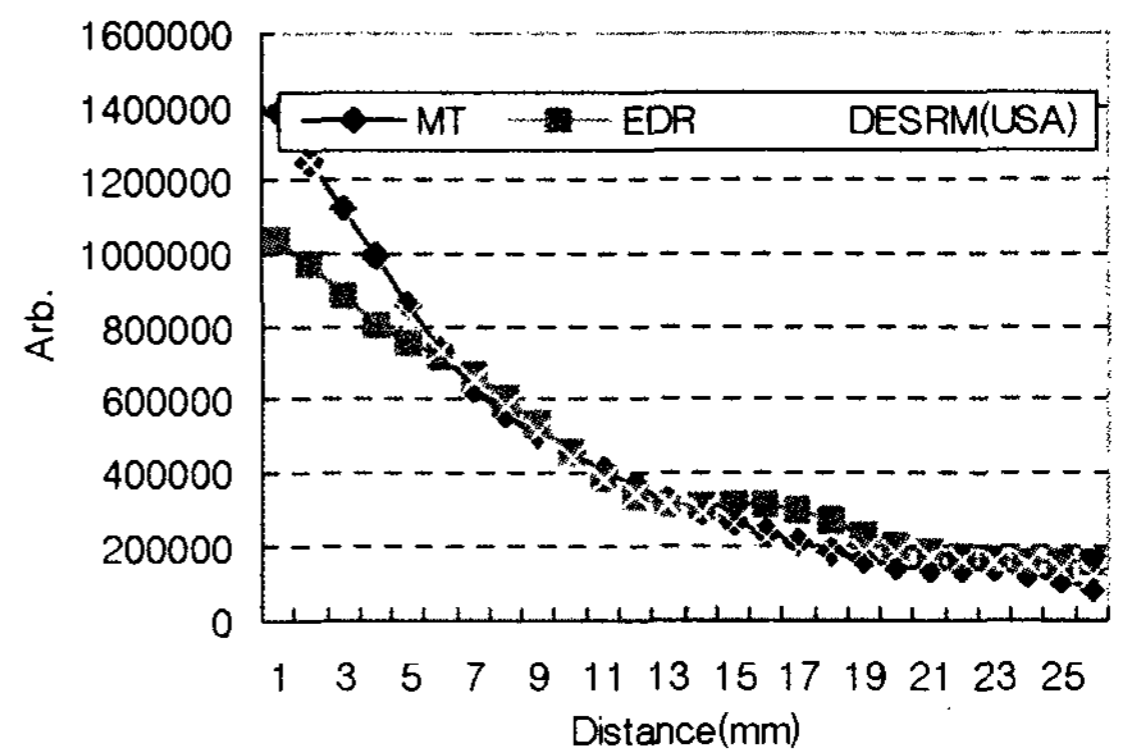
According to the changing of the top side length of lamp reflector and increasing of the interval between the lamp and LGP, we simulated for degree of brightness "mura".(Fig. 8)



(a)



(b)



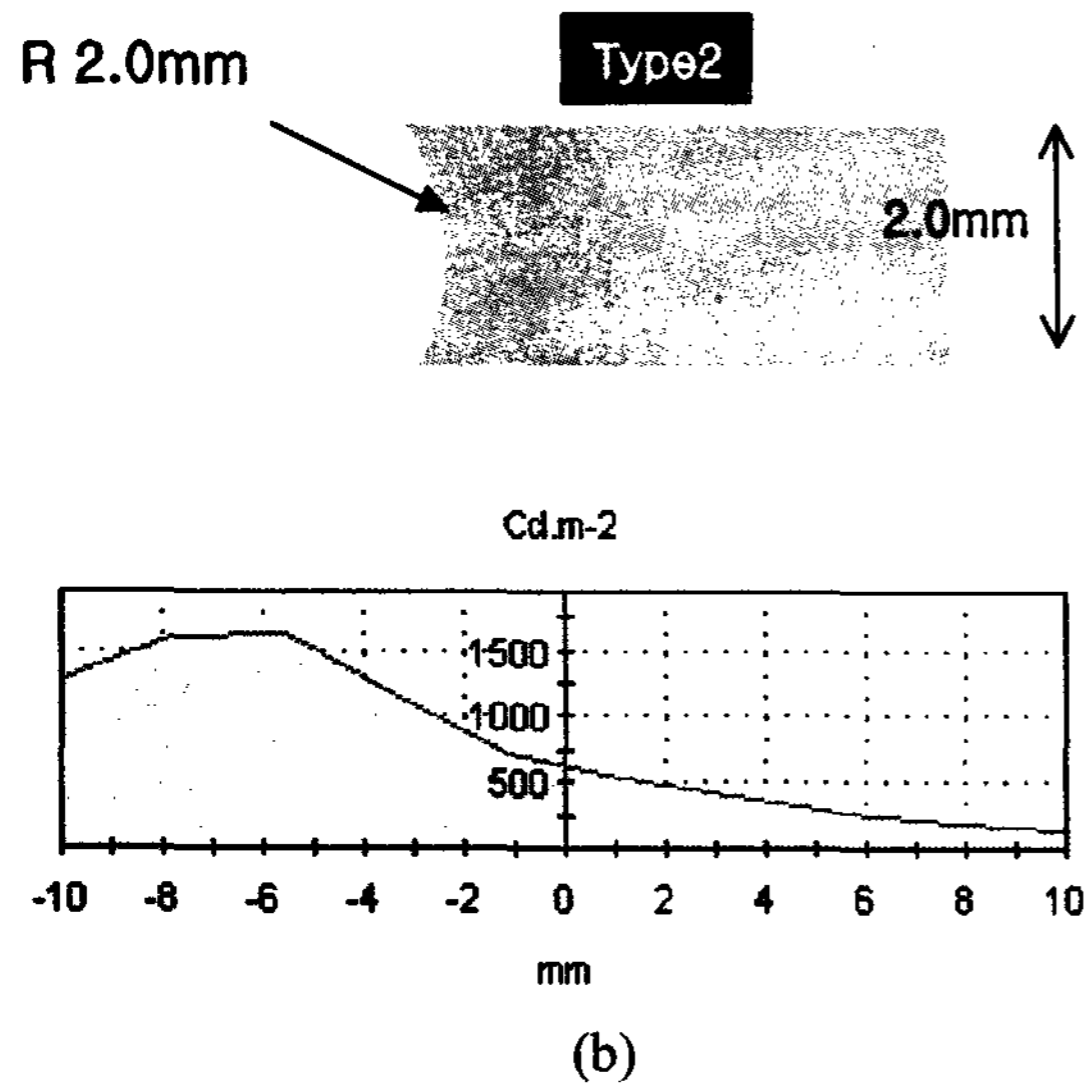
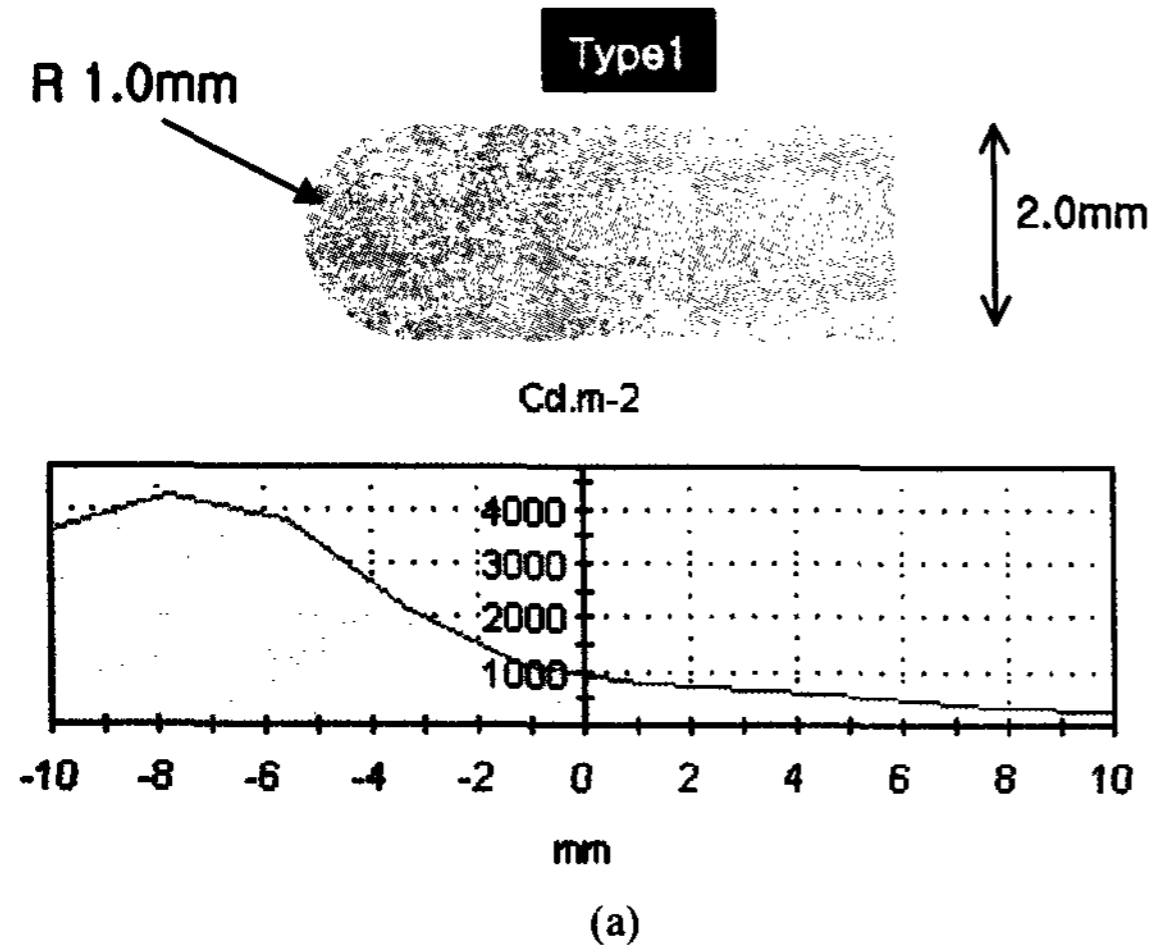
(c)

Figure 8 Simulation result (a) Lamp reflector Length simulation (b) Lamp to LGP distance simulation (c) Lamp reflector surface property simulation

Two results to effect of the brightness "mura" did not become the big factor.

And according to the changing with concave lens, the

convex lens and a prism form, the degree of brightness "mura" changed. (Fig 9)



**Figure 9 Simulation result (a) convex lens type LGP (b) concave lens type LGP**

Also according to the changing for the dispersion degree of lamp reflector, the degree of Brightness "mura" is considerably changed.

From this cause, brightness "mura" is reduced by form of the LGP and diffusion degree of the different parts.

And with this method the prism will be able to improve the black "mura" in prism LGP.

#### 4. Conclusion

For BLU of high brightness, prism LGP is effective method. But when black "mura" of at input light part is not improved, the problem of mass production occurs.

For the improvement of black "mura", removal of brightness "mura" at input light part must precede preferentially because of the prism LGP with reflection characteristics.

Removal of brightness "mura" is improved by changing of input light part in LGP and dispersion treatment.

#### 5. References

<sup>1</sup> Henri J.B. Jagt, Hugo J. Cornelissen, Dirk J. Broer, SID 02 DIGEST 45.3

<sup>2</sup> K. Kälantär, Journal of the SID 11/4, 2003