The optical characteristics of White LED BLU with tunable chromaticity coordinates

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Abstract

LCD(Liquid Crystal Display) products is needed to have high reliability and are produced without harmful material. Because Substitution for CCFL of Light source used to Conventional backlight unit, research is going about product with LED of light source at present. In this experiment, We made the LED backlight unit with high quality for automotive-navigation. This backlight unit has center luminance of 6500 nit at15W power consumption. We adjusted chromaticity by using ten Blue LED and eight side emitting type White LEDs with high power LED from Lumileds company.

1. Objectives and Background

According to the accelerative modern industry, the application fields of many display industries become various. TFT(Thin Film Transistor)-LCD field is continuously processed by means of the large size display from conventional Monitor and Note PC to TV industry. And the application field is enlarged to the mobile, PDA, and the camera. CNS(Car navigation system) appears the most requirement of customers. CNS product is gradually required in many needs of convenience of user interface, multimedia player and an intelligent car navigation system. Difference from properties of conventional TFT-LCD is that car navigation system is needed to have high reliability in the wide operating temperature range, vibration and shock. And use of mercury is strictly restricted for driver security in a closed structure of car.

We have to use backlight unit because liquid crystal display is non-emissive display of active type recently. CCFL of backlight unit of TFT-LCD is contented in mercury for generation of plasma discharge and starting up. It helps to discharge of CCFL in the normal temperature. But CCFL has defects in the lifetime, characteristics of alteration to the liquid in the lower temperature and environmental problem. So guaranteed LED needed to operating in lower temperature, endurable shock and vibration by backlight unit source of solid semiconductor is used. And optical design is competed by considering to the characteristics of LED light source.

By using the eight Side emitting type LEDs(each LED has 1W high power), we achieved to the simplicity of mechanical structure and we verified the center brightness of this LED BLU is 6500nit by measurement.

2. Experimental and results

2.1 The characteristics of side emitting type White LED and the structure of LED BLU

In order to the development of TFT-LCD used in automobile navigation with needs of high reliability, we made LED BLU by using the side emitting type white LED with 1W high power of the Lumileds company in this experiment.

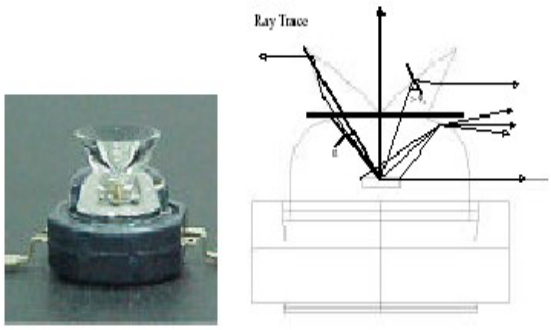

Fig.1. Luxeon side-emitter with ray trace

Figure1 shows the structure of side emitting type White LED with the consumption power of 1W and

emitting characteristics of light. Figure2 shows the spectrum data of that. Before manufacturing of LED Backlight unit, we measured the light flux of conventional TFT-LCD used by CCFL. The result is 203lumen in 4W of the power consumption for the measurement of light intensity. In the base of result, the light Flux of 237lumen is measured by used to eight side emitting type White LEDs of 1W with emitting characteristics of 35lm/W. Side-emitting LEDs are particularly suitable for coupling the light from the LEDs directly into a light guide[1-3].

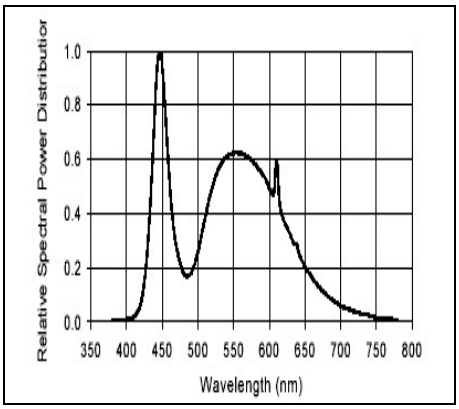

Fig.2. Spectra for 1W side emitting type White LED

2.2 Simulation

Modeling method is completed by considering of backlight structure and LED shape in the structure of eight white LED of side emitter type.

Figure3 is structure of manufactured LED Backlight unit. Manufactured LED Backlight unit has four LEDs at up side and other four LEDs at down side, which emit parallel light to the LGP. Optical characteristic is simulated by use of the LED condition according to LGP thickness. We get that most suitable thickness of LGP is 4 mm by simulation result. And we used to optical sheet BEF-III of 3M company for improvement of optical efficiency.

LED Driver is located in lower part of reflector sheet due to mount height of LED for characteristic of Liquid Crystal Display with light and thin thickness in this structure. As a result of use to White LED is not need to mixing area, LED external is minimized

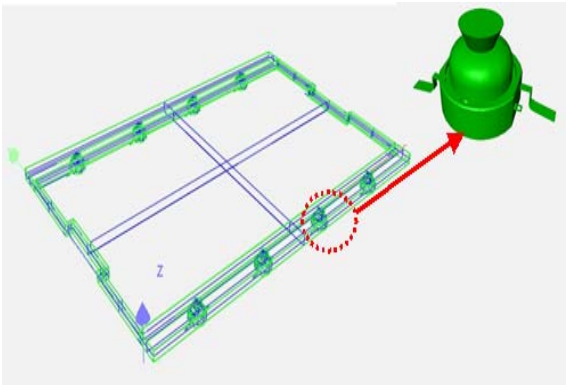

Fig.3. Structure of White LED backlight.

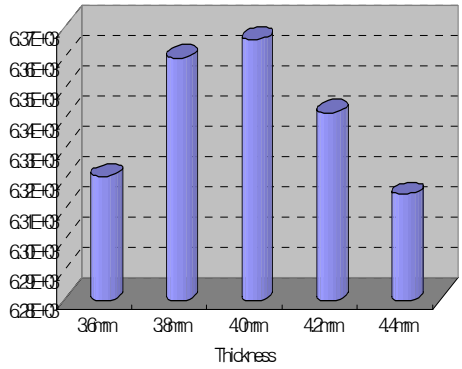

Fig.4. Luminance intensity for thickness of light guide plate

2.3 Result

Basic structure of LED by simulation result is the same as Figure 3 LED is fixed on Metal PCB for protection against heat of LED by Adhesive. Metal PCB is used by AL category 50## for protection against heat and efficiency of soldering operation. For one body structure, operating diver is set on metal PCB. Thickness of LGP is applied by 4mm according to simulation result. And adjustment of LED chromaticity is modified by changing of each LED Red, Green, Blue color. But because each intensity of Red, Green color for adjustment of chromaticity in the White LED is impossible, we are developed modify method by increase of Blue color intensity.

Figure 5 is chromaticity according to increase of light intensity. This experiment was achieved center luminance 6500 nit at power consumption of 15W by eight White LED of 1W side emitting type and ten blue LED of 0.05W. And variation ratio of chromaticity was Wx : 0.3044~ 0.2940(delta Wx

0.01)and Wy : 0.3242 ~ 0.3088(delta Wy 0.015) at same condition. Table1 is variation value of chromaticity according to operating driving of blue LED Figure 6 is measurement result of 7 inch LED Backlight Unit by CA-1500 Minolta.

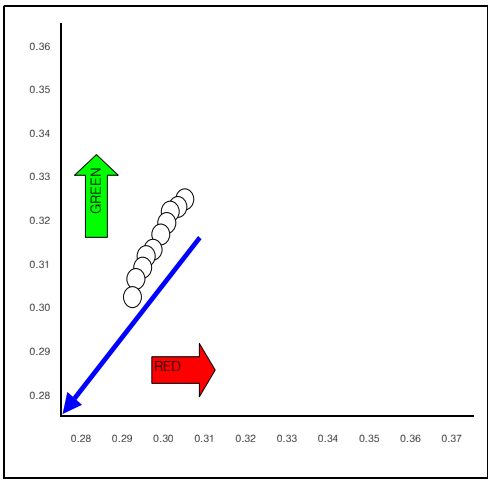

Fig.5. Chromaticity chart for luminance intensity of Blue LED

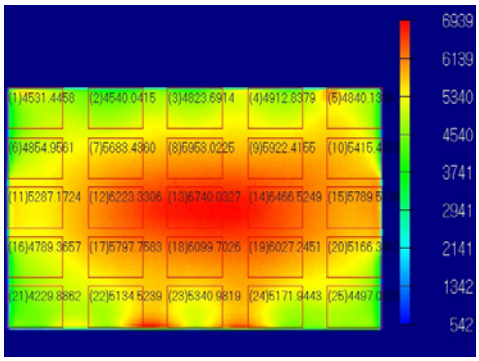

Fig.6. Measurement result of 7 inch LED Backlight Unit (with Blue LED).

Blue LED Power[W]	x	y
0	0.3044	0.3242
0.21	0.303	0.3225
0.4	0.3004	0.03182
0.71	0.2999	0.03165
1.01	0.2977	0.3143
1.24	0.2965	0.3124
1.42	0.2951	0.3106
1.74	0.2946	0.3097
1.84	0.294	0.3088

Table 1. Chromaticity coordinates for power consumption of Blue LED

3. Summary

Alternation solution of Backlight Unit at lower temperature state is presented by LED Backlight unit of this experiment. And we were achieved center luminance 6500 nit at power consumption of 15W by eight White LED of 1W side emitting type and ten blue LED of 0.05W. And We knew that chromaticity (Wx and Wy) in backlight unit of White Phosphor LED was modified by intensity control of blue LED in this experiment.

4. References

[1] K. Käläntär, K. Shimabukuro, Y.V. Martynov and T. Heemstra. SID Vehicle Conference 2003

[2] Yourii martynov,Huub Konijy,Nicola Pfeffer, Simmon Kuppens and Wim Timmers,"High-Efficiency Slim LED Backlight System with mixing Light Guide,"SID Digest 03, pp(1259~1261).

[3] Wiep Folkerts, "LED Backlighting Concepts with High Fluxs LEDs," SID Digest 04, pp.(1226~1229).

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