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## LED 평판조명의 저온환경에서의 전기광학특성

### Electro-optical Characteristics of LED Flat Light Source in Low Temperature Condition

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**요 약** 최근 액정디스플레이는 TV, Monitor, Note PC를 비롯한 모든 디스플레이영역에서 활발하게 사용되고 있다. 그러나, 액정디스플레이의 배경광원으로 사용하는 평판조명장치(백라이트)에서 주로 사용하는 광원인 CCFL(냉음극방전관)의 경우 수은 가스를 사용하기 때문에 저온 환경에서의 구동특성에 한계를 갖고 있다. 본 연구에서는 이러한 CCFL 광원이 갖고 있는 문제점을 해결하기 위해서, LED 광원을 사용한 백라이트 조명장치를 고안하고, -40도의 극저온환경에서의 동작특성을 CCFL 광원을 사용한 백라이트 조명장치와 비교분석하여, 저온환경에서의 LED 백라이트의 효율성에 대해서 연구하였다.

**Abstract** Recently, LCD (liquid crystal display) industry is needed to goods of high reliability and wide range temperature condition and it is interested in products for extremely cold condition without failure of light-up. In this experiment, we made the LED backlight unit for Automotive-navigation under the extremely cold condition. And for making this backlight unit, we used to eight side emitting type white LEDs with 3W high power LED. We could know that this backlight unit releases to 18,000 nit in 24W power consumption and start up voltage time is under the 1ms in the ambient temperature at -40.

**Key Words** : Low temperature operation light, LED, Backlight, Flat Light Source, Automotive-LED

#### I. Introduction

According to the accelerative modern industry, the application fields of many display industries are various gradually. 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 TFT-LCD by the application field is applied as the mobile, PDA, and the camera. CNS (car navigation system) is appeared to the most

requirements of customers. CNS product is gradually appeared to many needs in 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 high reliability in the wide operating temperature range, such as -40 to 70°C, vibration and an shock. And use of mercury is strictly restricted for driver security in the shut tight structure of car.

We have to use backlight unit because liquid crystal display is non-emissive display of active type recently. Therefore CCFL of backlight unit of TFT-LCD is contented in mercury for generation of plasma discharge and starting up. It helps to discharge of

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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 [1-2]. So, guaranteed LED needed to operate in lower temperature, inside shock and vibration by backlight unit source of solid semiconductor is used for backlight source development of TFT-LCD in this experiment. And optical design is competed by considering to the characteristics of LED light source [3-4].



그림 1. 3W 고출력 백색 LED

Fig. 1. Features of 3W high power white LED

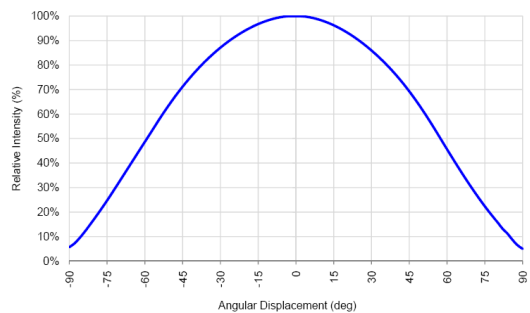
## II. Experimental Method and Results

In order to the development of TFT-LCD used by automobile navigation with needs of high reliability, we made LED BLU by using the white LED with 3W high power of the Lumileds company in this experiment. Figure 1 and Figure 2 are showing to the feature of high power white LED with the consumption power of 3W and emitting characteristics of light and Figure 3 shows spectrum data for high power white LED.

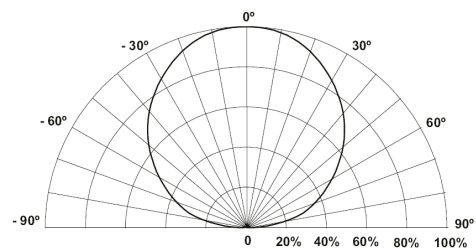
Before manufacturing of LED Backlight Unit, we measured the light Flux of conventional TFT-LCD used by CCFL. The Result is 1652lumen in 24W of the consumption power for the measurement of light intensity. In the base of result, the light Flux of 420 lumen is measured by used to white LEDs of 3 W with emitting characteristics of about 70 lm/W. White LEDs are particularly suitable for coupling the light from the LEDs directly into a light guide [5-8]. Figure 4 is showing to the structure of LED Backlight unit.

LED-BLU is arranged by light source at bottom side. And generative emitting light by arranged light source has structure for incidence ray inside to the horizontal setting LGP. We used Prism sheet in order to improve the optical performance. In particular for properties maintenance of LCD with a light weight and small size this BLU is designed in lower part of reflector generated by mount horizontal height of LED.

The CCFL is mainly used by backlight unit of LCD at the present time.



(a) Spatial radiation pattern for lambertian of high power white LED



(b) Polar radiation pattern for lambertian of high power white LED

그림 2. 고출력 백색 LED 의 광출력 특성

Fig. 2. Radiation patterns of high power white LED

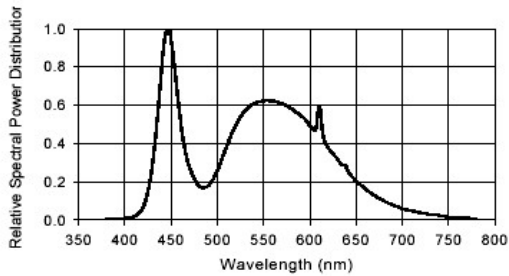


그림 3. 고풍력 백색 LED 의 스펙트럼 특성  
Fig. 3. Spectrum data for high power white LED

Because the brightness, lifetime and reaching time until the starting up voltage are changed by variation of the ambient temperature, the application of automobile navigation for needs of high reliability is unsuitable.

Because of the problem of the operating characteristics and lifetime at the lower temperature, initial starting up voltage is particularly required to higher voltage value. The CCFL is contented in mercury, argon and neon gases in the vacuum. The very important gas of contents in lamp is mercury. Although the mercury is existed in the lamp, mercury is partly turned to liquid according to decreasing of ambient temperature. Because of this phenomenon, starting discharge voltage for lamp starting up is required high voltage value at lower temperature. And brightness is decreased. Figure 4 is showing to brightness characteristics graph of lamp.

The CCFL is required to High voltage at initial starting up voltage. But LED backlight unit needs to lower starting up voltage of input voltage about 3V. Also because of superior brightness characteristics in lower temperature, LED backlight unit is suitably applied to automobile navigation and military use for needs of high reliability. Figure 4 is showing to brightness characteristics of LED backlight unit according to change the temperature.

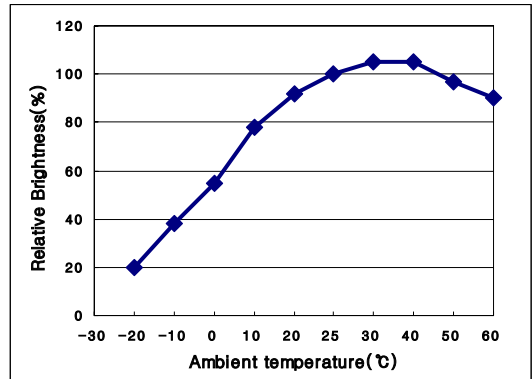


그림 4. CCFL 광원의 온도에 따른 출력 특성  
Fig. 4. Relative brightness of CCFL for ambient temperature

We compared normal backlight unit with conventional CCFL (Ne:Ar = 90%:10%, 80 torr) with manufactured LED-backlight for this experiment. We measured delay time of the starting up voltage according to the changing temperature with two backlight units. The normal BLU was operated by the Royer type inverter (HIU 741, Harison Co., Ltd) in condition that voltage 1100 Vrms. Figure 5 is showing to a scheme of experimental setting for operating voltage measurement of backlight unit.

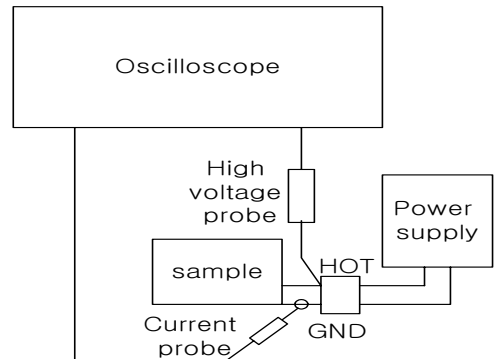


그림 5. 온도에 따른 출력지연 특성을 측정하기 위한 실험장치  
Fig. 5. Equipment of measure to delay time for BLU in the ambient temperature

Figure 6 is showing to the starting up voltage time of normal backlight unit used to CCFL and LED backlight unit in the normal temperature. And, Figure 7 is showing to the starting up voltage time of normal

backlight unit used to CCFL and LED backlight unit in the ambient temperature  $-40^{\circ}\text{C}$ .

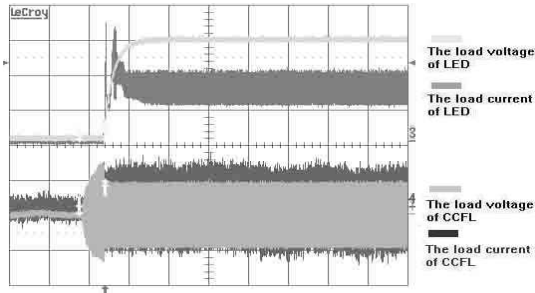


그림 6. LED 및 CCFL광원을 사용한 백라이트의 상온에서의 동작 지연시간 측정결과 ( $25^{\circ}\text{C}$ )

Fig. 6. Delay time of normal BLU and LED BLU in the normal temperature. ( $25^{\circ}\text{C}$ )

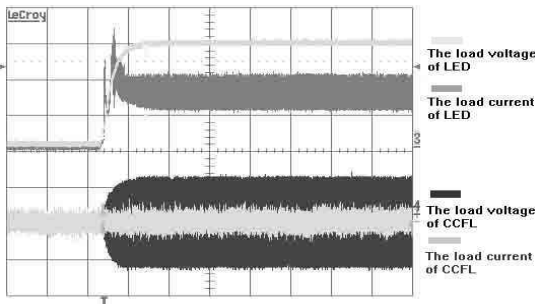


그림 7. LED 및 CCFL광원을 사용한 백라이트의 저온에서의 동작 지연시간 측정결과 ( $-40^{\circ}\text{C}$ )

Fig. 7. Delay time of normal BLU and LED BLU in the low temperature. ( $-40^{\circ}\text{C}$ )

### III. Conclusion

Normal backlight unit with CCFL used to conventional backlight source of LCD occurs to the reliability problems at the lower temperature. To solve this problem, we release to the LED backlight unit. The LED backlight unit with eight side emitting type white LED of 1W appears to reach characteristics to the center brightness 18,000 nit at total consumption power about 24 W.

As a result of this experiment result, we know that the reaching time to the starting up voltage value in backlight unit which used LED light source in the

ambient temperature  $-40^{\circ}\text{C}$ s under 1ms. And we confirmed that LED backlight source is solution for the starting up voltage characteristic improvement of CCFL with no discharge phenomenon in the lower temperature according to the result.

### 참고 문헌

- [1] D. Ravichadran, S. T. Johnson, and S. Erdei, "Crystalchemis tryandluminance of  $\text{Eu}^{2+}$ -activate dalkalineeartha luminate phosphors", SID Digest paper, 99. 197-203(1999).
- [2] X. X. Zhang, P. Hong, M. Bass, and B. H. T. Choi, "Blue upconversion with excitation into  $\text{Tm}$  ions at 780 nm in  $\text{Yb}^{-}$  and  $\text{Tm}$ -codoped fluoride crystals", Phys. Rev. B. 51, No. 14, pp. 9298-9301 (1995).
- [3] Y. Martynov, H. Konijn, N. Pfeffer, S. Kuppens, and W.Timmers, "High efficiency slim LED Backlight system with mixing light guide", SID Digest paper, pp. 1259-1261 (2003).
- [4] W. Folkets, "LED backlight concepts with high fluxs LEDs", SID Digest paper, pp. 1226-1229 (2004).
- [5] T. Yagi, S. T. Hsu, A. Perduijn, S. de Krijer, and J. Claessens, "Light output feedback solution for RGB LED backlight applications", SID Digest paper, pp. 1254-1257 (2003).
- [6] H. Sugiura, H. Kaneko, S. Kagama, M. Ozawa, K. Niki, and H. Tanizoe, "Prototype of a wide gamut monitor adopting LED-backlighting", SID Digest paper, pp. 1266-1269 (2003).
- [7] G. Harbers and C. G. A. Holen, "High performance LCD backlighting using high intensity Red, Green and Blue light emitting diodes", SID Digest paper, pp. 702-706 (2001).
- [8] G. Harbers, W.Timmers, and W.Silleris Smitt, "LEDBacklightingforLCD-HDTV", International Display Manufacturing

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