A Study of The Novel External Electrode Fluorescent Lamp For High Optical Efficiency

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Abstract

We study on the Electro Optical Properties of the EEFL (External Electrode Fluorescent Lamp) Backlight system is based on the lamp type characteristics and diameter of the lamp tube under the equal manufacturing of the lamps. In this contribution, through the analysis of the different lamp type and diameter of the lamp tube gain the effective luminance and reduce the lamp voltage from aspect in the electro optical properties with EEFL and LCD backlight system.

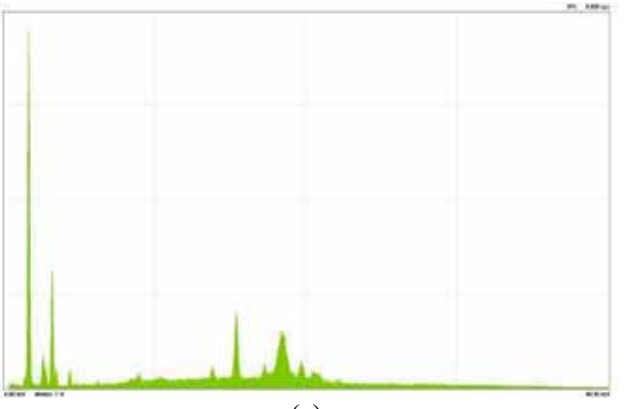
1. Introduction

In recent years conventional CCFL (Cold Cathode Fluorescent Lamp) is influenced for the lifetime of the lamp by its inner electrodes induce a sputtering at the discharged area of the lamp. Whereas EEFL is a kind of alternative discharge type both side inner wall-charge turns on the plasma current to be an alternative at the lamp as a discharged space. As the electrodes are located out of the lamp tube EEFL is protected the electrode sputtering from the plasma that makes a merit for the lifetime of the lamp. Also the process of the external electrode manufacturing of the lamp is simple. Moreover EEFL backlight system is able to drive parallel lamps with one inverter. So, the application of EEFL for the direct backlight type with many lamps like a TV has many advantages. Nowadays these merits of EEFL system use for the LCD backlight system. [1- 7] LG.Philips LCD has expanded the EEFL Backlight System after a world's first mass product at 2003.

The EEFL system is operated with the input voltage to the external electrodes are edge sides of the lamp tube. At this point, the lamp type is an important parameter to determine the lamp characteristic. We performed an experiment with different type (A-Type, B-type) and different diameter of the lamp that is applied the EEFL backlight system.

2. Results

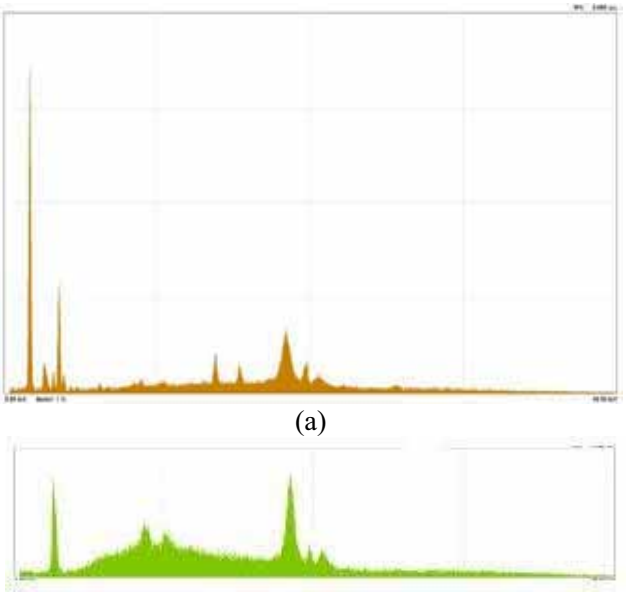
To increase of the luminous efficiency, we study on the lamp tube material and diameter of the tube. One of the lamp tube material is A-Type and the other is B-Type. We analyze the lamp material by the XRF equipment. Figure 1 is showed the analysis result of the A-Type and the reference blank. Figure 2 is the analysis result of the B-Type. The measurement condition is that like : 1) Live time : 200sec , 2) XGT Dia. : 10 ㎛ , 3) Current: 1.000 mA



(a)

(b)

Figure 1. The analysis result of the lamp type (a) A-Type lamp (b) Blank by the XRF



(a)

(b)

Figure 2. The analysis result of the lamp type (a) B-Type lamp (b) Blank by the XRF

The diameter of lamp tube is Φ4.0, Φ3.55 and Φ3.0 that are considered the material characters. Table 3 shows the description of the lamp and performance result of the EEFL. Even though input the same current, there is a different result 1) Lamp voltage of a applied A-Type lamp tube with Φ4 diameter is 1,496(Vrms) 2) Lamp voltage of a applied B-Type lamp tube with Φ3.55 diameter is 1,452 (Vrms) 3) Lamp voltage of a applied A-Type lamp tube with Φ3 diameter is 1,741(Vrms) That lamp tube characteristic and diameter of the lamp caused of the different lamp voltage and brightness.

Type of lamp tube	A-Type	A-Type	B- Type
Outer Diameter [mm]	Φ 4.0	Φ 3.0	Φ3.55
Lamp tube thickness [mm]	0.5	0.5	0.5
Lamp Current [mArms]	4	4	4
Lamp Voltage [Vrms]	1,496	1,741	1,452
Brightness [cd/㎡]	10,469	15,562	13,539

Table 3. EEFL Properties for applied different lamp tube (A-Type and B-Type)

The result is depended on the capacitance that is depended on the external electrode. When input the same voltage, an increase of the capacitance of the electrode leads to gain the current in the discharged space with a lamp tube. Therefore we perceive that increase of the capacitance proceeds to drop the lamp voltage as make up same current with this experiment. Figure 3 shows the I-V characteristics curve of a Φ3.0, Φ3.55 and Φ4.0 EEFL having the same external-electrode length, lamp-tube thickness, filling gas and filling gas pressure.

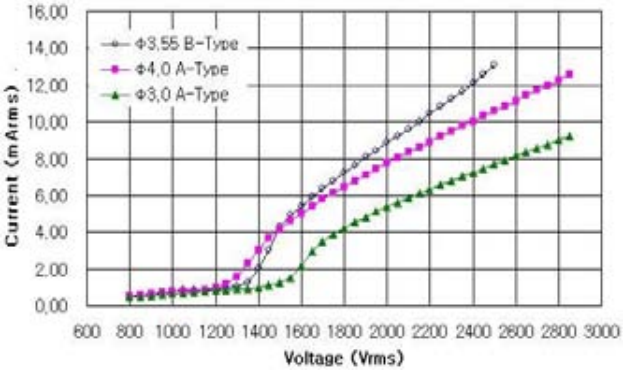


Figure 3. The I-V characteristics curve between the lamp material and the different diameters

From the I-V characteristics curve, the following conclusions can be reached: (1) The EEFL lamp current of a B-Type of Φ3.5 is higher than that of a A-Type of Φ4.0 in the lamp voltage range of 1600-2500Vrms at driving frequency of 65kHz. (2) The gradient of the I-V characteristics curve is dependent of lamp material at the lamp voltage ranges of 1600-2500Vrms. To compare the A-Type of Φ4.0 and B-Type of Φ 3.55, the B-Type gradient of the I-V characteristics curve is higher beyond the lamp voltage 1500Vrms. The gradient of the A-Type (Φ3.0, Φ4.0) are similar in the lamp voltage range of 1700-2900Vrms at the driving frequency of 65kHz.

Table 4 is the data of the LCD Module is applied the EEFL Backlight system with Φ3.55 B-Type. There is an 8.6 % difference of lamp voltage with same current at the LCD Module. In the case of B-Type lamp tube the power consumption is raised up 6% than A-Type, luminance also increases to 12 % than A-Type.

Type of lamp tube	A-Type (Φ 4.0)	B-Type (Φ 3.55)
Lamp Voltage [Vrms]	1,522	1,401
Lamp Current [mArms]	90	90
Driving Frequency [kHz]	65	65
Brightness [cd/㎡]	522	588
Luminous Efficiency [lm/W]	5.17	5.49
Number of EEFL	20	20

Table 4. The electro-optical characteristics of the LCD Module with EEFL Backlight System

$$\eta = \frac{\pi \times A \times B}{P}$$

This formula means the luminous efficiency;
η: luminous efficiency (lm/W) , A: Active Area (m^2) , B: luminance (cd/㎡) , P: Power consumption (W)
Luminous efficiency according to type of lamp tube B-Type is 5.49 (lm/W) that is more raised up 6.2 % than A-Type 5.17 (lm/W)

3. Conclusion

The application of different lamp tube and diameter increase the Luminous efficiency in EEFL system. Through this experiment, solve the over driving voltage problems to get a high luminance to select the B-Type Lamp tube that is extended the Capacitance of electrode. Also B-Type Lamp tube with narrow diameter (Φ3.55) achieve the high luminance then gain the luminous efficiency.

4. References

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