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Discharge Characteristics of a Mercury Free Flat Fluorescent Lamp Without the Dielectric Layers

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We developed a mercury free Flat Fluorescent Lamp (FFL) with a high luminance by using the same discharge mode as PDP. Our FFL has the simple structure where the glass substrates are used as the dielectric layer. The panel has a striped line shape of 7-inch diagonal size. The Xe-Ne-He mixture gas was used to generate the plasma, and the gas discharge characteristics under both total gas pressure and partial gas pressure were investigated. The panel showed a maximum high luminance 7,270 cd/m^2 under biasing 20 kHz pulse of 3 kV.

Keywords: FFL; gas discharge; lamp; LCD backlight

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INTRODUCTION

The size of LCD TV is growing by virtue of the technology progress of LCD TV. As its size grows, the role of the backlight on the LCD TV is of much importance. At present, the serious problems of the backlight are the high electricity consumption, the high price, and the insufficient luminance characteristic due to the increasing number of the lamps. Developing the oncoming generation of LCD backlight units has been proceeded to solve these problems. Currently, improving the luminance and luminance efficiency of the panel is a main concern of the LCD backlight industry. FFL is known to be one of the next generation LCD backlight unit devices. Recently, panel fabrication process, phosphors, and discharge cell structures gas mixtures have been investigated in order to improve the insufficient FFL luminance. In this study, we fabricated 7 inch diagonal FFL and investigated optical characteristics such as luminance, PL spectrum, color coordinates as the functions of the total gas pressure and the mixing ratios of Xe gas. Our FFL has a peculiar structure without dielectric layers by using the glass substrate as dielectrics.

EXPERIMENTAL

Figures 1(a) and (b) show the structure of our FFL. The ribs with a stripe line shape are formed on the rear substrate by a sandblasting method. The ITO electrode and metal electrodes are formed at the outside of the front and rear substrates, respectively so that we could remove the conventional dielectric layers. The thickness of the front glass is 1.9 mm and the etching depth of the rear glass with thickness of 3.0 mm is 1.5 mm. The easily formed ribs by the glass sandblasting and the cell structure without the dielectric layers lead us to a simple panel fabrication process. As for the phosphor, we obtained used white phosphors obtained by simply mixing three-color phosphors for PDP.

We connected the panel to a laboratory mode test chamber and investigated the electrical characteristics and luminance characteristics of panel. The discharge gas used at this experiment is the mixed gas of Xe, Ne, and He.

RESULTS AND DISCUSSION

The FFL panel needs the strong white lights that generate in phosphors excited by the vacuum ultraviolet (VUV) to happen in the gas discharge. Xe gas has been used currently for VUV source in FFL.

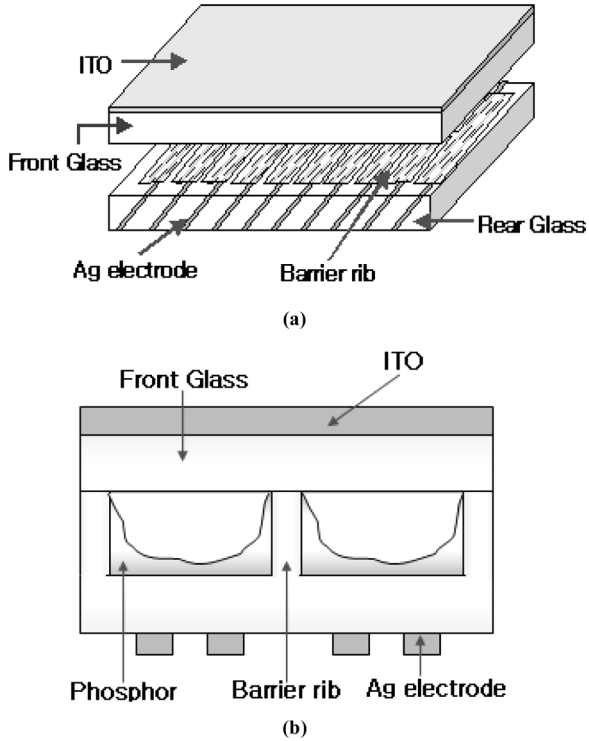

FIGURE 1 (a) Structure of FFL and (b) Cross-section of FFL.

But it is known that the penning gas is more desirable because a firing voltage comes to be high when only Xe gas is used. This is why we used the Xe, Ne, He mixed gas in our FFL.

The lamp to use the plasma takes big at the characteristic influence according to the pressure with the kind of the gas to use. Low firing Volt has good characteristic because the stress of driving circuit reduce as firing voltage low. A firing voltage takes big at a secondary electron influence. Figure 2 shows that firing voltages increase according to increasing of Xe gas pressure. Firing voltage increases according to increasing of Xe gas pressures and total gas pressure as shown in Figure 3.

Figure 4 shows the luminance characteristics according to applied voltages under Xe-Ne-He mixture gas. We measured them, changing the ratios of Ne to Xe when the total gas pressure was fixed at 600 torr with He concentration fixed at 1%. The luminance increased as the Xe concentration became higher but firing voltages have a tendency to be

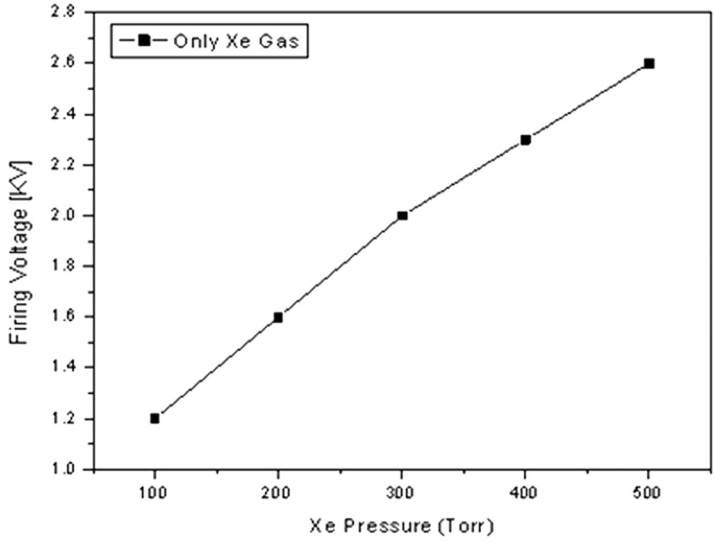

FIGURE 2 Firing voltages by Xe pressures.

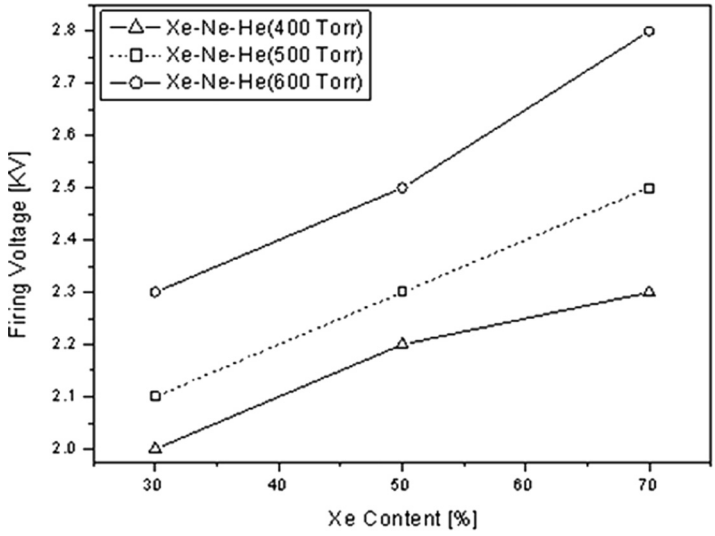

FIGURE 3 Firing voltages by total gas pressures of Xe(70%)-Ne(29%)-He(1%) gas mixture.

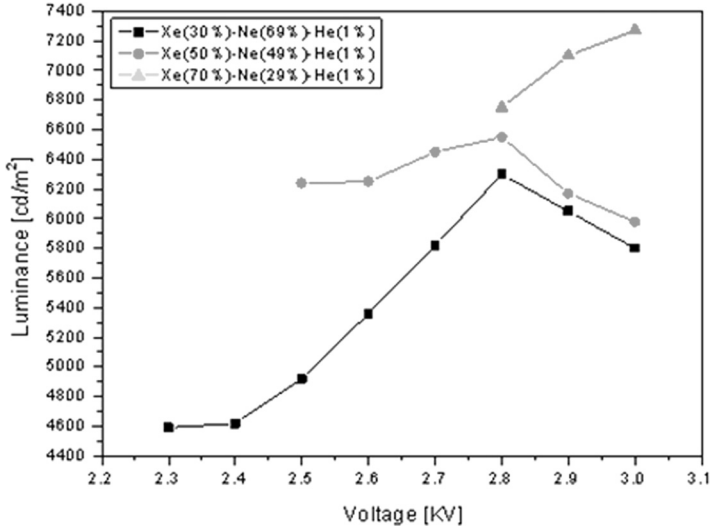

FIGURE 4 Luminance vs applied voltages under several Xe-Ne-He mixing ratios (600torr).

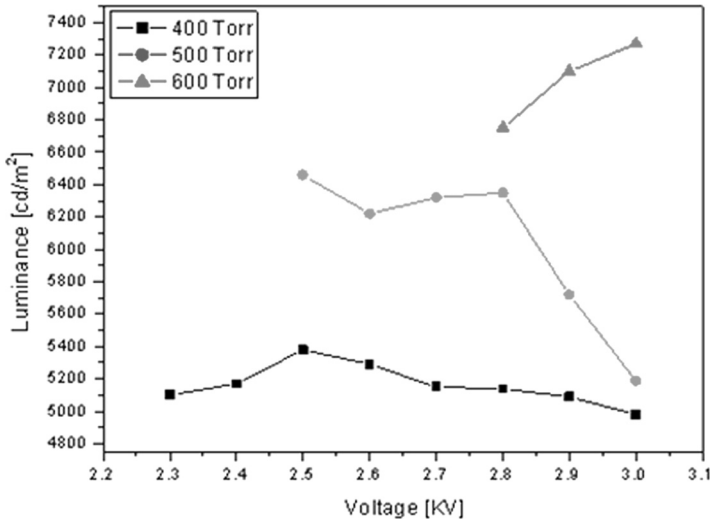

FIGURE 5 Luminance vs applied voltages under several total gas pressures of Xe(70%)-Ne(29%)-He(1%) gas mixture.

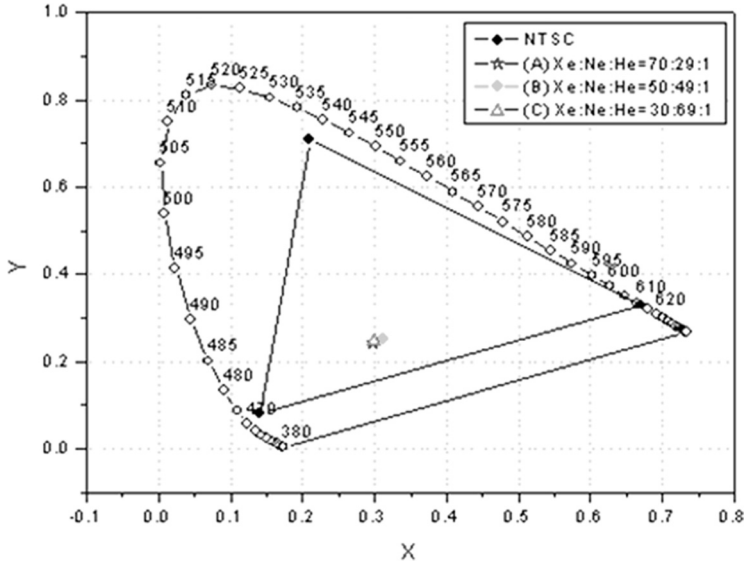

FIGURE 6 Colors coordinate by Xe mixing ratios. (See COLOR PLATE XII)

higher. Figure 5 shows luminance characteristics according to applied voltages under several total gas pressures. When the ratio of the Xe-He-Ne mixture gas is 70:29:1. The luminance increased with increasing total gas pressures but the firing voltages also moved to be higher values to the 3 kV. The luminance increased with the total gas pressures can be explained by increasing VUV emission with the gas amount.

Figure 6 shows the color coordinates of A type (X = 0.298, Y = 0.243) and B type (X = 0.313, Y = 0.253) and C type (X = 0.299, Y = 0.248) which is classified by the mixied gas. It is found that the changing of Xe amounts makes little influence on the color coordinates.

The experimental results reveal that the luminance and firing voltages increased with the increasing amounts of Xe and the total gas pressures. The changing of Xe amounts makes little influence on the color coordinates. When the total gas pressure of Xe (70%)-Ne (29%)-He (1%) is 600 torr, the FFL panel showed the maximum luminance of 7,270 cd/m^2 under biasing 20 kHz pulse of 3 kV.

CONCLUSIONS

We fabricated a simple structured FFL without the dielectric layers, and investigated its electrical and luminance characteristics under

several mixed gas conditions. The main feature is that the luminance and the firing voltages increase with increasing the amounts of Xe and total gas pressures, and that the color coordinates are seldom affected by the Xe amounts in FFL. Even though our FFL revealed the maximum luminance of 7,270 cd/m^2, available to LCD backlight, the phosphors with higher efficiency are still needed in reducing the drive voltages.

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