Properties of Xe plasma flat fluorescent lamp by screen printing

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Abstract

In this study, a plasma flat fluorescent lamp having a new structure was fabricated by screen printing technique. Coplanar types of silver electrodes with a dielectric layer were screen-printed on a rear glass plate, and then fired at 550°C and 580°C, respectively. Phosphor was spin-coated on the dielectric layer with firing at 490°C. Several types of lamps were designed and its properties wee investigated with electrode shape, gas pressure, etc.

1. Introduction

LCD has taken the largest market share in flat panel display areas due to its superior properties such as large scalability with economic price, lightweight, slimness, and lower power consumption. As the LCD panel size increases, the uniformity of backlight with high brightness and low power consumption become more important. In addition, the conventional backlight, i.e. cold cathode fluorescent lamp, needs small amount of mercury for the efficient emission of phosphors. However, European countries began to regulate the hazardous substances (Hg, Pb, etc) to environment in accordance with the directives of RoHS and WEEE this year and the development of new eco-backlight system has been more required [1-3].

In the present paper, we developed and investigated a flat fluorescent lamp (FFL) using mercury-free gases (e.g. Xe gas).

2. Experiments

A flat fluorescent lamp having a new structure was fabricated by screen printing technique. Silver electrodes and a dielectric layer were screen-printed and fired at 550℃ and 580℃, respectively. Phosphor was spin-coated and then 7 inch diagonal panel was sealed using crystalline frits at 490℃. The dimensions of the newly-designed FFL and the pressure of Xenon gas in FFL were varied and characterized

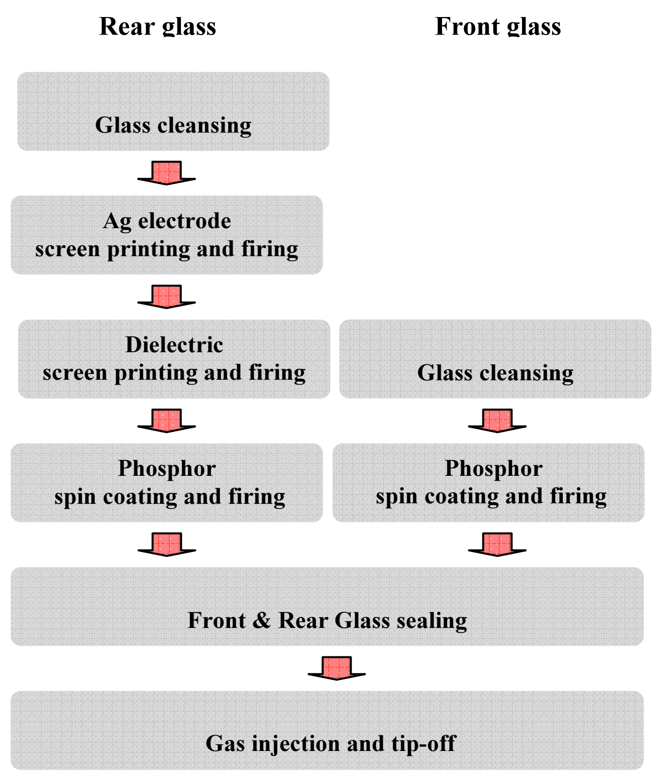
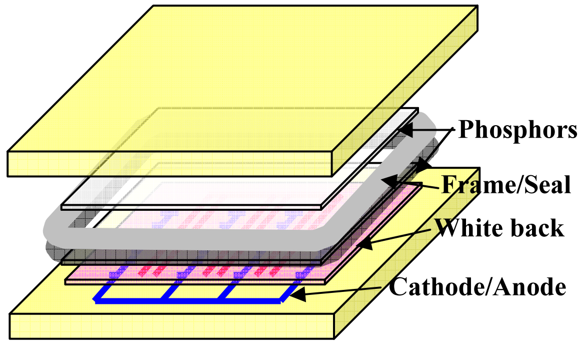


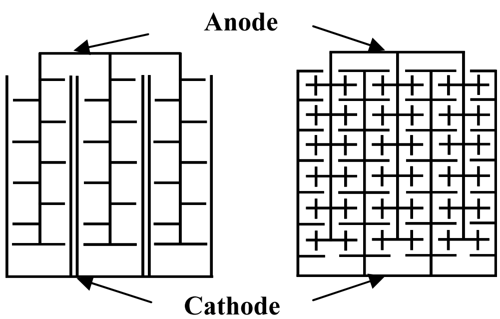
Fig. 1. Schematic diagram of fabrication process

3. Results and Discussion

Two different types of electrodes in FFL were designed as shown in Fig. 2 and their emission characteristics were compared..

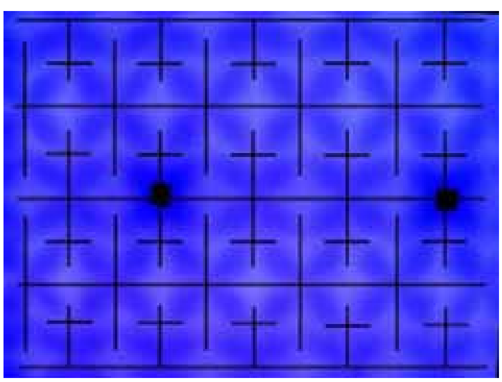


(a)

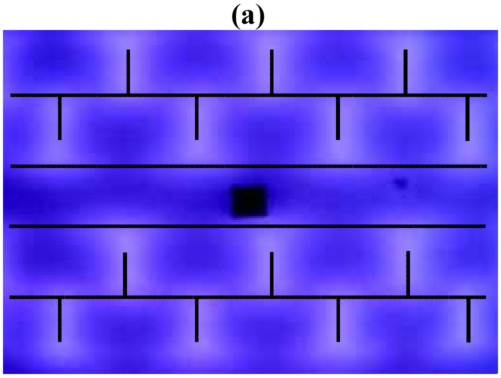


(b) (c)

Fig. 2. (a) Structure of coplanar electrode FFL, (b) A type electrode, and (c) B type electrode



(a)



(b)

Fig. 3. Emission pattern of (a) A type electrode and (b) B type electrode. (Electrodes are drawn on the emission images)

First of all, two type of electrode was compared in luminance with change in voltage. The electrodes were directly drawn on the emission images in order to easily understand where the emission occurred. Emission was generated by plasma at the tips of electrode edge. This pattern was arrayed periodically (Fig. 3.). In general, Electric field is stronger at the tip of electrode edge. B type luminance was brighter than A type because B type electrode has more tips in which vacuum ultra-violet (VUV) is generated efficiently.

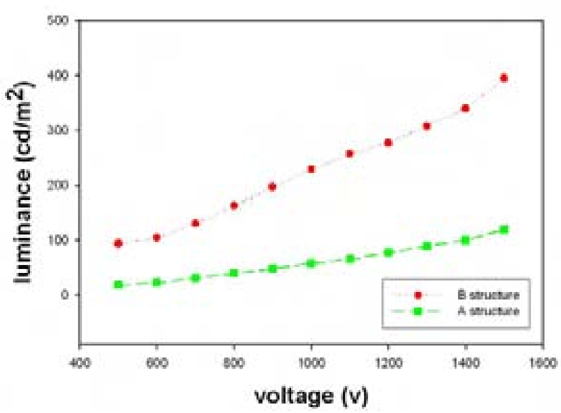
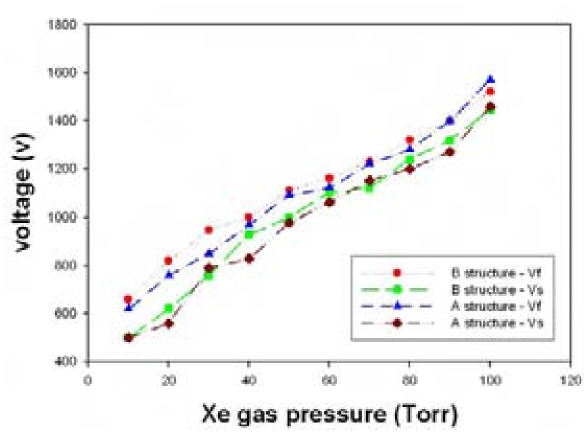
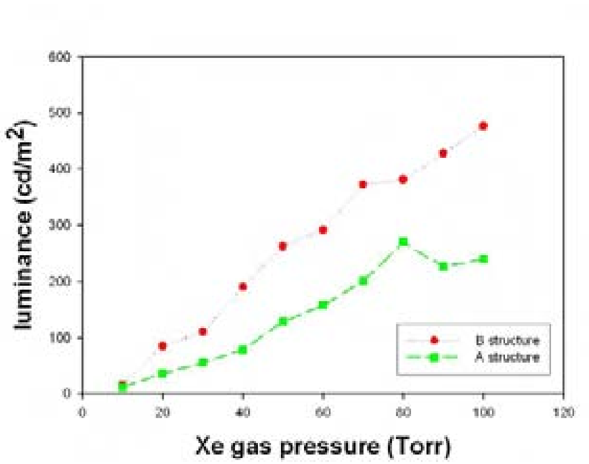


Fig.4. Curve of luminance with applied voltage.

Luminance was also influenced by gas pressure as shown in Fig. 4 because the emission characteristics of panel was dependent on plasma efficiency.



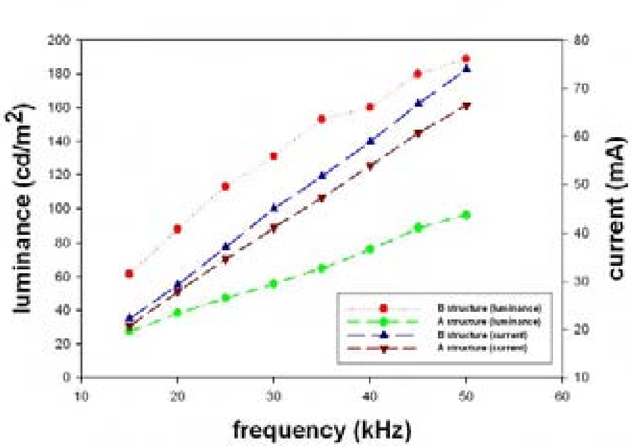
(a)



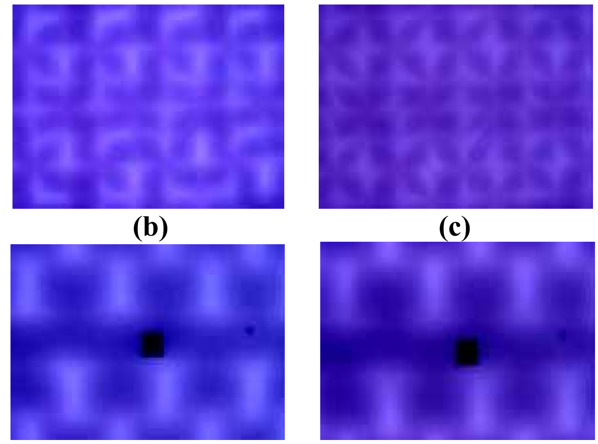
(b)

Fig. 5. (a) Curve of firing and sustain voltage with increase in Xenon gas pressure and (b) curve of luminance with Xenon gas pressure.

The higher Xenon pressure in the panel the higher firing and sustain voltage should be applied. Amount of ionization is proportional to Xenon gas volume. Therefore, more VUV is generated to excite the phosphor with higher Xe pressure. When two shape of electrodes were compared, the firing and sustain voltages were similar irrespective of shape of electrodes in this study but luminance was a little different. Luminance of A type electrode went down at 90 Torr (Fig. 5) because excessive Xenon gas volume caused unstable plasma, which resulted in decreasing luminance of panel.



(a)



(b) (c)

(d) (e)

Fig. 6. (a) Curve of luminance as a function of frequency under 30 Torr Xenon gas, 1000 V; B type emission pattern of (b) 25 kHz and (c) 50 kHz , and A type emission pattern of (d) 25 kHz and (e) 50 kHz.

As operation frequency increased, electrons were accelerated and electron avalanche happened. Therefore, the current and luminance for both A and B type electrodes increased with higher frequency (Fig. 6.). Figure 6(c) had larger plasma region than Fig. 6(b). Both Fig. 6(d) and 6(e) showed no difference in emission in naked eye.

4. Conclusion

B type electrode generated brighter luminance than A type electrode and both type of electrodes had similar firing and sustain voltage.

5. Acknowledgements

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6. References

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