32"-diagonal Gated CNT Cathode

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Abstract

32"-diagonal gated carbon nanotube(CNT) cathodes named under-gate cathodes for large-size display applications have been fabricated and characterized. The emission uniformity looks fine, even without the resistive layer. The emission performance has been improved by scaling down the cathode electrode dimension.

Introduction

Field emission displays(FEDs) are generally described as a device to have CRT-like image qualities and low power consumption and is expected to be a candidate for large-size flat panel display. Therefore, it is important to find the most cost-effective way to produce FED panels with large screen size.

For large-size TV applications, the field emission displays with the gated CNT cathodes have been intensively developed in Samsung. As preliminary studies, two types of gated cathode structure have been researched and characterized[1,2]. The c-FED(CNT-FED) samples with the gated cathodes exhibited good display quality. Such successful demonstrations indicated that c-FED could be the direction for the FED to achieve the subject of cost-effective large panels.

In this study, the fabrication process and device characteristics of the 32"-diagonal under-gate cathode will be described and discussed.

Fabrication

Figure 1 shows the fabrication process of the 32" gated CNT cathode. The stripe-patterned under-gate electrodes were formed on a glass substrate(a). 30 μm-thick dry film resist(DFR), which is generally used for ITO patterning in the PDP process, was applied as the photosensitive masking layer. A thick film insulating layer was screen-printed and fired at 550 °C(b). The contact via holes were formed by the conventional wet etching process(c). A thin film metal layer was deposited by the sputtering process, and patterned to the cathode electrodes and the counter electrodes with the DFR(d). Finally, a CNT emitting layer was screen-printed and patterned into rectangular dots with photosensitive CNT

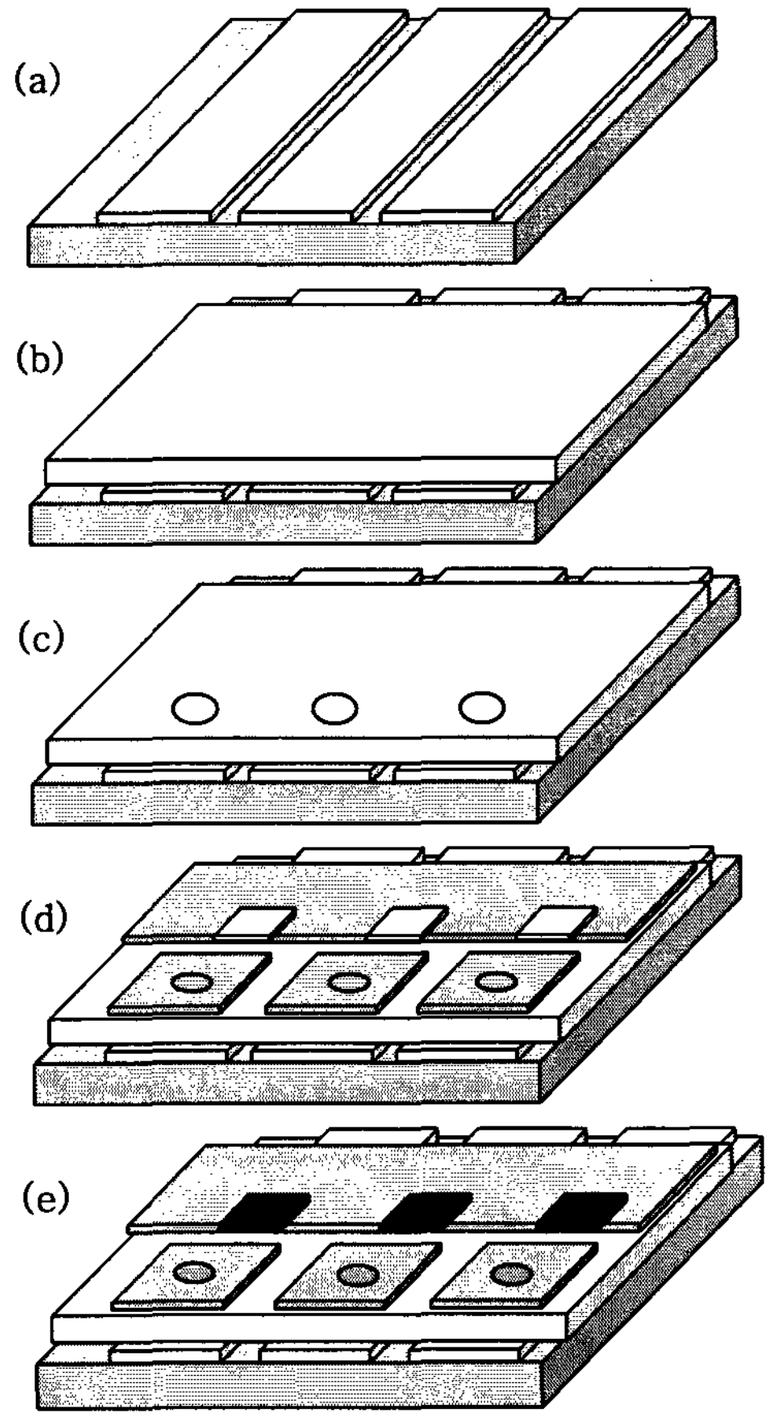

Fig. 1. The process sequence of the 32" gated CNT cathode; (a) Stripe-patterned under-gate formation, (b) Thick-film insulator printing, (c) Contact via hole formation, (d) Cathode and counter-electrode formation, and (e) CNT emitting layer formation.

paste. After firing and certain activation process of the CNT layer, the 32" gated CNT cathode was completed.

Results & Discussion

Figure 2 shows the top-view of the fabricated cathode. The cathode size was 32"-diagonal, and the pixel number was 480(V)*704(H)*3. The CNT-to-counter electrode gap(d_G) and the cathode electrode width(w_C) were 60 μm and 110 μm, respectively. The

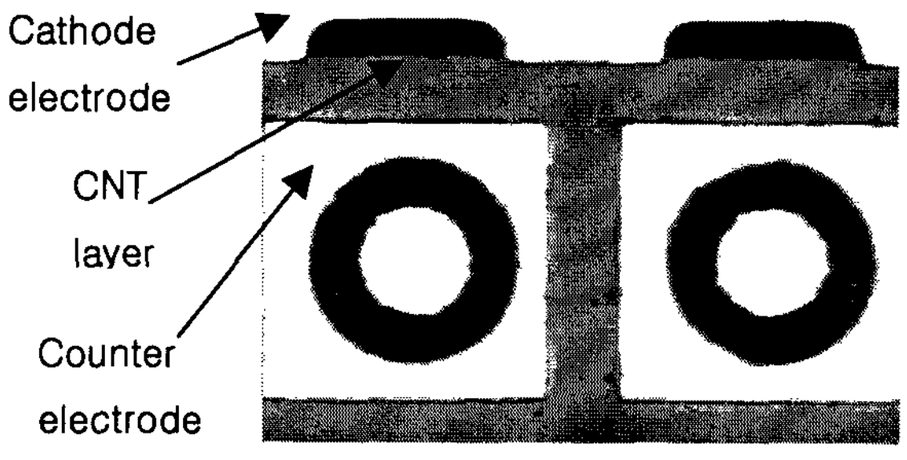

Fig. 2. The top-view of the fabricated cathode.

CNT was 170 μm wide. Figure 3 shows an I-V characteristics measured at the vacuum chamber. On measurement, the anode-to-cathode gap was 2.8 mm and the anode voltage was 700 V. The anode current of 455 μA was obtained at the cathode-to-gate voltage of 150 V and 1/480 duty driving. In the under-gate structure, the narrower cathode-to-anode gap with the same anode voltage generally enhances the emission current from the CNT emitting layer. However, there was some difficulty in approaching that two large plates closer without spacers. Therefore, the operating voltage for the same emission current should be reduced much by assembling the two plates with spacers.

In the conventional Spindt-type field emission cathode structure, the smaller the gate hole becomes, the lower the operating voltage becomes. In the same manner, the operating voltage could be reduced with the narrower cathode electrode in the under-gate cathode. To implement the cathode with lower operating voltage, the cathode electrode width was reduced to 60 μm. In order to minimize the neighboring effect, which will be described elsewhere, the CNT-to-counter electrode gap was reduced to 30 μm. Figure 4 shows the I-V

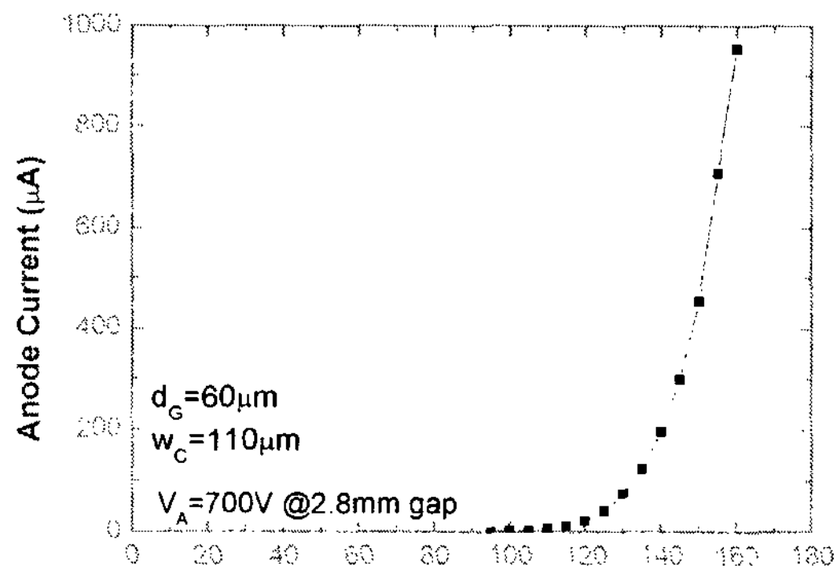

Fig. 3. I-V characteristics of the fabricated cathode, of which the CNT-to-counter electrode is 60 μm and the cathode electrode width is 110 μm.

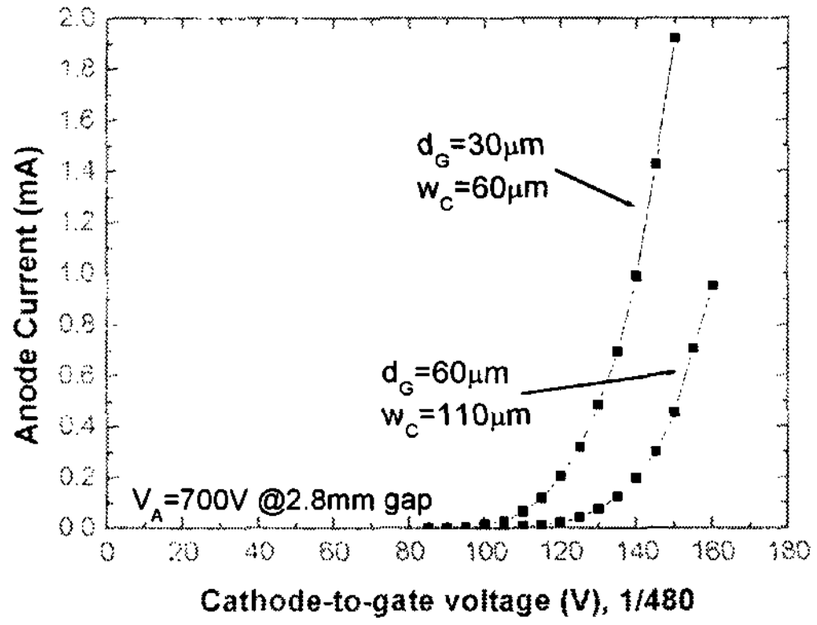

Fig. 4. The comparison of the I-V characteristics for two cathodes with different dimension.

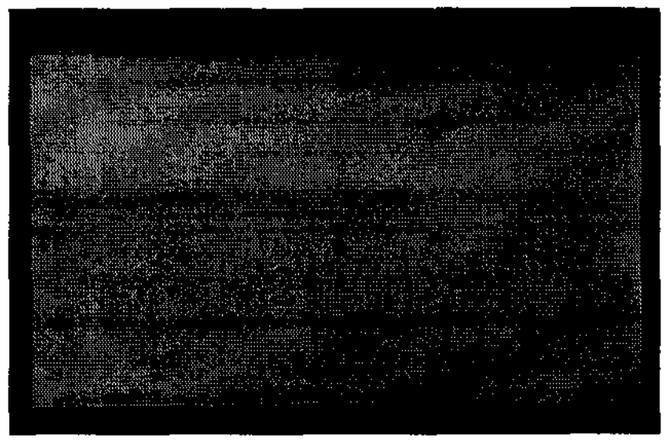

Fig. 5. A luminance image of the 32" gated CNT cathode with a green phosphor screen.

characteristics of the improved cathode. The I-V curve of the device with relatively wider cathode electrode was also shown in the figure for comparison. The anode current was dramatically increased from 445 μA to 1,940 μA at the operating voltage of 150 V. We expect that further scaling-down of the cathode dimension could result in much lower operating voltage.

Figure 5 shows the luminance image of the 32"-diagonal cathode. Even though the resistive layer was not adopted, the global emission uniformity in the 32" cathode looked so good. The fabricated cathodes are assembled with the phosphor screen plates and displayed.

Conclusion

32"-diagonal gated CNT cathodes have been implemented with the under-gate structure. The emission uniformity looks acceptable for large TV applications. The emission performance has been improved by adjusting the electrode dimensions such as cathode electrode width.

References

[1] J. M. Kim and *et al.*, "High Performance CNT FED", IDMC '02.

[2] C. G. Lee and *et al.*, "Fabrication and Characterization of the Under-gated Carbon Nanotube Cathode Structure", IDMC '02.