Fabrication and Characterization of Carbon Nanotube Field Emission Display for HD-TV Applications

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Abstract
For the CNT-FED to be cost-effective, many efforts for the lower voltage operation have been made in the under-gate cathode structure. In this study, the effects of the frit proportion in the CNT paste, cathode electrode width, CNT-to-counter electrode gap, and the CNT length in the cathode structure were examined.

Introduction
The advantages of CNT-FED are its capability to display video image that is similar to CRT and its low power consumption. Since plasma display panel has difficulty in scaling down and LCD has difficulty in scaling up for mass market, display companies have indicated that CNT-based FED could be a winning technology for large area (20~40" diagonal) flat displays.

For CNT-FED to be more competitive in the large area flat display market, it is very important to reduce the electronics costs by optimizing the cathode structure for the low driving voltages. In this study, some experimental results will be given for the low voltage operation in the under-gate CNT-FED structure[1,2].

Experimental
As an emitting layer, photo-sensitive carbon nanotube paste is screen-printed and patterned on the under-gated cathode substrate by a photolithography process. The CNT paste is composed of many ingredients such as CNT powder, vehicle, frit, and so on. The frit is commonly inserted to enhance the CNT layer's adhesion to the bottom layer

Fig. 1 shows the adhesive power between the CNT layer and the oxide metal as a function of the frit proportion to CNT powder. As expected, the adhesion was enhanced as the frit portion increased. However, much frit can degrade the emission current from the CNT layer. Fig. 2 shows the relative emission current densities, which were measured in the diode

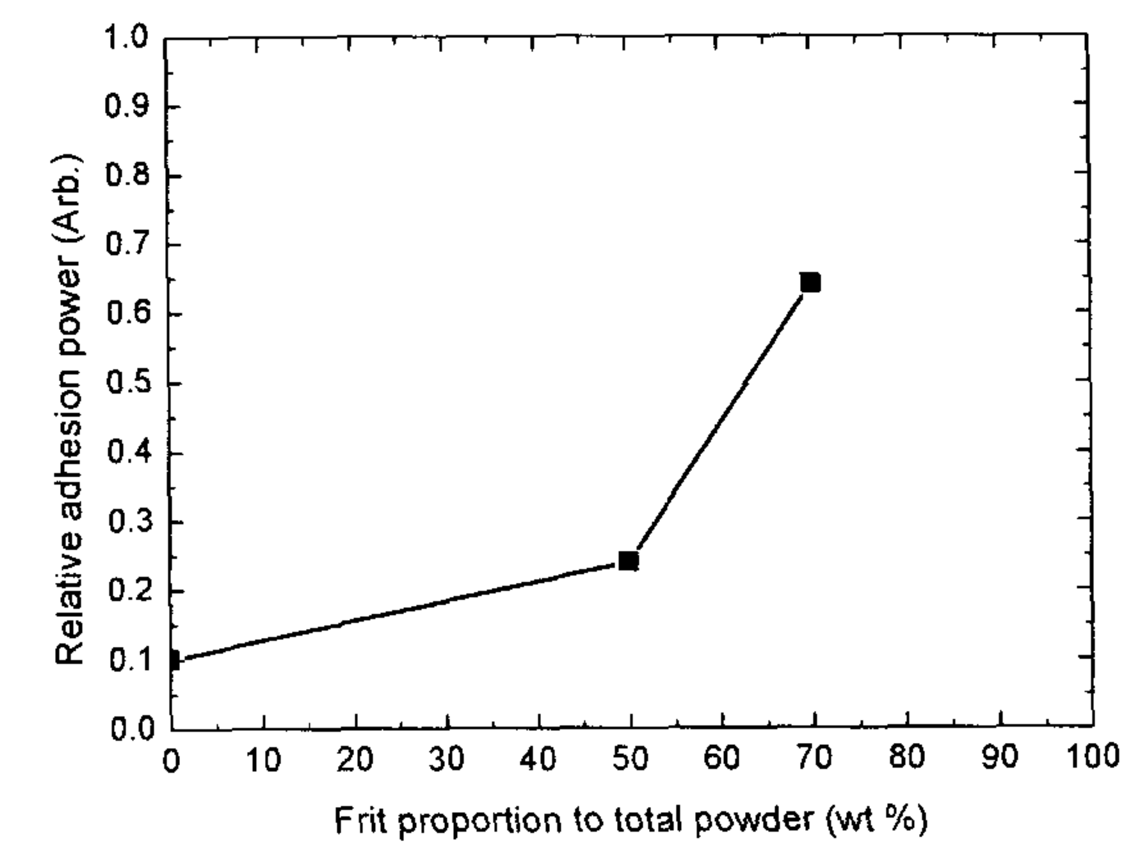

Figure 1. The relative adhesion as a function of the frit material proportions.

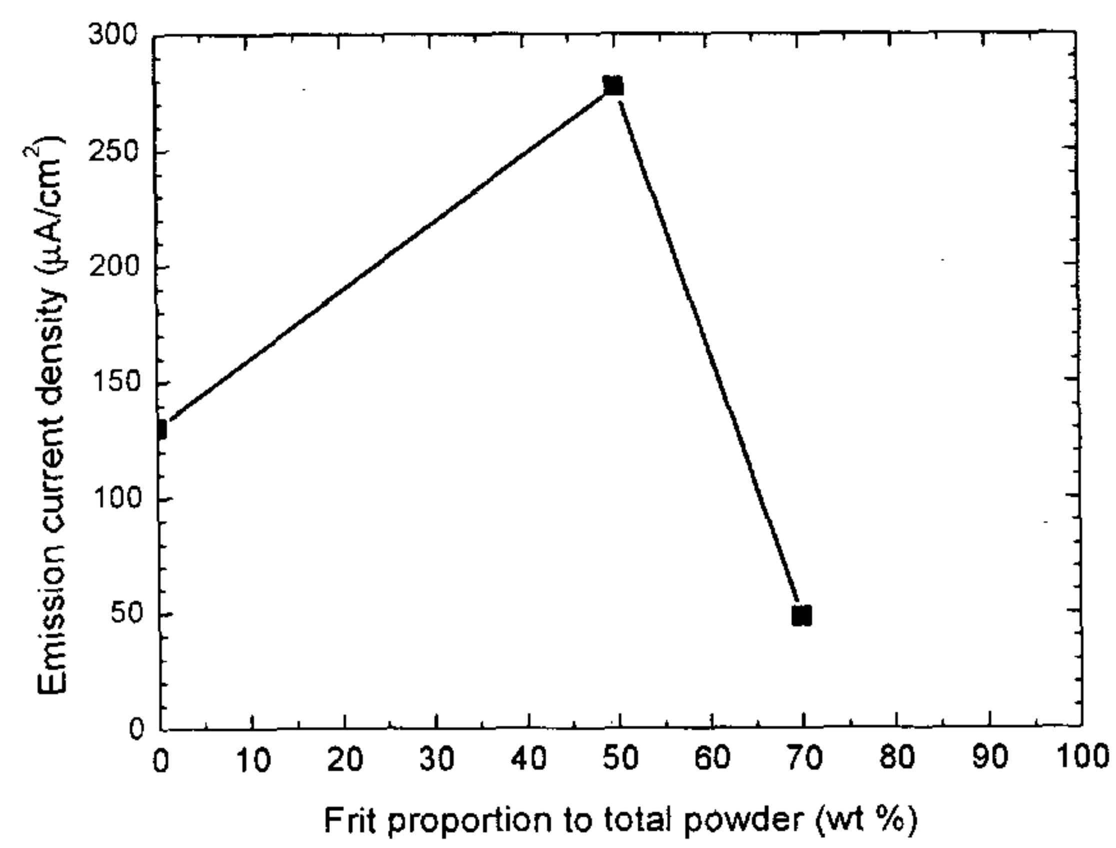

Figure 2. The emission current density as a function of the frit material proportions.

configuration, as a function of the frit proportions. It seems like that there is an optimal point in the frit proportion to the CNT powder in terms of the emission efficiency.

In order to see how the driving voltage depends on the dimensional factors in the under-gate cathode structure, some experiments have been done. Fig. 3 shows the top-view of the under-gate cathode structure.

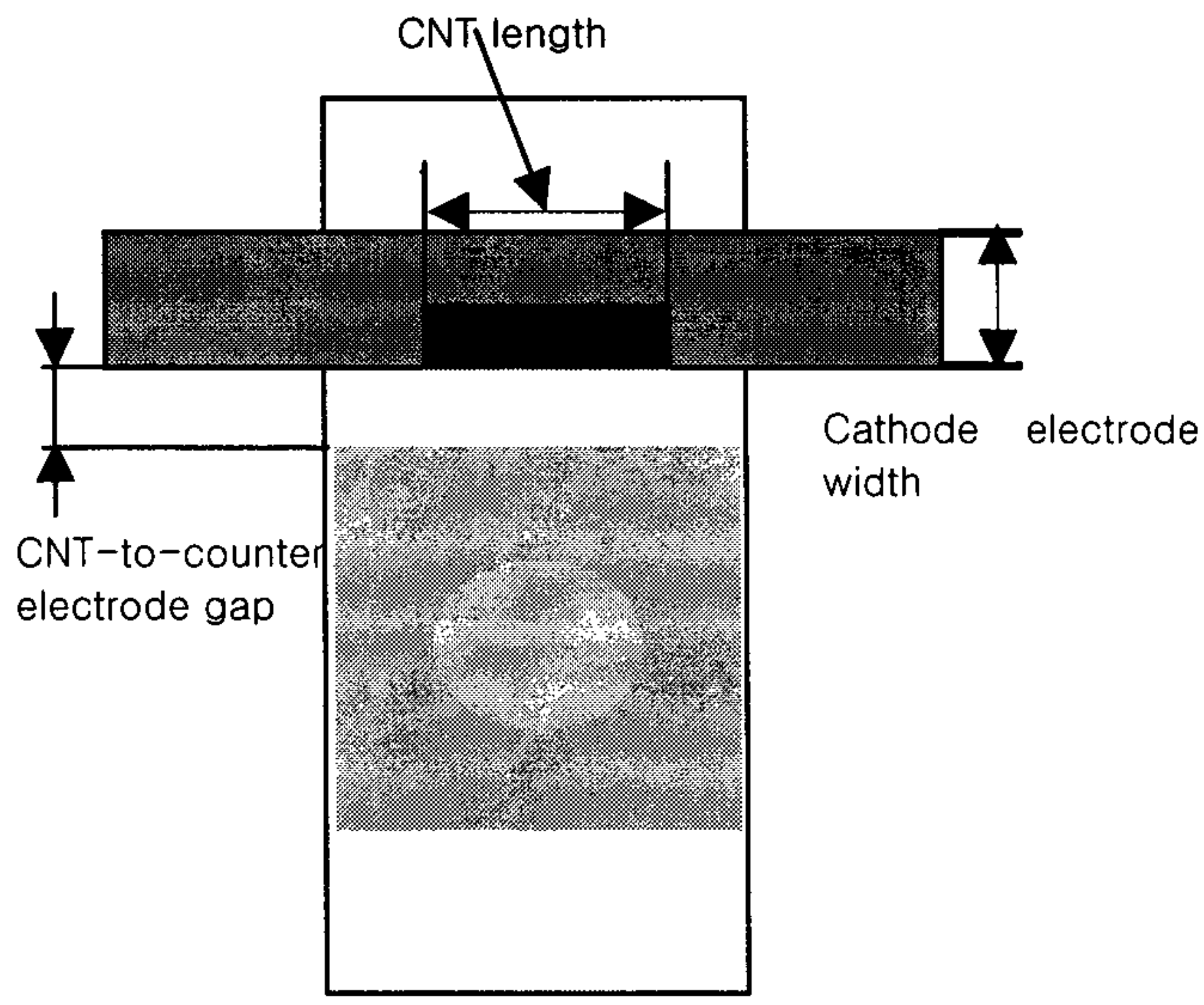

Figure 3. The under-gate cathode electrode structure.

The thick film insulating layer between the gate and the cathode is omitted in the figure. The CNT layer is dot-patterned on the edge of the cathode electrode. Fig. 4 shows the relative change of the emission current as a function of the cathode electrode width(a), CNT-to-counter electrode gap(b), and the CNT length(c). It can be seen that the emission current increases with the narrower cathode electrode. The closer CNT-to-counter electrode gap enhances the electric field applied to the edge of the CNT layer. In order to avoid the electrical short, however, the process margin should be considered carefully when reducing the gap between the counter electrode and the CNT layer. It can also seen that the long CNT results in the increase of the emission current due to the increase of the emission area. The fabricated large size cathodes have been assembled with the phosphor screens and characterized.

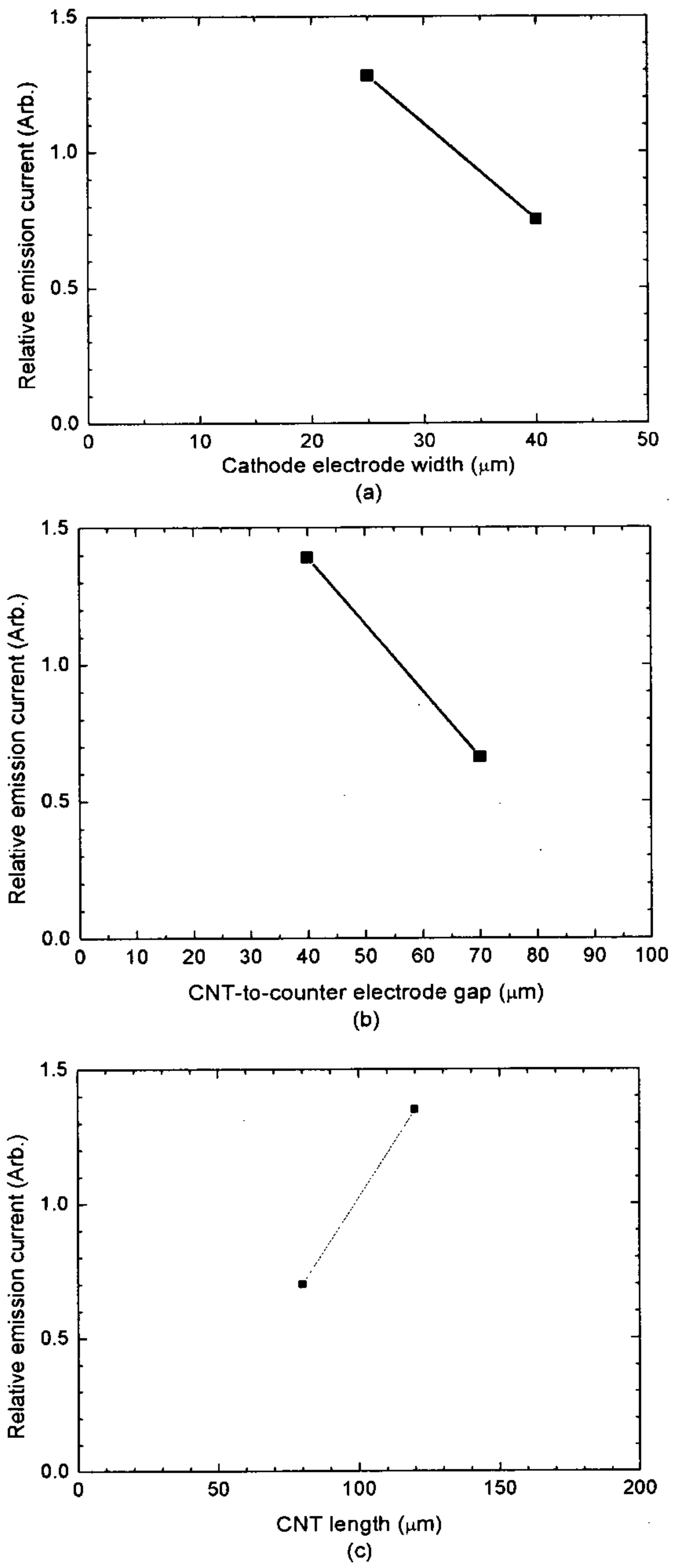

Figure 4. The emission current as a function of the cathode electrode width(a), the CNT-to-counter electrode gap(b), and the CNT length(c).

Conclusion

It was found that there is a suitable proportion of the frit in the CNT paste for the higher emission current. It was also observed that the narrower cathode electrode, the narrower CNT-to-counter electrode gap, and the longer CNT edge are more advantageous in terms of the cathode driving voltage.

Acknowledgement

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References

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[2] C. G. Lee and *et. al.*, "32" UNDER-GATE CNT CATHODE FOR LARGE TV APPLICATIONS", IVMC '02.