

# Fabrication of high resolution electron beam with one carbon nanotube cold cathode

H. R. Lee, J. S. Kang, T. G. Kim\* and K. C. Park

*Department of Information Display and Advanced Display Research Institute,  
Kyung Hee University, Seoul 130-701, Korea*

*Kyupark@khu.ac.kr*

*\*TDS Co., ltd., RM 1005, 1233 Jungang-Ro, Ilsan dong-Gu, Goyang-City,  
Gyeonggi-Do, Korea*

We developed novel carbon nanotube (CNT) growth techniques, i.e. resist-assisted patterning (RAP) process, for high performance electron beam application.<sup>1</sup> The CNT emitters has very unique properties of fully vertically aligned, more than 50  $\mu\text{m}$  in length with less than 100 nm tip radius, 1000  $^{\circ}\text{C}$  durability in oxygen ambient, higher electron emission characteristics, and possible free standing one emitter. With the CNT emitters, we could obtain more than 100 mA electron emission current in less than 1  $\text{cm}^2$  area. Also, the electron beam could drive less than 1  $\mu\text{s}$  duty.

In this study, we developed electron beam with one CNT emitters and measured its electron emission and spatial resolution characteristics. The one emitter grown with RAP process shows higher electron emission current compare other cold cathode electron emitters. Also, spatial resolution which measured with phosphor light images show less than 100  $\mu\text{m}$ . The resolution would be met for electron microscope application.

In this presentation, we will report on the one electron emitter fabrication process and its structural properties, electron emission characteristics of the emitters and electron beam fabrication process, and spatial resolution analysis with phosphor.

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<sup>1</sup> J. H. Ryu, N. Y. Bae, H. M. Oh, O. Zhou, J. Jang, and K. C. Park. Growth of carbon nanotubes with resist-assisted patterning process. Journal of Vacuum Science Technology B 26:02B120, 2011.

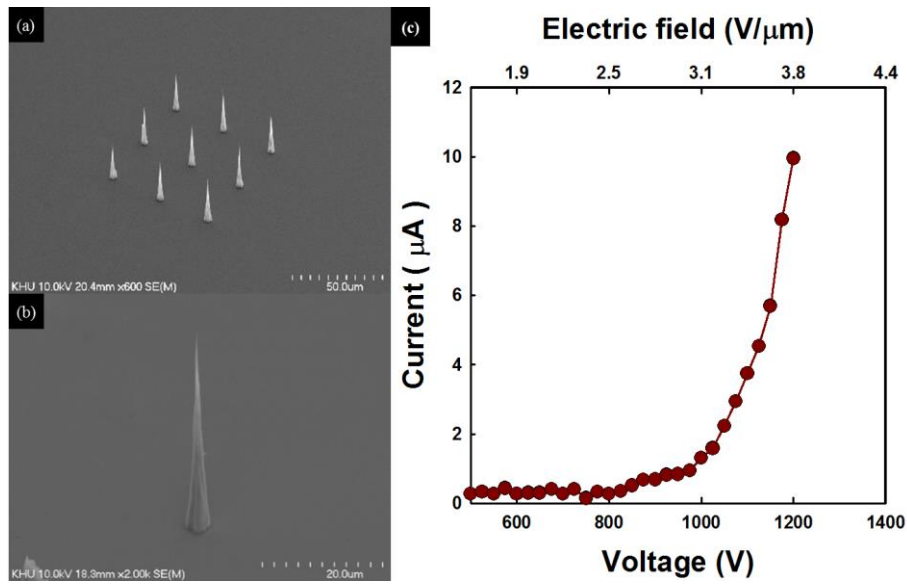


Fig. 1. Fabrication of high resolution electron source with carbon nanotube emitters and its electron emission characteristics. (a) 3×3 electron emitters array (b) Fabricated one emitter for high resolution microscope (c) Current voltage characteristics of one CNT emitter

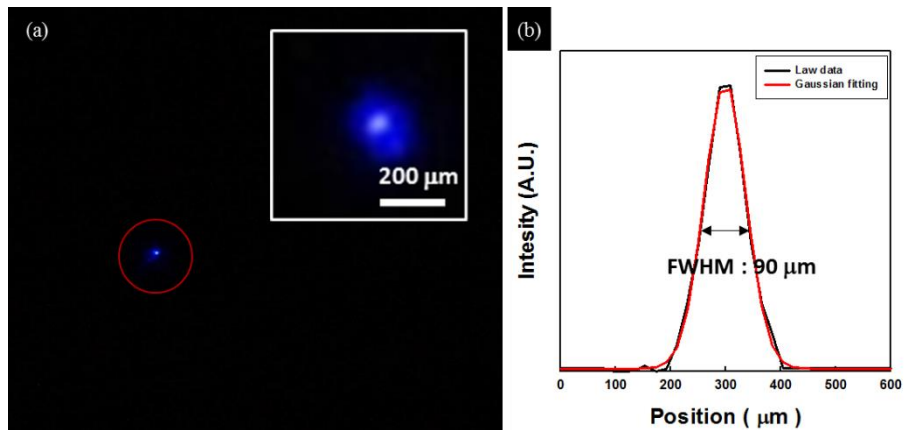


Fig. 2. Spatial resolution of electron beam with one CNT emitters. (a) Phosphor light emission image of electron beam with one CNT emitters (b) Spatial resolution of lighting image of the electron beam with phosphor layer. Less than 100 μm in diameter phosphor lighting obtained.