

Fabrication of glass sealed x-ray tube with high resolution carbon nanotube cold cathode

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We developed glass sealed x-ray tube fabrication technique with novel carbon nanotube (CNT) emitters grown with resist-assisted patterning (RAP) process.¹ The CNT emitters show very high electron emission characteristics and stable operation in long time. With the CNT emitters, we fabricated high performance electron beams and evaluated its performance. We call the CNT cold cathode based electron beam as a C-beam, to strengthen on the carbon and cold cathode. The C-beam shows more than 90% electron from cathode transmittance through gate electrode compare others emitters for less than 70% electron transmittance. The importance of electron transmission and its enhancement will be presented.²

For high performance electron beam fabrication, we optimized gate structure, mesh hole design and module structure and CNT patterning area. The electron emission current strongly depend on the off-set distance between gate mesh and CNT emitters. Detail of the performance of the C-beam will be presented.

Finally, we fabricated x-ray tubes with glass seal technique and measure its x-ray images, for high performance electron beam application. Electron emission characteristics in the x-ray tube were evaluated. The x-ray tube with C-beam shows very high resolution. With the PCB board and finger image, we confirmed more than 100 μm resolution. Detail of the fabrication of x-ray tube and images will be presented.

¹ 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.

² J. S. Kang, J. H. Hong, M. T. Chung and K. C. Park. Highly stable carbon nanotube cathode for electron beam application. *Journal of Vacuum Science & Technology B* 34:02G104, 2016

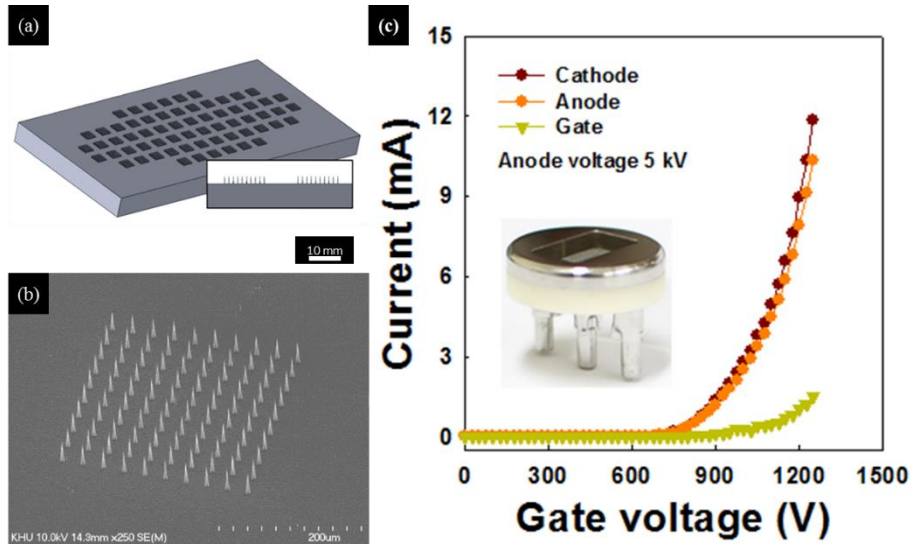


Fig. 1. Fabrication of high resolution electron source with carbon nanotube emitters and its electron emission characteristics. (a) Schematic of cathode with CNT emitters arrays for x-ray application. (b) CNT emitters array in one island. (c) Current voltage characteristics of the C-beam. C-beam module was inserted

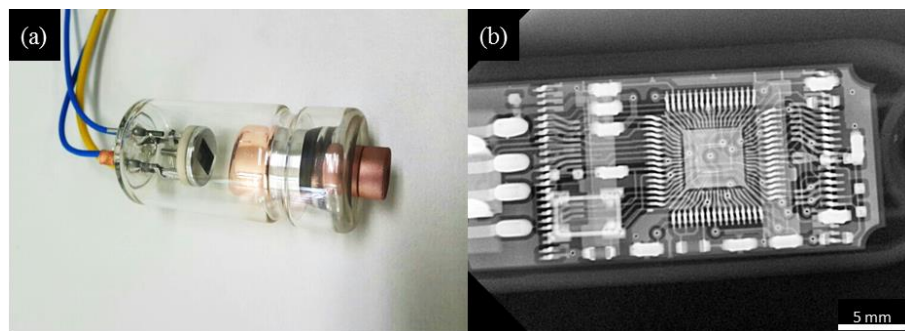


Fig. 2. Spatial resolution of electron beam with one CNT emitters. (a) X-ray tube with CNT cold cathode electron beam (C-beam) (b) X-ray image of USB of the x-ray tube with the C-beam