

## **[Display Technology]**

# **Field emission from nanostructure carbon films**

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We developed a new carbon nano-structure, which comprised of high density carbon nano-tips on graphite layer. These novel carbon nano-tips are grown by a high density plasma chemical vapor deposition (HDPCVD) using inductively coupled plasma on Ni coated Si.

The carbon nano-tips show extremely low turn-on field of 0.1 V/mm and good adhesion to the substrate and are almost aligned to the substrate with a average radius of 20 nm. They exhibited an emission current density of 2 mA/cm<sup>2</sup> at a field of 2 V/mm and uniform electron emission from the whole emitting area. The field enhancement factor calculated from the slope of F-N plots with the assumption of 5 eV emission barrier (as for graphite) was about 103,000. The  $\beta$  is in the range of  $2.6 \times 10^4 \sim 8.81 \times 10^4$  for the CNTs reported in Ref. 1, the 8.81 $\times 10^4$  is the highest value reported so far for single-walled CNTs[1]. The  $\beta$  reported here is higher than that of any CNTs. The  $\beta$  is a geometrical factor for field enhancement and is approximated by  $1/5r$ , where  $r$  is the radius of curvature of a single tip [2]. The average radius of carbon nano-tips calculated from this approximation is about 19 nm and this value agrees with the value of 15~ 25 nm obtained from the SEM image.

### [References]

1. S. Uemura, T. Nagasako, J. Yotani, T. Shimojo and Y. Saito, *SID98 Digest*, 1052 (1998).
2. R. Gomer, *Field Emission and Field Ionization*, (Harvard University Press 1961), Chapters 1&2.