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FIELD EMISSION PROPERTIES OF VERTICAL AND LOOPED CARBON NANOTUBE FIBERS

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Carbon Nanotube Fibers (CNFs) have demonstrated excellent field emission (FE) properties and thus hold significant potential for use as electron sources for vacuum electronic devices (VEDs). CNFs were fabricated from pre-made carbon nanotubes (CNTs) mixed with chlorosulfonic acid resulting in a dopant with CNTs composing 2-6% of the solution mass. This dopant was extruded through a small diameter spinerette to make CNFs with a diameter of ˜20 ⊠m. The CNFs were then cut into segments and arranged in various emitter geometries and their field FE performance was measured. The CNF cathode samples were mounted in a vacuum chamber with a simple DC diode configuration for measuring I-V curves up to a maximum voltage of 3 kV. Both free standing and looped configurations were measured for their emission current and temperature. The free standing CNF was 4 mm tall and the looped CNF was 4 mm tall at the loop apex. Direct IR imaging during FE showed that the maximum temperature of the looped CNF was half that of the vertical CNF at the same emission current of.. The lower temperature operation is due to improved thermal management resulting from having both ends of the looped fiber connected to the substrate. Field emission microscopy was used to examine the looped CNF. Results indicated that initial emission is confined to isolated stray single CNT bundles that comprise the CNFs, with the total output current on the order of 100's μA to a few mA. Initial stray emitters condition away via a series of micro-breakdowns caused by extreme thermal loads due to high current density. The looped CNF produced high output current and directed emission after undergoing the initial conditioning process. This work demonstrates the CNFs offer significant potential for use as high current density, low temperature FE cathodes for use in VEDs.

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