

High Performance Field Emission from Line-type Carbon Nanotube Field Emitters

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Compared to a planar or a point electron beam, which is widely used in the conventional vacuum electronics, a sheet electron beam has attracted much attention for x-ray tubes, micro-CT, and microwave amplifiers because it allows a higher emission current and a larger interaction area than other electron beam sources [1,2]. Until now, sheet electron beam was produced by thermionic emitters. By the way, the thermionic emitters presented several disadvantages, such as a low brightness, a high energy dispersion, and a low operation speed [3]. Recently, a few groups have reported sheet electron beam sources generated by field emitters, but they have not yet exhibited high field emission performance and uniform electron emission [4,5]. Therefore, it is highly challenging to realize field emission based sheet electron beam source with a high field emission performance and a good emission uniformity.

In this study, we demonstrated a line-type carbon nanotube (CNT) field emitter, which emits electrons from its line-edge, as for a sheet electron beam source. We also proposed a novel cathode structures for obtaining sheet electron beams with a high-quality and a high-aspect-ratio. The line-type CNT field emitters show an emission current of up to 45 mA, which corresponds to an emission current density of 150 A/cm² and well-confined sheet electron beams with an improved emission stability. We expect that the excellent performance of the sheet electron beam source can be applied to various next-generation applications such as high-resolution micro-CT and high-power microwave amplifiers.

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