Electron Field Emission from Carbon Nanotubes

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Carbon Nanotubes have been identified as a suitable source for cold cathodes due to its high aspect ratio, robust microstructure, and high current carrying capability. Its electrical, mechanical and thermal properties are ideally suitable for high current density applications. The potential applications of these cathodes range from field emission displays, to X-ray sources, to space thrusters, to electron guns. Before such materials can be adopted for technologies, routes to manufacture, with suitable quality and appropriate characteristics must be realised.

We examine the properties of single emitter carbon nanotubes, ropes of nanotubes and arrays of nanotubes with a view to optimising the electron emission properties [1]. Within the programme we develop technologies that can be used to manufacture carbon nanotube field emission arrays over large areas using a novel Photo-Thermal Chemical Vapour Deposition process, which can precisely growth nanotube arrays over large areas on predefined catalysts at low temperatures compatible with CMOS processing [2]. We show by simulation optimised designs to maximise electron emission properties in arrays to reduce screening effects, and varying the height profiles within each pixel [3].

To fully understand the electron emission process in carbon nanotube structures and to verify the electron emission experimental data obtained as a function of anode to cathode spacing, we model the process by using a direct calculation of the solution for the 2D Schrodinger equation [4]. The effect of high electric field on the electron as it transfers from the surface of the 2D carbon nanotube to a 3D vacuum is analysed, and the influence of the geometric effects examined to qualitatively replicate a large number of experimental results. Our model goes beyond the usual 1D semi-classical W-K-B approach, and is able to describe some of the quantum behaviour observed in electron emission from the surface of carbon nanotubes when emitted to vacuum [4,5].

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