Carbon Nano-Tube Electron Emission Devices

Category: Other Technologies
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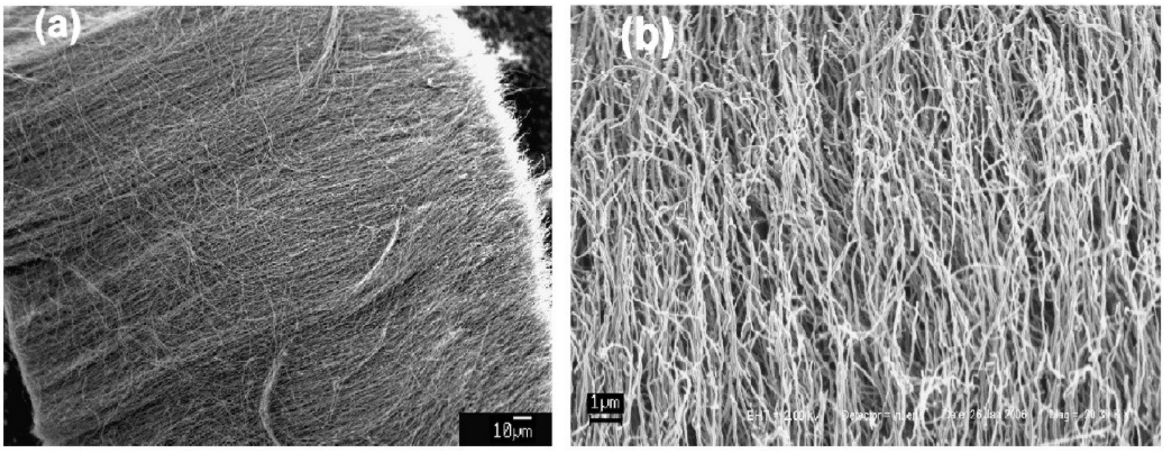

Fig. 1. Field emission scanning electron micrographs of the aligned multiwall carbon nanotube film under test: (a) cross section of the free-standing nanotube film peeled off from the silica substrate. The nanotubes were grown into a carpet-like film from the surface of the substrate (from the left- to the right-hand side). Note that the alignment of some nanotubes at the surface of the cross section area was interrupted during the sample preparation and (b) plan view of the nanotube film showing the top tip end of the nanotube arrays, which face the external mesh gate.

Abstract:

A leading UK university has developed a method that uses highly aligned carbon nanotubes (CNT) to emit electrons at high current density (60mAcm^{-2}) and ultra-low power. The CNTs are grown in a highly aligned carpet in order to maximise the electron emission. These are particularly suited for applications where size and power need to be kept to a minimum.

Description:

Carbon nanotubes are attractive for neutraliser devices because they have low emission threshold potentials, high current densities, stable field emission over prolonged time periods and are simpler to manufacture than silicon field emission arrays. As field electron emission is principally a function of applied electric field, the CNT alignment optimises geometrical field enhancement and reduces operating power.

It is well established that field emission does not occur at electric fields <10^8V/m, however, the CNTs were observed to emit at an unenhanced field of 10^5V/m. Therefore, the enhancement in the field from the tube geometry must be substantial and of the order 10^3V/m. During the course of endurance tests it was noted that there was no significant change in the current to the mesh, but the change in voltage was +0.05V/h (0.02%/h). This represents a substantial improvement in perfomance when compared to the silicon FEAs that were tested. In lifetime tests the CNT field emitters lasted in excess of 1400 hours. This is lower than the 6000 hours logged by some of the silicon FEAs available. However, there has been much iteration in the manufacturing process of Si FEAs which has not yet been done with the CNT counterparts. Once this has been completed a more realisic lifetime value can be expected

Innovations and advantages of the offer:

- The CNT are grown to be highly aligned which maximises electron emission.
- The CNT are secured to a substrate which allows for safe working.
- The CNT can be produced in whatever format is needed (e.g. with integral micro-machined electrodes)

Further Information:

N/A

Application:

- Generation of electrons in vacuum (<10^{-2} torr) for a variety of purposes.
    - Microscopy, X-ray generation, and microwave tubes.
    - Particularly suited for applications where size and power need to be kept to a minimum.
- Potential for generation of electrons or atmospheric ions at air pressure.
    - More work needs to be conducted to confirm this.

Space Heritage:

Method for electronic propulsion for satellites in space.

Broker comments:

At a quite low TRL so a collaborative development project is probably the most effective route to transfer.

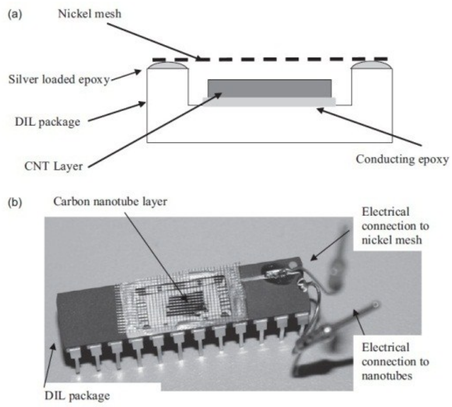

Fig. 2. Dual in line package (DIL) used for carbon nanotube (CNT) testing: (a) schematic showing the location of the nickel extractor mesh at a distance of ~1 mm from the upper surface of the CNT layer and (b) photograph of the DIL package showing the external mesh, fixed to the package manually using conductive epoxy. The individual electrical connections to the mesh (top of the package) and nanotubes (base of the package) are also indicated.