Electron Field Emission from Multiwalled Carbon Nanotubes

Martin Sveningsson, Oleg. A. Nerushev[1], Krister Svensson, Eva Olsson, Eleanor E. B Campbell.
Department of Experimental Physics, School of Physics and Engineering Physics, Göteborg University and Chalmers University of Technology,
SE-412 96 Göteborg, Sweden.
[1] Permanent address: Institute of Thermophysics, 1 Acad. Lavrentyev Ave., Novosibirsk 630090, Russia.
Email: f3amsv@fy.chalmers.se

Films of aligned multi-walled carbon nanotubes are produced by two different methods, thermal chemical vapour deposition (CVD) and plasma chemical vapour deposition, on different substrates. The field emission measurements show that films from the thermal CVD have excellent field emission properties, while the plasma CVD films seem to have lower field emission due to the screening effect which is a result of the better nanotube alignment that is achieved in the plasma CVD. In the thermal CVD the results show that the current density as a function of applied electric field (on multiple cycles) is reproducible up to a value around 1 mA/cm^2. Exceeding this value leads to light emission and irreversible changes occur in the nanotube film. This light emission is also seen for the films produced by plasma CVD.
Spectral measurements of this light show a purely blackbody radiation effect with a temperature around 1550 K for the onset current density, but temperatures over 2000 K are also seen for higher current densities [1]. The onset of the light emission also occurs at approximately the same value as a noticeable change in the slope of the Fowler-Nordheim plot, indicating a structural change of the nanotube film. Measurements of the light emission dependence on different substrates and catalyst particle material will also be shown.
Investigation of the emission properties of individual as-produced individual multi-walled carbon nanotubes is carried out using a combined transmission electron microscope (TEM) and a scanning tunneling microscope (STM). This gives the unique possibility to observe the carbon nanotube while the field emission measurements are performed, revealing structural changes of the tube at high emission current. The observation and results from the individual nanotubes will be correlated to the results obtained from the macroscopic measurements.

Reference

[1] Black body radiation from resistively heated multi-walled carbon nanotubes during field emission, M. Sveningsson, M. Jönsson, O.A. Nerushev, F. Rohmund, E.E.B. Campbell, Appl. Phys. Lett., **81** (2002) 1095