# SINGLE CARBON NANOTUBE ELECTRICAL CONNEXION BY ELECTRON BEAM AND ION BEAM PLATINUM DEPOSITION

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In this poster, we will discuss the issue of the nanopatterning of electrical connexions to carbon nanotubes using *focused Ion Beam* or *focused Electron Beam* Platinum deposition [1]. These solutions apply for a quick characterization of Carbon Nanotube Field Effect Transistors [2].

The electrical properties of the e-beam or i-beam deposited platinum electrical contacts will be presented. Both beams are seen to lead to halos surrounding the platinum deposition patterns, as seen for instance from SEM images. The leakage conduction through these halos is investigated, and imaged using from Kelvin force microscopy [3] experiments on biased nanotubes (fig. 1).

It is shown that on the one hand the ion-beam deposition creates highly conductive electrical connections, however associated with fairly conductive µm-size halos. This limits the CNT electrode separation by a few microns. On the other hand, electron beam induced platinum deposition creates poorly conducting halos, but also generate higher resistivity platinum patterns. Four-probe measurements are then required to characterize the nanotubes electrically.

Using EFM, we demonstrated the possibility to quantify the presence of charges on nanotubes. This allows the possibility to demonstrate and quantify stored charges inside a MWCNT (fig.2).

**References:**

[1] Vidyut Gopal, Eric A. Stach and Vladimir R Radmilovic, *Applied Physics Letters*, **85**, 1 (2004)

[2] Ebessen T.W, Lezec H.J, Hiur, H., Bennett J.W., Ghaemi H.F, Thio T., *Nature,* **382**, 6586 (1996)

[3] B. N. Nonnenmacher, M.P. O'Boyle, and H. K. Wickramsinghe, *Applied Physics Letters*, **58**, 2921 (1991)

**Figures:**

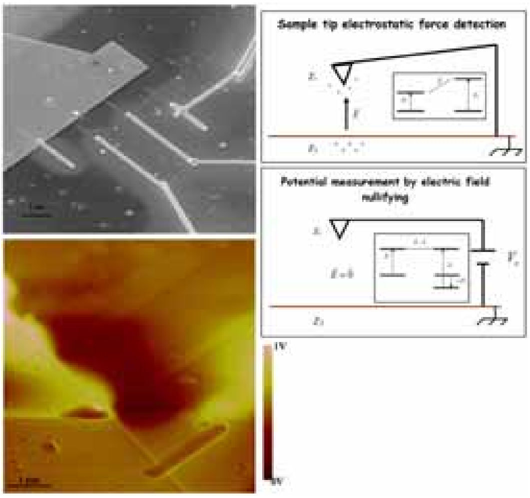
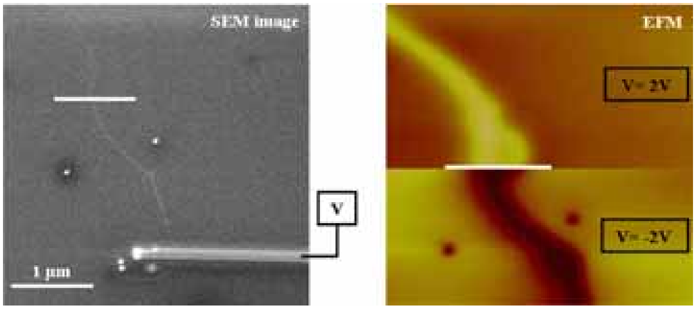



**Figure 1** Top : SEM image of a MWCNT contacted by ion beam induced platinum deposition. Two separated groups of halos can be identified. The inset shows the principle of KFM imaging. Bottom: Kelvin force Microscopy image of the biased MWCNT (here through the outer electrodes), showing surface potential distribution along the nanotubes. Each group of halos is seen to be equipotential.




. **Figure 2**. Left: SEM Image of a MWCNT contacted by electron beam induced platinum deposition. Right: Electrostatic force microscopy (EFM) image of the MWCNT biased from the contact electrode. The white line shows the correspondence between the EFM and the SEM image. The electrode polarization is reversed ad mid-scan, corresponding to the contrast inversion in the EFM image.