CARBON NANOTUBE AFM PROBES FOR HIGH RESOLUTION IMAGING OF BIOLOGICAL SYSTEMS

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The structural, mechanical, chemical and electrical properties, of the carbon nanotubes (CNT) [1] have made them candidates to fabricate devices such as nanometer-scale transistors [2], field emission displays [3], actuators [4], etc.. A lot of progress has been done along the years, however even nowadays there are difficulties to guide them in the appropriate direction and to control their longitude.

The high aspect ratio, chemical stability and mechanical strength make carbon nanotubes as ideal probes for scanning probe microscopy, especially in atomic force microscopes (AFM). Several methods have been developed to attach carbon nanotubes in an AFM tip, such as to glue the CNT onto a silicon tip [5], or to place catalytic metallic particles to grow the carbon nanotube by chemical vapour deposition (CVD) [6] or by electron beam deposition (EBD) [7]. Nevertheless, to improve the spatial resolution in imaging is necessary to control in a precise way the length of the nanotube [8].

Here we report on the successful placement of an individual CNT onto the end of a silicon AFM tip by using a nanomanipulator inside a scanning electron microscope. This method allows to retrieve a single CNT with the AFM tip from an electrode covered with CNTs. Once the CNT is on the tip, we have developed a new technique to control the desired length of the nanotube. This technique permits the fabrication of CNT AFM tips from 40 nm till 2 um in length (Fig.1). Finally, the performance of these tips was tested by imaging different biological systems with amplitude modulation AFM in air.

As an example (Fig.2), the twisted structure of double stranded DNA on mica can be observed.

References:

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Figures:

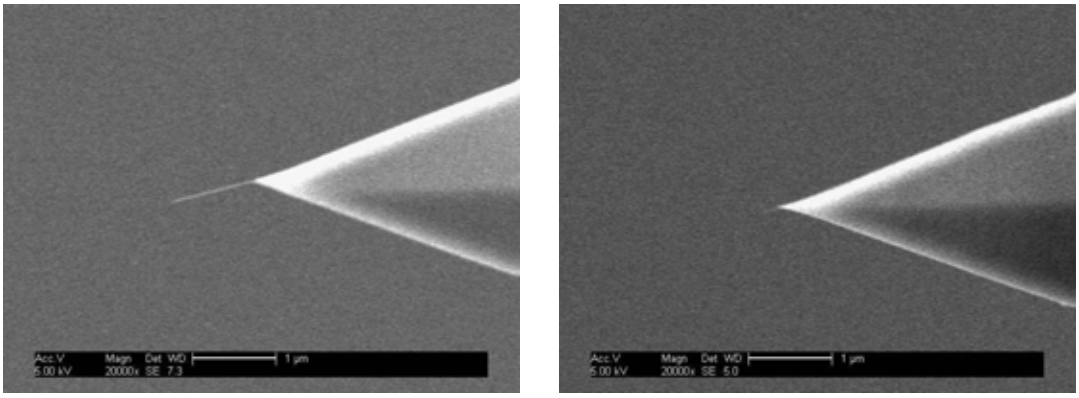

Figure 1. Two examples of CNT AFM tips: On the left 1um tip, and on the right 100 nm tip.

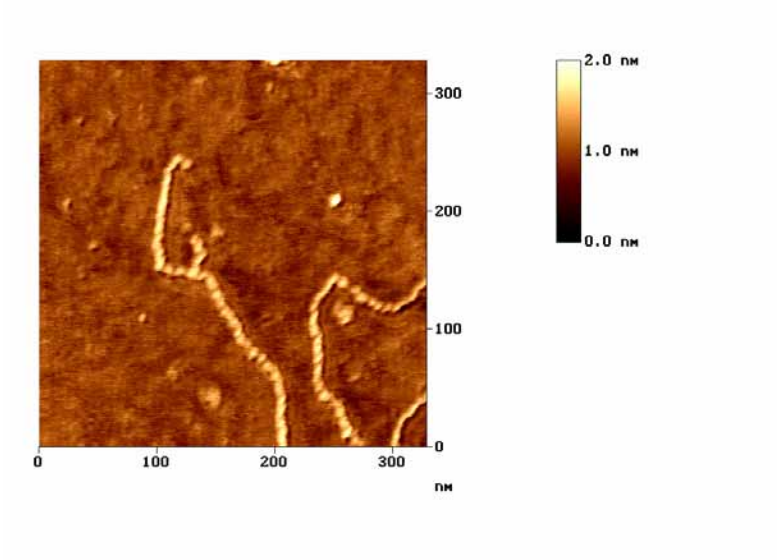

Figure 2. Tapping mode AFM image of DNA on mica acquired with a 50 nm CNT tip