Poster

COMPARISON BETWEEN ARC-DISCHARGE AND CHEMICALLY VAPOR DEPOSITED CARBON NANOTUBES AS ATOMIC FORCE MICROSCOPY PROBES

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Atomic force microscopy (AFM) has become one of the most indispensable surface characterization techniques in nanotechnology. In nanoscale surfaces dominate the physical and chemical properties and it is, therefore, critical to have means for characterization of surface properties at the nanoscale. Commercially available AFM probes are typically made of silicon or silicon nitride. Ideal AFM probes have a high aspect ratio, high stiffness and high chemical and mechanical stability. Carbon nanotubes (CNTs), with their very high aspect ratios, their high tensile strength and high resilience have become one of the promising materials for AFM probes.

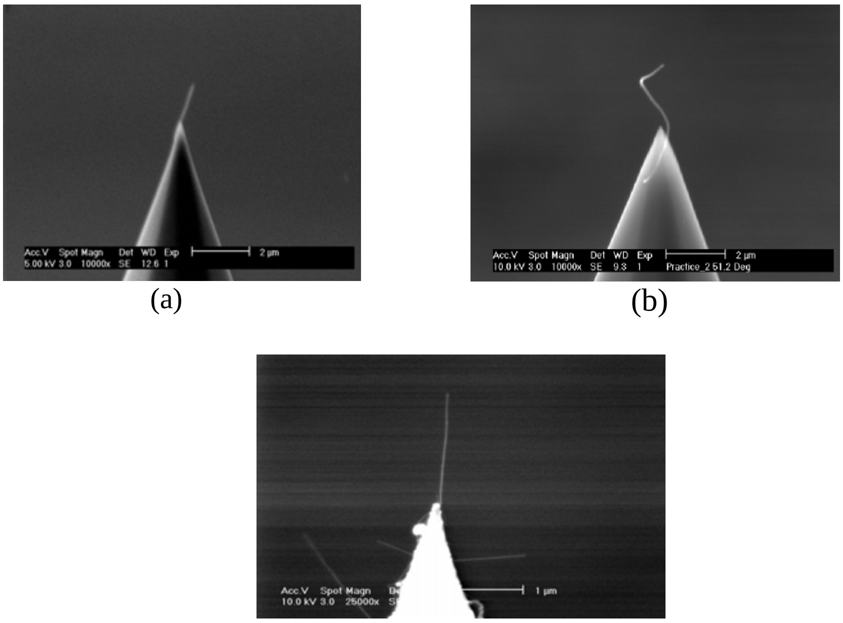
CNTs can be produced by different methods, i.e. arc-discharge, catalytic chemical vapor deposition (CVD) and laser ablation. CNTs produced with different methods exhibit different physical properties. For example, arc discharge CNTs have higher Young's modulus with less defects than the CVD CNTs have.

It has become possible to fabricate AFM probes tipped with CNTs within the last decade. There are two major methods to produce CNT decorated AFM probes. One method uses pre-grown CNTs. In this method pre-grown CNTs are attached onto the AFM probes under the optical microscope or in the scanning electron microscpe (SEM) / transmission electron microscope (TEM). In the other method CNTs are directly grown on the AFM probe by CVD or plasma enhanced CVD. Examples of CNT decorated AFM probes produced with different methods during our studies are seen in Figure 1. Figure 1 (a) shows an arc-discharge CNT mechanically attached onto an AFM probe. Figure 1 (b) shows a mechanically attached CVD CNT on an AFM probe. And, figure 1 (c) shows a CNT which was grown directly by CVD on an AFM probe.

In this study we've attached both pre-grown CVD and arc-discharge CNTs onto the AFM probes. Attachment was carried out in the SEM with the help of a dedicated nanomanipulator. Our goal is to compare the performance of arc-discharge and CVD grown CNTs when they are used as AFM probes. We've used these CNT decorated AFM probes to scan mica substrates with colloidal gold particles of different diameters scattered on the surface. The results were also compared with commercial AFM probes. All AFM measurements were carried out in the tapping mode.

Our results show that scanning with arc-discharge CNT decorated AFM probes give higher resolution images with respect to the images gathered with commercial AFM probes. CVD CNTs grown directly on AFM probes couldn't be used for scanning since they are too long and have a tendency to buckle. However, we've been able to scan with manually attached CVD CNT decorated AFM probes. Since this technique enables the selection of well aligned and short CNTs. The images gathered with CVD CNT decorated AFM probes have higher resolution than the images gathered with commercial AFM probes. Our preliminary results show that the arc-discharge CNT decorated AFM probes exhibit the best performance.

Figure 1: Arc-discharge CNT attached onto an AFM probe (a). CVD CNT attached onto an AFM probe (b). CNT that has grown by CVD directly on an AFM probe (c).



(a) (b)

(c)