Modification of AFM tips by depositing nanoparticles with an Ion Cluster Source. Enhancement of the aspect-ratio and lateral resolution.

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The use of Atomic Force Microscopy (AFM) for imaging nanostructures has become a fundamental tool nowadays. However, as the forefront technology fabricates systems with more and more reduced dimensions, the spatial resolution of these systems with AFM is limited fundamentally by the physical size of the probe. In this talk we present a new method to reduce the final radius of the scanning probe microscopies (SPM) tips, by depositing nanoclusters on standard silicon tips. The modified tips present an enhanced resolution, which can be competitive with sharp tips with high aspect ratios. We will explain the modification process of the AFM tips [1] and present some examples comparing images acquired with standard silicon tips and the same tips modified with the deposition of nanoparticles of different sizes [2]. The use of an Ion Cluster Source (ICS) to deposit the nanoparticles, offers the possibility to tune the chemical composition of the deposited nanoparticles. This implies that, in addition to the enhancement of the aspect ratio, this technique can be extended for specific measurements in other force microscopy techniques such as magnetic force microscopy.

Some examples of AFM measurements on zero dimensional, one dimensional and two dimensional structures will be presented. The figure below displays AFM images of a single wall carbon nanotube (SWCNT) deposited on a flat silicon Si(100) substrate, measured with a standard silicon tip (a) and a modified tip covered with 2-3 nm nanoparticles (b). It can be observed a reduction in the feature size and increase of the in-plane contrast and resolution with the modified tip. The increase in the lateral resolution was evaluated by fitting the profiles of the features present in the AFM images. The fit were performed using Gaussian functions and a reduction between 30 % and 50 % of the full width at half maximum (FWHM) of the profiles of the features was determined.

In resume, the use of those tips leads to atomic force microscopy images of higher aspect ratios and spatial resolution. The presented tips modification method represents an alternative for the generation of high-aspect ratio tips for high-resolution measurements. It should be mentioned that the modification of the tips by deposition of nanoclusters is a "one step process" that does not need any additional chemical of physical processes. More information about the process and modification of tips could be found in [3].

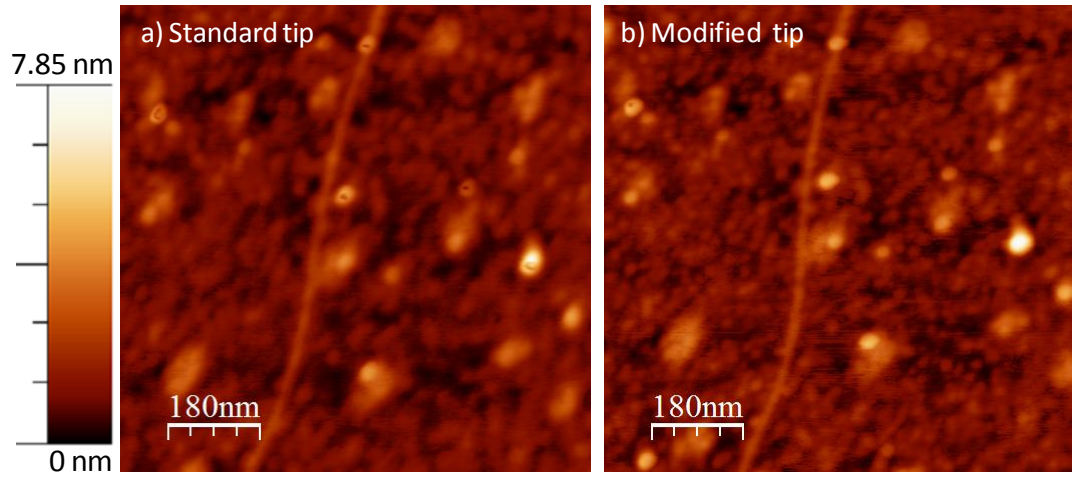
References

[1] Spanish patent number P201030059, Elisa L. Román García, Lidia Martínez Orellana, Mercedes Díaz Lagos, Yves Huttel.

[2] L. Martínez, M. Tello, M. Díaz, E. Román, R. Garcia, and Y. Huttel, Review of Scientific Instruments, accepted paper.

[3] http://www.icmm.csic.es/yveshuttel/WebPageYves.html

Figure



AFM images of SWCNT deposited on a silicon wafer. a) AFM image recorded by using a standard silicon AFM tip; b) AFM image recorded by using a standard silicon AFM tip covered with 2-3 nm nanoparticles.