Novel SuperSharp AFM tips with enhanced resolution and durability

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Abstract

One of the factors that limit the spatial resolution in Atomic Force Microscopy (AFM) is the physical size of the probe. This limitation is particularly severe when the imaged structures are comparable in size to the tip's apex. The resolution in AFM is usually enhanced by using sharp tips with high aspect ratios. In this talk we present modified AFM tips based on a new method for both the functionalization and the reduction of the final radius of the tips that can be used in scanning probe microscopies (SPM). This approach to modify AFM tips consists in depositing nanoclusters on standard silicon tips. We will explain the modification process of the AFM tips [1] and present some examples comparing images acquired with the modified tips with SuperSharp tips.

In a previous work [2] we demonstrated that the modified tips improved the aspect ratio and the lateral resolution of standard tips. In this work an additional comparison with SuperSharp tips is performed. Figure 1 presents a comparison of a nanoparticuled system measured exactly in the same region. It can be observed how the NPs are better resolved with the modified tips. We know from previous studies that these nanoparticles presented a round shape. The ratio between the width and the height of the nanoparticles, measured in the attractive regime, presented around a 37 % reduction when using the modified tips. When performing similar experiments on single wall carbon nanotubes, SWCNT; (figure 2), we also observed a reduction of the measured width (see profile). In addition to this, we will present some other examples to prove how by the modification of standard tips with nanoparticles it is possible to improve also the spatial resolution of SuperSharp tips. This modification has a long lasting effect and the durability of the tips is larger than the SuperSharp and the standard probes which makes it particularly interesting for several applications.

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. Furthermore, the ability to tune the chemical composition of the deposited nanoparticles implies that the technique can be extended for specific measurements in other force microscopy techniques such as Kelvin Probe Microscopy [3] or magnetic force microscopy. These tips are commercially available in a recently created spin-off of the CSIC, named Next-Tip [4].

References

[1] Spanish patent number P201030059, PCT/ES2011/070319, 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, **82** (2011) 023710.

[3] C. V. Manzano, O. Caballero-Calero, S. Hormeño, M. Penedo, M. Luna, M. S. Martín-González, J. Phys. Chem. C, **117** (2013) 1502.

[4] http://www.next-tip.com/

Figures

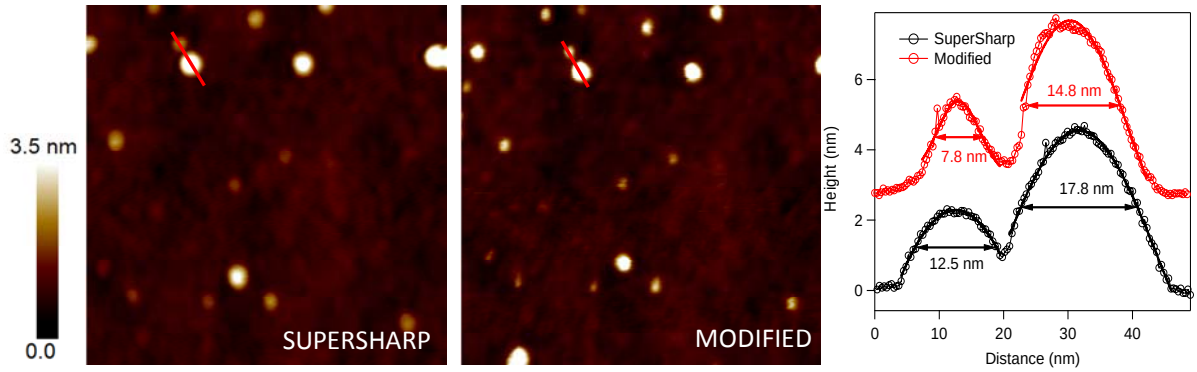

Figure 1. AFM images (300x300 nm^2) of Au nanoparticles deposited on a Si(100). The left image was acquired with a commercial SuperSharp tip and the center image with a modified tip. In the right image is displayed a comparison profile of two nanoparticles.

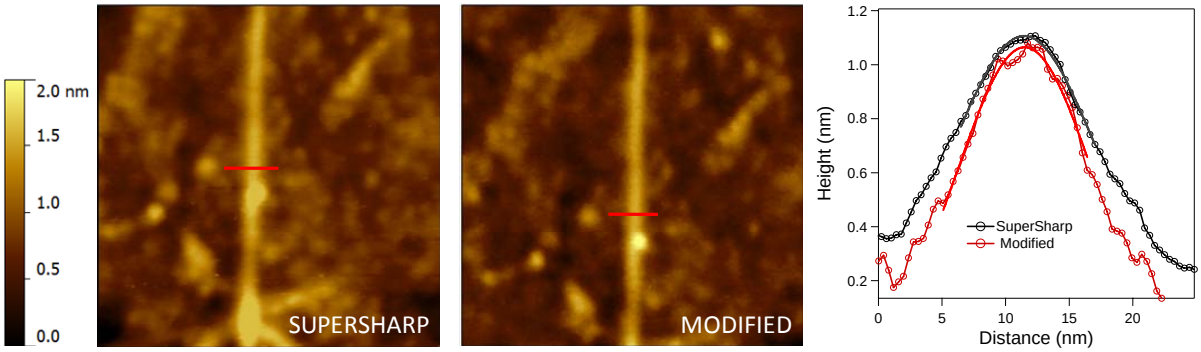

Figure 2. AFM images (200x200 nm^2) of SWCNT deposited on a Si(100). The left image was acquired with a commercial SuperSharp tip and the center image with a modified tip. A comparison profile is presented in the right image.