EFFECTIVE ELECTROSTATIC TIP RADIUS IN FORCE MICROSCOPY

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One of the most important issues in the analysis of Force Microscopy experiments is the characterization of the geometry of the tip apex. This can be done directly by imaging the tip with scanning electron microscopy (SEM) or by using calibration samples together with different deconvolution techniques [1]. Here we propose a simpler method to determine the tip radius by measuring the electrostatic force between the tip and a flat metallic sample. Recent calculations [2] showed that the electrostatic force between a tip and a metallic surface can be approximated as

$$F \approx F_{macro} - \pi\varepsilon_0 V^2 \frac{R_{eff}}{D}$$

where F_{macro} is a constant (that depends on the overall tip shape), V is the applied bias and R_{eff} is the theoretical effective radius. The effective radius can then be obtained directly from the experimental force versus distance (F-D) plot. To analyze the relation between R_{eff} and the real tip apex shape we have obtained *SEM* images of the tip and *F* vs *D* curves with an *EFM*. As it can be seen in Figure 1, the effective electrostatic radius is in excellent agreement with that obtained directly from the SEM images.

References:

[1] H. –Y. Nie and N. S. McIntyre. Langmuir **17**, 432 (2001); J. S. Villarubia, Surf. Sci. **321**, 287 (1994).
[2] S. Gómez-Moñivas, L.S. Froufe, A.J. Caamaño and J.J. Sáenz. Appl. Phys. Lett. **79**, 4048 (2001)

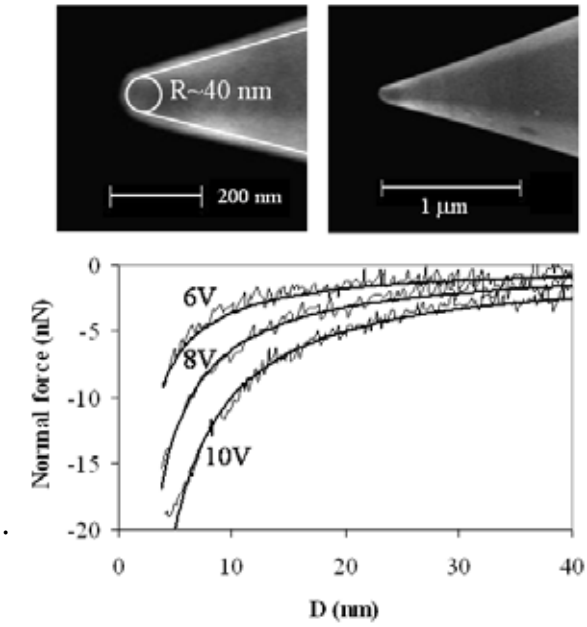

FIG. 1: (a) SEM images of a force microscope tip. The images show a conical shape ended at a sphere of R~40 nm. B) electrostatic normal force versus tip-sample distance for different applied voltages. Theoretical force has been obtained with R_{eff}=35 nm