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Nano-materials Interrogation Using Novel Ultrasonic Atomic Force Microscopy Technologies

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Abstract:

Atomic Force Microscopy (AFM) with ultrasound excitation was implemented as an attempt to develop a Near-Field Probe Technique to render elastic information (as the Acoustic Microscope) with resolution on the nanometer scale [1, 2]. An AFM cantilever with the tip in contact with a sample surface will linearly follow small-amplitude surface ultrasonic vibration provided that its frequency is below the cantilever resonance frequency. However, due to the inertia of the cantilever, the linear behavior is not evident in the limit of high frequency signals.

Techniques such as Acoustic-AFM rely on monitoring cantilever vibration linearly induced through the tip-sample contact when the tip is in contact with a vibrating surface typically excited at frequencies of some tens of MHz. Ultrasonic Force Microscopy (UFM) is based in the so-called Mechanical-Diode (MD) effect: when a cantilever tip is in contact with a sample surface excited at ultrasonic frequencies with sufficiently high amplitude, the cantilever experiences a quasi-static deflexion – the MD deflexion – because of the net force acting upon a cantilever during a complete ultrasonic cycle, due to the nonlinearity of the tip-sample interaction force.

UFM has already demonstrated its ability to provide *nanoscale surface and subsurface information* on the dynamic elastic, viscoelastic and adhesive properties of the tip-sample contact. UFM can be applied to *both hard and soft samples.* In the presence of ultrasonic vibration, a soft cantilever can indent hard materials, due to its inertia. Hence, it is possible to obtain material contrast on hard surfaces or coatings. In addition, in the presence of ultrasonic vibration, friction reduces or vanishes, which facilitates the investigation of soft delicate samples. In the talk, I will illustrate some innovative procedures to apply nanoscale ultrasonics currently under development in our lab, and discuss experimental ultrasonic force data that we have measured on different samples such as TiN coatings, silicon nanostructures, nanoparticles, and polymer films and gels.

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Members and visitors from our laboratory are listed here:
http://www.uclm.es/organos/vic_investigacion/gruposweb/nanotecnologia/index_archivos/Page570.htm.
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References:

[1] M.T.Cuberes, Nanoscale Friction and Ultrasonics, in "Fundamentals of Friction and Wear on the nanometer scale", E. Gnecco and E. Meyer (editors) Springer, 2007.
[2] M.T. Cuberes, Mechanical-diode mode Ultrasonic Friction Force Microscopies in “Applied Scanning Probe Methods”, B. Bhushan and H. Fuchs (ed.), Springer 2009 .