Nanomechanics Fundamentals and Application in NEMS Technology

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The development of new materials with the size of a few nanometers has opened a new field of scientific and technological research. Nanomaterials such as carbon nanotubes, oxide nanobelts and semiconductor nanowires are promising building blocks in future integrated nano-electronic and photonic circuits, nano-sensors, interconnects and electro-mechanical nanodevices. The goal is to develop faster and better communication systems and transports, as well as smarter and smaller nanodevices for biomedical applications. To reach these objectives it is crucial to have knowledge and ability to control the mechanical behavior of these nano-objects. In general, the mechanical properties of the materials at the nanoscale are not well understood. The experimental challenge is to have an instrumentation that allows us to image and manipulate a nano-object, characterize its atomic structure and measure forces of the order of nanonewtons. From the theoretical side, developing a theory of elasticity and friction at the nanoscale is an also intriguing task that lies at the crossover between the atomic level and the continuum.

In this lecture we will describe recently developed experimental methods to measure the elastic, friction and adhesive properties of the materials at the nanoscale. Particular attention will be given to scanning probe microscopy based methods. New important findings, which will have an impact in the NEMS-MEMS technology, will be also treated.

References :

1. I. Palaci, S. Fedrigo, H. Brune, C. Klinke, M. Chen and E. Riedo, “Radial Elasticity of Multiwalled Carbon Nanotubes”, Phys. Rev. Lett. 94, 175502, (2005).

2. R. Szoszkiewicz and E. Riedo, “Friction forces as a local probe of Phase transitions”, App. Phys. Lett. 87, 033105 (2005).

3. J.H. Song and X.D. Wang and E. Riedo and Z.L. Wang, “Elastic Property of Vertically Aligned Nanotubes/Nanowires”, Nano Letters 12, 1954 (2005).

4. R. Szoszkiewicz and E. Riedo, “Nucleation time of nanoscale water bridges”, Phys. Rev. Lett. 85 135502 (2005).

5. T.-D. Li, J. Gao, R. Szoszkiewicz, U. Landman and E. Riedo “Ordered and viscous water in subnanometer gaps” submitted to PNAS.

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