

MECHANICAL AND AEROSPACE ENGINEERING DEPARTMENT SEMINAR

Friday, March 31, 4:00 PM, BR2211

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TITLE: Nanomechanical Testing and Nanomachining of Low-Dimensional Nanomaterials

We have extended applications of traditional nanoindentation and atomic force microscopy (AFM) approaches to zero- and one-dimensional nanobuilding blocks for directly measuring their mechanical properties. Hardness and elastic modulus of Cu₂O nanocubes [1], silver nanowires [2], gold nanowires [3] and ZnS nanobelts [4] were measured by directing indenting them with a nanoindenter. Nanoscale deformation behavior and fracture mechanisms were studied by post *in-situ* imaging of the indents [5]. Mechanical properties of SiO₂ nanowires were obtained by directly bending individual suspended wires using an AFM tip [6].

Another immediate challenge in nanotechnology is machining and integration of these nanobuilding blocks into functional, usable structures and devices. Can we push application of traditional mechanical machining approaches in nano paradigm for directed assembly of heterostructures? For instance, can one machine a nanowire as easily as machining a metal bar? We have developed novel nanomechanical machining methodologies and tools that are able to perform operations such as indenting, cutting, milling, shaping, forging, and polishing to realize functional nanostructures and nanodevices [7]. The nanoindenter and AFM have been successfully used to directly machine individual nanoparticles, nanowires and nanobelts without applications of conventional lithography.

[1] X. Li, H. Gao, C. J. Murphy and L. Gou, *Nano Letters*, 4 (2004) 1903-1907.

[2] X. Li, H. Gao, C. J. Murphy and K. K. Caswell, *Nano Letters*, 3 (2003) 1495-1498.

[3] X. Li, P. Nardi, C.-W. Baek, J.-M. Kim and Y.-K. Kim, *Journal of Micromechanics and Microengineering*, 15 (2005) 551-556.

[4] X. Li, X. Wang, Q. Xiong and P. C. Eklund, *Nano Letters*, 5 (2005) 1982-1986.

[5] Z. Xu and X. Li, *Acta Materialia*, 54 (2006) 1699-1703.

[6] H. Ni, X. Li and H. Gao, *Applied Physics Letters*, 88 (2006) 043108.

[7] X. Li, X. Wang, Q. Xiong and P. C. Eklund, *Applied Physics Letters*, 87 (2005) 233113.