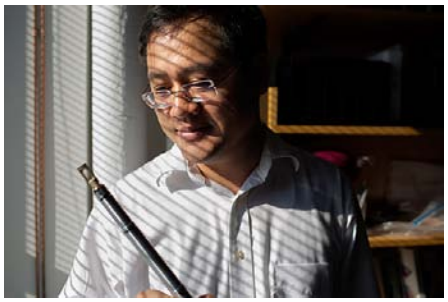
International Center for Quantum Materials, PKU

Weekly Seminar

Elastic Strain Engineering for Unprecedented Materials Properties



Ju Li

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Time: 4:00pm, July. 10, 2013 (Wednesday)
时间：2013年7月10日 （周三）下午4:00
Venue: Room 607, Science Building 5
地点：理科五号楼607会议室

Abstract

As “smaller is stronger”, nanostructured materials such as nanowires, nanotubes, nanoparticles, thin films, atomic sheets etc. can withstand non-hydrostatic (e.g. tensile or shear) stresses up to a significant fraction of its ideal strength without inelastic relaxation by plasticity or fracture. Large elastic strains can be generated by epitaxy, or by static or dynamical external loading on small-volume materials, and can be spatially homogeneous or inhomogeneous. This leads to new possibilities for tuning the physical and chemical (e.g. electronic, optical, magnetic, phononic, catalytic, etc.) properties of a material, by varying the 6-dimensional elastic strain as continuous variables. By controlling the elastic strain field statically or dynamically, one opens up a much larger parameter space for optimizing the functional properties of materials, which gives a new meaning to Feynman’s 1959 statement “there's plenty of room at the bottom”. The roadmap for rational ESE will be addressed. These include precisely applying and measuring large elastic strain (AFM, nanomechanics, microscopy and spectroscopy), predicting what strain does to physical and chemical properties (ab initio to continuum scale modeling), tailoring (sometimes via in situ experiments) quantitatively the properties in desired directions, and understanding how large an elastic strain can be sustained for how long (mechanisms of plastic deformation, defect evolution and failure in small-volume materials).

[1] Liu, Ming, Li, "Ab initio calculation of ideal strength and phonon instability of graphene under tension," Phys. Rev. B 76 (2007) 064120.
[2] Zhu, Li, "Ultra-strength materials," Progress in Materials Science 55 (2010) 710-757.
[3] Qi, Qian, Qi, Feng, Shi, and Li, "Strain-Engineering of Band Gaps in Piezoelectric Boron Nitride Nanoribbons," Nano Lett. 12 (2012) 1224-1228.
[4] J. Feng, Qian, Huang, Li, "Strain-engineered artificial atom as a broad-spectrum solar energy funnel," Nature Photonics 6 (2012) 865-871.
[5] Hao et al, "A Transforming Metal Nanocomposite with Large Elastic Strain, Low Modulus, and High Strength," Science 339 (2013) 1191-1194.

About the Speaker

Ju Li is Battelle Energy Alliance Professor of Nuclear Science and Engineering and a full professor of Materials Science and Engineering at MIT. Using atomistic modeling and in situ experimental observations, his group (http://li.mit.edu) investigate mechanical, electrochemical and transport behaviors of materials, often under extreme environments, as well as novel means of energy storage and conversion. Ju was a winner of 2005 Presidential Early Career Award for Scientists and Engineers, the 2006 MRS Outstanding Young Investigator Award, and 2007 TR35 award from Technology Review magazine.