



## “Graphene: Mechanics, NEMS, and 2D Heterostructures”

This talk will review our work with graphene and related 2D materials over the past four years. This work has centered on three areas: measurements of mechanical properties; implementation and applications of graphene nano-electromechanical devices (NEMS); and creation of heterostructures of graphene with hexagonal boron nitride (h-BN).

**Mechanics:** our measurements have showed that graphene is the strongest known material, with a breaking strength that can reflect the intrinsic material strength rather than being limited by defects. As such, it provides an opportunity to study materials properties at ultrahigh tensile strain, much in the way that diamond anvil cells are used to study properties at ultrahigh compressive strain. On a fundamental level, these experiments can be used to validate first-principles electronic structure calculations in regimes that were previously inaccessible.

**NEMS:** I will briefly describe our implementation of high-speed electronic readout of graphene NEMS and studies of their basic properties. I will then focus on our recent studies of graphene NEMS in the quantum Hall regime. In this regime, the mechanical motion is strongly coupled to the electronic state of the system, and we find large frequency shifts that can be used to directly read out the chemical potential and compressibility of the system. We further use this novel mechanism to quantify the many-body exchange interaction of broken-symmetry QH states. This new mechanism may prove to be a useful tool for magnetic studies across low-dimensional materials and in sensing applications.

**Heterostructures:** We have developed techniques for manipulation of such atomically thin flakes, that allow us to combine 2D materials to make entirely new types of heterostructures. We have used these techniques to study the properties of graphene on h-BN, which acts as an ultralow-disorder insulating substrate. I will review the basic behavior of graphene on h-BN, implications for practical devices, and then discuss recent results on more exotic effects and devices.

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Monday, September 24, 2012  
428 Pupin Hall / 4:10 PM

