Exploring Graphene and its Chemical Derivatives by Scanning Tunneling Microscopy

Scott W. Schmucker

Department of Electrical and Computer Engineering

University of Illinois at Urbana-Champaign

The scanning tunneling microscope (STM) provides a unique capability for both structural and electronic imaging of surfaces, as well as the controlled manipulation of these surfaces on the atomic scale. As a result, the STM is a superb tool for characterization of novel materials including graphene and fluorinated graphene. In discussing our ongoing graphene research program, we will explore three distinct capabilities of the STM: topographic imaging, spectroscopic imaging, and tip-induced modification of surfaces.

With ultra-sharp metal probes, we obtain unprecedented imaging and patterning resolution on both silicon and graphene surfaces. Atomic-resolution imaging enabled by STM not only provides structural information for monolayer graphene, but also for graphene fluoride, a wide band gap chemical derivative of graphene. Combined with scanning tunneling spectroscopy (STS), we are able to understand the atomic and electronic structures of this novel, and poorly understood, material.

The STM is also used to modify the atomic structure of these surfaces, including hydrogen passivated silicon and puckered-sheet graphene fluoride. We demonstrated unprecedented patterning capabilities with ultra-sharp tips, atomic-scale patterning of graphene-encapsulated silicon, and tip-induced silicon etching beneath puckered-sheet graphene fluoride platelets.