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NEBRASKA CENTER FOR MATERIALS AND NANOSCIENCE
2015 SEMINAR SERIES PRESENTS

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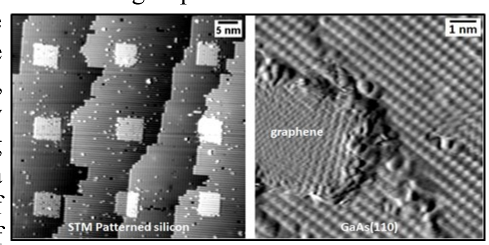
Scanned Probe Based Nanofabrication and Nanostructure Analysis

Professor Joseph Lyding

One nanotechnology scenario is the development of hybrid schemes that involve integration with standard platforms such as silicon. As a step in this direction, we have developed the STM-based hydrogen resist process in which hydrogen serves as an atomic layer electron resist. STM electrons can desorb this hydrogen with atomic precision to create templates for selective chemistry. Aside from exploring nanofabrication possibilities, we have looked in detail at this electron-induced desorption process. Two desorption regimes are observed. At higher electron energies, Si-H bonds are broken by direct excitation from the bonding-to-antibonding state, whereas at lower voltages vibrational heating leads to desorption from "hot" ground state. A technology spin-off of these experiments is the use of deuterium to enhance the lifetime of the silicon transistors used in CMOS technology. We have also used silicon and the III-V semiconductors GaAs and InAs as supports for carbon nanotubes and graphene. Using a simple process that we call dry contact transfer (DCT), we can deposit nanostructures onto atomically clean surfaces in ultrahigh vacuum. Examples will be presented including the subtle dependence of carbon nanotube electronic structure on the underlying lattice orientation, and the first observation of the metallic zigzag edge state in graphene. STM analysis of atomically precise graphene nanoribbons fabricated by the Alexander Sinitskii group at Nebraska will also be presented. This talk will also show results for the use of electron-beam induced deposition to create sub-5nm metal wires for contacting nanostructures, the used of a graphene shrink wrap to study aqueous systems in UHV, a SPM probe sharpening technique for producing 1 nm radii probes, and a new technique for increasing the performance of carbon nanotube array transistors by an order of magnitude.



Joe Lyding is a Professor of Electrical and Computer Engineering at the University of Illinois in Urbana-Champaign. He received his PhD in Electrical Engineering from Northwestern University in 1983. He joined the Illinois faculty to work with Nobel laureate John Bardeen on the 1D charge-density wave problem. During that time, he developed the first scanning tunneling microscope in the Midwestern United States, with which he developed the atomic resolution hydrogen resist process for patterning silicon surfaces. In these experiments he also discovered the giant deuterium isotope effect that is now being used in large-scale chip production to reduce hot-carrier degradation in CMOS technology. Recently, he has developed a method to improve the performance of carbon nanotube transistors and he invented a technology for producing ultra-sharp hard-coated electrically conductive probes for scanned probe microscopy that is now being commercialized. Lyding is a Fellow of the IEEE, APS, AVS and AAAS. He received the 2012 IEEE Pioneer in Nanotechnology Award, the 2013 AVS Nanotechnology Recognition Award, the 2013 Research Excellence Award from the Nano/Bio Interface Center at the University of Pennsylvania, the 2014 AVS Prairie Chapter Award for Outstanding Research, and the 2014 Foresight Institute Feynman Prize in Nanotechnology.

Host:
Professor Alexander Sinitskii

Department of Chemistry

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Wednesday, October 28, 4:00 pm | 136 Jorgensen Hall
3:45 – refreshments in Jorgensen Atrium