Carnegie Mellon
Materials Science and Engineering Seminar Series

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"*Carbon Nanotechnology on Semiconducting Platforms*"

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10 AM Seminar in Hamerschlag B103

Hybrid systems based on the integration of carbon nanotubes and graphene with conventional semiconductor platforms (Si, GaAs, etc.) are being actively pursued worldwide. The potential exists to leverage the ultrahigh mobilities of these carbon nanomaterials with the vast existing chip fabrication infrastructure. Nevertheless, this integration will depend on the atomistic details of the interactions of carbon nanotubes and graphene with their local environments. We are studying these interactions with ultrahigh vacuum scanning tunneling microscopy (UHV STM) and spectroscopy. To facilitate this work we have developed an *in situ* dry contact transfer (DCT) procedure that allows us to create atomically clean carbon-semiconductor systems.

Single-walled carbon nanotubes (SWNTs) show a preferential alignment along the $<\bar{1}10>$ direction on GaAs(110) and InAs(110) surfaces, with SWNT bandgap modification and Fermi level shift based on the alignment. For SWNTs on H-passivated Si(100) there is a weaker interaction. However, when proximal hydrogen is removed by the STM the SWNT can shift into a preferential alignment with its zigzag direction parallel to the underlying Si dimer row direction.

For monolayer graphene we observe a size-dependent energy gap for pieces smaller than 20nm in lateral dimension. We also observe a predicted energy state associated with zigzag edge symmetry that could have a strong influence on nanoscale device properties. Also, we observe an energy-dependent transparency in which the substrate atomic structure can be viewed through the graphene.

This talk will also present some of our earlier work on atomic resolution patterning of Si(100)2x1:H surfaces and their deuterated analogs and how this has led to the use of deuterium in commercial chip processing. Also, our new method for producing ultra-sharp (1nm radius) STM tips will be presented.

Joe Lyding is a Professor in the Department of Electrical and Computer Engineering at the University of Illinois in Urbana-Champaign. He received his B.S. (1976), M.S. (1978) and Ph.D. (1983) degrees in Electrical Engineering from Northwestern University. In 1984 he joined the UIUC ECE Department as an Assistant Professor to work with John Bardeen and colleagues on the 1D charge-density wave problem. In 1986 Professor Lyding developed the first STM at Illinois and was promoted to Associate Professor in 1988 and Professor in 1993. Professor Lyding's research interests include carbon nanotechnology, nanofabrication on semiconductor surfaces, hot-carrier degradation in CMOS devices and development of scanned probe technology. He is a Fellow of the American Physical Society, a Fellow of the AVS, was selected as a Finalist for the Feynman Prize in Nanotechnology and has been selected as a UIUC University Scholar.