Carnegie Mellon
Materials Science and Engineering Seminar Series

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"Chemically refined carbon nanomaterials for electronics, energy and medicine"

Friday, February 3, 2012
11:30AM Seminar in Wean Hall 7500

Carbon nanomaterials have attracted significant attention due to their potential to improve applications such as transistors, transparent conductors, solar cells, batteries, and biosensors. This talk will highlight our latest efforts to develop strategies for purifying, functionalizing, and assembling carbon nanomaterials into functional devices. For example, we have recently developed and commercialized a scalable technique for sorting surfactant-encapsulated single-walled carbon nanotubes (SWCNTs) by their physical and electronic structure using density gradient ultracentrifugation (DGU). The resulting monodisperse SWCNTs enhance the performance of thin film transistors, infrared optoelectronic devices, photovoltaics, catalysts, and transparent conductors. The DGU technique also enables multi-walled carbon nanotubes to be sorted by the number of walls and solution phase graphene to be sorted by thickness, thus expanding the suite of monodisperse carbon nanomaterials. By extending our DGU efforts to carbon nanotubes and graphene dispersed in biocompatible polymers (e.g., DNA, Pluronics, Tetronics, etc.), new opportunities have emerged for monodisperse carbon nanomaterials in biomedical applications.

In addition to these solution-phase approaches, this talk will also discuss vacuum compatible methods for functionalizing the surfaces of carbon nanomaterials. For example, a suite of perylene-based molecules form highly ordered self-assembled monolayers (SAMs) on graphene via gas-phase deposition in ultra-high vacuum. Due to their noncovalent bonding, these SAMs preserve the superlative electronic properties of the underlying graphene while providing uniform and tailorable chemical functionality. In this manner, disparate materials (e.g., high-k gate dielectrics) can be seamlessly integrated with graphene, thus enabling the fabrication of capacitors, transistors, and related electronic/excitonic devices. Alternatively, via aryl diazaonium chemistry, functional polymers can be covalently grafted to graphene. In addition to presenting opportunities for graphene-based chemical and biological sensing, covalent grafting allows local tuning of the electronic properties of the underlying graphene.

Mark C. Hersam is currently a Professor of Materials Science and Engineering, Chemistry, and Medicine at Northwestern University. He earned a B.S. in Electrical Engineering from the University of Illinois at Urbana-Champaign (UIUC) in 1996, M.Phil. in Physics from the University of Cambridge in 1997, and a Ph.D. in Electrical Engineering from UIUC in 2000. In 1999, he also performed research at the IBM T. J. Watson Research Laboratory under the support of an IBM Distinguished Fellowship. His research interests include single molecule chemistry, nanofabrication, scanning probe microscopy, semiconductor surfaces, and carbon nanomaterials. As a faculty member, Dr. Hersam has received several awards including the Beckman Young Investigator Award, NSF CAREER Award, ARO Young Investigator Award, ONR Young Investigator Award, Sloan Research Fellowship, Presidential Early Career Award for Scientists and Engineers, TMS Robert Lansing Hardy Award, AVS Peter Mark Award, ECS SES Research Young Investigator Award, MRS Outstanding Young Investigator Award, and five Teacher of the Year Awards. In recognition of his early career accomplishments, Dr. Hersam was directly promoted from assistant professor to full professor with tenure in 2006. In 2007, Dr. Hersam co-founded NanoIntegris, which is a start-up company focused on supplying high performance carbon nanomaterials. Dr. Hersam is actively involved in professional societies including serving as the Chair of the AVS Nanometer-scale Science and Technology Division and as Associate Editor of *ACS Nano*.