Institute for Molecular & Nanoscale Innovation
Division of Engineering

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Barus & Holley Room 190
10:00 – 11:00 am

Advanced Electronic Materials from Organic Semiconductors to Carbon Nanotubes

A myriad of promising applications have been proposed for organic semiconductors and carbon nanotubes due to their outstanding physical and electronic properties. Organic semiconductors are lightweight, flexible, and inexpensive, which suggests their use in bendable electronics, in lightweight displays, for cost-effective white light illumination, and as low-cost photovoltaic solar cells. Carbon nanotubes are excellent conductors that are capable of carrying electrical current at an astounding density of 1E8 A/cm2, have extreme charge transport mobilities that exceed 1E5 cm2/V/s, and are characterized by ballistic, scatter-less transport on length scales less than 500 nm. As a result, carbon nanotubes have potential applications as ultra-high speed nanoscale transistors, flexible thin-film semiconductors, metallic interconnects, transparent conductors, and electrically active biomaterials.

In the first half of this talk, a new strategy for patterning and depositing organic semiconductors called organic vapor jet printing (OVJP) will be discussed. OVJP can be utilized to print small molecule organic semiconductors in a mask-free and solvent-free fashion. The scientific principles behind OVJP will be detailed, and its applicability for printing white organic light emitting diodes will be demonstrated. In the second half of this talk, a new method for processing and sorting carbon nanotubes will be presented that addresses one of the prevailing challenges in the carbon nanotube field – the heterogeneity of as-grown nanotubes. Specifically, a technique for sorting carbon nanotubes by their physical and electronic structure called density gradient ultracentrifugation (DGU) will be presented. Using DGU, carbon nanotubes have been sorted to purities exceeding 99% of a single electronic-type and to within a 0.02 nm diameter range. The discovery of DGU will enable the widespread application of carbon nanotubes in nanoelectronics, photonics, photovoltaics, and sensing.

Bio: Dr. Michael S. Arnold received his Bachelor of Science degree in electrical engineering from the University of Illinois at Urbana-Champaign in 2001. After graduating summa cum laude, Dr. Arnold studied with Dr. Phaedon Avouris of the IBM T. J. Watson Research Laboratory in Yorktown Heights, New York. At IBM, Dr. Arnold developed the widely cited technique of "constructive destruction" for engineering carbon nanotube based transistors. After, Dr. Arnold studied materials science and engineering at Northwestern University, where he was awarded a National Science Foundation Graduate Fellowship and a National Defense Science and Engineering Graduate Fellowship for his work with Professors Samuel Stupp and Mark Hersam. Since finishing his doctorate in 2006, he has conducted post-doctoral research at the University of Michigan at Ann Arbor with Prof. Stephen Forrest. There, Dr. Arnold has investigated new means of patterning organic semiconductors and controlling the molecular ordering and crystallinity of organic thin films for opto-electronic applications.