Nanotubes: Essential Components in Molecular Scale Electronics & Bioelectronics

Jason Moscatello
(Advisor: Dr. Yoke Khin Yap)

Multi-walled carbon nanotubes have powerful properties and many potential uses. Two major fields of application are molecular electronics, leading to molecular scale devices, and biomolecular electronics, used primarily for biosensing. The basics of functionalizing the nanotubes in order to make these devices are explored.

Growth of Doped-Silicon Nanotubes by dual-RF-plasma Treatments

Ming Xie
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Due to the quantum size effects and technological interest, silicon nanostructures attracted a lot of research attention. Here we describe the growth of Silicon Nanotubes (SiNTs) by dual-RF-plasma treatments. Electron microscopy shows that these SiNTs are having uniform diameters of ~60 nm and wall thickness of ~5 nm. These SiNTs are doped as judge by the local density of states (LDOS) measured by tunneling spectroscopy.

Multi-Scale Modeling of Interesting Materials

Wil Slough
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Improvements in computational resources (namely pc-clusters) allow ab initio electronic structure calculations to be done on ever larger systems of interest. These calculations can then be used as inputs for the multi-scale modeling of even larger systems (currently on the order of a billion atoms) and predictions of macroscopic behavior. Of course, the veracity of these predictions can be negatively influenced by a less than sufficient ab initio representation. Our group's motivation for investigating ab initio electronic structure calculations, some initial results, and some material systems of interest are presented.

Side-Chain Ordering of Polyglutamic Acid

Yanjie Wei
(Advisor: Dr. Ulrich Hansman)

How proteins fold spontaneously from the amino acid sequences into their unique native structures is still a puzzle! Here we are trying to solve the relation between side-chain ordering and the secondary structure formation of a polypeptide. Using multicanonial Monte Carlo simulations, the thermal properties of polyglutamic acid are obtained over a wide temperature range. We find that there is helix formation. Also a secondary peak of the specific heat happens at low temperatures, corresponding to side-chain ordering of the polypeptide. But the nature of the side-chain ordering is changed by the solvent. This can be understood from the solvent molecules competing with side chains in forming hydrogen bonds.

Optimizing Carbon Nanotube Growth for Future Device Applications

Benjamin Ulmen
(Advisor: Dr. Yoke Khin Yap)

Carbon nanotubes (CNTs) are an important material for future applications such as gas sensing, electron field emission, and field effect transistors. In order to use nanotubes for these applications, we need to have control over the properties of the nanotubes. Quality, length, and spacing are important and unique requirements exist for each application. This work describes our results in controlling these parameters for multiwalled CNTs in a dual-RF plasma enhanced chemical vapor deposition system.

Supplementary Paper:

Stability of Electron Field Emission from Various Types of Carbon Nanotube Films

Vijaya Kayastha and Benjamin Ulmen
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Carbon Nanotubes (CNTs) are known for their excellent electron field emission. However, they have the problem in long term stability of emission current. Fundamental Factors that contribute to the emission stability have not been well studied. Here, we found that stability of emission current from CNTs is related to their graphitic orders. We have tested various CNT films grown by thermal chemical vapor deposition (CVD) and plasma enhanced CVD (PECVD). Even with better vertical alignment and controllable inter-tube spacing suitable for field emission, currents from PECVD grown films degraded by ~70% within a period of 20 hours. In contrast, random CNT films grown by thermal CVD exhibited stable emission current at a much higher level ~ 0.5mA/cm^2. These CNTs also have relatively lower threshold electric field of field emission. Transmission electron microscopy and Raman spectroscopy confirmed that field emission stability is dependent on the graphitic structures of these CNTs.