

# Lectures on Pure and Applied Physics



## Announcing

A Seminar Presentation  
on May 7, 2013 at 3:30 pm

Henry Lee Institute 301

at The University of New Haven

### Dr. Sanju Gupta

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Department of Chemistry, the University of Pennsylvania

### Title: Science and Technology of NanoCarbons: Nanodiamond and Nanotube

#### Abstract:

Carbon, the sixth most abundant element in the universe, has been known since ancient times and its appeal owe to its versatile nature of chemical bonding resulting in various forms where diamond (tetragonal) and graphite (trigonal) are the most well-known allotropes. Unprecedented worldwide activity in the investigation of novel nanostructured carbons was initiated by the discovery of C<sub>60</sub> molecule followed producing its elongated members namely, carbon nanotubes subsequented to nanocrystalline diamond. The talk will consist of two parts including chemical vapor deposited nanodiamond and carbon nanotubes with tailored structural and physical properties for desired technologies: a) vacuum microelectronics or field emission displays and b) electrochemical actuators or artificial muscles. a. Electron emitting materials at room temperature known as cold cathodes are of vital importance enabling a variety of applications such as flat panel displays, RF/MW amplifiers for communication and radar, as bright electron beam for microscopes, electric propulsion for microsatellites and portable X-ray sources for medical and security diagnostics. Nanotubes and nanodiamond in the family of nanostructured carbons proved to be potential candidate materials as planar cold cathodes yet possessing nanoscale heterogeneities. I will discuss the synthesis of vertically-aligned carbon nanotube (VACNT) films using plasma-enhanced chemical vapor deposition technique and the field emission (I-V) properties including temperature dependent field electron emission microscopy (TFEEM) enabling real-time imaging of electron emission with higher spatial resolution providing evident information on emission site density, temporal variation or flicker of the emission intensity, and insight into the role of adsorbates from nanotubes These results will be complemented with findings from nanodiamond. b. The isothermal conversion of chemical energy into mechanical work underlies the motility of all living systems. The artificial muscles lie under the class of electro-chemo-mechanical devices, which are electro-driven chemo-mechanical- whereby the transformation of chemical energy into mechanical energy is triggered by electric pulse. I will present development of single-walled carbon nanotubes sheet as actuators so as to understand the principle of actuation and to estimate the associated parameters using in-situ Raman spectroscopy. This is since Raman spectra can monitor the changes in C-C bond length as a function of applied bias. The estimated in-plane microscopic compressive strain ( $-0.25\%$ ) and the equivalent charge transfer per carbon atom ( $f_c -0.005$ ) were found as an upper bound. The cyclic voltammetry (CV) and ac electrochemical impedance spectroscopy (EIS) results help to demonstrate well-developed capacitive behavior of single-wall carbon nanotubes sheet and to estimate the specific capacitances viable as supercapacitors.

#### Further Information

Refreshments are served from 1:20 pm until 1:30 pm.