Stevens Institute of Technology

Nanotechnology Graduate Program

Optical Spectroscopy of Individual Carbon Nanotubes

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Nanomaterials are receiving enormous attention in part due to interesting physical properties that emerge from quantum confinement effects. However, a challenge of these materials is the diversity of material physical structures that are usually produced even from the best synthesis techniques. For example, a high quality "well-dispersed" carbon nanotube sample usually contains hundreds of nanotube structures, as defined by the chiral vector. Since physical properties are often intimately related to the precise nanoscale structure, we have developed a suite of techniques to investigate nanomaterial structure and properties with high sensitivity. Most recently, we have developed a fast, high resolution, high-sensitivity, and broadband Fourier transform photocurrent (FTPC) spectroscopic technique at the IR ring of the National Synchrotron Light Source at Brookhaven. Using FTPC we have measured the photoconductivity spectrum of an individual single-walled carbon nanotube which reflects both the optical excitations of the material and the collection efficiency. In contrast to traditional bulk inorganic materials, optical excitation in these 1D nanomaterials results in strongly bound excitons under ambient conditions. As a result, the ultimate utility of these materials in devices, either directly or as composite materials, depends on the rapid and efficient dissociation of the excitonic state. In this talk we will discuss the optoelectronic properties of carbon nanotubes and the spectroscopic techniques that allow high sensitivity probing of individual nanotubes [1-3].

1. J. Misewich et al., *Science* **300**, 783 (2003)
2. M. Freitag et al., *Nano Letters* **3**, 1067 (2004)
3. M. Sfeir, J. Misewich et al., *Science* **312**, 554 (2006)

Jim Misewich is Associate Laboratory Director for Basic Energy Sciences at Brookhaven National Lab in Upton New York. Since 2001 he has also been an adjunct Professor of Electrical Engineering at Columbia University where he teaches and has research collaborations. His current research focus centers on the optical properties, transport properties, and biocompatibility of nanoscale materials including hybrid inorganic-biological nanomaterials. Prior to Brookhaven, he worked for twenty years in the Laser Physics group in the Physical Sciences department at the IBM Thomas J. Watson Research Center in Yorktown Heights where he made contributions to laser science, correlated electron material transport, and nanoscience. He received his Ph.D. from Cornell University in 1983 and joined IBM directly from graduate school. He is a Fellow of the American Physical Society and the Optical Society of America.

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