MAR07-2006-003479

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Optical Spectroscopy of Individual Carbon Nanotubes

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Single-walled carbon nanotubes (SWNTs) constitute a family of more than 100 one-dimensional structures. With properties varying significantly as a function of their precise atomic structure and environment, SWNTs provide a rich material system to study 1-dimensional physics. To unravel the wealth of different behavior in the SWNTs, which range from metallic to semiconducting, it is generally desirable, and often essential, to probe them *individually*. In this talk, I will describe the development and application of three techniques for optical spectroscopy of individual SWNTs: Rayleigh scattering[1], multiphonon-Raman scattering[2], and absorption spectroscopy. We will illustrate the wide range of physical information attainable from these methods, including analysis of the excited electronic states of semiconducting and metallic nanotubes[1], nanotube-nanotube interactions[3], and electron-phonon coupling[2]. In addition to their separate use, these spectroscopies can also be fruitfully combined with one another and with other complementary non-optical, single nanotube characterization methods. The correlation of Rayleigh scattering with multi-phonon Raman measurements provides, for example, direct information on the resonance enhancement of electron-phonon interaction[2]. On the other hand, application of Rayleigh scattering in conjunction with single nanotube electron diffraction has permitted us to obtain electronic spectra of SWNTs of independently determined structure[4]. These measurements have permitted verification of the underlying theoretical trends used in previous assignments of nanotube optical spectra. Work done in collaboration with: D. Cho, W. Liu, B. Kessler, A. Zettl, Y. R. Shen (UC Berkeley and LBNL), J. Schuck (LBNL) T. Beetz, J. A. Misewich, L. Wu, Y. Zhu, M. Y. Sfeir (Brookhaven National Lab), and Y. Wu, L. Huang, J. Hone, S. O'Brien, L. E. Brus, and T. F. Heinz (Columbia University).

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