MAR12-2011-001324

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

High Throughput Optical Imaging and Spectroscopy of Individual Carbon Nanotubes

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Laser-based imaging and characterization of individual carbon nanotubes provides a number of significant advantages over other imaging techniques, including its high throughput, spectral characterization capability, and relatively simple sample preparation. We recently reported a novel on-chip Rayleigh imaging technique using widefield laser illumination to measure optical scattering from individual single-walled carbon nanotubes (SWNTs) on a solid substrate with high spatial and spectral resolution. This method accurately measures the resonance energies and diameters for a large number of SWNTs in parallel. This technique can be used for fast mapping of key SWNT parameters, including the electronic-types and chiral indices for individual SWNTs, position and frequency of chirality-changing events, and intertube interactions in both bundled and distant SWNTs. Further Rayleigh characterization showed that SWNTs can form ideal optical wires. Interestingly, the spatial distribution of the radiation scattered by the nanotubes is determined by their shape, but the intensity and spectrum of the scattered radiation are determined by exciton dynamics and other intrinsic properties. Moreover, the nanotubes display a uniform peak optical conductivity, suggesting universal behavior similar to that observed in nanotube conductance. Finally, two other high-throughput optical imaging techniques, widefield Raman imaging and confocal absorption microscopy, and their applications in nanotube imaging will be discussed.