Physical Chemistry Seminar

Tuesday, April 21, 2015 | **11:00 am** | **Room 1315 Chemistry Building**

Harnessing Dark Excitons: Interplay of Chemistry and Optics in the 1-D World of Carbon Nanotubes

Dr. Stephen K. Doorn

Center for Integrated Nanotechnologies
Los Alamos National Laboratory

Host: Professor Marty Zanni

The carbon nanotube surface presents a unique 1-dimensional world in which to probe the interplay between chemistry and exciton photophysics. Understanding and control of nanotube surface chemistry is vital to tuning their photophysical properties, enabling separations, developing functional optical materials, and introducing new optical states. This talk will present a broad range of photoluminescence (PL) imaging and spectroscopic studies at the single tube level that probe behaviors including how the nanotube surface defines exciton migration and interaction of excitons with adsorbed and covalently bound surface species. Of particular interest is the introduction of new photoluminescent states generated via low-level covalent doping of carbon nanotubes. Such states are red-shifted from the normal exciton emissive state and are gaining in interest due to their chemical stability and potential for significantly enhancing the nanotube PL quantum yields through conversion of dark excitons. The nature of these optical states, however, is not yet well-understood. PL imaging and spectroscopic studies of oxygen- and aryl diazonium-doped tubes at the single-tube and single-dopant site levels will be presented. Dynamic and static emission behaviors will be discussed as the interaction of 1-D exciton behaviors and 0-D trap states introduced at the dopant sites. PL spectroscopy of single doped tubes at cryogenic temperatures and dramatic increases in PL lifetimes indicate exciton localization at dopant sites. Fine structure in emission spectra may also be used to identify the chemical functionality of the dopant sites. Relevant to interest in these new emitting states as single photon emitters for quantum information processing, we also demonstrate an approach to stabilizing emission output while also introducing solitary dopant sites. Finally, lifetime and photon correlation studies enabled by superconducting nanowire single-photon detectors will be presented. Evolution of behaviors as a function of temperature will be discussed in the context of realizing room-temperature photon antibunching.

Refreshments will be available prior to the seminar at 10:45 a.m. outside room 1315

Graduate Students may meet with the speaker at 1:00 p.m. in Room 8305F