PHYSICAL SEMINAR

"Photophysics and Quantum Emission Behavior of Carbon Nanotube Defect States"

Guest Speaker:

Dr. Stephen K. Doorn

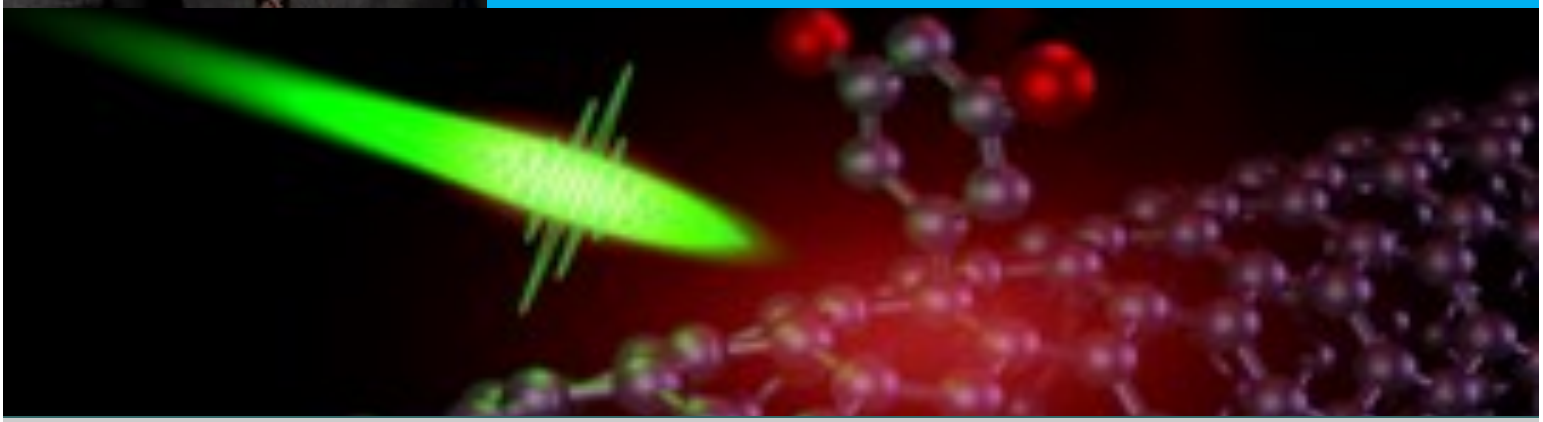
Center for Integrated Nanotechnologies

Los Alamos National Laboratory

Monday, January 29th, 4:00pm

Hutchison Hall Room 473

University of Rochester



Abstract: Red-shifted emitting states in carbon nanotubes, introduced by chemically stable and synthetically tunable covalently-bound dopants,[1,2] are gaining attention for their potential to boost photoluminescence (PL) quantum yields,[1,2] add new functionality,[3,4] and serve as single photon emitters.[5,6] These sites present a rich array of new photophysics, with dependences on specific functionalization chemistry and environmental interactions. As examples, low-T photoluminescence probes of defect-state electronic structure will be presented for sp^3 defects introduced by aryl functionalization[7] and compared to quantum chemical theory and results on oxygen-introduced defects.[8] Exciton localization at defect sites[9] and conversion to the new emitting states will be discussed in the context of the consequences localization has for relaxation dynamics and functionality. A significant increase (up to 10-fold) in exciton lifetimes results.[10] Dependence of lifetimes on nanotube chirality and specific dopant suggest multiphonon relaxation mechanisms.[10] Finally, defect-site localization paired with nanotube structural tunability will be shown as a route to room temperature single photon emission at telecom wavelengths.[5,6] Control over chemical functionality and dielectric environment will be shown as routes for optimizing single photon emission behaviors. Results will be summarized with a brief perspective on possible future directions.

References: 1. Ghosh, S. et al., *Science*, **330**, 1656 (2010). 2. Piao, Y. et al., *Nature Chem.*, **5**, 840 (2013). 3. Kwon, H. et al., *J. Phys. Chem. C*, **119**, 3733 (2015). 4. Akizuki, N. et al., *Nature Comm.*, **6**, 8920 (2015). 5. Ma, X. et al., *Nature Nanotech.*, **10**, 671 (2015). 6. He, X. et al., *Nature Photonics*, **11**, 577 (2017). 7. He, X. et al, *ACS Nano*, **11**, 10785 (2017). 8. Ma, X. et al., *ACS Nano*, **8**, 10782 (2014). 9. Hartmann, N. et al., *Nanoscale*, **7**, 20521 (2015). 10. Hartmann, N. et al., *ACS Nano*, **10**, 8355 (2016).

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