New red-shifted emitting states in carbon nanotubes (CNTs), introduced by stable covalently-bound dopants,1,2 are gaining attention for their potential to boost photoluminescence quantum yields,1,2 add new functionality,3,4 and serve as single photon emitters.5 Critical to these possibilities is the demonstration of exciton localization or trapping at individual dopant sites.6 This talk will present an overview of photoluminescence (PL) spectroscopy, imaging, and time-resolved studies revealing the origins of these new CNT optical behaviors. Results from oxygen-and aryl diazonium-doped tubes leading to the demonstration of room-temperature single photon emission from the dopant states will be described. Direct imaging evidence for exciton localization at dopant sites will also be shown. As a consequence of trapping, exciton dynamics are significantly altered, with photoluminescence (PL) lifetimes being extended significantly.4,7 A detailed study of the emission dynamics associated with dopant states introduced by aryl diazonium functionalization of semiconducting carbon nanotubes will be discussed. Dopant-state PL lifetimes are found to increase by around a factor of 10 in comparison to E11 exciton lifetimes. Dependence of lifetimes on nanotube chirality, specific dopant, and dielectric environment will be presented and shown to exhibit a strong dependence on emission energy. Relaxation mechanisms will be discussed in terms of multi-phonon decay processes and exciton detrapping and the additional role played by localization in determining exciton-phonon coupling strength.