Fundamental Properties of Ultra-Clean, Nearly Defect-Free, Suspended Carbon Nanotubes

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Fabricating ultra-clean, nearly defect-free, suspended carbon nanotubes (CNTs) has enabled several interesting phenomena to be observed, including breakdown of the Born-Oppenheimer approximation, mode selective electron-phonon coupling, and non-equilibrium phonon populations. In this talk, we will review several recent observations in these nanotubes, which include temperature-induced non-adiabatic and adiabatic phase transitions, abrupt modulations in the Raman intensity under small applied gate voltages, and pronounced Kohn anomalies due to electron-phonon interactions that are more than five times larger than theoretical predictions[1]. We also report an anomalous kink behavior in the current–voltage characteristics of suspended carbon nanotubes, due to their non-equilibrium transport[2]. A comparison of suspended and on-substrate CNTs reveals a substantial reduction of the mini band gaps of quasi-metallic carbon nanotubes due to the influence of the substrate[3]. The decreased band gaps are attributed to localized doping caused by trapped charges in the substrate that result in inhomogeneous broadening of the Fermi energy, which in turn limits our ability to modulate the conductance.

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