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In situ Raman Spectroscopy of Suspended Carbon Nanotubes under High Voltage Bias[1]

STEPHEN CRONIN, University of Southern of California

We report recent results of Raman spectroscopy taken of individual suspended single-walled carbon nanotubes exhibiting negative differential conductance (NDC) *in situ* under high voltage biases [1]. The transverse and longitudinal optical phonon modes (G_+ and G_- band) are found to respond differently to the applied voltage bias. We observe preferential downshifting of only one optical phonon mode while the other remains largely unchanged, indicating a non-equilibrium phonon population caused by the preferential electron-phonon coupling of only one optical phonon polarization. This preferential coupling is caused by the differences between the two Kohn anomalies in the TO and LO phonon branches [2]. Surprisingly, in most metallic nanotubes, the narrow G_+ band (TO band) is more strongly heated by electron-phonon scattering at high biases. The non-equilibrium phonon populations produced under high biases are corroborated by anti-Stokes Raman spectroscopy. We correlate the optically measured phonon population to the electrically measured resistivity using a Landauer model to determine key scattering parameters. The electron-phonon scattering mechanism revealed by these measurements and this analysis show the importance of electron-phonon scattering by phonon absorption from the large non-equilibrium phonon population in explaining the observed negative differential conductance [3].

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