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Theory of coherent phonon spectroscopy in carbon nanotubes[1]
G. D. SANDERS, C. J. STANTON, University of Florida, Y. S. LIM, Konkuk University, K. J. YEE, J. H. KIM, Chungnam National University, E. H. HAROZ, L. G. BOOSHEHRI, J. KONO, Rice University — We develop a theory for the generation and detection of coherent phonons in single wall carbon nanotubes. Coherent phonons are generated in the nanotube by ultrafast laser pulses via the deformation potential electron-phonon interaction with the photogenerated carriers. The electronic states are treated in a tight binding formalism which gives a description of the states over the nanotube Brillouin zone while the nanotube phonon modes are treated in a valence force field model that includes bond-stretching, in-plane and out-of-plane bond-bending, and bond-twisting interactions. Equations of motion for the coherent phonon amplitudes are obtained in a density matrix formalism and we find that the coherent phonon amplitudes satisfy driven oscillator equations. In coherent phonon spectroscopy the coherent phonons are detected by ultrafast pump probe differential transmission measurements. We find that for uniform illumination with a 5 fs pump pulse only the q = 0 radial breathing mode and a high frequency G mode are strongly excited. We will discuss excitation strengths for different coherent phonon modes and compare to recent experiments.

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