Phonon sideband in optical spectra of C13 carbon nanotubes

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Photoluminescence (PL) of single-walled carbon nanotubes (SWNTs) has been widely used for the measurement of chirality distribution of single-walled carbon nanotubes (SWNTs). However, there are unassigned peaks in the 2-D photoluminescence map plotted as a function of emission and excitation photon energy. In order to clarify the origin of these peaks, we have studied photoluminescence (PL) and resonant Raman scattering of single-walled carbon nanotubes (SWNTs) consisting of carbon-13 (SW^{13}CNTs) synthesized from a small amount of isotopically modified ethanol [1]. There was almost no change in the Raman spectra shape for SW^{13}CNTs except for a downshift of the Raman shift frequency by the square-root of the mass ratio 12/13. By comparing photoluminescence excitation (PLE) spectra of SW^{13}CNTs and normal SWNTs, the excitonic phonon sideband due to strong exciton-phonon interaction was clearly identified with the expected isotope shift [2]. The PLE line shape and energy difference from E_{ii} are remarkably similar to the excitonic phonon sideband predicted by Perebeinos *et al.* for (7, 5) and (6, 5) nanotubes. In addition to these phonon sideband features, we also found low-intensity 'pure electronic' features whose origin has never been elucidated. In order to examine these 'pure electronic' features, polarized PLE measurements on individually-dispersed SWNTs aligned in a gelatin-based thin film. By comparing optical transitions of SWNTs for incident light parallel or perpendicularly polarized to the nanotube axis, we have attributed these features to excitation by perpendicularly polarized light to the nanotube axis. The measured absorption energies of perpendicularly polarized light are compared with cross-polarized version of the Kataura plot. References: [1] S. Maruyama and Y. Miyauchi, AIP Conf. Proc. 786, 2005, 100-105. [2] Y. Miyauchi and S. Maruyama, cond-mat/0508232.