Identification of photoluminescence through electron-phonon interaction by isotopically modified single-walled carbon-13 nanotubes

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Photoluminescence (PL) of single-walled carbon nanotubes (SWNTs) has been widely used for the measurement of chirality distribution single-walled carbon nanotubes (SWNTs). However, there are many 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, isotopically modified SWNTs were employed. Using Alcohol catalytic CVD (ACCVD) technique optimized for the efficient production of SWNTs from very small amount of ethanol, SWNTs consisting of carbon-13 isotope ($SW^{13}CNTs$) were synthesized. Raman scatterings from $SW^{13}CNTs$ showed no change from $SW^{12}CNTs$ in spectrum shape except for the Raman shift frequency down-shifted as much as square-root of mass ratio 12/13. By comparing photoluminescence excitation (PLE) spectra of $SW^{13}CNTs$ and normal SWNTs, PL peaks with electron-phonon interactions were clearly identified for (7, 5) nanotubes. In Fig. 1, a clear isotope shifts are observed for peaks A and C. The energy difference (E_C-E_{22}) was reduced for $SW^{13}CNT$ by the factor of $\sqrt{12/13}$. Hence, the peak C is assigned as phonon-E_{22} related signal.

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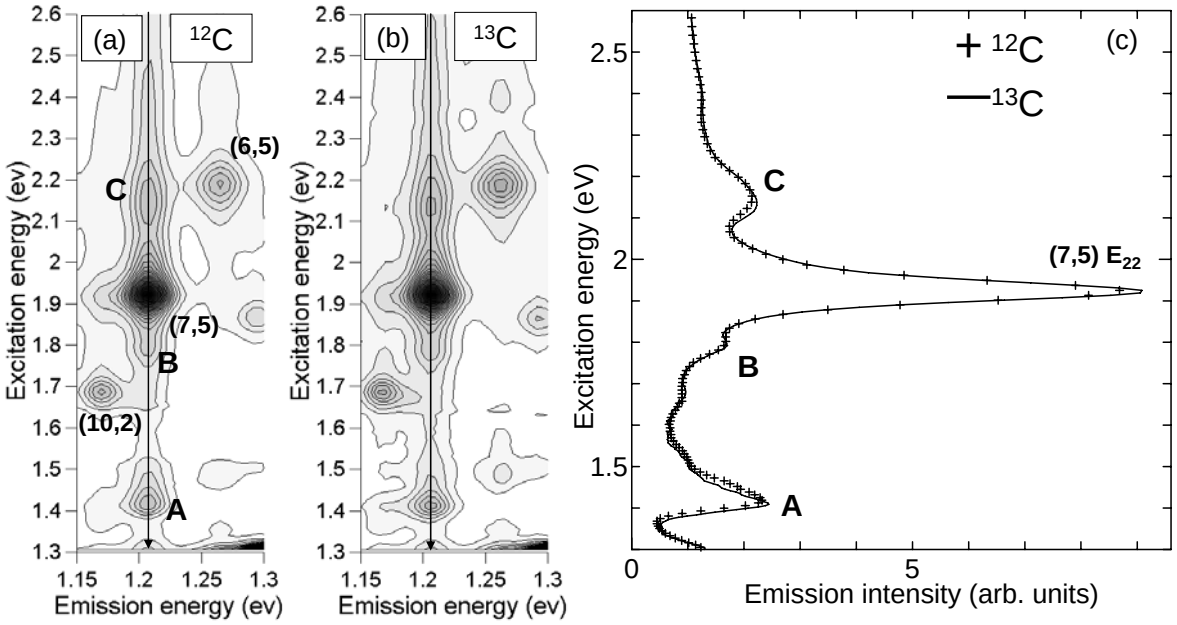

Fig.1 PL maps of (a) normal SWNTs and (b) $SW^{13}CNTs$ dispersed in surfactant suspension. (c) Comparison of PLE spectra of $SW^{13}CNTs$ and normal SWNTs at the emission energy of 1.208 eV (corresponding to E11 energy of (7,5) nanotubes).