

Identification of the origin of features in photoluminescence excitation spectra of single-walled carbon nanotubes

Yuhei Miyauchi and *Shigeo Maruyama

Department of Mechanical Engineering, The University of Tokyo, 7-3-1 Hongo,
Bunkyo-ku, Tokyo 113-8656, Japan

In a photoluminescence (PL) map of single-walled carbon nanotubes (SWNTs), one can generally find some peaks other than bright PL peaks assigned to each (n, m) nanotube. In this study, we have investigated the origin of these unassigned features.

Firstly, we have studied PL and resonant Raman scattering of SWNTs consisting of carbon-13 (SW¹³CNTs) synthesized from a small amount of isotopically modified ethanol. By comparing photoluminescence excitation (PLE) spectra of SW¹³CNTs and normal SWNTs, the excitonic phonon sideband due to strong exciton-phonon interaction was clearly identified with the expected isotope shift [1]. In addition to the direct experimental proof of the strong exciton-phonon interaction, we also found low-intensity ‘pure electronic’ features whose origin has never been elucidated.

In order to investigate the origin of unassigned features other than phonon sideband peaks, we performed polarized PLE measurements on SWNTs in gelatin based thin film and aqueous suspension for the UV-VIS-NIR range. We found that some PL peaks for cross-polarized excitation to the nanotube axis can be clearly observed in the PLE spectra of isolated SWNTs [2]. The measured transition energies for perpendicular excitations were blue-shifted compared to the qualitative values predicted within a single-particle theory. The results indicate a smaller exciton binding energy for perpendicular excitations than for parallel excitations. Fig.1 shows a PL map and schematic of typical peak positions and origins of various PL peaks, which were identified in this study.

[1] Y. Miyauchi, S. Maruyama, Phys. Rev. B, 74 (2006) 35415.

[2] Y. Miyauchi, M. Oba, S. Maruyama, cond-mat/0608073 (2006).

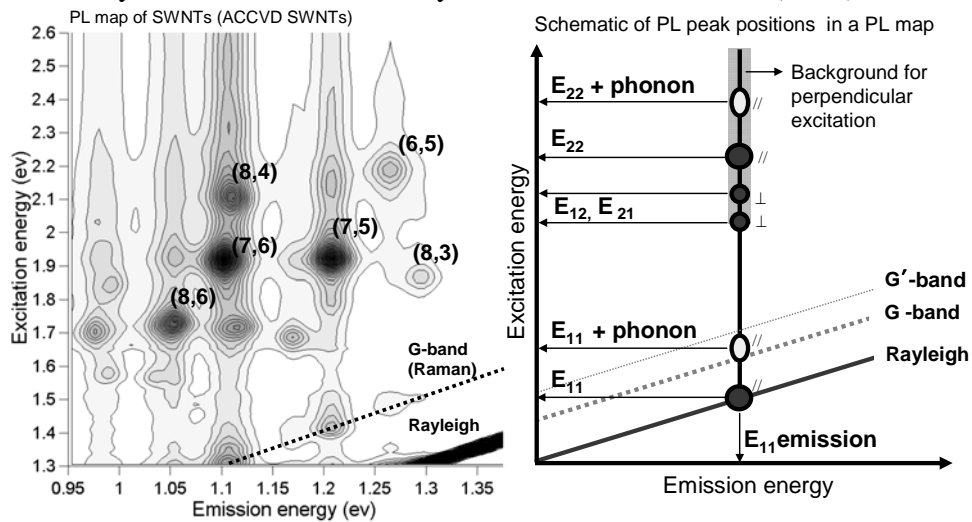


Figure 1. (a) PL map and (b) schematic of PL peak positions.

*Email address: maruyama@photon.t.u-tokyo.ac.jp