Photoluminescence mapping of various (n, m) nanotubes by cross-polarized light

○Yuhei Miyauchi, Mototeru Oba and Shigeo Maruyama

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

Photoluminescence excitation (PLE) spectroscopy of single-walled carbon nanotubes (SWNTs) have been extensively studied for characterization of their unique electronic properties due to the one-dimensionality. Theoretical studies and recent experiments have demonstrated that these optical transitions in SWNTs are dominated by strongly correlated electron-hole states in the form of excitons. Major peaks in a PL map correspond to the excitation transition energy of the second subband (E_{22}) and the photon emission energy of the first subband (E_{11}) of a specific SWNT, and these peaks are assigned to particular (n, m) nanotube species [1]. On the other hand, we can also find lower-intensity features around main PL peaks in a PLE spectrum. Recently, we have clearly identified that some of these features are phonon sideband peaks by measuring isotopic shift in PLE measurement using SWNTs consisting of carbon-13 [2]. In addition to the direct experimental proof of the strong exciton-phonon interaction [3], we also found low-intensity 'pure electronic' features whose origin has never been elucidated [2]. To investigate the origin of these unassigned 'pure electronic' peaks, we have performed polarized-PLE spectroscopy on independently aligned SWNTs in a gelatin thin film, and some unassigned PL peaks of (7, 5) nanotubes were attributed to excitation by cross-polarized light to the nanotube axis [4].

In this report, we have studied polarized PLE spectra of various (n, m) nanotubes. Fig. 1 shows PL peaks attributed to excitation by cross-polarized light. Detailed experimental techniques for identification will be discussed. Obtained experimental Kataura plot for cross-polarized light will be compared with tight-binding calculation of SWNTs considering geometry optimization and curvature effect [5].

[1] S.M. Bachilo, M.S. Strano, C. Kittrell, R.H. Hauge, R.E. Smalley, R.B. Weisman, Science **298,** 2361 (2002).

[2] Y. Miyauchi and S. Maruyama, submitted to Phys. Rev. Lett., cond-mat/0508232.

[3] V. Perebeinos, J. Tersoff, Ph. Avouris, Phys. Rev. Lett. **94**, 027402 (2005).

[4] Y. Miyauchi, and S. Maruyama, to be submitted.

[5] M. Oba, S. Okada, T. Miyake, S. Maruyama, the 30th Fullerene Nanotubes General Symposium, Nagoya (2006).

Corresponding Author: Shigeo Maruyama
TEL&FAX: +81-3-5800-6983
E-mail: maruyama@photon.t.u-tokyo.ac.jp

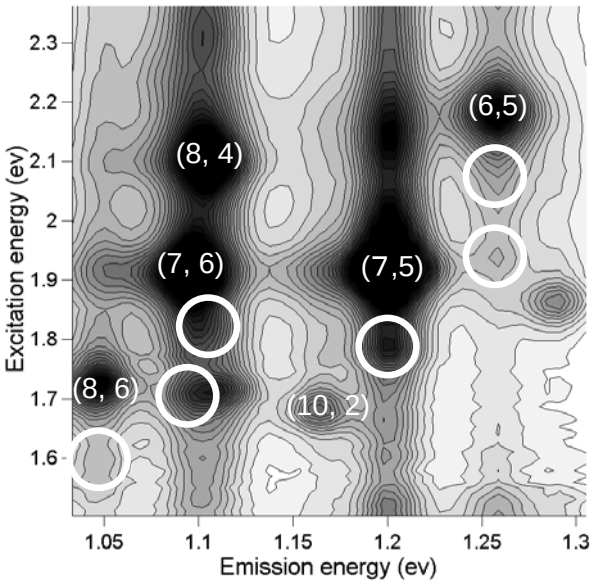

Fig. 1 Polarized PL map of dispersed SWNTs in surfactant solution. Peaks indicated by circles were attributed to excitation by cross-polarized light. Configuration of polarizations was for enhanced cross-polarized absorption.