Single SWNT spectroscopy for nano-metrology

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A single-walled carbon nanotube (SWNT), suspended between micro-structures, is an excellent system for probing responses to molecular adsorption/encapsulation, optical/thermal excitation, etc., because of the quasi 1D electronic structure of the SWNT allowing highly resonant optical transitions, and sensitivity to the surrounding environment with the outer surface and the inner space. We have developed techniques for fabrication of a perfectly isolated SWNT, as long as 10 μm, between a pair of silica pillars as shown in Fig. 1, and for selective detection of photoluminescence (PL) and/or Raman scattering from it [1].

In this talk, we will focus on two topics: phase analyses of water confined in an SWNT [2] and thermal conductivity measurements of SWNTs [3]. Water molecules confined in the inner space of SWCNT affect the optical transition energy in the SWNT depending on the dielectric constant of water that varies with its phase. Thus, the phase diagram of water confined inside of an SWNT could be constructed from the temperature and water vapor pressure dependent spectra. The water in an SWNT is one dimensional, thus the phase change is of interest. The thermal conductivity of an SWNT is difficult to measure because of a small diameter and low heat capacity. With the spectroscopic PL imaging, we could obtain the temperature distribution along the tube axis under laser irradiation based on the temperature dependent PL spectrum change. From the temperature distribution, the temperature dependence of thermal conductivity was derived by solving heat equation. The single SWNT spectroscopy provides fruitful information on molecules on/in an SWNT as well as the properties of SWNTs.

[1] Y. Homma, S. Chiashi, Y. Kobayashi, Rep. Prog. Phys. **72**, 066502 (2009).
[2] S. Chiashi, Y. Homma, *et al.*, to be published.
[3] K. Yoshino, S. Chiashi, Y. Homma, *et al.*, to be published.

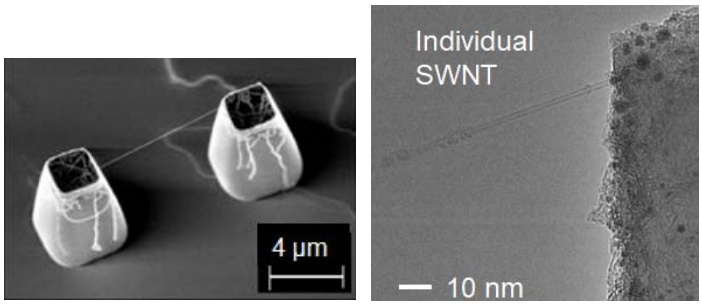

Fig.1 Scanning electron micrograph (left) and transmission electron micrograph (right) of a singly suspended SWNT between micropillars.