Temperature dependence of radial breathing modes of SWNTs

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In order to understand the in-situ Raman scatterings [1] during ACCVD [2] growth of SWNTs, Raman scatterings from SWNTs over a large temperature range (4~ 1000 K) were measured. Raman scattering was measured in vacuum with low laser intensity (~10^4 mW/cm^2) to avoid the oxidation of SWNTs or additional heating of samples. Raman shift, peak width and intensity of the major peak in the G-band (G$^+$ peak) had universal temperature dependence, for the various SWNTs samples and for 3 excitation lasers (488.0, 514.5 and 632.8 nm).

RBM peaks also showed temperature dependence. Fig. 1(a) shows RBM peaks of HiPco sample measured with 488.0 nm excitation laser at various temperatures. RBM peaks were decomposed into Lorentzian curves and they were assigned to chirality index (n,m) [3]. Raman shift, peak width and intensity of each RBM peaks had clear temperature dependence. Raman shift was downshifted and peak width was broadened with increasing temperature and the downshift and broadening rates were almost constant for most of peaks. While intensity of most of RBM peaks decreased with increasing temperature, the intensity of "Peak B" in Fig. 1(a) increased. This peak (at 229 cm^{-1} at room temperature) did not correspond to any assignment of chiral index. The reason for this drastic change of the resonance condition of this peak would be discussed.

[1] S. Chiashi *et al.*, *Chem. Phys. Lett.*, .**386** (2004) 89-94.
[2] S. Maruyama *et al.*, *Chem. Phys. Lett.*, **360** (2002) 229-234.
[3] A. Jorio *et al., Phys. Rev. B*, **71** (2005) 075401.

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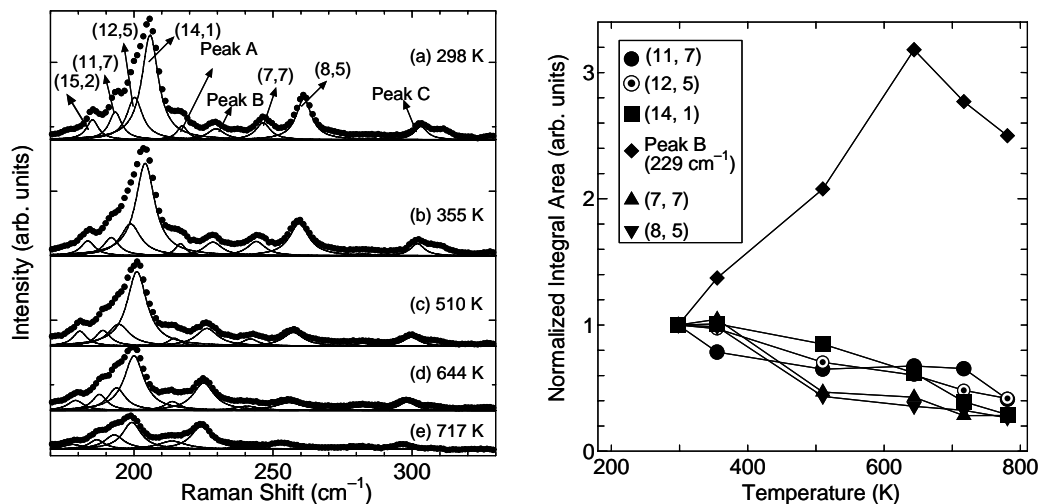**Tel&Fax: +81-3-5800-6983**

Fig. 1   (a) RBM peak spectra measured at different temperatures (HiPco sample, 488.0 nm excitation laser). (b) Temperature dependence in RBM peak's intensity.