

# Phonon Assigning of G-band from Suspended Single-walled Carbon Nanotubes

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Generally, phonon symmetry of Raman peaks is assigned by polarized Raman spectroscopy because polarization dependence of Raman intensity is affected by phonon symmetry. However, as for a single-walled carbon nanotube (SWCNT), polarization dependence is affected by the selection rule of light absorption and antenna effect [1] as well as the phonon symmetry. Thus, determining phonon symmetry of Raman peaks from SWCNT by polarized Raman spectroscopy was difficult especially for G peaks. Moreover, it is known that six G peaks could exist in SWCNT [2] while only two G peaks ( $G^+$ ,  $G^-$ ) are detected from isolated SWCNT [3]. The problem is that it is unknown which of six G peaks could be assigned to  $G^+$ ,  $G^-$  peaks.

In this study, we tried to determine phonon symmetry of  $G^+$ ,  $G^-$  peaks from measurements of suspended SWCNTs considering the selection rule of light absorption and antenna effect. In polarization measurements, Raman scattering was detected only when its polarization was parallel (VV) or perpendicular (VH) to that of incident laser beam. Because the intensity of Raman scattering depends on incident and scattered polarization and phonon symmetry, phonon symmetry could be determined from polarization dependence by fixing polarization configurations. The result of polarization dependence of  $G^+$ ,  $G^-$  peaks in VV configuration is shown in Fig. 1. The solid line in Fig. 1 is the fitting result. The fitting was succeeded by using equations presumed that both  $G^+$ ,  $G^-$  peaks have  $A$  symmetry considering the selection rule of light absorption and antenna effect. Raman tensor elements of  $A$  symmetry were calculated by the result of fitting parameter in  $G^+$ ,  $G^-$  peaks, respectively.

[1] G. S. Duesberg et al., *Phys. Rev. Lett.* **85**, 5466 (2000).

[2] R. Saito et al., *Phys. Rev. B* **64**, 085312 (2001).

[3] S. Piscanec et al., *Phys. Rev. B* **75**, 035427 (2007).

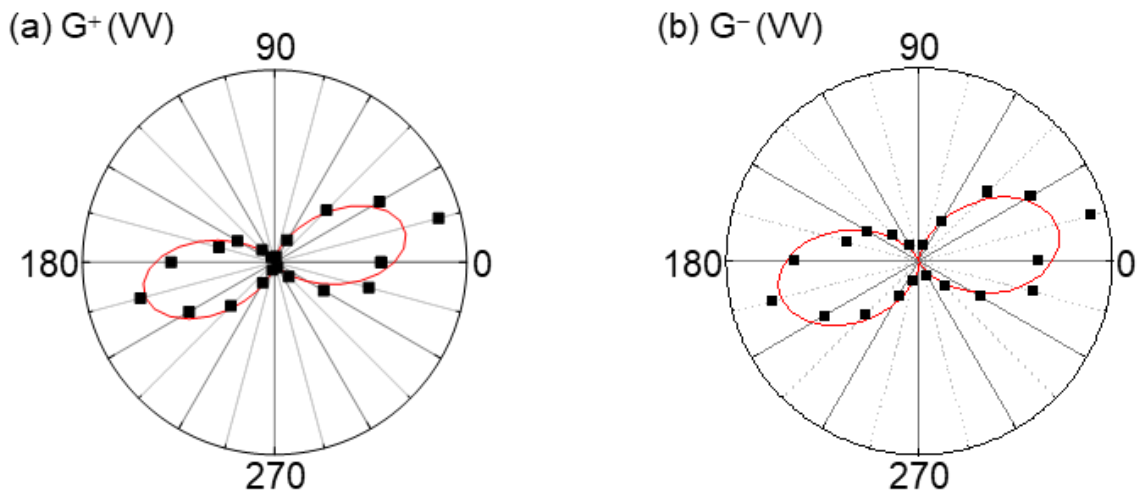


Fig. 1. Polarization dependence of the intensity of (a)  $G^+$  and (b)  $G^-$  peaks from (9,8) suspended SWCNT in VV configuration.