Exciton Environmental effect on Raman spectroscopy of single wall carbon nanotubes

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Resonance Raman spectroscopy (RRS) is a powerful tool for characterizing the structure and electronic properties of single wall carbon nanotubes. When we assign the chiral index integers (n,m) by RRS, we need a precise value of the transition energies as a function of (n,m) for resonance Raman spectra, which is called Eii values. J. Jiang et al. have developed the computer program of exciton energies within the extended tight-binding method and the Bethe-Salpeter equations [1], and the exciton-photon, and exciton-phonon interaction of a nanotube [2], which reproduce the Eii values which are observed by the experiment and relative Raman intensities, respectively. However, depending on the surrounding materials or the environment of a nanotube, the Eii values are shifted up to +- 100meV. This shifts depend on the type (mod(2n+m,3) = 0, 1, 2 for Metallic, Type 1 and 2 semiconductor nanotubes) and diameter of nanotubes. We call this effect of Eii, environmental effect. The environmental effect can be included in the calculation as an effective dielectric constant kappa [3, 4, 5] in the Bethe-Salpeter equation which depends on the surrounding material and the diameter of nanotube. In this talk, starting from the background of the exciton calculation, we will introduce diameter-dependent kappa [6] which reproduce many different resonance Raman measurement within a reasonable accuracy. Further, we will discuss the physics of exciton energy in the wrapping materials using a scaling theory and analytical expression [7].

References:

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