

Exciton-phonon and exciton-exciton interactions studied by micro-photoluminescence spectroscopy of individual single-walled carbon nanotubes

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Recently, the dynamics of one-dimensional excitons in single-walled carbon nanotubes (SWNTs) has attracted great deal of attention. The exciton coherence contains the information on the exciton-phonon and exciton-exciton interactions. However, the exciton coherence time and the detail mechanism of decoherence in SWNTs are not clear. The spectral linewidth of a single SWNT provides us the information on the exciton lifetime and exciton coherence time. It is therefore needed to perform micro-photoluminescence (PL) spectroscopy on individual SWNTs for clarifying the intrinsic spectral linewidth [1], hidden by inhomogeneous broadening of ensemble-averaged PL spectra.

We have studied temperature and excitation intensity dependence of PL spectra from spatially isolated single SWNTs by means of single-nanotube spectroscopy. The value of the spectral linewidth almost linearly decreases with a decrease of temperature. It was found that the spectral linewidth is almost determined by the exciton coherence time from the exciton lifetime [2]. The temperature dependence of the linewidth (homogeneous linewidth) implies that the exciton decoherence is dominated by the interaction between the exciton and phonon mode with very low energy. In the high excitation condition, the homogeneous linewidth broadens with an increase of the excitation intensity. Our observation suggests that the broadening of homogeneous linewidth comes from the annihilation of excitons through the Auger-process in a SWNT. The detail of the exciton-exciton interaction including the stability of biexcitons will be discussed.

[1] T. Inoue, K. Matsuda, Y. Murakami, S. Maruyama, and Y. Kanemitsu, *Phys. Rev. B* **73**, 233401 (2006).

[2] H. Hirori, K. Matsuda, Y. Miyauchi, S. Maruyama, and Y. Kanemitsu, *Phys. Rev. Lett.* **97**, 257401 (2006).