Optical and Electrical Properties of Vertically Aligned Single-Walled Carbon Nanotubes

*Shigeo Maruyama[1]

[1] Department of Mechanical Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan

A new insight is gained on the structure of the vertically aligned single-wall carbon nanotubes (VA-SWNTs) [1-3] generated by alcohol catalytic CVD (ACCVD) technique [4]. The thickness-controlled growth of VA-SWNTs by using in-situ laser absorption method is now a routine as in Fig. 1(a) [2]. Our recent finding of the simple removal method using hot-water [5] enabled us to transfer this film to various flat substrates for various applications. At the same time, transferring this film on transmission electron microscopy (TEM) grid made it possible to directly observe the morphology of nanotubes from the top as shown in Fig. 1(b). To our surprise, the average number of nanotubes of a bundle is less than about 10. Electronic properties measured by EELS and X-ray absorption revealed that nanotubes are virtually electronically isolated [6]. Then, the characteristic resonant Raman features as in Fig. 1(c) [7] should be reconsidered to be from isolated nanotubes. The higher resolution Raman measurements show the sharp features for the RBM peak which have been assigned to cross-polarized resonance [6]. The isolated and cross-polarized absorption resonance in Raman will be discussed based on Kataura plot and on the recent identification of the excitonic cross-polarized absorption through photoluminescence spectroscopy of surfactant-wrapped D_2O solution [8].

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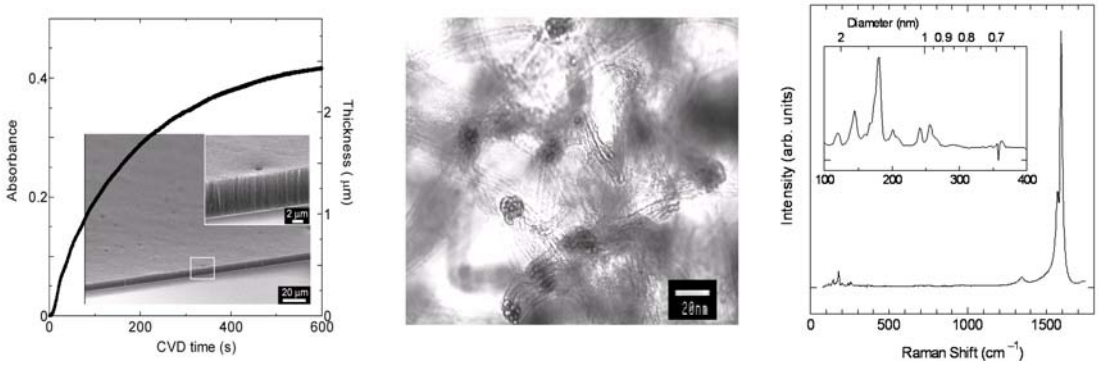

(a) Growth Process and SEM (b) TEM from top (c) Low-resolution Raman

Figure 1. SEM, TEM and Raman of vertically aligned SWNTs by ACCVD.

*Email address: maruyama@photon.t.u-tokyo.ac.jp