Vertically aligned SWNTs synthesized on quartz substrate and their optical properties

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To best utilize fascinating physical properties of SWNTs, controlled positioning of SWNTs on appropriate substrates is intensely being sought. However, whereas the vertical growth of MWNTs by chemical vapor deposition (CVD) is well known, the alignment of SWNTs has been limited to in parallel to the substrate plane. Here we first demonstrate that even flexible SWNTs can take the vertically aligned configuration by means of our alcohol CCVD process [1, 2]. Specifically, a dense and uniform "mat" of vertically aligned SWNTs with a thickness of a few μm is grown on the surface of a quartz substrate on which dense (approx. 1.3×10^{17} m^{-2}) but finely monodispersed Co-Mo catalyst with a diameter of 1.0 ~ 2.0 nm [3] is supported by our dip-coat process [4]. This densely monodispersed catalyst with a comparable diameter to that of SWNTs led to the high density of SWNTs that is needed to the vertical alignment. The generated SWNTs have relatively wide diameter distribution according to a Raman analysis shown in Fig. 2. Thereby prepared vertically aligned SWNT film exhibit an optical anisotropy and could accelerate a variety of SWNT-based applications that have been proposed thus far using randomly oriented SWNTs deposited on a substrate. This method could also be suitable to obtain SWNTs with nearly constant lengths defined by a thickness of the SWNT mat.

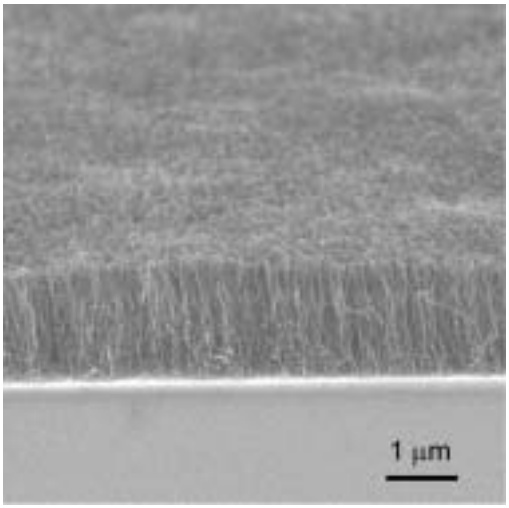

Fig. 1. FE-SEM micrograph of the vertically aligned SWNT mat at a fractured edge of a quartz substrate taken from 20° from horizon.

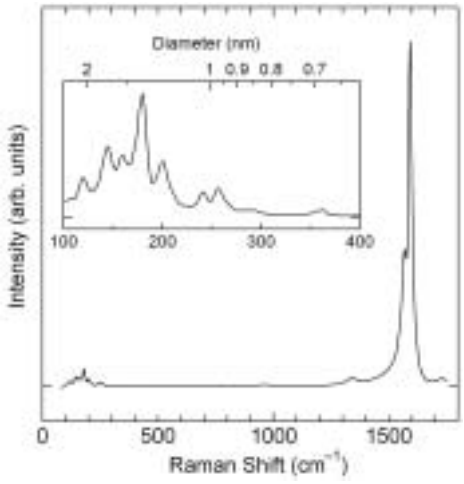

Fig. 2. Raman scattering spectrum of vertically aligned SWNTs shown in Fig. 1 taken with 488 nm laser light.

[1] S. Maruyama *et al., Chem. Phys. Lett.*, **360** (2002) 229.

[2] Y. Murakami *et al., Chem. Phys. Lett.*, **374** (2003) 53.

[3] M. Hu *et al., J. Phys. Chem. B*, To be submitted.[4] Y. Murakami *et al., Chem. Phys. Lett.*, **377** (2003) 49.

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