Elucidation of the growth process of vertically aligned SWNT films via *in situ* optical absorbance measurements

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Stemming from recent findings that the optical absorbance of a vertically aligned SWNT film (VA-SWNTs) is proportional to its thickness [1], an optical absorbance measurement method was developed to study the growth process of these films *in situ*, as shown in Fig. 1. Measurements using this method revealed the catalyst activity diminishes in an exponential fashion with reaction time. Reduction in thickness due to burning of the SWNT film was also confirmed, but was found to be negligible when the rate of air entering the CVD chamber was minimized.

In the current study, a model describing the growth of VA-SWNT films is presented (Fig. 2), which depends on the initial catalyst activity and the catalyst lifetime [2]. The VA-SWNT films employed in this study were produced on an optical-grade quartz substrate using the alcohol catalytic CVD method [3,4]. Absorbance of the film was determined from the transmitted intensity of laser light (488 nm) passed through the substrate and SWNT film during growth. The growth model is fit to absorbance data under various growth conditions, including cases where burning is significant. Applications of this measurement method, such as the potential for producing films of vertically aligned SWNTs with equal thicknesses, are addressed.

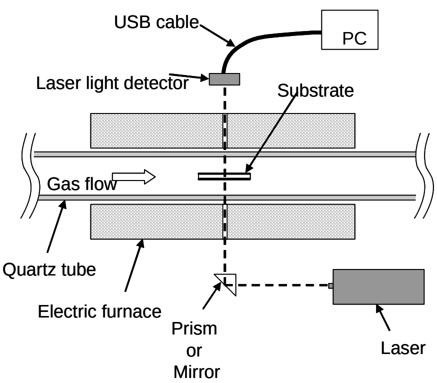

Fig. 1: Setup for *in situ* optical absorption measurement during CVD growth of VA-SWNTs.

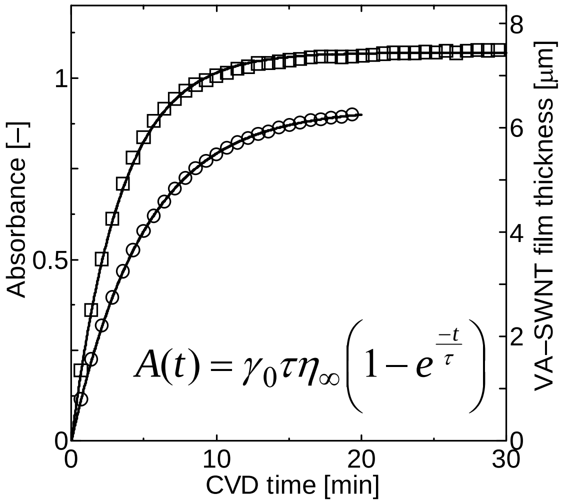

Fig. 2: *In situ* absorbance data fitted by the inset equation. The variables γ_0 and τ represent the initial growth rate and catalyst lifetime, respectively, and η_∞ is the molar absorption cross-section of the vertically aligned SWNT film.

[1] S. Maruyama, E. Einarsson, Y. Murakami, and T. Edamura, *Chem. Phys. Lett.* **403** (2005) 320.
[2] E. Einarsson, Y. Murakami, T. Edamura, S. Maruyama, to be submitted.
[3] S. Maruyama, R. Kojima, Y. Miyauchi, S. Chiashi, and M. Kohno, *Chem. Phys. Lett.* **360** (2002) 229.
[4] Y. Murakami, S. Chiashi, Y. Miyauchi, M. Hu, M. Ogura, T. Okubo, and S. Maruyama, *Chem. Phys. Lett.* **385** (2004) 298.

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