

# Synthesis of Vertically Aligned Single-Walled Carbon Nanotubes in Mesoporous Silica Film as a Field Emitter

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Single-walled carbon nanotubes (SWNTs) have been expected as a field emitter toward realizing lower threshold voltage and higher electric current density compared with those using silicon and molybdenum. Alignment and density of SWNTs are important factors for designing a field emitter. Mesoporous silica films, which have highly-ordered structure with nanometer-sized pores, are attractive as a guide for SWNTs.

In this study, SWNTs were vertically grown in a mesoporous silica film as a guide (Fig 1), and their field emission property has been investigated. A mesoporous silica film was prepared on the Au-Ti coated silicon substrate according to the literature [1]. Subsequently, Co catalysts were deposited at the bottoms of the pores by the electroplating method. SWNTs were synthesized by the alcohol (ethanol) catalytic chemical vapor deposition at 750 °C and 10 Torr for 5 minutes [2] [3].

Raman spectra of the sample revealed that SWNTs were synthesized on the substrate. Bundles of SWNTs were observed on the mesoporous silica film by FE-SEM (Fig. 2). These results indicate that vertically aligned SWNTs were grown in the film. *I-V* field emission curves of the samples (Fig. 3) revealed that field emission current from SWNTs was observed. The details of the property will be shown in the presentation. To our knowledge, field emission from vertically aligned SWNTs guided by mesoporous silica film was achieved for the first time.

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**References:** [1] S. P. Naik, *et al.*, submitted. [2] S. Maruyama, *et al.*, *Chem. Phys. Lett.*, **360** (2002) 229-234 [3] Y. Murakami, *et al.*, *Chem. Phys. Lett.*, **375** (2003) 393-398

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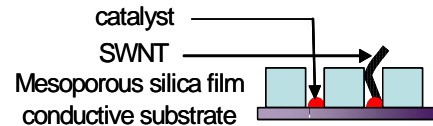


Figure 1 A schematic image of vertically aligned SWNTs

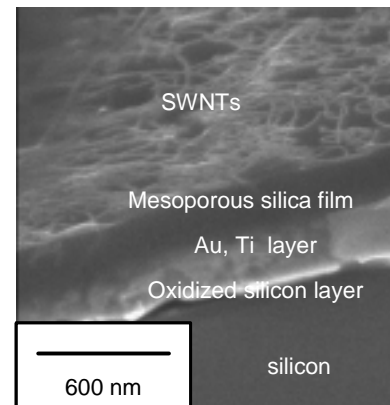


Figure 2 A cross sectional SEM image of products on Au substrate after ACCVD

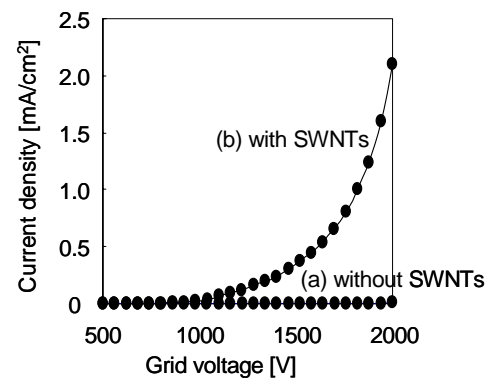


Figure 3 I-V field emission curves of (a) before ACCVD and of (b) after ACCVD