# Gradual etching and long-length burning of metallic single-walled carbon nanotubes toward semiconducting nanotube arrays

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High carrier mobilities and finite band gaps of semiconducting (s-) single-walled carbon nanotubes (SWCNTs) make them a promising candidate for channel materials of future electronics. While random networks of separated s-SWCNTs have provided high enough performances for thin film transistor applications, high-purity and well-aligned s-SWCNT arrays are required for high-speed field-effect transistors (FETs) in logic circuit applications. Direct-growth of aligned SWCNTs together with long-length selective removal of metallic (m-) SWCNTs is a possible way for scalable fabrication of s-SWCNT arrays.

We developed methods for controlled etching as well as long-length removal of m-SWCNTs. Firstly, horizontal arrays of SWCNTs were grown on crystal quartz substrates by alcohol chemical vapor deposition [1] and transferred onto silicon with silicon dioxide substrates. Back-gated FET structures were fabricated by defining source and drain electrodes with 20 μm channel width and 5 - 20 μm channel lengths. Source–drain voltages were applied to SWCNT channels in various atmospheres, including ambient air, vacuum, water vapor, and oxygen with water vapor. Sequential application of increased voltages to SWCNTs in water vapor conditions was found to induce gradual extension of nanogaps in SWCNTs (Fig. 1) [2]. We also found that the long-lengths of m-SWCNTs were burnt away by applying voltages to polymer-coated SWCNTs under water vapor and oxygen conditions (Fig. 2).

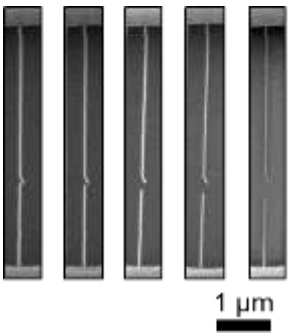


Fig.1: Gradual etching of SWCNTs.

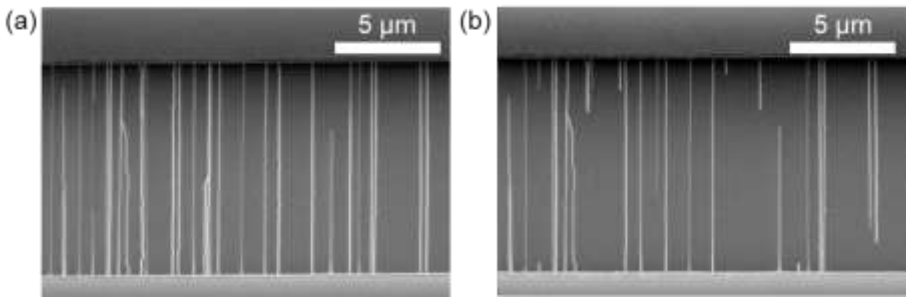


Fig.2: (a) Before and (b) after long-length selective burning of m-SWCNTs.

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

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