

Manipulation of horizontally aligned single-wall carbon nanotubes

Taiki Inoue, Keigo Otsuka, Shohei Chiashi, Shigeo Maruyama

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

maruyama@photon.t.u-tokyo.ac.jp

Abstract: Horizontally aligned single-walled carbon nanotubes (SWNTs) grown on crystal quartz substrate are very promising material for electronics devices such as field-effect transistors (FETs). In addition to the CVD growth control [1,2] and characterization of chirality distribution of aligned SWNTs, we will discuss two manipulation techniques of horizontally aligned SWNTs. First is the full-length removal of metallic SWNTs by using polymer-assisted electric breakdown. When the electric breakdown technique is applied to SWNT array covered with organic polymer such as poly(methyl methacrylate) (PMMA), metallic nanotubes continues to burn as fuses for fireworks. This method yielded a high on/off ratio (ca. 10,000) of an FET, which indicates high removal selectivity between semiconducting and metallic SWNTs, and also showed fine spatial resolution (ca. 55 nm) in the same way as in-air breakdown [3]. The second manipulation technique is the bundling of a part of the array by the capillary process. By the standard photolithography process, a photoresist was patterned on the targeted bundling spot. Then, the substrate was covered with a PMMA film by spin coating. The PMMA film with the SWNTs and the photoresist patterns was peeled off from the substrate. Then, the photoresist was dissolved to give partially suspended SWNTs over the trenched PMMA film. During this process, evaporation of liquid induced neighboring suspended SWNTs to bundle together. After placing this film on a substrate, the PMMA was dissolved away to leave the manipulated SWCNTs.

Key words: Single-walled carbon nanotubes, horizontally aligned, crystal quartz

Reference:

- [1] S. Chiashi, H. Okabe, T. Inoue, J. Shiomi, T. Sato, S. Kono, M. Terasawa, S. Maruyama, Growth of Horizontally Aligned Single-Walled Carbon Nanotubes on the Singular R-Plane (10-11) of Quartz, **J. Phys. Chem. C**, 2012, 116: 6805-6808.
- [2] T. Inoue, D. Hasegawa, S. Badar, S. Aikawa, S. Chiashi, S. Maruyama, Effect of Gas Pressure on the Density of Horizontally Aligned Single-Walled Carbon Nanotubes Grown on Quartz Substrates, **J. Phys. Chem. C**, 2013, 117: 11804-11810.
- [3] K. Otsuka, T. Inoue, S. Chiashi and S. Maruyama, Selective removal of metallic single-walled carbon nanotubes in full length by organic film-assisted electrical breakdown, **Nanoscale**, 2014, 6: 8831-8835.