Fabrication of Polysilicon Electrode Pattern for Growing Aligned, Single-Wall Carbon Nanotubes


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Single-wall carbon nanotubes (SWNTs) are envisioned for a new form of electronic, optical, and chemical sensing devices. Two of the greatest challenges in integrating SWNTs with standard silicon technology are positioning them and aligning them. In this work, we present a new way of aligning and positioning the SWNTs in a regular array. The SWNTs are grown across two poly-Si electrodes, which serve both as electrical contacts and as elevated structures for suspending the SWNTs. The poly-Si electrodes are fabricated using standard silicon technology [Figure 1(a)]. First, a 1-µm-thick poly-Si film is grown by chemical vapor deposition (CVD) on top of a thermally-grown 1-µm-thick SiO$_2$ film on a silicon substrate. Then, photolithography and a reactive-ion etching are used to pattern the poly-Si film and the oxide film. The electrodes contain two regions: the narrow trench region (1–4µm wide) and the wide trench region (10µm wide), as Figure 1(b) shows. During the SWNT growth, a high electric field on the order of 10$^6$V/m can be selectively applied across the narrow trenches only. A high electric field is known to enhance the growth rate of SWNTs and to align them [1,2]. Moreover, controlling the maximum length of the SWNTs can guarantee that no suspended SWNTs grow across the wide trench [Figure 1(c)]. The SWNTs are grown directly on the sample by a methane-CVD process. Samples were prepared both with and without applied electric fields between the electrodes, as Figures 1(d) and 1(e) show. Using the presented electrode structure along with the electric field during the SWNT growth produces well-aligned SWNTs in a regular array.

REFERENCES: