Synthesis of Single Walled Carbon Nanotubes from a Novel Polymer Based Catalyst for Applications in Device Fabrication

by

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ABSTRACT

The goal of this work was to develop an industrially viable fabrication of single walled carbon nanotube (SWNT) devices which could potentially replace the present silicon technology. Thus, I have focused on three major areas of SWNT development, namely: 1) the controlled synthesis of well dispersed, highly uniform, low defect bundles; 2) the direct fabrication of SWNT field effect transistors (FETs) from such organized nanotube growth; 3) the investigation of chemical sensitivity by modification of the SWNT FETs through incorporation of receptors. By taking advantage of the natural microphase separation characteristic of asymmetric block copolymers, we employed a ferrocene based block copolymer to uniformly disperse iron nano-domains that in turn result in the highly dispersed growth of SWNTs at controlled density and bundle diameter. The SWNT yield and disentangled nature allowed for the fabrication of over 160 SWNT transistors on a single 15 mm x 15 mm silicon chip without previously mapping the nanotube location on the sample. Each device contained over 300 nanotube channels in parallel. These devices show high current output while maintaining high surface area exposed to environmental conditions, and are thus excellent candidates as tiny, reliable, cost effective sensors. The SWNT FET chemical sensitivity was analyzed through the adsorption of an aniline oligomer in both its conductive and insulating states. We found that the oligomer successfully bound to the SWNT sidewalls and that the electrically conductive form could modulate SWNT channel conductance by charge transfer whereby all n-type current flow carried through semiconducting nanotubes was inhibited. The FET response to aniline adsorption provides key insight into the sensitivity of the nanotubes and their future application as electrical interconnects in nano-chemical sensors.