Directed assembly of solution processed single walled carbon nanotubes via dielectrophoresis: from aligned array to individual nanotube devices*.

Saiful I. Khondaker[a], Paul Stokes and Shashank Sekhar
Nanoscience Technology Center & Department of Physics, University of Central Florida, 12424 Research Parkway, Orlando FL 32826, USA

Abstract

Solution processed single walled carbon nanotubes (SWNTs) have attracted a lot of attention due to their ease of processing at room temperature, CMOS compatibility, and potential for scaled up manufacturing of SWNT devices on various substrates. For high throughput fabrication of SWNT devices from solution, it is necessary that (i) individual SWNTs are dispersed and stabilized in the solution after removing catalytic particles and amorphous carbons from the growth procedure and (ii) SWNTs are assembled in precise and controllable way at selected position of the circuit with high yield. In addition, the quality of SWNT in the solution is also important as it is generally believed that solution processing techniques can introduce defects and degrades the intrinsic electrical properties of SWNTs. We used commercially available SWNT solution and AC dielectrophoresis (DEP) technique to achieve directed assembly of high quality SWNT devices with high yield. SWNTs are assembled from a surfactant free commercially available aqueous solution using a non uniform electric field. By controlling the shape of the electrodes, electric field strength, frequency, density of solution, and novel device design, we are able to control the assembly of SWNTs from dense arrays to single SWNT devices with high yield. Electronic transport properties of large area field effect transistors (FET) fabricated from aligned arrays of SWNT show field effect mobility as high as 27.1 cm^2/Vs, which is two orders of magnitude higher than solution processed organic FET devices. On the other hand, FETs fabricated from individual SWNTs show field effect mobilities up to 1380 cm^2/Vs and on-state conductance of up to 6 μS. The mobility values are an order of magnitude improvement over previous solution processed SWNT devices and close to the theoretical limit. Fabrication of quantum nanoelectronic devices using solution processed SWNTs will also be presented.

[a] To whom correspondence should be addressed. E-mail: saiful@mail.ucf.edu

* This work is partially supported by US National Science Foundation under grant ECCS-0748091 (CAREER).