Solution-Processed, Unpurified, Semiconducting Enriched Single Walled Carbon Nanotube Field Effect Transistors and Their Electrical Characteristics

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Recently solution processed single walled carbon nanotubes(SWNTs)[1] have attracted great attention for their excellent electrical and mechanical properties. However, most of devices and circuits, reported in the literatures[1], have been implemented with highly purified, solution-processed SWNTs which typically resulted in deterimental effects associataed with intrinsic field effect mobility degradation (μ_{eff}) and reduction of average length (~a few μm) of SWNTS. Even though high on-off ratio (I_{on}/I_{off} >10^5) for SWNT field effect transistors(FETs) can be typically achived by using highly purified SWNTs solution[2] (~98%), the cost-ineffectiveness and intrinc device reliability issues caused by defect generation in SWNTs associated with harsh purification process (i.e, mechanical (or/and chemical) treatments) should be potentially addressed and resolved for the competative electronic applications including large area, advanced flat panel displays. However, there has been few reports on solution-processed FETs based on unpurified and semiconducting enriched SWNTs, thereby, in this work, we prepared semiconducting enriched single walled nanotubes by using novel chemical vapor deposition, followed by solution-type single walled nanotubes preparation. For the evaluation of electrical properties of semiconduting enriched single walled nanoubes, we implemented field effect transistors with channel length ranging from 5 μm to 200 μm, immediately followed by electrical characteristics. Fig.1(a) shows scannig electron microscope image of SWNTs with average length (~more than 10 μm) SWNTs, which indicates intrinsic long length of SWNTs are nicely preserved even after solution process. Fig. 1(b) shows that typically high current on/off ratio, in the range from 5 to 50, is observed compared with as-grown CVD based SWNTs, which has typical on/off ratio (less than 2). The data substatiate that unpurified SWNTs have semiconducting enriched SWNTs. Stipping process[3] to increase on/off ratio upto 10^6 has been underway and their electrical charcteristics depending on average SWNTs density, length, physical dimension (~width to length ratio) are systematically analyzed and plan to be reported later.

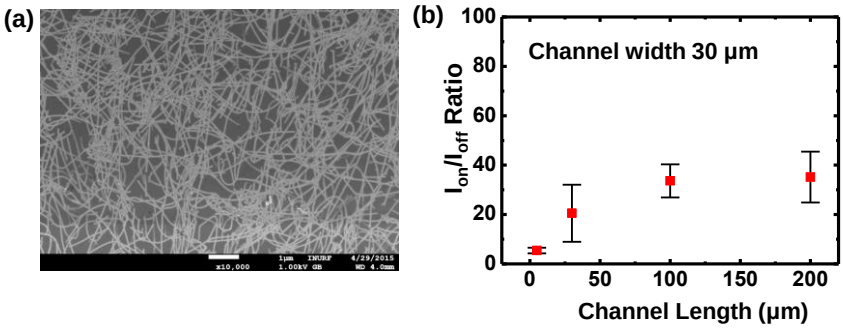

Fig. 1. (a) A scanning electron microscope (SEM) image for solution processed, unpurified, semiconducting enriched single walled nanotubes deposited on the surface of thermal oxide/doped Si substrate (b) current on/off ratio for the implemented SWNT FETs with channel length, ranging from 5 um to 200 um. All transfer characteristics were measured in the liner regime at a drain bias of -1V and on- (or off-) current was extracted for a maximum (or a minimum) current in the transfer characteristics.

Acknowledgment

This work was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (NRF-2014R1A1A1038274).

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