Integrated Carbon Nanotube Sensors

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Sponsorship: Intel, MARCO IFC

Single-walled carbon nanotubes (SWNT) exhibit unique mechanical and electrical properties that make them attractive for nanoelectronic applications. In particular, the conductance of a semiconducting SWNT is known to change significantly when exposed to certain gases [1]. The high sensitivity and fast response time make carbon nanotubes (CNT) very attractive for chemical sensing applications. However, the underlying sensing mechanism of CNT sensors is quite different from Si-based chemical transistors, and fabrication methods generally yield devices with large variations. Device variations and technology integration issues must be resolved before any CNT sensor devices can become practical [2].

In this project, we grow carbon nanotubes through chemical vapor deposition (CVD) and fabricate devices for an ultra low-power wireless sensing system. This work is done in collaboration with T. S. Cho in Professor A. Chandrakasan's group from the Department of Electrical Engineering and Computer Science at MIT, whose back-end circuitry will provide an interface to our CNT sensor array. The main goals of this project are to build a CNT sensor array with high yield of semiconducting SWNTs, high sensitivity and selectivity of gases, and low variability in the performance of the device. Through statistical characterization of the device, we attempt to get a better grasp of the underlying CNT sensing mechanism and find enhanced fabrication methods to reduce performance variability. In addition, chemical functionalization of CNT sensors will allow the target application to detect different types of toxic gases for environmental and industrial applications.

REFERENCES

[1] J. Kong, N.R. Franklin, C. Zhou, M.G. Chapline, S. Peng, K.J. Cho, and H. Dai, "Nanotube molecular wires as chemical sensors," *Science*, vol. 287, pp. 622-625, Jan. 2000.

[2] Y.C. Tseng, P. Xuan, A. Javey, R. Malloy, Q. Wang, J. Bojor, and H. Dai, "Monolithic integration of carbon nanotube devices with silicon MOS technology," *Nano Lett.*, vol. 4, no. 1, pp. 123-127, Dec. 2004.

[3] P. Qi, O. Vermesh, M. Grecu, A. Javey, Q. Wang, H. Dai, S. Pend, and K.J. Cho, "Toward large arrays of multiplex functionalized carbon nanotube sensors for highly sensitive and selective molecular detection," *Nano Lett.*, vol. 3, no. 3, pp. 347-351, Feb. 2003.