Carbon Nanotube - CMOS Chemical Sensor Integration

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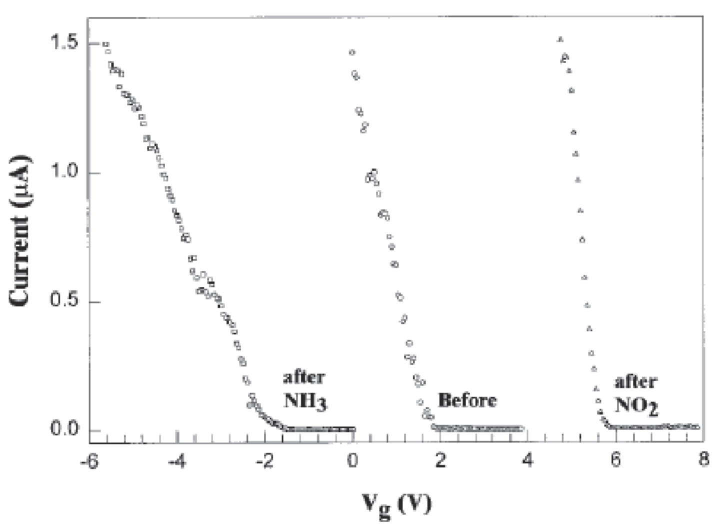
Sponsorship: MARCO IFC, Samsung Lee Kun Hee Scholarship Foundation

In this research, we propose an energy-efficient architecture to interface carbon nanotube (CNT) chemical sensors, and the development of signal processing algorithm to reliably infer the chemical concentration in air based on the sensor read-out results. The CNT changes its conductance when exposed to certain chemicals [1] (Figure 1), and thus we can effectively utilize CNTs as resistive chemical sensors. The room-temperature operation of the chemical-sensing mechanism makes CNT an appealing candidate for low-power chemical sensor application.

However, poor control over the CNT process, the resolution requirements in conductance measurements, and the changes in conductance due to specific chemicals in air require that the front-end circuitry has a dynamic range of more than 18 bits. While such accuracy is power-consuming to attain [2], the reduction in power-supply voltage further aggravates the dynamic-range limitations in analog circuits. In order to surmount such problems, we are developing a new architecture suitable for this application.

The stochastic nature of CNT chemical sensors calls for multiple deployments of CNT sensors in one sensor node. This constraint, in turn, requires an efficient algorithm to infer the concentration of the chemical we are interested in. Thus, this research will also delve into developing an energy-efficient algorithm that can be operated in real time.

This project is currently carried out in collaboration with Kyeongjae Lee and Professor Jing Kong from the department of Electrical Engineering and Computer Science at MIT to design an integrated gas sensor.



▲ Figure 1: Conductance change in response to gas detection. Courtesy: J. Kong et al, *Science* [1].

REFERENCES

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

[2] M. Grassi, P. Malcovati, and A. Baschirotto, "A 0.1% Accuracy 100 Ohm-20 Mega Ohm dynamic range integrated gas sensor interface circuit with 13+4 bit digital output," *Proc. of ESSCIRC*, Grenoble, France, 2005.