Design and Characterization of CNT-CMOS Hybrid Systems

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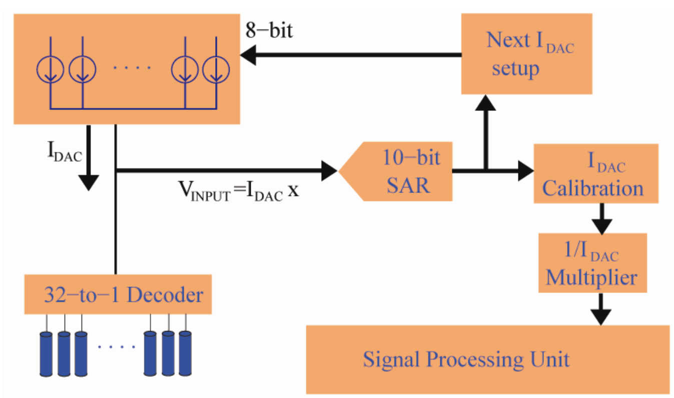
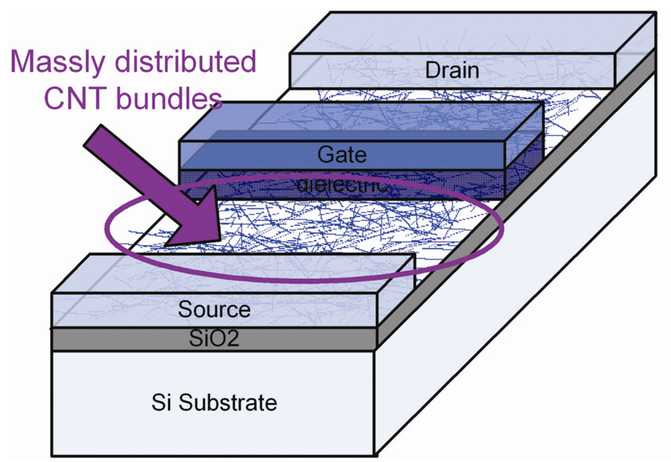
Carbon nanotubes (CNTs) are nanometer-diameter cylinders formed from rolled-up graphene sheets [1]. CNTs have found widespread interest due to many of its excellent electrical properties. In particular, the low density and high electron mobility of CNTs make them attractive for electronic applications. Our investigation of hybrid CMOS-CNT systems attempts to take advantage of the superior properties of CNTs while building on top of existing CMOS technology.

We propose an integrated chemical sensor system to verify the concept of a CNT-CMOS hybrid system design. The CNT changes its conductance when exposed to certain chemicals, and thus we can effectively use CNTs as resistive chemical sensors [2]. Room-temperature operation of the CNT sensors makes them an appealing candidate for low-power chemical sensor application. However, poor control over the local and global variation of CNT devices, the resolution requirements in resistance measurements, and the changes in resistance due to specific chemicals implies a large dynamic range in the front-end circuitry. We investigate energy efficient architectures to accommodate the specification (Figure 1). Chip fabrication is done by National Semiconductor.

Another system of interest is a DC-DC power converter circuit. Near ballistic transport behavior [3] of CNTFET makes it a potential energy-efficient candidate in power applications. In addition, the power transistor size could be greatly reduced if CNTFETs can replace the CMOS power transistors and the CNTs are aligned. Currently, we are looking into ways to model CNTFET behavior and fabricating CNT devices that can support large currents (Figure 2).



▲ Figure 1: Diagram of CMOS interface. The interface architecture includes on-chip calibration functionality. This interface chip and CNT sensors are integrated at the PCB level.



▲ Figure 2: Device schematic of a massively distributed CNTFET. Bundles of CNTs are fabricated to support large currents. Additional chemical or electrical treatment may be required to eliminate metallic CNTs.

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