Revolutionary Electronics through Carbon Nanotube Nano-Electro-Mechanical Switches

Supporting/Contributing Agencies: National Reconnaissance Office

The need for a very high speed, radiation hardened, and low power logic technology exists to support national security space and terrestrial systems. However, as we scale down in feature size to achieve higher levels of performance, issues with power, radiation sensitivity, and reliability arise that make the use of conventional < 90 nm semiconductor technology problematic. Carbon Nanotube (CNT) logic technology provides the revolutionary means to fabricate families of basic circuits, e.g., NAND, NOR, and NOT gates, that can be used to design and fabricate complex Application Specific integrated Circuits (ASIC), processors, and other high level circuits for radiation survivable electronics.

CNT logic technology uses nano-scale CNT fabrics as Nano-Electro-Mechanical switches—similar in concept to a standard household on-off light switch—to operate with picosecond throughput delay. Additionally, the on-off nature of the CNT switch eliminates the penalties of standby power and leakage current that is increasing exponentially as conventional transistor feature size decreases—avoiding these penalties for space electronics makes CNT logic technology a highly desirable technology.

The CNT logic technology is being developed by Lockheed Martin (LM), based on technology developed by Nantero (recently acquired by LM). LM demonstrated basic logic devices through this effort and has a plan in place to transfer this technology to BAE systems for a more comprehensive demonstration. Additionally, an out-year plan will incorporate CNT logic circuits into more complex devices such as a Field Programmable Gate Array and ASIC as replacements for the standard silicon based logic to enhance both radiation and electrical performance. Figure 1 below shows a conceptual schematic of the CNT Nano-Electro-Mechanical switches and a scanning electron micrograph (SEM) of an as-built CNT switch.

In conclusion, CNT logic technology has the potential to affect a paradigm shift in our ability to demonstrate very high speed ASIC and processor circuits that use significant amounts of logic with low usage rates where static leakage current is a major factor impacting system design and performance.

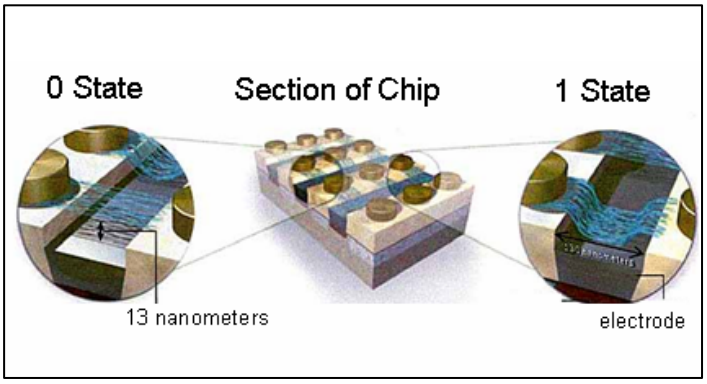

Figure 1a. Schematic[1] of a CNT fabric "switch"

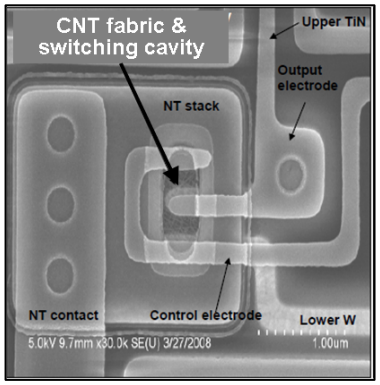

Figure 1b. SEM of an as-built CNT switch

References/Publications

Stix, G. "Nanotubes in the Clean Room," *Scientific American*, Vol. 289, pg 82-85, Feb. 2005.