

# Nano World: Chemical sensing transistors

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Hybrid transistors using stacks of organic molecules for wires and carbon nanotubes as electrodes could serve as ultrasensitive sensors for explosives and other compounds, experts told UPI's Nano World.

Scientists are working to incorporate sensor elements only nanometers or billionths of a meter large into electronics because such elements are extraordinarily sensitive to whatever they are meant to detect. The problem lies with the materials these nanoscale ingredients are often linked with, said researcher Colin Nuckolls, an organic chemist at Columbia University in New York.

Conventional electronics made with silicon and other semiconductors spontaneously develop an oxide layer that renders them less sensitive to their environment. On the other hand, organic electronics are comprised of many layers of materials, making them relatively insensitive, and can only work with air because they can dissolve and degrade in liquid, Nuckolls said.

Nuckolls and his colleagues employed organic compounds known as polycyclic aromatic hydrocarbons that can both serve as sensor elements and can assemble themselves into layers only a molecule high. The researchers laid out these compounds between gaps a few molecules wide etched into single-walled carbon tubes a nanometer or two in diameter. The organic molecules and the carbon nanotubes rest on a silicon foundation.

This extreme thinness of the organic molecule layer makes it "very

sensitive to their environment" compared with sensors based on conventional organic electronics, which possess many organic molecule layers because with the methods typically used to make conventional organic electronics, "there is no way to limit the number of molecules that come down on the surface," Nuckolls said.

The tiny gaps in the carbon nanotubes these organic molecules lie in are key to the success of the sensors. If the gaps are too large, defects can develop that can ruin the performance of the devices. The carbon nanotubes are necessary because they can form stable connections with the organic molecules. Past molecular electronics that did not use carbon nanotubes as electrodes often had poor contact between organic molecules and their electrodes, resulting from the size mismatch between the organic molecules and these far larger electrodes.

These devices "should allow the detection of very small amounts" of TNT and other explosives," Nuckolls said. Nuckolls and his colleagues reported their findings online this week via the Proceedings of the National Academy of Sciences.

"We are trying to create the prototypes of the devices for detection of explosives and are working to incorporate them into CMOS," Nuckolls said. Microchips based on CMOS, or complementary metal-oxide-semiconductor, nowadays comprise the vast majority of chip manufacturing in terms of dollar amounts. The hope is to "integrate these sensors into chips" and read out results using personal computers, he added.

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