Nano sensor 'immune' to toxins it detects

By R. Colin Johnson , EE Times
February 25, 2005 (12:53 PM EST)
URL: http://www.eetimes.com/article/showArticle.jhtml?articleId=60403587

Portland, Ore. - Engineers at the University of Texas (Austin) and Georgia Institute of Technology say they have built a reusable sensor that can detect nerve gas and similar toxic airborne agents without getting contaminated itself. By integrating nanoscale techniques with microelectromechanical systems, the team has created a so-called nanoelectromechanical system that is sensitive enough to detect as few as 50 molecules per billion of nerve gas.

"Sensor poisoning is a persistent problem with other designs," said UT professor Li Shi. "Their active element is not a single-crystal film like ours. Nor do others operate their sensors at 500 degrees C." He described the nerve gas sensor, which he designed with professor Zhong Lin Wang from Georgia Tech, as "completely self-cleaning, yet small and low-power enough to be wearable, since it can run off a battery with a power consumption of only 3 to 4 milliwatts." Choongho Yu, a postdoctoral fellow at Lawrence Berkeley National Laboratory, assisted in the work.

Since the March 20, 1995, attack in which terrorists killed 11 and injured more than 5,500 by releasing sarin in the Tokyo subway system, researchers have fabricated various sensors to detect nerve gas and similar agents (www.eetimes.com/futureofsemis/showArticle.jhtml?articleId=18307831&kc=6255). According to Shi, those designs use sensor elements of polysilicon, which can fail to detect trace amounts of toxin.

The new sensor uses a 10-nanometer film of single-crystal tin oxide sandwiched between two platinum electrodes that are held at 500 degrees C by a MEMS heater. Whenever a molecule of sarin or similar nerve agent lands on the tin oxide, it changes the device's current-carrying capability, thereby setting off an alarm in the circuitry monitoring the sensor.

For testing, the team used dimethly methylphosphonate, a gas that mimics sarin. The researchers found that all they had to do to clean out the toxins was to purge the environment around the sensor; not even trace amounts of the sarin stand-in remained stuck to the sensor after the tests. This means the sensor could be automatically reset and refielded in seconds-even during a terrorist attack.

The initial sensor's platinum electrodes were isolated by silicon nitride membranes that attached to the electrodes with long, nanoscale, trapezelike strands. Next, the researchers want to extend this strand architecture to arrays of sensors that could simultaneously test for dozens of toxins. "We think of it as an electronic nose," Shi said, adding that the team expects to demonstrate such an array within about a year.

Developing a device that tests for many toxins at once is key to lowering the cost enough to commercialize the technology, according to Shi. An electronic nose could be marketed not only for terrorist-attack prevention but also to detect industrial toxins and flammable substances on the factory floor.