Posted: Jun 30, 2016

Wireless, wearable toxic-gas detector made from carbon nanotubes

(*Nanowerk News*) MIT researchers have developed low-cost chemical sensors, made from chemically altered carbon nanotubes, that enable smartphones or other wireless devices to detect trace amounts of toxic gases.

Using the sensors, the researchers hope to design lightweight, inexpensive radio-frequency identification (RFID) badges to be used for personal safety and security. Such badges could be worn by soldiers on the battlefield to rapidly detect the presence of chemical weapons -- such as nerve gas or choking agents -- and by people who work around hazardous chemicals prone to leakage.

"Soldiers have all this extra equipment that ends up weighing way too much and they can't sustain it," says Timothy Swager, the John D. MacArthur Professor of Chemistry and lead author on a paper describing the sensors that was published in the *Journal of the American Chemical Society* ("Ultratrace Detection of Toxic Chemicals: Triggered Disassembly of Supramolecular Nanotube Wrappers"). "We have something that would weigh less than a credit card. And [soldiers] already have wireless technologies with them, so it's something that can be readily integrated into a soldier's uniform that can give them a protective capacity."

The sensor is a circuit loaded with carbon nanotubes, which are normally highly conductive but have been wrapped in an insulating material that keeps them in a highly resistive state. When exposed to certain toxic gases, the insulating material breaks apart, and the nanotubes become significantly more conductive. This sends a signal that's readable by a smartphone with near-field communication (NFC) technology, which allows devices to transmit data over short distances.

The sensors are sensitive enough to detect less than 10 parts per million of target toxic gases in about five seconds. "We are matching what you could do with benchtop laboratory equipment, such as gas chromatographs and spectrometers, that is far more expensive and requires skilled operators to use," Swager says.

Moreover, the sensors each cost about a nickel to make; roughly 4 million can be made from about 1 gram of the carbon nanotube materials. "You really can't make anything cheaper," Swager says. "That's a way of getting distributed sensing into many people's hands."

The paper's other co-authors are from Swager's lab: Shinsuke Ishihara, a postdoc who is also a member of the International Center for Materials Nanoarchitectonics at the National Institute for Materials Science, in Japan; and PhD students Joseph Azzarelli and Markrete Krikorian.