New method for detecting explosives

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A group of researchers in Tennessee and Denmark has discovered a way to sensitively detect explosives based on the physical properties of their vapors. Their technology, which is currently being developed into prototype devices for field testing, is described in the latest issue of the journal *Review of Scientific Instruments*, which is published by the American Institute of Physics.

"Certain classes of explosives have unique thermal characteristics that help to identify explosive vapors in presence of other vapors," says Thomas Thundat, a researcher at Oak Ridge National Laboratory (ORNL) and the University of Tennessee who conducted the research with his colleagues at ORNL and the Technical University of Denmark.

In their paper, the scientists show that their technology is capable of trace detection of explosives. They also show that it is capable of distinguishing between explosive and non-explosive chemicals and of differentiating between individual explosives, such as TNT, PETN, and RDX.

Thundat and others have been working on explosive sensors for years. Typical sensors use ion mobility spectrometers, which ionize tiny amounts of chemicals and measure how fast they move through an electric field. While these instruments are fast, sensitive, and reliable, they are also expensive and bulky, leading many researchers in the last few years to try to find a cheaper, more portable device for detecting explosives.

Much of this research focuses on "micromechanical" devices -- tiny sensors that have microscopic probes on which airborne chemical vapors deposit. When the right chemicals find the surface of the sensors, they induce tiny mechanical motions, and those motions create electronic signals that can be measured.

These devices are relatively inexpensive to make and can sensitively detect explosives, but they often have the drawback that they cannot discriminate between similar chemicals -- the dangerous and the benign. They may detect a trace amount of TNT, for instance, but they may not be able to distinguish that from a trace amount of gasoline.

Seeking to make a better micromechanical sensor, Thundat and his colleagues realized they could detect explosives selectively and with extremely high sensitivity by building sensors that probed the thermal signatures of chemical vapors.

They started with standard micromechanical sensors -- devices with microscopic cantilevers beams supported at one end. They modified the cantilevers so that they could be electronically heated by passing a current through them. Next they allowed air to flow over the sensors. If explosive vapors were present in the air, they could be detected when molecules in the vapor clung to the cantilevers.

Then by heating the cantilevers in a fraction of a second, they could discriminate between explosives and non-explosives. All the explosives they tested responded with unique and reproducible thermal response patterns within a split second of heating. In their paper, Thundat and his colleagues demonstrate that they could detect very small amounts of adsorbed explosives -- with a limit of 600 picograms (a picogram is a trillionth of a gram). They are now improving the sensitivity and making a prototype device, which they expect to be ready for field testing later this year.

More information: The article "Micro differential thermal analysis detection of adsorbed explosive molecules using microfabricated bridges" by Larry R. Senesac et al was published March 4, 2009 [*Rev. Sci. Instrum*. 80, 035102 (2009)]. The article is available at link.aip.org/link/?RSINAK/80/035102/1 .

Source: American Institute of Physics