Development of Simulants of Hydrogen Peroxide Based Explosives for use by Canine and IMS Detectors

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Abstract

The objective of this project is to further technology transfer, validate and test the use of a Planar Solid Phase Microextraction (PSPME) device for the rapid extraction and concentration of volatiles from peroxide based explosives using an Ion Mobility Spectrometer (IMS). Our results show that 10 milligrams of TATP can be detected in as little as 10 seconds of static extraction or 5 seconds following dynamic headspace extraction from an enclosed space with PSME. The dynamic extraction was achieved with a commercial sampling system and the airflow collected and pre-concentrated on the newly developed PSPME device. The detection of the extracted volatiles was accomplished by two commonly used commercial ion mobility spectrometer units GE and Smith's detection, without any modification required to the units themselves. This presentation highlights the application and transfer of the PSPME technology to the real-world detection of TATP by the same Ion Mobility Spectrometry units currently deployed at security checkpoints nationwide.

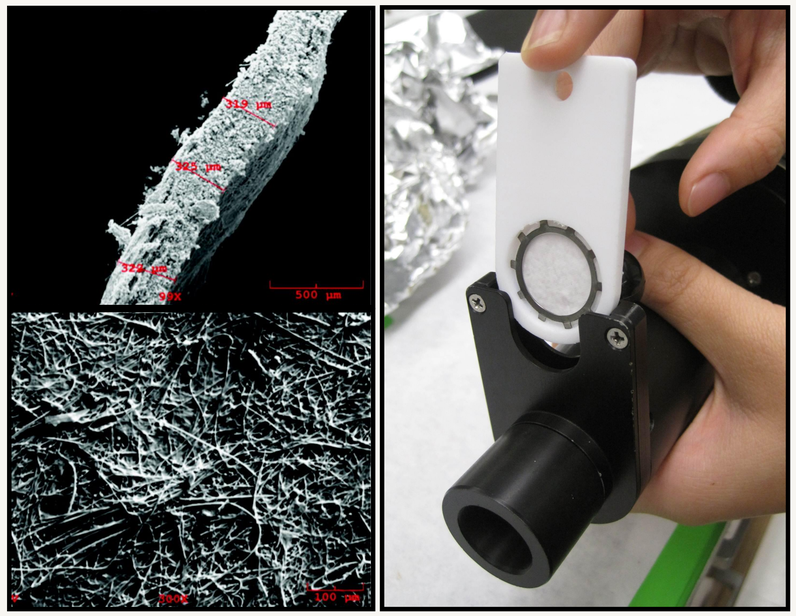
Relevance

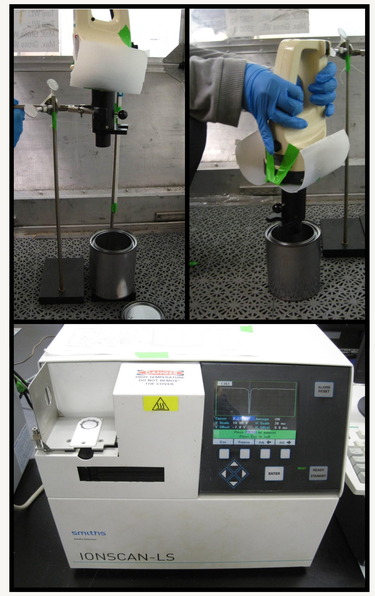
Improve the knowledge base for the composition of headspace volatiles from peroxide explosives so that these analytes can be targeted for detection by a number of methods (PSPME-IMS and canines).

Current state of the art techniques such as Gas Chromatography Mass Spectrometry are lab based techniques that cannot be deployed in the field where rapid analysis are needed to ensure the safety and security of the general public. Ion Mobility Spectrometry is currently used as a field deployable technique but lacks the sensitivity required for the detection of peroxide based explosives. PSPME allows for simultaneous sampling and pre-concentration followed by convenient sample introduction of volatile components from peroxide based explosives allowing for rapid in-situ detection.

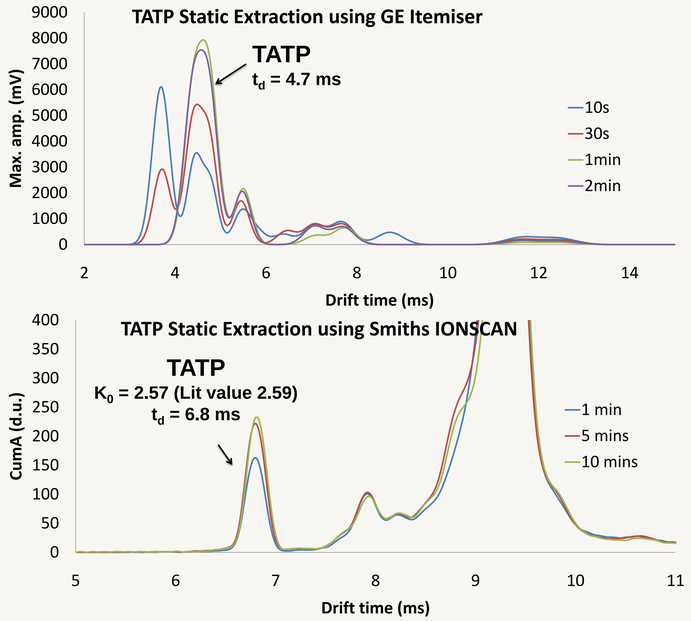
Technical Approach

Scanning electron micrograph of PSPME coating cross-section (top, left) and on surface (bottom, left). PSPME with vacuum pump (right).





Dynamic PSPME sampling at different distances (top) followed by detection using commercial IMS (Smiths IONSCAN-LS).



Plasmagrams of TATP using 10 mg of solid TATP detected by GE Itemizer (top) and 0.5 µg of liquid standard TATP detected by Smiths IONSCAN-LS (bottom).

Accomplishments Through Current Year

1. Characterization of volatiles composed in the headspace of a number of different peroxides.
2. Determined the limits of detection and optimal parameters for the use of PSPME-IMS for the detection of peroxide explosives.
3. Begin to evaluate inexpensive permeation devices that can be used to deliver simulants to be used for canine training aids and instrumentation testing

Future Work

Target additional peroxide based explosives and improve the performance of the existing PSPME device and suggest guidelines for both training of canines with new simulant kits and the use of PSPME-IMS in field detection of peroxide-based explosives at checkpoints.

Opportunities for Transition to Customer

The NIJ has funded the development and optimization of a PSPME device for rapid extraction and concentration of volatiles from MDMA tablets and smokeless powders. This proposed project aims to apply PSPME in the detection of peroxide-based explosives for field use.

Patent Submissions

1. Improvement to SPME-IMS for Detection of Explosives and Drugs using Planar Geometry Fabricated SPME devices (patent pending).
2. Solid Phase Microextraction Ion Mobility Spectrometer (SPME-IMS) Interface for the Detection of Explosive Odor Signatures (**Provisional Patent Awarded in Feb. 2006, licensed to Field Forensics Inc., a Florida Company**) US Patent Application: 20090309016

Publications/Presentations Acknowledging DHS Support

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This material is based upon work supported by the U.S. Department of Homeland Security under Award Number 2008-ST-061-ED0001. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied of the U.S. Department of Homeland Security.