A148 High - Volume Dynamic Sampling Using Planar SPME Coupled With IMS for the Detection of Explosives

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After attending this presentation, attendees will understand the principles of a planar solid phase micro extraction device (SPME), a component of a complete dynamic sampling device that circulates and samples the air of large areas to pre-concentrate the volatile and semi - volatile chemical markers of explosives followed by detection using ion mobility spectrometry (IMS).

This presentation will impact the forensic community by introducing a method that could help fill the urgent need for rapidly screening cargo containers for contraband using existing ion mobility spectrometers while having other monitoring applications.

For explosives, most parent compounds have very low vapor pressure making them unavailable available in the headspace for sampling but in contrast, the chemical marker compounds associated with parent explosives are very volatile with research showing that trained canines detect these compounds instead. Pre-concentration and detection of these chemical markers using SPME-IMS has shown much success by improving detection limits over particle sampling when sampling relatively small vessels. Since the advent of the planar SPME device, that boasts larger surface area, increased capacity, and greater extraction fficiency when compared to fiber SPME, larger areas can now be sampled for volatile and semi-volatile compounds of interest with easy coupling with existing ion mobility spectrometers by requiring no modification of the front-end of these instruments. For this research, the planar pre-concentration device is adapted to a modified handheld vacuum equipped with a filter that prevents the adsorption of unwanted particles onto the surface of the planar SPME device. Besides the analytical advantages of planar SPME over the fiber type, planar SPME is more rugged than the delicate SPME fiber for dynamic sampling at high flow rates. A controlled odor delivery device (COMPS bag) developed by Furton and workers, is used to deliver a constant rate of its contents into the ambient air. Pentalite, which is composed of 50:50 pentaerythritol tetranitrate (PETN): 2,4,6-trinitrotoluene (TNT), is used in the controlled devices, as is 2,4-dinitrotoluene (2,4-DNT), a chemical marker for smokeless powders. Since TNT is two orders of magnitude more volatile than PETN with a vapor pressure at 25°C of 7.1×10^{-6} Torr versus 1.4×10^{-8} Torr, it is the compound that is escaping the controlled delivery device. This is confirmed by fiber SPME-GC/MS. Two orders of magnitude more volatile than TNT is 2,4-DNT with a vapor pressure at 25°C of 2.1×10^{-4} Torr and is also used in separate COMPS bags. The dissipation rates for TNT, a relatively volatile explosive, and 2,4-DNT a volatile chemical marker, within heat-sealed low density polyethylene bags are determined in order to expose the planar SPME device to controlled amounts of target compound. The experiments involve static extractions conducted in a sealed hood with a volume of ca. 850 cubic in. with the lone planar SPME device, and then advance to dynamic extractions using the high volume sampling device in order to take a representative sample of the total air. The sampling air flow rates are measured using a handheld anemometer, varied and then optimized. Sampling time and vessel volume are also varied and optimized. The minimum amounts of TNT and 2,4-DNT that must be present in a large volume area to produce an IMS alert are determined. The results of the static and dynamic experiments are compared. The last step is a feasibility study to evaluate planar SPME capabilities for pre- concentrating TNT and 2,4-DNT into detectable amounts by IMS following sampling of a room. The results of this study will demonstrate that high volume dynamic planar SPME air sampling followed by IMS is a promising technique for sampling high-risks area for chemical markers of explosives and even drugs.

Planar Solid-Phase Microextraction, Ion Mobility Spectrometry, Dynamic Sampling

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