B130 New SPME Coatings for Explosives Detection by Ion Mobility Spectrometry (IMS)

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After attending this presentation, attendees will have learned about improved sampling and pre-concentration of increased capacity Solid Phase MicroExtraction (SPME) coatings and configurations for the detection of explosives, their taggants, and chemical markers by Ion Mobility Spectrometry.

This presentation will impact the forensic community and/or humanity by demonstrating improved sampling and pre-concentration of increased capacity SPME coatings and configurations for the detection of explosives, their taggants, and chemical markers by IMS.

Solid Phase MicroExtraction (SPME) is an effective sampling method which combines extraction and pre-concentration in one step and can be useful towards the detection and presumptive identification of trace level explosives. The use of SPME for explosives detection is advantageous since it is a solvent-free extraction method where virtually no sample preparation is required which saves time and reduces the use of harmful chemicals. Ambient conditions are suitable for SPME extractions making the method convenient for routine field analyses. SPME is not exhaustive, but is rather an equilibrium technique which allows for the concentration of analyte in the sample matrix to be correlated to the amount extracted. Forensic examiners will find SPME useful since it is a fast, clean, selective, and semi-quantitative method which can be made field-portable.

Recently, SPME has been successfully coupled to an ion mobility spectrometer (IMS)[1]. This interface combines both the extraction efficiency of SPME and the detection capabilities of IMS and is easily adaptable to the approximately 10,000 instruments currently in use which are conducting over 10 million analyses each year[2]. Moreover, this interface allows vapor sampling in addition to particle sampling, which has implications for increased sensitivity and affords the option for the extraction of taggants and odor signatures of explosives rather than the parent compounds themselves. The geometry of SPME in this interface is a fiber made of fused silica or a metal coated with a polymeric coating or a sorbent phase, but it is proposed that by coating disk-shaped substrates via dip-coating and/or spin-coating, the surface area and capacity of the extraction phase can be increased. This allows for more samples to be extracted thus increasing sensitivity. Additionally, it is conjectured that by increasing the surface area and capacity of the extraction phase, larger areas such as rooms, cargo holders, or outside areas can be sampled. These coated disks are similar conceptually to the stir-bar SPME configuration, but they will be amenable to a second-generation SPME-IMS thermal desorber. Polydimethyl siloxane (PDMS) has been found to be the most effective and most rugged polymeric phase at extracting explosives with the minimum carry-over of commercially available fibers, and will be the starting point for this evaluation of SPME phases for explosives extraction[3].

The aims of this work include improving the probability of detecting explosives in the field by increasing the surface area and altering the chemistry of SPME for improved selectivity and extraction of explosives. The extracted explosives are subsequently desorbed into an IMS for field analysis. Vapor sampling is conducted for various taggants present in explosives such as 2-nitrotoluene (2-NT), 4- nitrotoluene (4-NT), and 2,3-dimethyl-2,3-dinitrobutane (DMNB), and odor signatures, also known as chemical markers that emanate from explosives such as 2,4-DNT, 2,6-DNT, 1,3-DE-1,3-DPU, 2- ethylhexanol, R(+)-limonene, DPA, cyclohexanone, and 2-NPA. These have been identified as some of the volatile and semi-volatile compounds that canines alert to when detecting explosives[4]. The extraction of explosives, their taggants and odor signatures, are improved by the SPME coatings tested and this novel SPME geometry is coupled to IMS for detection.

References:

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SPME, IMS, Explosives

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