Y17 A Comparison of Sol-Gel Adsorption Phases and Their Extraction Efficiencies of Explosives Using Closed Headspace Sampling Coupled With Capillary Microextraction of Volatiles (CMV)

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Learning Overview: After attending this presentation, attendees will better understand how changing the sol-gel chemistry of a CMV device can alter the percent recoveries of explosive compounds.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by promoting a faster, more sensitive sampling technique to analyze explosive compounds.

When analyzing explosive residues from a crime scene, one common sampling technique for the detection and extraction of volatile explosive compounds involves headspace sampling, including the use of Solid Phase Microextraction (SPME). Although SPME sampling and extraction is sensitive, CMV, a faster and potentially more sensitive sampling technique is proposed as an improvement over the equilibrium-based SPME extraction. SPME is considered a passive air sampling technique, while CMV is an active air sampling technique; this makes CMV extraction have more mass transfer and reduces sampling time. Previous laboratory studies incorporated a trimethoxymethylsilane sol-gel adsorption phase within the CMV sampler (CMV-A) to analyze low nanogram quantities of volatile explosives. The overall goal of this current effort is to create a new sol-gel adsorption phase and evaluate the extraction efficiency of three example explosives (or compounds associated with explosives and propellants) using the new phase.

The purpose of changing the adsorption phase was to investigate new intermolecular interactions between the sol-gel and the incoming explosive sample, similar to changing phases in column chromatography to increase or decrease interaction with the solute. The new sol-gel polymer containing 3-cyanopropyltrimethoxysilane (CMV-F) was created and is reported here for the first time. A detailed comparison of the extraction efficiencies between CMV-A and CMV-F for 1,3-Dinitrobenzene (1,3-DNB), 2,4-Dinitrotoluene (2,4-DNT), and Diphenylamine (DPA) through closed headspace sampling are reported. The listed explosives were chosen as they are commonly detected in Gunshot Residue (GSR) analysis, an application previously reported on using CMV-A. Future work will include a more in-depth look into the interactions between the cyanopropyl functional group and the three target compounds selected for this study. A Keyence® digital microscope was used to image the morphology of each phase and Fourier Transform Infrared (FTIR) was used to chemically characterize the sol-gel coating on the CMV-F glass filters. The results showed that CMV-F increased the recovery of DPA by one order of magnitude for a 75ng spike over CMV-A. These results are potentially useful for detection of extremely low (sub-ng) quantities for GSR since DPA is the most common organic compound residue found on the hands of persons who had recently fired a gun. The overall conclusions of this effort suggest that CMV-F has potential as an improvement for the extraction of other explosives and compounds associated with explosives and propellants.

Headspace Sampling, Explosives, Sol-Gel