B123 The Development of a Paper Microfluidic Device for the Detection of Organic Smokeless Powder Residue

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After attending this presentation, attendees will better understand current research relating to the development of microfluidic Paper-based Analytical Devices (μPADs) as an easy and cheap alternative to current presumptive field-testing of low explosives, particularly smokeless powders. Minimal training is required to operate these devices and they are ideal for use in the field by the military and law enforcement. Attendees will also gain a basic understanding of the organic compounds contained in smokeless powders.

This presentation will impact the forensic science community by providing insight into the possibility of cheap, user-friendly, presumptive testing devices for smokeless powder residues.

In this project, colorimetric tests are implemented on paper microfluidic devices, permitting organic residues from smokeless powders to be detected in the field. Paper microfluidic devices are usually prepared from chromatographic paper. For these particular devices, wax printing was followed by lamination at elevated temperatures to create hydrophobic wax barriers and hydrophilic channels. Capillary action is then used to mobilize liquids containing dissolved analytes through the channels of the device. Colorimetric reagents are placed at the end of each channel for detection of the individual compounds, which are, in this case, organic additives. Paper-based microfluidic devices were initially designed for application in medicinal and disease testing in remote areas where the lack of refrigeration limited the ability to store expensive reagents. Because reagents are dried on the device prior to use, shelf lives are prolonged when compared to these liquid reagents. μPADs now have a wide variety of applications. This research been exploring forensic applications of this technology. In this project, a paper microfluidic chip has been developed that involves presumptive, colorimetric tests for multiple different organic compounds contained in smokeless powder residues.

Residue from smokeless powder-based explosive devices mainly consists of nitrocellulose and other organic compounds. Contained within the powder are additive packages that consist of energetic materials such as nitroglycerine, deterrents such as dibutyl phthalate, plasticizers such as ethyl centralite, and stabilizers such as diphenylamine. For this project, a paper microfluidic device for the detection of various organic smokeless powder additives is currently being developed. For example, potassium hydroxide has been used for the colorimetric detection of dinitrotoluenes producing a green color and the Greiss reagent can be used for the detection of nitroglycerine producing an orange/brown color. These tests, among others, were first prepared in solution and then optimized for use on paper.

These devices are currently undergoing developmental validation to measure the reproducibility, stability, and sensitivity of the analysis. These paper-based devices should prove useful to the analysis of smokeless powder residue, as the chips are compact and minimal time is needed to produce results. The ultimate goal of this project is to design and test a series of these devices for the presumptive detection of a variety of explosives residues in the field.

Smokeless Powder, Paper Microfluidics, Low Explosives