B147 Development of Paper Microfluidic Devices for the Detection of Low-Explosives Residue

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After attending this presentation, attendees will better understand current research on the development of paper microfluidic devices as a simple and inexpensive alternative to existing presumptive tests for low-explosives residues. Minimal training is required to operate these devices and they are ideal for use in the field by military and law enforcement entities. Attendees will also gain a basic understanding of the metallic components contained in low-explosive devices.

This presentation will impact the forensic science community by providing insight into the possibility of inexpensive, user-friendly, presumptive testing devices for low-explosive residues. This detector could be implemented in pre- and post-blast explosive detection and should be useful in screening unknown materials.

In this project, colorimetric tests are implemented on paper microfluidic devices, permitting metallic residues from low-explosive devices to be detected in the field. Paper microfluidic devices are typically prepared from chromatographic paper creating hydrophilic channels through the use of wax printing followed by lamination at elevated temperatures. Capillary action is then used to mobilize liquids containing dissolved analytes through the wax ink channels of the device. Colorimetric reagents are placed at the terminal end of each channel for detection of the individual analytes, which in this case are metallic salts. Paper-based microfluidic devices were initially designed for application in medicinal and disease testing in remote areas where the lack of refrigeration limits the ability to store expensive reagents. These devices now have a wide variety of applications. Because reagents are dried on the device prior to use, shelf lives are prolonged when compared to liquid reagents. Forensic applications of this technology have been explored. In this study, a paper microfluidic chip has been developed that involves presumptive, colorimetric tests for multiple, different metallic compounds contained in low-explosive residues. Colorimetric tests have been designed for a variety of these components. These tests were first prepared in solution and then optimized for use on paper.

Residue from flash powder-based explosive devices typically consists of inorganic salts resulting from the rapid deflagration of mixtures of inorganic oxidizers and metallic fuels. A paper microfluidic device for the detection of chlorate, perchlorate, and nitrate oxidizers was previously developed. As a follow-up, a paper microfluidic device for the detection of barium, aluminum, iron, and zinc fuels is being developed. Barium is detected via a buffered mixture of sodium rhodizonate, which yields an orange color upon reaction. Aluminum is confirmed via aluminon and ammonium acetate, which yields a pink/red color upon reaction. Iron is detected via p-aminophenol, which yields a purple color upon reaction. Lastly, zinc is detected with dithizone, which yields a bright pink/purple color upon reaction.

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

Paper Microfluidics, Low Explosives, Colorimetric

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