A17 Volume Reduction Solid Phase Extraction of Forensic Samples on a Plastic Microfluidic Device

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After attending this presentation, attendees will gain an understanding of progress towards disposable plastic microdevices that can facilitate the volume reduction of large volume, dilute biological samples for downstream processing in human identification via STR analysis.

This presentation will impact the forensic science community by introducing a disposable plastic microdevice applicable for DNA extraction and purification from dilute biological evidence collected in forensic investigations, enabling higher throughput of samples than previous glass devices. This work is a step towards the use of a micro-total analysis system for forensic genetic analysis.

Microfluidic devices present numerous advantages to current forensic analyses, including low reagent consumption and reduction in analysis time, combined with the ability to deliver a closed sample in-answer out multi-process system within a single device.[1] Additionally, these devices require less sample template, enabling preservation of sample for further analysis when there is limited quantity during forensic casework.

Successful utilization of solid phase extraction (SPE) within microfluidic devices has been established through numerous publications from our lab, demonstrating silica-based phases capable of highly efficient and reproducible DNA purification.[2] Although successful, a challenging forensic sample type for microfluidic platforms are those collected from surfaces or stains, which may involve large volume (milliliters) of a dilute sample for processing. The challenge of macro-to-micro interfacing has been previously addressed by the development of volume reduction solid phase extraction (vrSPE), where a large SPE phase was designed to accept sample volumes 10-fold larger than traditional SPE devices.[3,4] Such microdevices have been fabricated in glass: an expensive, time-consuming process that utilizes hazardous chemicals (e.g., HF), however, the use of plastic substrates (like poly (methyl methacrylate); PMMA) circumvents these issues. Volume reduction SPE microdevices can be created from PMMA by micromilling processes for pennies per chip using laser ablation, with an 8-fold reduction in fabrication time. The presented research adapts the vrSPE technology to a plastic device, allowing for simple, inexpensive extraction and concentration of DNA from dilute biological samples, ready for PCR and subsequent STR analysis.

The ease of design and fabrication of vrSPE PMMA devices enables creation of multiple geometries to tailor a device to a specific purpose. Several new designs will be presented including those that allow for a 4-fold increase in the sample volume (from 500µL to 2mL) to be accepted onto the device, or conversely, a 4-fold reduction in time (from 30 minutes to ~8 minutes) to load a 0.5mL sample. Furthermore, multiplexing the vrSPE method will be shown for the simultaneous tetraplex extraction of four whole blood samples from four different individuals, with each 16-plex STR profile reported. Each design provides a significant improvement for both analysis time and throughput compared to traditional glass vrSPE.

References:

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Volume Reduction, PMMA Microchip, DNA Extraction

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