A76 A Multichannel Microfluidic Cartridge for Rapid Forensic DNA Analysis

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After attending this presentation, attendees will understand the development and functionality of a system developed for fully-integrated microfluidic forensic DNA analysis.

This presentation will impact the forensic science community by demonstrating the advantages of using a microfluidic system for DNA analysis, including a reduction in analysis time, footprint of the microfluidic cartridge, and a reduction in consumables required for end-to-end analysis that ultimately will allow forensic scientists to process more samples.

STR typing is the accepted gold standard for human identification, and is now successfully employed in forensic, civil, and military laboratories. Although highly successful and reliable, the process typically requires 8-10 hours to complete under routine conditions, employs large sample volumes, costly reagents, and is labor-intensive. Additionally, samples are susceptible to contamination as they are exposed to the environment at multiple points during sample processing. Transitioning sample processing and analytical methods to the microscale format will permit automation, miniaturization, and integration, providing the end user a system capable of expedited, cost-effective analysis in a closed system that reduces sample handling and possible contamination.

Previously, a system capable of performing PCR and ME on a plastic chip following LE in a tube was presented. Although this system was capable of detecting 16-18 STR loci in <75 minutes, it required human intervention prior to PCR and was not capable of performing true end-to-end DNA testing.

The work presented here highlights improvements to the fully-integrated system. The transition to a plastic microfluidic cartridge for fully integrating sample preparation, PCR, and ME is described, and is the first step toward cost-effective analysis using a single-use chip with reagents on-board. With the improved system, expedited purification of DNA from crude samples is performed, and a mixture of DNA and commercially-defined PCR reagents are guided into chambers on a device for quadriplexed PCR analysis. Rapid amplification of 16-18 STR loci is achieved through use of an IR laser for non-contact heating and a non-contact method for temperature sencing. A six-fold reduction of the conventional amplification time is feasible while still achieving STR profile quality required for forensic interpretation. Simultaneous amplification of multiple samples is presented, demonstrating the capability of increased sample throughput. Following PCR, precise fluidic control allows for movement of the amplified product into the separation domain of the device. Electrophoretic separation of the amplified fragments is performed with five-color fluorescence detection using an improved detection system capable of multiplexed detection. Single-base resolution is achieved during a separation that requires <12 minutes, a three-fold time reduction from conventional separation and detection processes. A software system allows for all processes to be completed without user intervention, including automated and accurate allele calling of samples from multiple donors. An overview of the functionality of the integrated instrument capable of accepting the microfluidic cartridge will be presented, with data supporting the capability of the microfluidic system for rapid, automated, end-to-end genetic analysis for human identification.

DNA, STR, Microfluidic

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