B107 Cell Separation and Solid Phase Extraction on a Single Microfluidic Device: Evaluation of Alternative SPE Matrices

Jessica V. Norris, MSc, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904; Joan Bienvenue, PhD, 8604 General Sykes Circle, Fredericksburg, VA 22407; and Susan L.R. Barker, PhD, Jerome P. Ferrance, PhD, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

The goal of this presentation is to discuss the separation of sperm cells from epithelial cells with subsequent on-chip DNA extraction from each cell fraction on a single microdevice. Several solid phase extraction matrices are evaluated.

This presentation will impact the forensic community by presenting work that represents a major step towards the development of a fully integrated microdevice capable of total DNA analysis for forensic casework.

Microchip technology offers the potential of a rapid, cost-effective alternative to conventional DNA analysis methods. The research presented will highlight the development of an integrated microdevice that combines cell separation and solid phase extraction (SPE) of DNA from the separated cells, two of the procedures necessary for analysis of sexual assault evidence where male and female DNA must be separately identified. This presentation will demonstrate the application of microchip technology to forensic casework analysis, illustrating the significant potential impact these devices might have on the forensic community.

The proven utility of forensic DNA evidence has increased the demand for DNA analysis services. Although conventional DNA analysis techniques are effective, they are time-consuming and laborious, which has contributed to an overwhelming backlog of forensic casework samples with possible biological evidence. Research efforts have focused on the development of more rapid and efficient analytical methods to reduce the time and cost of forensic analysis, as well as the magnitude of the existing casework backlog. Techniques performed on microchips are particularly advantageous because they can be integrated with upstream or downstream analytical steps on a single microfluidic device in the form of a lab-on-a-chip. These integrated systems, which incorporate all the sample processing steps required for forensic DNA analysis, will reduce analysis times, and therefore, the forensic casework backlog.

An integrated microdevice combining sedimentation-based pressure-driven cell sorting and solid phase extraction (SPE) of DNA has previously been presented.[1] The microdevice was designed with a domain for cell sorting and two separate regions for the simultaneous purification of DNA from the separated cells. Preliminary attempts to attain an STR profile from DNA purified from the sperm cell separation product saw some success with a silica bead/sol-gel hybrid SPE matrix; however, simultaneous DNA purification from the two cell types was not possible due to variability in packing the two separate SPE beds. In addition, simultaneous DNA extraction from the separated male and female cells was possible with the use of silica beads alone, but only partial STR profiles were obtained.

Alternative SPE matrices have recently been developed and demonstrated on microchips[2, 3] which provide higher extraction efficiencies than silica-based extractions; therefore, it was of interest to evaluate different SPE matrices using the integrated microdevice. The research presented here describes the use of these matrices, as well as efforts towards optimization of extraction conditions for each matrix. Results from PCR amplification of genomic DNA isolated from cells sorted based on their physical properties are also presented. The sperm and epithelial cells were lysed on-chip in their separate areas, followed by isolation and purification of their respective DNA fractions; DNA amplification and separations were performed using conventional laboratory methods. The presented work represents a major step towards the development of a fully integrated microdevice capable of total DNA analysis for forensic casework.

References:

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3 Wen J, Guillo C, Ferrance J, Landers J. DNA extraction using a tetramethyl orthosilicate-grafted photopolymerized monolithic solid phase. *Anal Chem* 2006;78(5):1673-1681.

DNA, Cell Separation, Solid Phase Extraction

 ** Presenting Author*