B113 Solid Phase Extraction of DNA in a Plastic Microfluidic Device

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After attending this presentation, attendees will learn the advantages of utilizing a plastic disposable microfluidic device for extraction of DNA from various biological samples.

This presentation will impact the forensic community by demonstrating the use of plastic microfluidic devices for DNA extraction. The low cost associated with these devices provides disposability, a major requirement for forensic analysis.

This research project exhibits the use of low cost plastic microdevices for the extraction of nucleic acids from various biological samples.

Purification of DNA from biological samples for forensic analysis is primarily performed using solid phase extraction (SPE), most often on a silica substrate to which DNA will bind in the presence of a chaotropic salt. Current methods are labor intensive and often require large sample volumes that are not always available in forensic casework. An effective alternative is microchip based SPE, which allows for smaller sample and reagent volumes, thereby decreasing the cost and time of analysis. Microchips provide the advantages of a closed system, reduced sample handling, and the possibility to integrate multiple methods in a single device.[1] Microchip DNA extraction is most often performed on glass microchips, but the substrate and fabrication costs make these devices too expensive to be disposable after each use. This prevents their implementation into forensic science laboratories, where carry-over contamination would be a significant concern.

Plastic microdevices provide a possible substitute to the current glass substrate, allowing for low cost fabrication, on the order of pennies per device once the devices are mass-produced. This permits disposal of the device after a single extraction, eliminating contamination and carry- over from previously-analyzed samples. Plastic SPE microdevices have previously been prepared from several polymers, including polyolefin[2] and poly (methyl methacrylate) (PMMA).[3] However, these devices utilize solid phases that are often difficult to generate and not reproducible, thereby affecting the extraction efficiency. Presented here, is an easily fabricated, plastic, disposable microfluidic device with a highly reproducible extraction matrix capable of solid phase purification of DNA.

The devices developed for this work were fabricated using the LIGA process that exploits X-ray lithography to construct complex 3-D structures. The channel structures investigated consist of various designs for PMMA posts with and without silica coatings, which provide a high surface area for binding of DNA in the presence of a chaotropic salt. The optimal PMMA post layout and coating will be presented along with preliminary capacity studies and extraction profiles. Results from purification of DNA from various biological samples performed on the device will be presented to demonstrate the reproducibility and efficiency of the extractions. This research lends itself to the forward movement of implementing a cost-effective, disposable device for use by the forensic community for DNA extraction.

References:

1 Easley, CJ, Karlinsey, JM, Bienvenue, JM, Legendre, LA, Roper, MG, Feldman, SH, Hughes, MA, Hewlett, EL, Merkel, TJ, Ferrance, JP and Landers, JP. 2006. “A Fully Integrated Microfluidic Genetic Analysis System With Sample-in-Answer-out Capability”. PNAS. 5(103): 19272-77.

2 Bhattacharyya, A and Klapperich, CM. 2006. “Thermoplastic Microfluidic Device for On-Chip Purification of Nucleic Acids for Disposable Diagnostics”. Anal. Chem. 78, 788-92.

3 Diaz-Quijada, GA, Peytavi, R, Nantel, A, Roy, E, Bergeron, MG, Dumoulin, MM, Veres, T. 2007. “Surface Modification of Thermoplastics-Towards the Plastic Biochip for High Throughput Screening Devices”. Lab Chip. 7, 856-62.

Solid Phase Extraction, Microdevice, DNA

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