

# Multi-DNA Extraction Chip Based on an Aluminum Oxide Membrane Integrated into a PDMS Microfluidic Structure

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**Abstract** – A novel microfluidic DNA extraction system was designed and fabricated using an AOM (aluminum oxide membrane) capture surface sandwiched between PDMS microfluidic channels in a parallel format. The completed system was tested with Lambda DNA mixed with the fluorescence dye SYBR Green I. Following extraction, the surface of AOM was examined with fluorescence microscopy while still embedded in the microfluidic system. Successful extraction and immobilization of DNA on the AOM was observed in almost every separation chamber. This microsystem has potential applications in high-throughput DNA extraction and analysis, with the capability to be integrated into polymer-based microfluidics systems.

**Keyword** – multi-DNA extraction, high-throughput, AOM

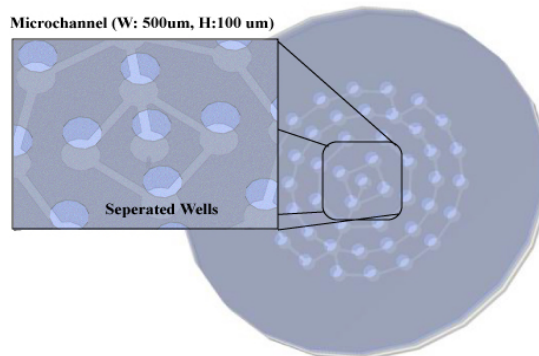
## I. INTRODUCTION

Most molecular analysis techniques require sample preparation steps involving sample concentration, biomolecule extraction, chemical reactions, mixing with a reagent, PCR, or sensing [1]. DNA extraction for PCR or other analysis is one of the most important steps in many of these systems. For example, during an initial analysis, DNA or RNA is extracted from raw samples. Conventional extraction procedures are labor-intensive and time-consuming, requiring laboratories to use large and expensive automated sample preparation systems [2, 3]. As such, a need is present to develop a new extraction system that is able to overcome the shortcomings of conventional systems and to satisfy the requirements for non-inhibition of PCR, low operational costs, fast processing time, small device footprint, and high DNA purification levels. The purpose of this research is to introduce a novel multichannel extraction system that was designed and implemented using an AOM and embedded microchannels.

## II. MATERIALS AND METHODS

The multichannel extraction system is composed of a series of PDMS reservoirs for depositing the sample in defined areas onto the front side of the membrane, the aluminum oxide membrane and a PDMS microchannel system for applying a vacuum to each of the reservoirs through the membrane (Fig. 1).

Fabrication of the microchannel and reservoir were made using a mold that was fabricated by the Xurography method, or a knife plotter [4]. The mask pattern was drawn with a commercial CAD software package and exported as an EPS to the knife plotter. The pattern was cut out of a sheet of adhesive-backed plastic using the knife plotter and transferred to the surface of a Petri dish. The PDMS (Sylgard 184®, Dow Corning) used to create the molds was supplied in two components: a base and curing agent. The base resin and curing agent were mixed thoroughly in a 10 to 0.7 ratio and placed under vacuum for one hour to remove any air bubbles. To prevent the PDMS from bonding to the mold, the surface was treated using the fluorosilane compound (tridecafluoro-1,1,2,2-tetra hydrooctyl) triethoxysilane (Gelest). The PDMS mold was placed under vacuum again for one hour to remove any air trapped close to the mold, then baked at 65°C for one hour. Following demolding, the input and output holes were made with a modified 20-gauge syringe needle. The front and backside of the completed device are shown in Fig. 2.



**Fig. 1. Diagram of the multi-DNA extraction microsystem.** Each separate front side reservoir can hold a different DNA sample, while waste products that pass through the membrane are removed through a single outlet port.

To perform the DNA extraction process, a vacuum was connected to the backside of the PDMS channel system. Lambda DNA was mixed with SYBR Green I and deposited on the front side of the membrane via ports over each reservoir.

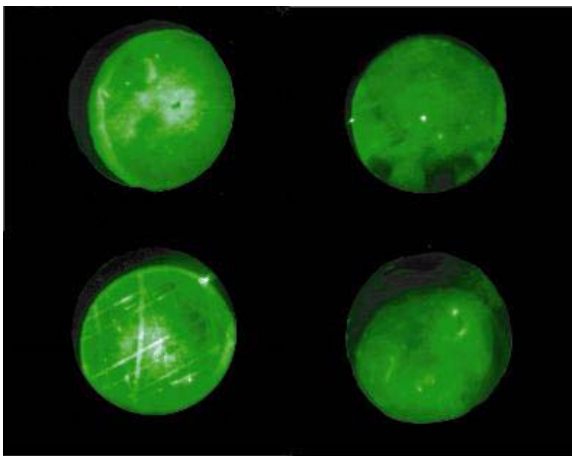
Once each reservoir had emptied of waste material, leaving the DNA on the surface of the membrane, the membrane was examined using a fluorescence microscope without disassembling the device.



**Fig. 2 Completed multi-DNA extraction device.**

### III. RESULT

Since this microsystem is capable of extracting multiple samples via adjacent reservoirs, the membrane was examined for cross-talk between wells. Microscope examination showed successful DNA extraction onto the AOM surface without leakage to other ports. The SYBR Green I was excited with blue light at a frequency of 475nm and fluorescence was detected at close to 520nm. Every well was checked with the fluorescence microscope. Most of wells produced identical results, so four wells were selected randomly (Fig. 3). Although preliminary testing of the completed device has demonstrated successful extraction of DNA, the correlation between the DNA quantity and the fluorescence intensity has not yet been investigated completely.



**Fig. 3 Fluorescence images of extracted DNA on the AOM.**

### IV. CONCLUSION

In this research, a multi-DNA extraction microsystem was implemented using PDMS microfluidic channels coupled with an aluminum oxide membrane to extract the DNA. After extraction, the successfully deposited

DNA on the surface of AOM was examined using fluorescence microscopy to validate the function of this microsystem. The absence of cross-talk within the system also validates the assertion that this multi-DNA extraction system can be used perform extraction on many different DNA samples in parallel.

### V. REFERENCES

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