

# Reagentless, Cartridge-based Sample Extraction Tool for Biodetection



**Darren W. Branch, Erika J. Cooley, and Thayne Edwards**  
 Sandia National Laboratories, PO Box 5800 MS-1425, Albuquerque NM 87185, Tel: 505-284-5843 Fax: 505-844-1198  
 (dwbranc@sandia.gov)



## Technology

### Motivation

- The need to rapidly extract and process genomic material for identification of biological agents and disease is an ever increasing requirement.
- Methods that allow the complete unbiased isolation of nucleic acids from microorganisms and cellular samples are necessary for today's high throughput molecular analysis methods and detection schemes.
- Existing nucleic acid extraction systems require significant manual intervention and consumables leading to limitations that are especially relevant for the unattended, timely detection of biological warfare agents or other microorganisms.

### Approach

- This technology accomplishes cell lysis quickly and efficiently by coupling high frequency bulk acoustic waves (BAW) into microchannels with sufficient pressure to disrupt cellular membranes.
- DNA extraction is performed using a low voltage electroactive binding method on the same cartridge as the cell lysis or by magnetically trapping beads bound with DNA in a reversible process.

### Distinctive Features

- Using *E. coli*, a lysing efficacy of 49.9% was achieved with a 757.2 % increase in ATP release after 20 seconds of exposure.
- Rapid and efficient DNA extraction was achieved on the same cartridge using a low voltage electroactive DNA binding method, yielding an extraction efficiency of 66.3% and overall lysing/extraction time of 5-10 minutes.
- The small footprint (100 mm x 160 mm x 100 mm) of this system allows it to be interfaced with minimal effort into existing biodetection systems.
- Ideal for raw biological samples.

## Markets

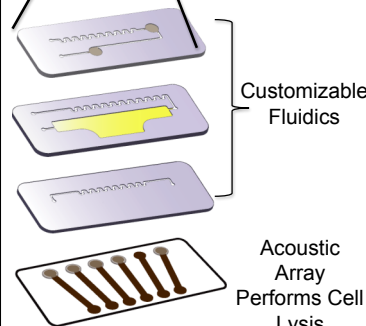
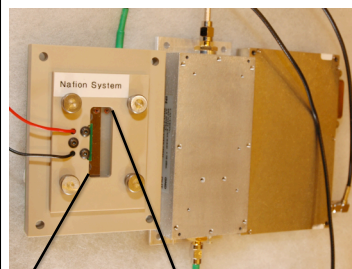
### Market Demand

- The pharmaceutical industry, medical diagnostics community, and the defense sector demand rapid DNA extraction technology.
- Applications include biowarfare agent detection, infectious disease monitoring, health point of care, and field deployable systems.

### Emerging Markets/Applications

- We are collaborating with the New Jersey Medical School (UMDNJ) on a joint NIH Challenge Grant "Acid Fast Bacilli smears for drug resistance detection and surveillance in Mycobacterium Tuberculosis," to develop a high throughput detection method for simultaneous tuberculosis (TB) identification and determination of drug susceptibility. This technology rapidly releases DNA and is ideal for organisms that are difficult to lyse and/or present in small volumes (< 0.2 mL).

### Nucleic Acid Extraction System



## Commercial Readiness

### Near-Term Applications (4-8 months)

- This lysing method is suitable for standalone implementation or used in conjunction with the nucleic acid extraction process in lieu of another DNA extraction approach.
- An investment time of several months may be required to identify suitable manufacturers. Once the criteria are known, the lysing front-end prototype can be adapted to meet the new requirements.

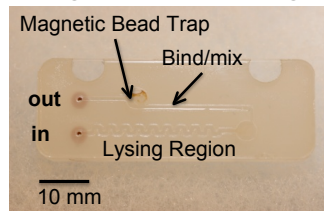
### Longer-Term Applications (12-24 months)

- This technology is being used for TB drug susceptibility and identification, which will make it possible to survey drug resistance rates simply and inexpensively, for the first time.

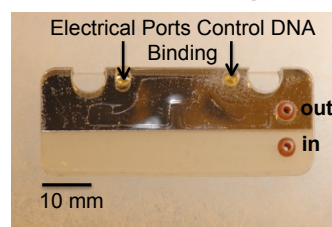
### Two Cartridge Options for DNA Extraction

- Magnetic bead
- Electrical (Nafion film)

### Magnetic Bead Cartridge



### Nafion Cartridge



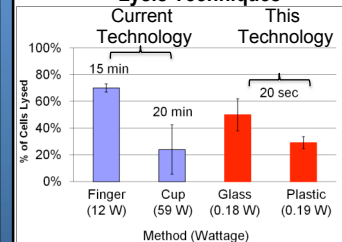
## Intellectual Property

- Intellectual property (IP) covers the lysing/nucleic acid extraction cartridge in the absence of a specific biodetection platform.
- Potential new IP would cover interfacing the lysing/DNA extraction with specific biodetection systems.
- Patent application has been submitted.
- Internal Sandia disclosure of idea is recorded.

### Key Innovations

- Plastic laminate and glass cartridges are low cost
- Small volumes (~50-500 µL)
- Low power (200 mW)
- Chemical free
- Rapid lysis (20 seconds)
- On-demand
- Scalable, customizable fluidics

### Comparison with Competing Cell Lysis Techniques



Terms: Finger and Cup refer to 20 kHz acoustic probes. Glass and Plastic refer to the laminate cartridge types in contact with the 54 MHz acoustic array.

### Contacts

**Darren W. Branch**, Principal Investigator,  
 MS-1425, Tel: 505-284-5843, Fax: 505-844-1198, Email: dwbranc@sandia.gov

**Steve Casalnuovo**, Manager, MS-1425, Tel: 505-844-6097, Fax: 505-844-1198 Email: sacasal@sandia.gov