

School of Biomedical Engineering, Science and Health Systems

Biomedical Technology Showcase, 2006



Drexel E-Repository and Archive (iDEA)

<http://idea.library.drexel.edu/>

Drexel University Libraries

www.library.drexel.edu

The following item is made available as a courtesy to scholars by the author(s) and Drexel University Library and may contain materials and content, including computer code and tags, artwork, text, graphics, images, and illustrations (Material) which may be protected by copyright law. Unless otherwise noted, the Material is made available for non profit and educational purposes, such as research, teaching and private study. For these limited purposes, you may reproduce (print, download or make copies) the Material without prior permission. All copies must include any copyright notice originally included with the Material. **You must seek permission from the authors or copyright owners for all uses that are not allowed by fair use and other provisions of the U.S. Copyright Law.** The responsibility for making an independent legal assessment and securing any necessary permission rests with persons desiring to reproduce or use the Material.

Please direct questions to archives@drexel.edu



BIOSENSORS LABORATORY



PORTABLE ANTHRAX DETECTION SYSTEM (PADS)

M.MATTIUCCI*, P.SHETTY*, N.MEHTA*, R. WEISBEIN*, H.MEHTA*

K.POURREZAEI*, M.SWOBODA*, R.M. LEC*

*Graduate students, *Faculty

School of Biomedical Engineering, Science & Health Systems, Drexel University



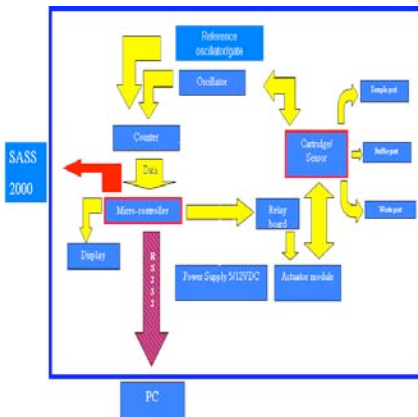
Abstract

Biosensors such as the Quartz Crystal Microbalance (QCM) and micro cantilever (MC) are becoming increasingly popular in homeland security applications due to their high sensitivity. Furthermore, they can be functionalized for specific pathogens such as bacillus anthracis (anthrax) to give high selectivity. These sensing platforms are currently available, but expensive laboratory equipment is required for sample preparation, measurement and analysis. The ideal device will give accurate and repeatable results on a real-time basis using a single system that completes the entire process for use in the laboratory or field. The Portable Anthrax Detection System (PADS) has been developed to meet these requirements. It utilizes a cartridge that contains either a QCM or MC sensor. The system introduces a sample to the sensor, then measures and analyzes it for bacillus anthracis. Sensor results are quantified based on a specific algorithm for the pathogen. The PADS is user friendly, inexpensive, compact, flexible, and is currently undergoing reliability testing.

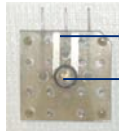
System specifications

- Size: 8 x 6 x 3 inches
- Weight: 10 pounds
- Power supply: 90-264 VAC, 47-63Hz
- Power consumption: 30W (max)
- Operational temperature range: ~22 °C
- Liquid inventory (PBS): 5-50 ml
- Sensor type: cantilever, QCM
- Sampling rate (fluidics): 0.1-3 ml/min
- Calibration time: ~15 sec
- Measurement time: ~15 sec
- Detection time: ~1.5 min
- Fluidic system: cartridge type

Block diagram

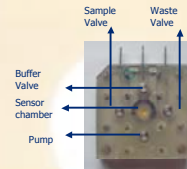


Cartridge fluids



- Sample introduced is pumped through the sensor chamber and out of the cartridge through the waste port
- If pathogen is present, mass loading will result in frequency shift that is measured by the system

- The cartridge consists of 3 ports - sample, buffer and waste
- The crystal sensor inside the cartridge is excited by the oscillator



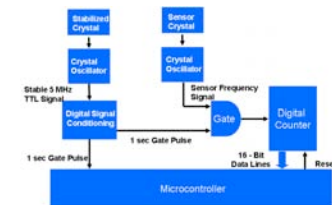
Cartridge insertion and actuators



QCM measurement system

- Oscillator
- Reference oscillator and gate
- Counter

Measurement system block diagram



Microcontroller functions and programs

- Processing measurement data
- Result display and warning messages
- Communication with PC
- Sampling control (fluidics)
- Cartridge accessibility control
- Testing the sample
- Purging the cartridge
- Eject and position cartridge

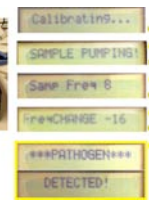
Operation

- Air is sampled by the SASS 2000 and the sample is transferred to the PADS
- The sensor is calibrated with buffer
- The base frequency of the sensor is measured and the value is stored and displayed by the microcontroller
- The action of actuators and pump, controlled by the microcontroller will maintain a steady flow rate of sample through the sensor
- After one minute, the sample frequency is measured and the value stored and displayed by the microcontroller
- If the frequency shift is greater than 400 Hz, an alarm is triggered, that indicates anthrax detection

Flowchart



Display message area



Potential applications

- Can be installed in critical areas and data sent to remote individual monitoring stations
- Sensor within the cartridge can be made selective to different types of pathogens such as E Coli, HIV, Small Pox and Hepatitis
- Sample concentration values can be determined
- In addition to QCM and micro cantilever, other sensors such as optical and thermal sensors can be mounted within the cartridge
- Homeland security
- Hospitals
- Food industry
- Pharmaceutical industry

Future work

- Field testing
- Communication networking with remote monitoring system
- Miniaturizing the fluidic system using MEMS technology
- Functionalize new surfaces on the sensor and test for different types of pathogens

Sponsor

This project is sponsored by the Department of Transportation (DOT)

