Title
SEN 1: Lab-on-a-Chip Aquatic Microorganism Analysis System

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Labs-on-Chip Aquatic Microorganism Analysis System

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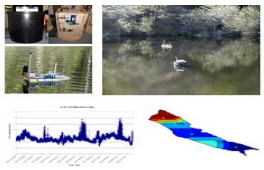
Introduction: Why Aquatic Monitoring and Lab-on-chip?

Motivation

- Need for monitoring the content of the sea water and assess the concentration of different algae – algal bloom monitoring
- Elucidate the cause of toxin production by algae



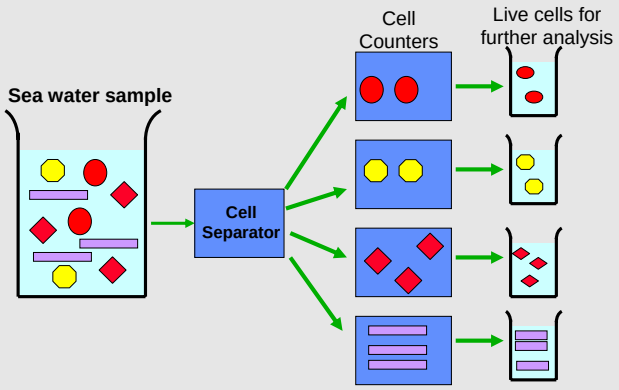
- *Example of a water monitoring system – "robot duck." The device can be bulky and miniaturization is desirable.*

Advantages of labs-on-chip systems

- Batch fabricated, low cost, small sample volume.
- Automation and miniaturization.
- Can be integrated with wireless networks
- Enable multiple parallel experiments.
- Field deployable, disposable, sterile

Algal Bloom Monitoring: Cell Separation and Counting

Flow chart of algae monitoring chip:

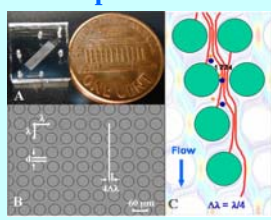


On-chip sea water microorganism monitoring

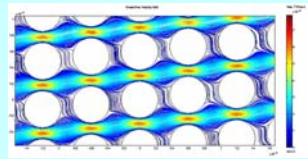
- *1. Collect sea water sample*
- *2. Separation of different cells based on SIZE*
- *3. Cell counting with impedance sensor.*
- *4. Further analysis (ELIZA, PCR,…etc)*

A. Cell Separation Based on Particle Size

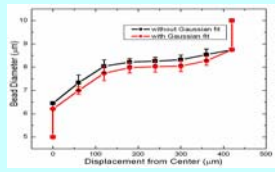
The separation chip has an *array of pillars* and the particles can be separated because different sizes of particle have different interaction with the pillars. Small particles can follow a separation lane exactly resulting in a zigzag flow pattern which follows the net fluid flow direction over a long distance. Large particles, incapable of making sudden turns around pillar, flow in displacement mode, and do not remain in one separation lane at all time.



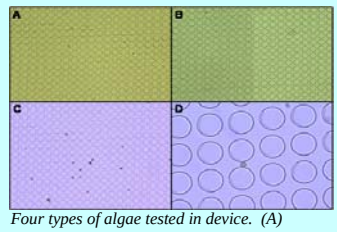
Device for particle separation



Simulated flow field inside device



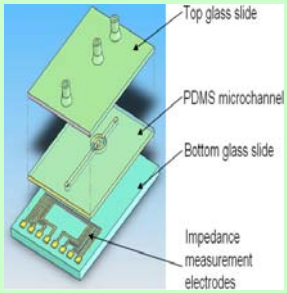
Separation function curve



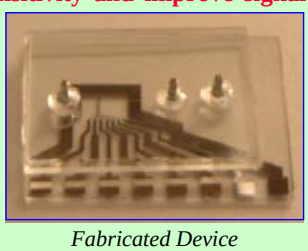
Four types of algae tested in device. (A) Aureococcus anophagefferens (B) Chlorella stigmatophora (C) Heterosigma akashiwo (D)Chlamydomonas sp

B. Cell Counting with Impedance Sensor

- Electrical impedance measurement to sense cells passing by electrodes
- Fabricated with PDMS sandwiched in glass
- Wheatstone bridge and amplitude/phase demodulation increase sensitivity and improve signal to noise ratio



Device Schematic



Fabricated Device

Successful sensing of cells

Algae Culture on Chip

- Culture Pseudo-nitzschia, a toxin producing algae, on chip.
- Culture cell under different conditions on ONE chip to screen for factors inducing toxin production.

BD Bioscience

•Replace several culture experiments with a single chip