A Miniaturized Sensor for Microbial Monitoring of Spacecraft Water Environment

Topic: X2.03, PI: Yi Wang, Project No. NNX10CE27P

Identification and Significance of Innovation

- Real-time monitoring of microbes in spacecraft environment is critical to ensure crew health and proper functioning and control of the life support system
- Conventional microbial assays are time-consuming, labor-intensive and difficult to deploy in the spacecraft environment; Rapid immunological and nucleic acid based approaches require consumables
- Need synergized harnessing of technological advancements in microfluidics, electrokinetics, microbiology, and lab-on-chip systems to engineer a solution
- Proposed effort is to develop a novel miniaturized, automated, label-free microbial sensor for microbial monitoring in spacecraft water environment

Technical Objectives & Work Plan

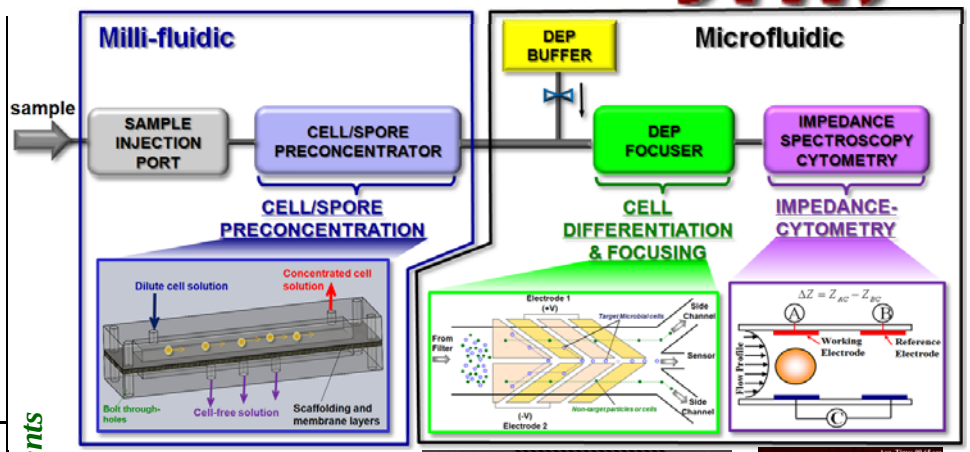
Phase I goal is to establish the proof-of-concept of the water monitoring sensor with focus on component development.

- Formulate specifications for the sensor cartridge
- Conceptualize milli-fluidic and microfluidic component design(s), viz., the cross-flow preconcentrator, DEP focuser, and impedance-based sensor
- Fabricate the components using state-of-the-art microfabrication techniques
- Experimentally test, characterize and demonstrate functional components
- Develop plans for optimization and component integration

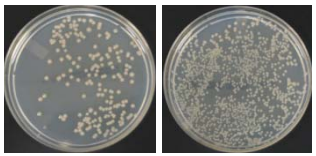
Phase I Accomplishments (TRL3)

All Phase I goals were successfully addressed, including:

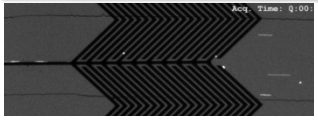
- Multi-physics simulations enabled virtual design of critical sensor components (cross-flow preconcentrator, dielectrophoretic focuser and microfluidic impedance sensor).
- Single component prototypes were fabricated using machining and lithography based microfabrication processes.
- Cross-flow preconcentrator was lab demonstrated to attain up to 14X concentration of Fab5 bacteria in a single unit
- Dielectrophoretic focuser was successfully demonstrated using Fab5 bacterial and PSL particles
- Micro-pore impedance sensor with smallest feature size of 3 µm was designed, microfabricated and experimentally demonstrated



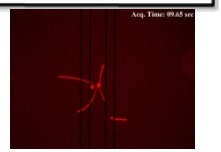
Accomplishments



14X concentration of Fab5



Particles focusing & alignment



Micro-pore sensor (3µ m)

NASA Applications

- Real-time microbial monitoring of water in spacecraft, shuttle, and ISS during long-term space mission to minimize microbial exposure/infection hazard to crew health
- Monitoring of microbes in water to evaluate the performance of the life support system

Non-NASA Applications

- Water monitoring in industrial facilities (e.g., wastewater treatment and food-processing)
- Water quality control in public sectors (e.g., hospitals, drinking and recreational waters)
- Pre-clinical and clinical point-of-care diagnostics (pathogen detection in body fluids)

Firm Contacts

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