IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Interfacing microfluidics, plasmonic surfaces and portable spectroscopic devices for the detection of E. coli in water supplies.	
Project Number	**IMURA0964**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one.** For more information, see www.iitbmonash.org)*	
1	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research Themes:

Highlight which of the Academy's Theme(s) this project will address? *(Feel free to nominate more than one. For more information, see www.iitbmonash.org)*	
1	*Advanced computational engineering, simulation and manufacture*
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	*Nanotechnology*
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*
8	Design

The research problem

Pathogenic infection represents one the greatest threats to human-kind as tragically emphasised by the ongoing COVID-19 pandemic and waterborne disease, which remains the world's leading killer. There is a critical need for point-of-site (PoS) testing for the detection of pathogens in water supplies, blood products, pharmaceuticals, food and now aerosols. Current approaches to bacterial detection rely on culturing, which can take several days and utilises staining and optical microscopy. Diagnostics for viruses are either genomic based utilising polymerise chain reaction (PCR) assays or rely on the detection of specific antigens related to the pathogen. PCR assays are time demanding, utilise expensive equipment and consumables and are susceptible to cross contamination. Antibody assays, although cheaper, require refrigeration and are far less sensitive compared to PCR based assays. In pursuit of new approaches to environmental pathogen detection, we have assembled a team of national and international scientists with complimentary expertise in analytical biospectroscopy, microfluidics, environmental engineering, device development, functionalised plasmonic surfaces and machine learning to develop inexpensive highly portable spectroscopic devices for pathogen identification of bacteria and viruses from fluids and air. **The project focusses on developing and testing novel spectral-fluidic devices utilising inexpensive miniaturised near-infrared (NIR), portable mid-infrared (MIR) and spatially off-set Raman (SORS) spectrometers in combination with functionalised plasmonic surfaces and filtration approaches to detect and quantify pathogen contamination in fluids and air.** The spectrum, which contains the molecular phenotype of the pathogen, will be deconvolved using our newly developed digital filtration approach and by utilising machine learning algorithms we will identify pathogens including bacteria, viruses and protozoans at low concentrations in water and air. Besides the development of novel approaches to filter, concentrate and spectroscopically identify environmental pathogens we hope to discover new spectroscopic phenotypic markers that can be used as simple indicators of water and air contamination.

Project aims

The central aims are:

1) To assess the applicability of portable spectroscopic devices and microfluidics to assess water contamination by quantifying so called “indicator” pathogens including *E. coli.*
2) Develop a SERS active carbon nano mesh capable of capturing bacteria.
3) Determine SERS Limit of Detection and capture efficiency of the mesh.
4) Investigate the potential of functionalised surfaces to chemically attach proteins, nucleic acids and cell wall and plasmonics to enhance the Raman/IR signal.

Expected outcomes

By this project, we expect to find an efficient and cost effective way to fabricate patterned substrate as efficient sensing platform for biological contamination. *Students will publish high quality research outputs in journal and academic conferences.*

Necessary Courses

BB653 Experimental Techniques in Biomedical Engineering
ES 639 Physico-Chemical Treatment Technologies
MM718 Laser processing & nanostructures
MM734 Electrical Properties of Materials

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Select up to **(4)** keywords from the Academy's approved keyword list **(available at http://www.iitbmonash.org/becoming-a-research-supervisor/)** relating to this project to make it easier for the students to apply.

Water, Nanoscience, Smart manufacturing, Sensor networks