

Sensing

Next-Generation Point-of-Care Multiplexing Blood Analyzers using High Sensitivity NanoPhotonic Devices
under the aegis of the Ontario Research Fund – Research Excellence program

December 2019 | Issue 1

www.sensing.utphotonics.ca

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Partners

Academic partners include faculty from the University of Toronto, McMaster University and University of Waterloo.

Industry (private sector) partners include Chip Care, Tornado Spectral Systems, Angle Biosciences, Sigma Bioinstruments, Advanced Electrophoresis Solutions, Relay Medical and AZMPC.

Medical community partners include Sunnybrook Hospital, Mount Sinai, Hamilton General, and Massachusetts General.

As the project evolves, we foresee engagement of new partners from all three sectors.

About Sensing

This first issue of the *Sensing* newsletter provides an overview of the research and development activities underway in the Ontario Research Fund – Research Excellence project, "Next-Generation Point-of-Care Multiplexing Blood Analyzers using High Sensitivity NanoPhotonic Devices". The newsletter also highlights key achievements which together underpin this "Point-of-Care Sensing" project and serves as a basis of engaging partners and stakeholders in advancing the project objectives.

Message from Pls Dr. Nazir Kherani & Dr. Stewart Aitchison

We are delighted to launch our first *Sensing* newsletter. The ORF-RE sponsored Point-of-Care Photonic-Microfluidic Sensing project is an exciting opportunity that aims to develop next-generation point-of-care multiplexing blood analyzers by combining novel nano-photonic sensing elements with state-of-the-art micro-fluidic devices in order to realize rapid and accurate detection of infectious diseases.

We have set our sights on transforming the efficacy, rapidity and reliability of point-of-care infection detection. We believe this will be made possible by the integration of unprecedented sensitivity offered by innovative advances in nanophotonic sensing (NPS) elements and commensurate developments in microfluidic handling and processing of whole blood samples.

This project will benefit other sensing applications which also demand identification of biochemical/chemical species with equal rapidity, reliability and high-sensitivity; for example, cancer and non-infectious disease detection, industry process monitoring, and environmental sensing.

The project is a confluence of expertise from academia, the medical community and industry. This enriched intersection of talent will serve to advance the overarching goal of reliable and early diagnosis of infectious diseases, such as sepsis, and thus allow for immediate and interactive lifesaving treatments – thus improving health delivery and reducing costs. Further, working with clinicians and industry partners will facilitate rapid knowledge/know-how translation.



2019 Research Highlights

An invited talk by Dr. Kherani, at the 10th Annual Nano Ontario Conference held at York University on Nov 29th, 2019: "[Multiwavelength Surface Enhanced Raman Spectroscopy using Deep-Subwavelength Gratings](#)"

Dr. Kherani presented research work from his group at S3IC (Single-Molecule Sensors and NanoSystems International Conference), Munich (Germany), in April 2019: "[High sensitivity molecular detection using rainbow trapping in width graded plasmonics gratings](#)"

Dr. Selvaganapathy's group from McMaster University recently published new studies on fabricating inexpensive microfluidic devices in: [Journal of Microelectromechanical Systems \(2019\) Mohammadzadeh et al.](#), and [Journal of Micromechanics and microengineering 29\(1\) p.015013 \(2019\)](#)



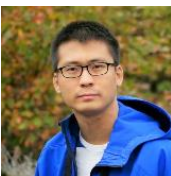
Katelyn Dixon, Drs. Kherani and Matsuura's doctoral researcher, gave a talk at SPIE 2019 held in San Diego, CA

"[Rainbow light trapping in ultrathin plasmonics nanogratings](#)"



Moein Shayegannia, Dr. Kherani's doctoral researcher, gave a talk at ICES 2019 at Univ. of Western Ontario:

"[Low concentration molecular detection using multiwavelength SERS on width graded plasmonics gratings](#)"



Ryan Xilong Yuan, from Dr. Aitchison's group gave a talk at CLEO 2019, San Jose CA:

"[Point-of-care multiplexing assay for dengue using barcoded fluorescence microspheres](#)"

Team



[Dr. Nazir P. Kherani](#)
Principle Investigator
Group Members
Dr. Arthur Montazeri
Dr. Nass Kazemi
Dr. Sidra Farid
Moein Shayegannia
Katelyn Dixon
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Project Overview

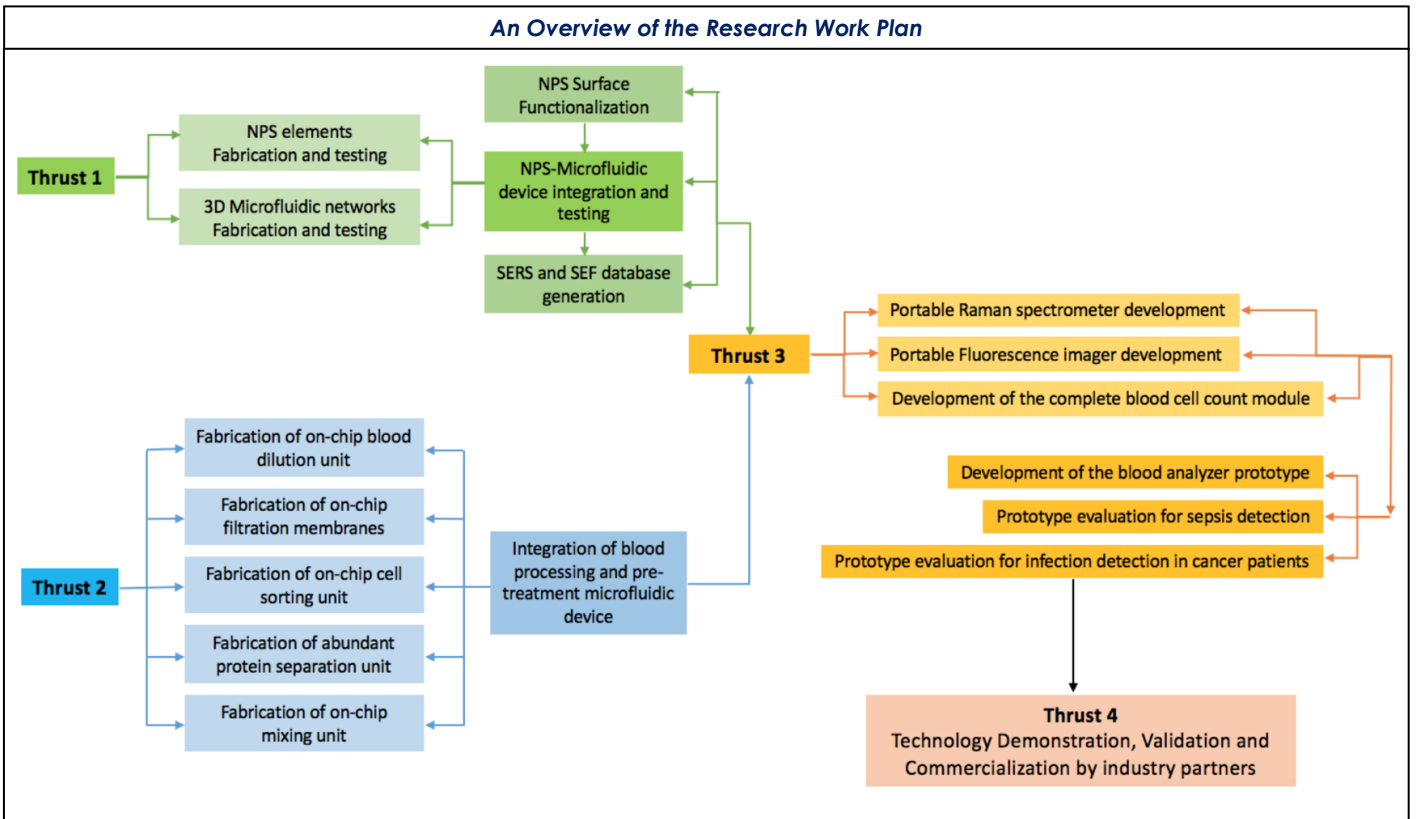
The focus of this project is to research, develop, prototype and commercialize high sensitivity multiplexing rapid blood analyzers which can be deployed at the point-of-care. This project involves four research thrusts that are expected to culminate in the development and integration of key technology elements comprising of: NPS (nanophotonic sensing) elements, state-of-the-art microfluidic devices for blood processing, portable optical imaging systems and spectrometers all packaged in a portable instrument with an intuitive user interface. The four thrusts and the corresponding objectives are summarized below:

- Developing integrated nanophotonic-microfluidic devices
- Developing on-chip whole blood processing devices
- Prototyping hand-held integrated nanophotonic-microfluidic multiplexing blood analyzers
- Technology demonstration, preliminary validation and commercialization

Sepsis, a blood-borne infectious disease, is a major cause of death worldwide. For example, there are one million sepsis diagnoses per year in the United States, of which a third do not survive. Sepsis is a life-threatening condition triggered by virulent infection or pathogens causing severe inflammation of bodily tissue and organs. In order to address this challenge, point-of-care (PoC) blood analyzers are critical for rapid and real-time screening, monitoring and diagnosing of blood-borne infectious diseases.

Kick-off Meeting of Academics

On Apr 23rd 2019, a Kick-Off Meeting of all the academic partners to the ORF NanoPhotonic Sensing project was held at the University of Toronto. The focus of this meeting was to (a) review and discuss the research work plan (see figure below), and (b) learn of the range of research activities underway and existent technical expertise - nano/micro-fabrication, microfluidics and sensing - among the collaborating research groups from McMaster University, University of Waterloo and University of Toronto. The meeting provided an opportunity for graduate researchers, post-doctoral fellows, and faculty to hear first-hand of leading-edge research in the various groups, to network, and thus the venue served to advance the ORF-RE project milestones. The meeting also included the participation of new allied research collaborators – exploring the potential of new linkages.



NanoPhotonic and Microfluidic Sensing Meeting at the University of Toronto. (a) Attendees listening to speakers. (b) Nazir Kherani presenting an overview of the ORF Project objectives. (c) Carolyn Ren speaking about the Microwave Enabled Microfluidic Platform. (d) Stewart Aitchison presenting his group’s research on Point of Care Technologies.



Workshop on “Point-of-Care Multiplexing/MicroFluidic Blood Analyzers using Advanced Photonic Sensing”, October 17th 2019

A workshop on Point of care (PoC) Multiplexing/MicroFluidic Blood analyzers using Photonic Sensing was held at the University of Toronto during the Fall term in 2019. The workshop brought together collaborators from academia, industry and clinicians to present research progress and novel perspectives, discuss challenges in the field, and explore opportunities for advanced PoC sensing platforms and techniques.

The detailed workshop program can be found here: [Workshop Program](#)



Workshop at Hart House, University of Toronto. (a) Nazir Kherani giving the Welcome Address. (b) Attendees listening attentively. (c) Stewart Aitchison chairing the Panel Discussion with panel members Paul Smith, Tiemin Huang, Ravi Selvaganapathy, Anna Zavodni. (d) Carolynn Ren speaking about recent advances in her group.

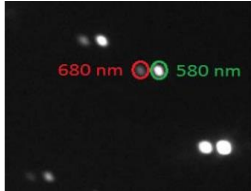
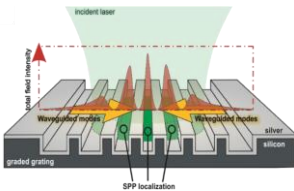
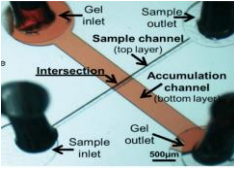
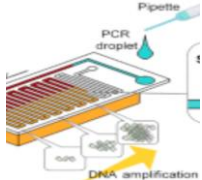
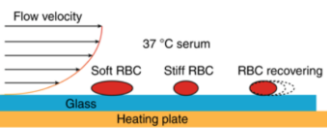

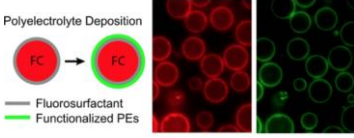
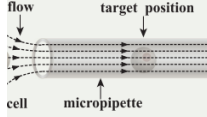
Workshop Highlights

- Kherani group presented results on ultra-high sensitivity of the multi-wavelength SERS platform.
- Selvaganapathy presented advances in microfluidics amenable for PoC sensing.
- Ren presented advances in microwave enabled sensing and heating of droplets.
- Wheeler group presented advances and potential of digital microfluidics.
- Progress and perspectives from industry on PoC sensing platforms were discussed.
- Challenges and opportunities on sensing technologies were discussed during the panel discussion.

Contact

- Visit our website/Sign up for updates and newsletter: www.sensing.utphotonics.ca
- Email us: kherani@ecf.utoronto.ca

The Reading Room

 <p>Aitchison Group Reports on: “Detection system for point-of-care multiplexed bead-based immunoassays”</p>	 <p>Kherani Group Reports on: “Multiwavelength surface enhanced Raman Spectroscopy using rainbow trapping in width-graded plasmonics gratings”</p>	 <p>Selvaganapathy Group Reports on: “A microfluidic device for rapid quantification of cell-free DNA in patients with severe sepsis”</p>	 <p>Selvaganapathy Group Reports on: “Microfluidic devices for DNA amplification”</p>
 <p>Sun Group Reports on: “Stiffness and ATP recovery of stored red blood cells in serum”</p>	 <p>Ren Group Reports on: “Microwave sensing and heating of individual droplets in microfluidic devices”</p>	 <p>Matsuura Group Reports on: “Polyelectrolyte coatings can control charged fluorocarbon nanodroplet stability and their interaction with macrophage cells”</p>	 <p>Sun Group Reports on: “Model-Based Robotic Cell Aspiration: Tackling Nonlinear Dynamics and Varying Cell Sizes”</p>