

ABSTRACT BOOK

CREATE ANNUAL CONFERENCE 2025

APRIL 28-29, 2025



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Keynote Speech



Innovative Food Production Platform to Address Nutritional Deficiencies

Bruce Hardy, President, Myera Group and Function Four Ltd.

Abstract

Aboriginal communities in rural Canada are highly vulnerable to the negative health and economic effects of food insecurity and the negative health consequences of nutritional imbalances that result from high-cost food with poor nutritional value. Resolving these issues in the future will require a greater understanding of the unique nutritional requirements and nutritional deficiencies within the food supply of these communities.

One of the primary solutions to these widespread community nutritional deficiencies will be the development and implementation of community-based sustainable food production systems that can be operated locally to meet local needs. Myera's innovative food-production platform technology seeks to be the primary means to achieving that objective. This proprietary integrated fish, Indigenous wild rice and algae production facility seeks to bridge the gap between health outcomes and missing nutritional factors.

Speaker Bio



Mr. Hardy has been President of Function Four Ltd since its inception in 1996, and has grown the firm into an e-health innovation, research, and software development company. Function Four offers unique e-health case management software for prenatal and early childhood developmental programs. Function Four is an active collaborator in provincial and international applied research and university based academic projects. Function Four is recognized for its novel approach to combining technology, data collection, and analytics with complex human, social, nutritional and economic challenges.

Seeing first hand the effect of food insecurity, food availability and the essential role nutrition plays in early childhood developmental disorders – Mr. Hardy established Myera Group. Its vision is to establish a more dynamically responsive link between health outcomes and a sustainable food production system.

Since 2012 Myera Group has been working on its vision to map community and individual health outcomes to a dynamic food production system. With the support of NSERC and MITACs funding, Myera is now leveraging AI to accelerate the development of an “Agri-health” functional foods and nutraceuticals platform.

Building a Circular Sanitation Movement: Empowering Communities and Fostering Behavioural Change

Mahesh Ganesapillai, Professor, Vellore Institute of Technology, India

Abstract

Circular sanitation presents a paradigm shift in wastewater management by integrating resource recovery and energy generation. This approach mitigates environmental pollution and enhances resource efficiency. Specifically, nutrient recovery from human excreta, a key component, reduces the demand for synthetic fertilizers, thereby minimizing eutrophication in water bodies caused by agricultural runoff. Recovered nutrients, such as struvite (magnesium ammonium phosphate), precipitated from urine, serve as slow-release fertilizers, improving crop yields and reducing agriculture's environmental footprint. Advanced technologies like membrane filtration further purify recovered nutrients, enhancing their agricultural applicability. The economic viability of circular sanitation is demonstrated through cost-benefit analyses, revealing reduced expenditure on synthetic fertilizers, decreased eutrophication, and mitigated greenhouse gas emissions. Furthermore, circular sanitation promotes social equity by minimizing environmental disparities and fostering economic opportunities in underserved communities. This presentation will detail the technical aspects of struvite crystallization, anaerobic digestion, and membrane filtration, elucidating their roles in nutrient recovery and purification. By adopting circular sanitation, we can achieve a sustainable and resource-efficient waste management and agricultural system, fostering equitable access to clean water and contributing to a resilient and environmentally sound future.

Speakers Bio



Mahesh Ganesapillai is a Professor in the School of Chemical Engineering at VIT University, Vellore, India, since 2011. He served the Indian Defense R&D Organization, as a Senior Research Fellow (2005 to 2007). He was awarded the esteemed NAWA Fellowship by the Polish Academy of Sciences (2024) and the prestigious Erasmus Fellowship (2016) for his Post-Doctoral research by the European Parliament. He serves as a visiting Professor in Yokohama National University, Japan; Gdansk University of Technology, Poland,

National Taipei University of Technology, Taiwan, Lublin University of Technology, Poland; National University of Science and Technology, Oman; and Kaohsiung National University of Science and Technology, Taiwan.

He received Masters in Engineering from Annamalai University, Chidambaram in 2002, and his Ph.D. in Chemical Engineering from AC Tech., Anna University, Chennai, India. Later in 2014. His study focuses on the anthropogenic closed-loop fertility cycle for sanitation and agricultural production via nutrient recovery technologies. He has worked on low-grade rock phosphate tailing enhanced human urine as a new fertiliser for grains and pulses. He also studied the effects of microwave pretreatment on pyrolysis of crude glycerol-olive kernel for low-cost alternative fuels. He has also studied the effects of microwave on agricultural biomass, pottery, food, minerals, medicinal herbs, etc. He regularly acts as reviewer for national and international journals.

He has been a guest speaker at a number of prestigious institutes in India and consults with businesses interested in waste minimization and management. Prof. Ganesapillai is the author of over 60 publications in the field of waste management and resource recovery. He received the Indian Institute of Chemical Engineers' Outstanding Young Chemical Engineer award, as well as the coveted Defense R&D Organization's Senior Research Fellowship. He received the 2012 Best Mineral Engineer Award for his remarkable approach and concept for achieving sustainable agricultural productivity through the use of low-grade rock phosphate tailings. He was honored with the "Pride of INDIA" from New Delhi on 15th August 2016 for his contribution in Sanitation and Hygiene in Rural India.

Professor Ganesapillai is a Fellow of the American Institute of Chemical Engineers, the Indian Institute of Chemical Engineers, the International Water Association, the Indian Society for Technical Education, the All India Council for Technical Education, the Indian Mineral Engineering Association.

Dr. M. Ganesapillai, Professor - School of Chemical Engineering, VIT University, Vellore, INDIA. Tel. +91 97 90 29 94 47; E-mail: maheshgpillai@vit.ac.in; drmaheshgpillai@gmail

Geomagnetic Storms: Earth Under Solar Assault

Parham Mohammadi, AI and Quantum Computing Researcher at Huawei

Abstract

"This speech will delve into the phenomenon of geomagnetic storms, significant disturbances in Earth's magnetosphere triggered by solar activity. It will begin by defining these storms and exploring their origins, focusing on coronal mass ejections (CMEs) and high-speed solar wind streams. We will discuss how these solar events interact with Earth's magnetic field, transferring energy and driving electrical currents within the magnetosphere and ionosphere.

The speech will then examine the wide-ranging impacts of geomagnetic storms on modern technology. We will explore their effects on satellite communications, radio transmissions (including HF/VHF blackouts), and GPS/GNSS navigation systems, highlighting how these disruptions can affect various sectors from aviation to finance. Furthermore, the speech will detail the threat posed to electrical power grids, explaining how geomagnetically induced currents (GICs) can lead to transformer saturation, voltage instability, and potentially widespread blackouts.

To provide historical context, the speech will review landmark geomagnetic storms, including the Carrington Event of 1859, the Quebec Blackout of 1989, and the Halloween Storms of 2003. These examples will illustrate the evolving vulnerability of technology to space weather over time. Finally, the speech will touch upon current monitoring, forecasting, and warning systems, as well as mitigation strategies being developed to protect critical infrastructure. The overall aim is to raise awareness about the risks posed by geomagnetic storms and the importance of preparedness in our increasingly technology-dependent world."

Speaker Bio



Parham Mohammadi, PhD, is an AI and Quantum Computing Researcher at Huawei, holding a doctorate in Computer Science and Electrical Engineering from York University. Renowned for his expertise in Large Language Models, MLOps, AI systems architecture, and quantum computing, Parham excels at translating cutting-edge research into practical solutions. His work focuses on optimizing AI systems and energy solutions, including robust ML infrastructure and cloud-native platforms.

With a passion for making AI more efficient and accessible through innovative infrastructure, Parham is a dynamic leader at the forefront of technology's future.

Smart Farming for Health Equity: Innovations Supporting Northern Indigenous Communities

Miyoung Suh, Professor, University of Manitoba

Abstract

Northern communities in Manitoba face significant health disparities, largely due to limited access to fresh, nutritious food. This project utilizes advanced agricultural techniques and smart farming technologies to improve the nutritional quality and health benefits of locally grown produce. By developing culturally appropriate functional foods, the initiative focuses on the prevention and management of diabetes, addressing the unique health challenges of northern Indigenous communities. With the potential to benefit approximately 98,000 people in northern and rural Manitoba, the project also supports food sovereignty by empowering communities with the tools and knowledge to grow their own nutritious food. We will also explore effective strategies for working with Indigenous communities, recognizing that meaningful engagement and active participation are essential to the project's success and to achieving long-term health and economic sustainability.

Speaker Bio



Dr. Suh is a Professor in the Department of Food and Human Nutritional Sciences at the University of Manitoba and serves as a Principal Investigator in both the Division of Neurodegenerative and Neurodevelopmental Disorders and the Canadian Centre for Agri-Food Research in Health and Medicine at the St. Boniface Hospital Research Centre. She is also the nutrition lead for the Canada-Israel International Fetal Alcohol Consortium, a global initiative focused on mitigating the impact of fetal alcohol spectrum disorder through perinatal nutrition strategies. Her ongoing research explores the critical roles of dietary lipids in the development and function of neural cells in the brain and retina, particularly under conditions of alcohol exposure, diabetes, and obesity. Additionally, she serves as a scientific health research liaison for the Opaskwayak Cree Nation (OCN) in The Pas, Manitoba. Her recent collaborative with OCN on a project to grow functional vegetables using smart vertical farm technology holds transformative potential

in combating chronic diseases, especially diabetes, which is prevalent in northern communities. Overall, her research lays the groundwork for optimizing nutrition and developing dietary strategies that benefit both targeted clinical populations and the general public. Her work is currently supported by CIHR, NSERC-Horizon, and the CIHR Healthy Cities Research Training Platform (HC RTP).

Automation of technical systems using modern tools supporting engineering work

Aleksander Gwiazda, Professor, Silesian University of Technology

Abstract

Designing modern technical systems (including production systems) requires designers to change their approach to design issues. Tools based on modeling and simulation are often used. In addition to the simulation of static parameters, it is also possible to simulate the dynamic parameters of the structure (the second level of simulation - in addition to static, it also takes into account dynamic loads related to movement). Currently, the third level simulation is also being developed, i.e., simulation of the mechatronic function. In this simulation, in addition to loads resulting from static and dynamic interactions, loads resulting from the implementation of a specific control program are also taken into account. The use of simulation of the mechatronic function allows for the creation and testing of prototypes of advanced technical systems only in virtual form. Examples of such projects will be shown as part of the prepared presentation.

Speaker Bio



Professor Aleksander Gwiazda graduated from the Faculty of Mechanical Engineering at the Silesian University of Technology in 1991. Since that year, he has worked as a researcher at his home Faculty. He has been a university professor since 2014. In 2021, he became the head of the Department of Automation of Technological Processes and Integrated Manufacturing Systems, which he has headed to this day. The department comprises almost 40 scientists representing two research areas: broadly understood production automation and related production and management engineering.

His scientific interests include the issues of automation of production systems and the use of artificial intelligence tools. During his professional career, he has participated in the implementation of many scientific and industrial projects. He is the author or co-author of over 300 peer-reviewed scientific publications, including several books. One of the last books he co-authored concerned industrial applications of the Internet of Things.

Career Compass: Navigating Your Future

Embarking on a new career path can be both exhilarating and daunting. Whether you're considering a switch to a different industry, pursuing a new role, or exploring entrepreneurship, navigating career transitions requires careful planning, resilience, and a willingness to embrace change. Join us for an insightful discussion where seasoned professionals share their personal stories, practical tips, and strategies for successfully transitioning careers.

PROMINENT GUESTS

Andrew Maxwell, Professor, York University



Andrew combines practical experience, award winning research and over thirty years of research and experience in the fields of Innovation Management and Technology Venture Creation, working with diverse enterprises (Fortune 500 companies, and SMEs), with a strong focus on the commercialization of University Research. He regularly runs short workshops, industry workshops and offers a graduate class in technology commercialization (which has been transformed into a global classroom with participation from students at global universities). He has collaborated on over 15 research awards since joining Lassonde in 2014, where his role has been partly training HQPs in the field of technology commercialization, and partly working with PIs, Innovation York and IP Osgoode, to devise the optimum commercialization strategy. Andrew is on the board of several technology start-ups, and an advisor to industry partners and government organizations on the challenges of creating more innovative organizations, commercializing technology research and scaling up technology ventures for global success. His current research is on the application of AI tools to innovation, technology commercialization and venture creation educational experiences, AI enabling tools and frameworks he previously developed. In his spare time, he is working alongside Frank Stronach on the creation of a disruptive micromobility electric vehicle – the SARIT.

Aniket Prabhudesai, Technical Staff, MDA Space



Aniket Prabhudesai holds a Master of Applied Science (MASc) in Mechanical Engineering and a Bachelor's Degree in Space Engineering from York University. Currently, Aniket is a Member of the Technical Staff at MDA Space, where he works on cutting-edge space robotics and rover missions. MDA is renowned for its pioneering contributions to space exploration and for advancing Canada's role in space robotics and engineering.

Aniket specializes in satellites and space robotics, with a focus on Guidance, Navigation, and Control (GN&C). His expertise lies in Attitude and Orbit Determination, which is crucial for satellite operations and space missions. He is currently working on the Canadarm 3 project and rover-centric programs as part of the Lunar Dawn team, pivotal for Canada's role in space exploratory missions.

His recent accomplishments include the successful launch of two student-led satellites (DESCENT and ESSENCE) at NASA's Kennedy Space Centre, in collaboration with York University and the Canadian Space Agency. Aniket's leadership extends beyond his technical expertise. As the Project Manager and Technical Lead for York University's ESSENCE CubeSat project, he not only oversaw the design, testing, and integration of key satellite systems, but also led cross-functional teams to manage complex budgets, orbital lifetime analyses, and mission-critical documents.

His Master's thesis titled "Attitude Determination using Asynchronous MultiSensor Fusion" addressed the critical issue of CubeSat failures due to suboptimal attitude determination algorithms. Aniket's graduate research enabled him to develop a robust attitude determination system standard for nanosatellites, integrating affordable and low-cost sensors to conduct testing in both simulated and hardware environment with a new attitude determination algorithm. Aniket's work in the space sector has established him as a standout figure in advancing space robotics and satellite technologies.

Bruce Hardy, President, Myera Group and Function Four Ltd.

Mr. Hardy has been President of Function Four Ltd since its inception in 1996, and has grown the firm into an e-health innovation, research, and software development company. Function Four offers unique e-health case management software for prenatal and early childhood developmental programs. Function Four is an active collaborator in provincial and international applied research and university based academic projects. Function Four is recognized for its novel approach to combining technology, data collection, and analytics with complex human, social, nutritional and economic challenges.

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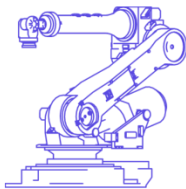
Mike Piotrowski, Vice President, Intuitive Water Systems



Mike is responsible for the design of new water treatment systems, retrofitting and upgrading existing systems, as well as testing and exploring new instrument technology related to water treatment plants. Mike is also an Electro-Mechanical Technician, LEED Green Associate, Small Drinking Water Systems Operator, and ASSE Rainwater Catchment Systems Designer. He is an active member with Professional Engineers Ontario, as well as Engineers and Geoscientists of British Columbia.

SMART-ART

Student Presentation Abstracts



Smart Autonomous Robotic Technology for Space Exploration



<https://lassonde.yorku.ca/smart-art/>



Dielectric Properties of Hydrated Smectites at Various Saturations and Temperatures

Abigail Lee, PhD student, York University

Poster Presentation

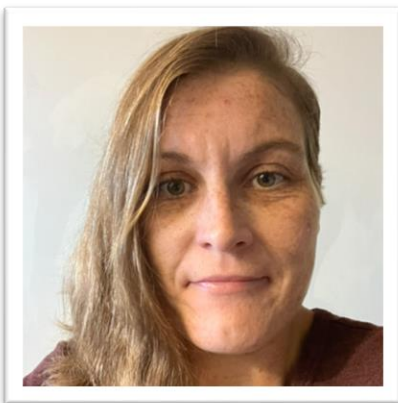


MARSIS detected bright basal reflections at Ultimi Scopuli, near the south pole of Mars, which could imply the presence of liquid water or water saturated sediments. The dielectric permittivity was modelled to be within 15-20 which is lower than expected for water in liquid form, and alternative materials were suggested, such as smectites. Two previous studies measured the dielectric permittivity of hydrated smectites at cold temperatures and found dielectric values of 22 and 8.4, which create a controversy. The larger number could explain the anomalous reflections, but the lower number would not. To settle this controversy, we conducted experiments using STx-1b at various hydration states at 230 K and 4 MHz. Our results show an average real part of the permittivity of 7.65, confirming that clays could not be the source of the reflections. This study refines the techniques from a past study at York University, especially related to temperature control and gradients, and demonstrates the increasing capabilities of the MARVIN chamber.

On-Orbit Inspection With A Free-Flying Space Robot

Antonia Hoffman, PhD student, Toronto Metropolitan University

Poster and Oral Presentation



A method for autonomous on-orbit inspection of space structures utilizing a free-flying space manipulator (FFSM) is proposed. In this method, the Next-Best-View (NBV) problem is solved, and an optimal sequence of viewpoints that ensure complete coverage of the surfaces of the target satellite is determined. As the NBV problem is NP-hard, a sampling-based planning algorithm is implemented. This algorithm optimizes a multi-objective viewpoint utility function, considering information gain, reconstruction quality, fuel expenditure, and inspection time. Furthermore, the planning and control framework explicitly accounts for uncertainties in control inputs, system dynamics, and sensor measurements, enhancing robustness and improving accuracy. The final output is

a reconstruction of the satellite which is accurate to high resolution, enabling automated detection and quantification of deviations from the nominal model.

Curriculum-Based Reinforcement Learning for Robust Pre-Grasp Control of Rotating Free-Floating Targets in Microgravity Environments

Bahador Beigomi, PhD student, York University

Oral and Poster Presentation



This work presents a Curriculum-based Reinforcement Learning (RL) framework for autonomous pre-grasp positioning of a robotic gripper relative to free-floating, rotating targets in microgravity. Addressing challenges such as erratic target motion and dynamic uncertainties, the framework employs Soft Actor-Critic (SAC) with a 40-dimensional state space and a 6-dimensional action space. Task complexity is progressively increased through four curriculum levels, each introducing greater rotational dynamics, guided by a biased sampling strategy to expose the agent to challenging scenarios. A performance threshold governs level transitions, ensuring adaptive learning. Domain randomization further enhances robustness across variations in target properties and environmental noise. Simulation results demonstrate that the agent achieves superior performance and faster convergence compared to baseline RL approaches. The framework enables successful pre-grasp configurations under high angular velocities, showing promise for real-world applications such as space debris capture. Future work will focus on hardware deployment and multi-objective curriculum extensions.

Object Manipulations Utilizing Soft Robotics Technologies

Dickson Chiu Yu Wong, Post Doctoral Fellow, York University

Oral Presentation



Three projects are presented. **The first one** is an octopus-inspired soft pneumatic actuator, which features a movable joint enabled by a light-weight slider whose position can be altered via pressurization. A mathematical model was built, and experiments were conducted to characterize the performance of the slider.

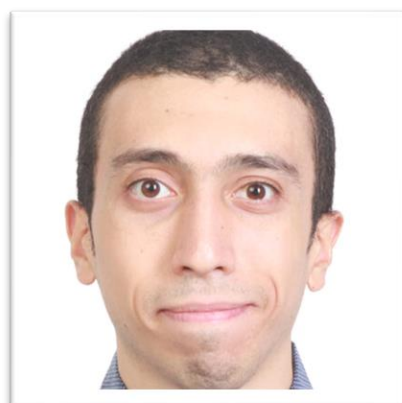
The second project focuses on a 3D-printed seahorse-tail inspired soft hydraulic actuator. This design incorporates a pre-curved geometry, allowing for dual-mode actuation through positive and negative pressures, effectively mimicking the seahorse tail's opening and gripping actions.

The third project is slip detection through a piezoresistive soft tactile sensor. In contrast to current research, which uses an array of sensors to detect slippage, we are going to study and develop a control strategy to carry out the same slippage detection functionality through a single, 3-axis piezoresistive sensor, especially in the area of incipient slip detection.

Planar Target Capture using Multiple Ground Mobile Robots

El Ghali ASRI, PhD student, York University

Oral Presentation



Advancements in space technology are ushering in a new era of exploration, commercialization, and industrial activity in orbit. As part of this transformation, space robotics are playing a critical role, particularly in performing complex on-orbit servicing tasks such as satellite assembly, inspection, and debris removal. Among emerging strategies, swarm robotics—where multiple autonomous agents work together—offers promising capabilities for handling unstructured and uncertain space environments. This research explores the use of swarm robotics to cooperatively capture an unknown and uncooperative target rigid body in orbit using multiple spacecraft. The proposed approach leverages decentralized coordination and distributed sensing to enable robust,

adaptive behavior without requiring prior knowledge of the target. To validate the feasibility and effectiveness of this method, an experimental setup using ground-based mobile robots is developed to emulate two-dimensional spacecraft dynamics. These planar experiments serve as a proof of concept for future space-based swarm robotic missions focused on autonomous capture and servicing.

Dynamic Simulation and Experimental Validation of Large Flexible Structure during In-Orbit 3D Printing

Fuzhen Yao, PhD student, York University

Oral Presentation



With the gradual realization of space travel and orbital stations, the demand for space-based manufacturing has become increasingly urgent. As a mature and flexible manufacturing method, 3D printing—with its compact mechanical structure and efficient spatial utilization—has emerged as a prime candidate for in-orbit fabrication. In a microgravity environment, in-orbit 3D printing enables the creation of large flexible structures that would be considered unfeasible or even impossible to produce

on Earth. However, the dynamic models associated with these application scenarios have rarely been studied. Continuously evolving geometries, irregular nozzle vibrations, low-frequency resonances, and chaotic behaviors present unique challenges. These factors may pose significant threats to the safety of both in-orbit assets and crew members. Understanding and modeling these dynamics are essential for ensuring the reliability and safety of future space manufacturing systems.

Neural Networks for Solving Differential Equations

Georgy Pegarkov, PhD student, York University

Oral Presentation



Differential equations are widely used to describe our complex world. From fields such as physics and chemistry to biology and economics, differential equations are the foundation of many models that mathematically explain how systems changing over time or in response to external influences. While some differential equations have known analytical solutions, many do not, and their solution must be obtained by other approaches. Numerical methods are widely applied to approximate differential equations, but these methods come with downsides. This study explores the use of neural networks for solving differential equations. Neural network theory is discussed and their application to solving differential equations is reviewed. A comparison with traditional methods is made.

Learning Dynamics for Free-Floating Space Manipulators: From Simulation to CubeSat Validation with Neural ODEs

Hadi Jahanshahi, PhD student, York University

Oral and Poster Presentation



This research explores the use of Neural Ordinary Differential Equations (NODEs) to model the dynamics of free-floating space manipulators, with particular emphasis on balancing predictive accuracy and adherence to physical laws in both simulated and real-world environments. We analyze two distinct modeling strategies: a Physics-Informed Neural ODE (PINODE) that learns the system's dynamics directly, and a Hamiltonian Neural ODE that infers the system's behavior through learned energy functions and Hamilton's equations. Our simulation studies highlight an inherent trade-off—PINODE delivers more precise state predictions but does not conserve momentum, while the Hamiltonian method preserves both linear and angular momentum exactly, albeit with lower prediction accuracy. However, over long-time horizons, the Hamiltonian model demonstrates slower error accumulation and better long-term stability in

some state variables, despite its initially higher error rates. We further validate the Hamiltonian approach using a physical CubeSat platform, achieving average position and orientation errors of 0.16 meters and 4.43 degrees, respectively, while maintaining physically consistent behavior even under noisy conditions. Notably, the model learns interpretable friction parameters, shedding light on the directional dependence of friction in the testbed. These results underscore the relevance of choosing the appropriate modeling approach based on mission-specific needs—whether prioritizing precise state estimation or physical fidelity. Overall, this study illustrates the potential of integrating physical constraints into machine learning models for space robotics, offering robust performance across both simulated and experimental domains.

Training-Free Test-Time Adaptation of Foundation Models

Hamidreza Dastmalchi, PhD student, York University

Oral and Poster Presentation



Foundation models have demonstrated impressive generalization across diverse modalities and tasks. However, their performance often drops under distribution shifts at deployment time, leading to reliability concerns in real-world applications. Test-time adaptation (TTA) has emerged as a practical alternative to domain generalization and continual scaling, allowing models to adapt to unseen data distributions on the fly. In this work, we focus on training-free TTA methods, which adapt foundation models during inference without accessing the original training data or requiring gradient updates. Such methods have shown strong potential in domains like point cloud classification and zero-shot vision-language models (e.g., CLIP). While our primary focus is on classification, we also highlight the emerging potential of test-time techniques for mitigating hallucinations in generative vision-language models, which remains an exciting direction for future exploration.

Multiphysics Simulation of Wire-Fed Laser Metal Deposition for Space-Based Additive Manufacturing

Mitra Taghizadeh, PhD student, York University

Oral Presentation



The rise of 3D printing in space marks a major step forward for off-Earth manufacturing, crucial for future space missions and habitats. This research investigates wire-fed laser metal deposition (LMD) as an additive manufacturing method tailored for space environments, focusing on challenges posed by microgravity and vacuum conditions. Unlike traditional Earth-based LMD, where gravity and atmospheric pressure are constants, space-based scenarios demand new considerations.

Using COMSOL Multiphysics, we simulate the LMD process first on earth condition then in zero-gravity and vacuum settings, exploring the impacts on heat transfer, phase transitions, and material deposition to identify key parameters like laser power, material feed rate that ensure high-quality metal printing in space. These simulation results will be validated through Earth-based experiments. Overall, this research supports the development of reliable in-space manufacturing for constructing and repairing spacecraft, promoting self-sufficiency in long-duration missions.

Tactile Feedback Control Strategy for the Autonomous Capture of Non-Cooperative Space Targets by Robots

Mohammad Alizadeh, PhD student, York University

Oral Presentation



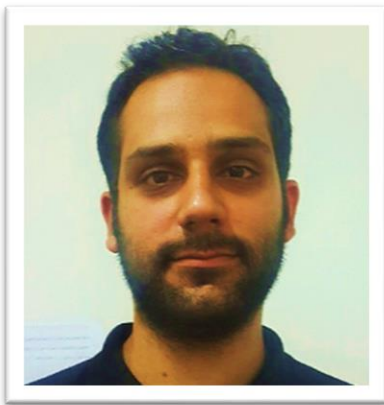
On-orbit servicing (OOS) is essential for maintaining and extending the lifespan of space assets. This research introduces a machine learning-based tactile feedback control strategy for the autonomous capture and manipulation of non-cooperative space targets. Traditional vision-based systems struggle with uncertain conditions, making tactile sensing crucial for secure grasping and detumbling. Our approach integrates real-time tactile feedback with deep learning to enhance grasping adaptability, reduce

slippage, and improve manipulation precision. Utilizing Jetson Orin and Intel RealSense, the system enables accurate object identification and pose estimation. The proposed strategy incorporates soft grasping techniques and a novel detumbling control method using contact force and torque data, ensuring stability in microgravity. By closing the loop between visual recognition and tactile-based manipulation, this research significantly enhances the reliability of robotic systems for OOS. These advancements contribute to cost-effective, sustainable space operations, improving mission success rates and reducing the risk of space debris.

Ensemble Reinforcement Learning for Rendezvous and Docking Control in POMDP Environments

Mostafa Shahrezaei, PhD student, York University

Oral and Poster Presentation

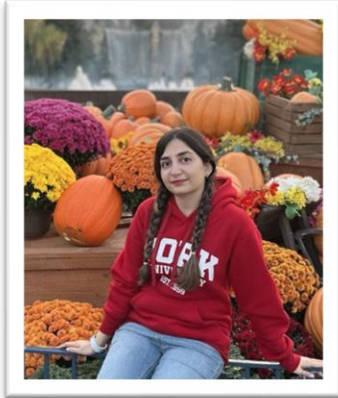


This research explores Ensemble Reinforcement Learning (ERL) as a robust control strategy for Rendezvous and Docking (RVD) operations in Partially Observable Markov Decision Process (POMDP) environments. Traditional control methods struggle with the nonlinear dynamics, high-dimensional action spaces, and uncertainties inherent in 6-degree-of-freedom (6-DOF) spacecraft proximity operations. This work proposes a model-free ERL framework combining Proximal Policy Optimization (PPO) and Deep Deterministic Policy Gradient (DDPG) to enhance adaptability and decision-making under uncertainty. The research includes simulation-based training and validation, with plans for real-world testing on an air-bearing spacecraft simulator. The ultimate goal is to bridge the gap between simulation and operational deployment, enabling autonomous, real-time spacecraft control in complex, uncertain conditions.

Collision-Aware Inverse Kinematics for Dual-Arm Space Robots in Random Target Capture Tasks

Nasim Fallahiarezoodar, PhD student, York University

Oral and Poster Presentation



The increasing accumulation of space debris presents a significant threat to operational spacecraft and future missions, underscoring the need for effective mitigation strategies. One promising solution is deploying robotic arms designed for capturing and removing debris. Dual-arm or multi-arm robotic systems, compared to single-arm alternatives, offer enhanced dexterity and flexibility, enabling more complex manipulation tasks such as grasping irregular or tumbling objects. In this work, we present a control framework for a fixed-base dual-arm space robot to autonomously capture a target object positioned at random locations in the workspace. Using inverse kinematics, the joint configurations of both arms are computed to reach specific gripping points on the target with high precision. To ensure safe and reliable operation, the framework incorporates joint-level self-collision avoidance, maintaining feasible arm configurations throughout the motion. Simulation results demonstrate the effectiveness of the proposed approach in achieving coordinated, collision-free dual-arm manipulation for capturing targets under spatial uncertainty.

Autonomous Quadcopter Navigation using Hybrid Control Approach - Reinforcement Learning and Adaptive Control

Phillip Arab, Master's student, Concordia University

Oral and Poster Presentation



Many Classical Control and Artificial Intelligence (AI) models have been applied to control quadcopter Unmanned Aerial Vehicles (UAVs) for various objectives. Area surveying, search and rescue, emergency landing and takeoff, target following, and obstacle avoidance are all significant navigation related objectives for quadrotors to achieve. There remains much research to be done in the field of control systems engineering and AI to realize the full potential of hybrid control schemes for these challenges.

The scope of this MASc project's is to research and develop methods of hybrid control for quadcopter UAVs. The effectiveness of pairing the versatility of AI with the robustness of classical control in this setting will be investigated. The specific objective of interest will be target-tracking and obstacle avoidance, and the specific control methods will be Reinforcement Learning and Adaptive Control. The implications of this research extend broadly to other quadrotor tasks, and other control methods.

Photonic Integrated Circuits Payload for Western Skylark CubeSat

Purvaja Karthikeyan, PhD student, University of Western Ontario

Oral Presentation



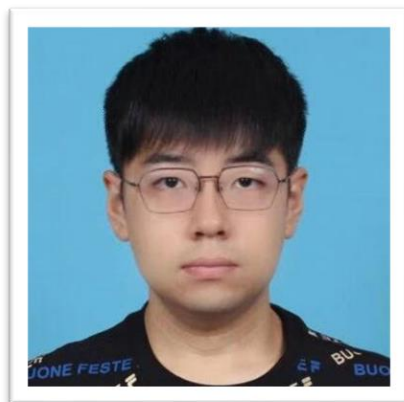
The Western Skylark is a 3U CubeSat designed for next-generation tracking of migratory wildlife, such as songbirds. Currently, data on the migration of these birds is collected by visiting Motus tracking stations in person, which is a time-consuming and tedious task. To address this, the Skylark CubeSat is intended to orbit Earth in a sun-synchronous orbit, collecting data from Motus tracking stations and transmitting it to the ground station at Western University.

The CubeSat carries a secondary payload called the Photonic Test Bench (PTB), a novel platform for testing photonic integrated circuits (PICs) in space, aimed at establishing a proof of concept. PICs include optical devices such as Mach-Zehnder interferometers and ring modulators, which have various applications in fields like filtering, sensing, and communication systems. The goal of this payload is to analyze the performance of the PIC chip in the space environment, with a focus on developing radiation-hardened PICs for future space applications.

Finite element model-based computational control framework for flexible tethered satellite system

Qi Zhang, PhD student, York University

Oral Presentation



This paper presents a computational feedback control framework for flexible tethered space systems by integrating dynamic modeling, state estimation, and a finite element-based two-loop control strategy. A high-fidelity dynamic model of the tethered system is developed using the nodal position finite element method. The positions and velocities of the entire tether are estimated via a robust finite element Kalman state estimator.

To regulate the geometrical profile of the flexible tether, a two-loop control strategy is introduced: the inner-loop controller is designed based on the inverse dynamic model of each element, while the outer-loop controller generates the desired trajectory of each element using sliding mode control theory. The overall control inputs are computed numerically through the finite element assembly procedure. The effectiveness of the proposed framework is demonstrated through numerical simulations of an initially bent tethered system. Results indicate that this approach can be extended to other flexible elastic systems, highlighting its potential for broader applications.

Influence of 3D Printing Process Parameters on the Anisotropic Viscoelastic Behavior of Thermoplastic Polyurethane (TPU)

Ragab Etiw, PhD student, York University

Oral Presentation



Additive manufacturing, particularly 3D printing, has transformed the creation of complex geometries and expanded the use of elastomeric materials. However, the influence of printing parameters on the anisotropic viscoelastic behavior of 3D-printed elastomers remains under active investigation. This study examines how drying time, printing temperature, raster orientation, layer height, and strain rate affect the mechanical performance of 3D-printed TPU. Extended filament drying (8 hours) enhances stiffness and stress response more

than increased printing temperature. Uniaxial tensile, planar, and stress relaxation tests show that 0° raster specimens, aligned with the loading direction, consistently exhibit higher strength, stiffness, and deformation, while 90° rasters fail earlier due to weak raster bonding. Although both orientations reach equilibrium stress within 900 seconds, 0° rasters display higher equilibrium stresses and greater stress decay, indicating more viscoelastic energy dissipation. Microscopy confirms that reducing the layer height from 0.24 mm to 0.18 mm improves interlayer adhesion but narrows raster-to-raster bond widths, leading to more pronounced anisotropic behavior.

Autonomous Gardener Robot: AI-Driven Automation for Intelligent Garden Maintenance

Wanda Guo, PhD student, Concordia University

Oral Presentation



Embodied intelligence has become a key research focus in autonomous robotics, particularly in gardening and agricultural applications. Recent advancements in deep reinforcement learning (DRL), dynamic obstacle avoidance, and 3D SLAM have enabled robots to achieve higher autonomy. However, challenges remain in integrating robotic arm and mobile platform coordination, improving DRL-based obstacle avoidance in dynamic environments, and adapting 3D SLAM to outdoor gardening scenarios. Traditional methods often fail to generalize well in real-world settings. This review examines the latest developments in embodied intelligence for garden maintenance robots, focusing on DRL applications in motion planning, dynamic obstacle avoidance strategies, and 3D SLAM implementations. By analyzing existing approaches, we identify key challenges and highlight potential research directions to enhance robotic autonomy and adaptability.

Effects of Gravity and Vacuum Conditions on Properties of 3D Printed Parts by Fused Deposition Modeling

Yanyan Zhao, Master's student, York University

Oral and Poster Presentation



This study conducted experimental investigation on the effects of gravity and vacuum conditions on properties of 3D printed parts fabricated via Fused deposition modeling on Earth. The gravity effect was investigated by rotating the 3D printer to print parts at various angles relative to the horizon, ranging from 0° to 90° at 15° interval, in air, respectively. The same fabrication processes were repeated in a vacuum chamber to investigate the combined effect of gravity and vacuum. By measuring the dimensional accuracy of parts, 3D

Nanometer-Scale Computed Tomography, MTS materials testing machine measured the mechanical properties to obtain relevant data for analysis of the results. The results shows noticeable difference between parts printed at different inclination angles and between parts printed in air and vacuum. Statistical analyses were conducted to reveal Process-Structure-Property (SSP) relationship to understand how environment and process parameters affect the microstructure and subsequently the properties of printed parts.

Stabilization of a Flexible Beam Using a Computational Controlled PZT Actuator

Zhengze Liu, PhD student, York University

Oral Presentation



Computational control is an emerging interdisciplinary field that integrates numerical modeling and control strategies with advanced computational techniques to enhance the management of complex dynamic systems. This presentation explores the application of a computational control framework for stabilizing flexible solid structures, utilizing the Nodal Position Finite Element Method (NPFEM) for system modeling and Sontag's formula as a universal control law derived from limited

system information. The PZT actuator is employed to stabilize the vibrations of a cantilever beam, serving as a practical testbed for the proposed methodology. The system features

vision-based displacement sensing and piezoelectric actuation using a two-layer PZT bender. Control signals, generated by the computational framework, are implemented via a custom LabVIEW Virtual Instrument (VI) and two voltage amplifiers, which convert the computed torque into actuation commands for real-time stabilization.

TABES

Student Presentation Abstracts



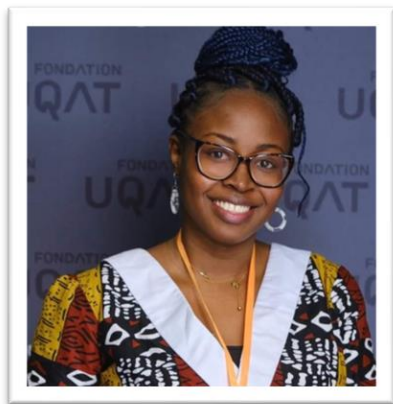
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Biomethanization of cattle, agricultural and forestry residues

Gérardine Feujio Voumo, PhD student, Université du Québec en Abitibi-Témiscamingue

Poster Presentation



My thesis project aims to improve the biomethanization of cattle manure to reduce agricultural greenhouse gas (GHG) emissions while producing renewable energy. Anaerobic digestion (AD) captures methane (CH₄), a potent GHG, and converts it into biogas. However, the efficiency of manure AD is limited by its low biodegradability, especially the lignocellulosic fraction. To address this, I propose using agroforestry residues (straw, softwood chips, sawdust) to boost biogas production by providing an accessible carbon source for micro-organisms. Objectives include identifying key enzymes for wood degradation, analysing how the nature and size of residues affect biogas and digestate, and quantifying GHGs avoided. The methodology combines biochemical and metagenomic analyses to better understand the process. The results could support GHG reduction in Canada and help develop on-farm biomethanization models, promoting a circular bioeconomy and reusing digestate as a biofertilizer in agriculture.

Valorization of Oil Sand Tailings for Critical Metal Recovery: What Bioleaching Could Bring?

Khyati Joshi, PhD student, York University

Oral Presentation



Oil sand tailings, produced during bitumen extraction, pose significant environmental challenges, including ecosystem disruption and toxic metal leaching into soil and water. Improper disposal can lead to groundwater contamination, biodiversity loss, and increased remediation costs. With growing industrial activities, the volume of tailings continues to rise, highlighting the need for sustainable management strategies.

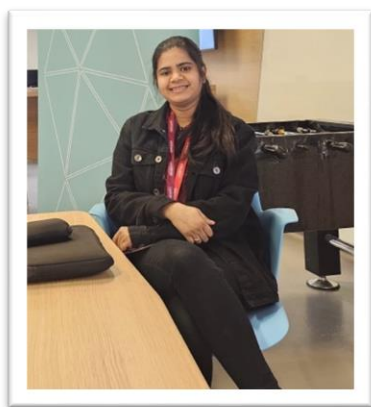
Despite environmental risks, oil sand tailings offer economic potential as a source of critical metals. Recovering these metals provides a sustainable alternative to traditional mining. ICP-AES analysis has revealed high concentrations of aluminum (~90,000

ppm), titanium (~4000 ppm), magnesium (~3500 ppm), and rare earth elements (~1000 ppm) in these tailings. Furthermore, 16S rRNA sequencing has identified bacteria capable of bioleaching, which enhances metal extraction while minimizing environmental impact. Integrating microbial bioleaching into metal recovery supports both sustainable waste management and resource efficiency, offering a promising solution for managing oil sand tailings.

Screening of *Rhodospiridium* strains for enhanced carotenoid production

Lachi Wankhede, PhD student, York University

Oral and Poster Presentation



Carotenoids are bioactive pigments with antioxidant properties and applications in food, pharmaceutical, and cosmetic industries. Their health benefits and potential as natural colourants show the need for sustainable production processes. Microbial biosynthesis using *Rhodospiridium* species offers a promising alternative to conventional extraction from plant sources, owing to the organism's rapid growth and efficient metabolic pathways. In this study, five *Rhodospiridium* strains (Rt 1588, Rt 6984, Rt 6987, Rt 7191, and Rt 1091) were evaluated under specific cultivation conditions. Growth kinetics and carotenoid yield were conducted, with particular attention to the synthesis of Torulene and torularhodin, two carotenoids of emerging interest due to their unique structural and functional properties. Comparative analysis showed that strain Rt 6984 outperformed the others, showing significantly higher total carotenoid content and enhanced production of both Torulene and torularhodin. These findings not only validate the potential of Rt 6984 as a superior candidate for industrial carotenoid production but also provide a basis for future process optimization and genetic modulation strategies.

How Can We Turn the Cold to Our Advantage? Unlocking Psychrophilic Fermentation for High Value Volatile Fatty Acids

Reema, PhD student, York University

Oral Presentation



Psychrophilic fermentation presents an energy-efficient alternative for volatile fatty acid (VFA) production, but its effectiveness is constrained by inefficient hydrolysis. This study systematically investigated optimization strategies to enhance VFA production, particularly butyric acid, under psychrophilic conditions. A comparative analysis between psychrophilic and mesophilic fermentation revealed that butyric acid sustained longer at lower temperatures. The enrichment of the hydrolytic bacterial community, dominated by *Solibacillus* and *Sporosarcina*, played a crucial role in supporting acidogenesis. To overcome hydrolysis as a major bottleneck, thermal-alkaline pretreatment was employed, significantly improving substrate breakdown and microbial accessibility. A meta-analysis confirmed a strong correlation between substrate concentration and VFA production, guiding the selection of optimal initial volatile solids concentrations and alkaline pH maintenance to support the acidogenesis. Further enhancement was achieved through rhamnolipid biosurfactants, which facilitated substrate utilization leading to a rise in VFA concentration. To further refine product specificity, bioaugmentation with *Clostridium butyricum* was applied, effectively enhancing butyric acid production. This increased butyric acid selectivity, demonstrated the potential for targeted microbial steering in psychrophilic systems. Overall, this study demonstrates that a combination of hydrolysis optimization, microbial enhancement, and process control can effectively improve both VFA concentration and specificity in psychrophilic fermentation, reducing the gap with mesophilic fermentation. These findings provide a foundation for more efficient low-temperature bioconversion strategies, offering new insights for advancing food waste valorization.

Comparison of the desalination potential of two microalgae strains

Vicky Alain, Master's student, University of Quebec at Trois-Rivières (UQTR)

Poster Presentation



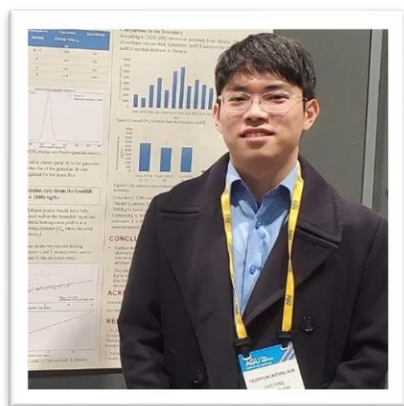
The use of microalgae for industrial effluent remediation has been well studied, and industries, such as aquaculture, are now exploring their potential for desalination. Biodesalination, an emerging technology, utilizes biological systems to remove salt from seawater or brackish water through adsorption and absorption. Adsorption is a rapid process (1–30 minutes), while bioaccumulation removes negligible amounts of salt in such a short timeframe. This presentation examines preliminary results on the adsorption potential of two freshwater microalgae strains:

a pure strain (*Chlorella sorokiniana*) and a consortium. Key parameters tested include salinity, cell concentration, temperature, and contact time, providing insights into their efficiency for sustainable desalination.

Efficient and Separable g-C₃N₄/TiO₂ Heterostructure Nanorods for Enhanced Photocatalytic Water Treatment

Yeuhyun (Kevin) Kim, PhD student, York University

Oral Presentation



Emerging contaminants, such as pharmaceuticals and textile dyes, present increasing challenges for water treatment. Photocatalysis, which uses light to break down pollutants, offers a sustainable solution but current nanomaterials often suffer from limited light absorption spectrum, rapid charge recombination, and difficulty in recovery after use. This study addresses these limitations by developing a novel composite made of graphitic carbon nitride (g-C₃N₄) and titanium dioxide

(TiO₂) nanorods. Designed for easy separation from treated water, the material maintains strong pollutant degradation performance. Its enhanced efficiency is attributed to an engineered S-scheme heterojunction, which improves charge transport and light utilization. Structural and functional properties were confirmed using scanning electron microscopy, X-ray diffraction, and electrochemical techniques. Improved photocatalytic activity was demonstrated

through model degradation tests using methylene blue dye. By combining high efficiency with practical usability, this work represents a step toward scalable and sustainable water treatment technologies.

Pre-hygrothermal analysis of adhesively bonded CFRP-to-concrete systems

Zahir Namourah, PhD student, Université du Québec en Abitibi-Témiscamingue

Oral and Poster Presentation



The use of fibre-reinforced polymer materials for strengthening existing structures has been increasing as an alternative to traditional materials due to their superior durability, lightweight, low maintenance cost, and rapid installation. Adhesive bonding techniques such as near-surface mounted (NSM) and externally bonded reinforcement (EBR) are preferable. Despite the increasing knowledge, the long-term performance of these strengthening techniques is still not clearly understood, limiting their use. This work aims to provide reliable predictions of the long-term performance of these techniques supported by numerical modelling and calibrated with the experimental program developed in this work. Current work represents single-lap shear tests on the EBR prototypes, morphological studies of the failure modes, and Fourier Transform Infrared on the concrete substrate. These ongoing tests will assist in understanding the mechanical, chemical, and morphological characterization at the pre-ageing stage and serve as a reference for the aged for long-term performance predictions of NSM and EBR.

MTA

Student Presentation Abstracts



**Microsystems
Technologies &
Application**



Advancements in Screen-Printed Copper Multilayer Circuits for Flexible Hybrid Electronics

Astrid Carolina, Master's student, École de technologie supérieure

Oral and Poster Presentation

Flexible Hybrid Electronics (FHEs) are revolutionizing electronic manufacturing by enabling additive, cost-effective, and scalable production. In this study, we explore the development of screen-printed multilayer copper circuits on flexible substrates, specifically flexible FR4 and polyimide (PI) sheets, addressing key process parameters and material compatibility. The fabrication involves successive deposition of conductive and dielectric layers, ensuring precise patterning while maintaining mechanical flexibility. Additionally, we investigate the integration of low-temperature solder (LTS) for Surface Mount Device (SMD) assembly, achieving a peak reflow temperature lower than conventional 220 °C processes. To assess the viability of this approach, the resolution of the printed traces, the elemental composition and oxidation behavior of copper inks, the electrical performance of the circuit, and the functionality of the assembled components were evaluated. The experimental results are compared with literature on conventional PCBs, highlighting the potential of screen-printed circuits to reduce material waste, improve cost-efficiency, and enhance scalability. This work advances additive manufacturing techniques for next-generation flexible and hybrid electronics, bridging the gap between printed electronics and conventional circuit assembly.

Low-Cost Electrochemical Microfluidic Sensor with Lead-Ion Imprinted Polymer Membrane for Low-Limit Heavy Metal Detection in Water

Ayobami Elisha Oseyemi, PhD student, York University

Oral Presentation

This study presents a low-cost electrochemical microfluidic sensor featuring a lead ion-imprinted polymer (Pb-IIP) membrane for selective detection of lead in water. The Pb-IIP membrane, synthesized using Pb^{2+} as a template, methacrylic acid as a monomer, and 8-hydroxyquinoline as a ligand, was photopolymerized on-chip between two unmodified electrodes. The resulting sensor achieved a detection limit of 7.3 ppb and quantification up to 100 ppm. Compared to control configurations, it showed a 6.1-fold increase in current response over the membrane-less version, and up to 13-fold over non-imprinted polymer controls. Specificity tests revealed 12.5–69.4% higher Pb^{2+} responses than for Cd^{2+} and Zn^{2+} , with

significant statistical differences ($P < 0.01$ to $P < 0.0001$). The membrane's customizable chemistry and the scalable microfluidic architecture make this platform ideal for Point-of-Need (PoN) environmental testing and broader applications in water quality monitoring.

Phase extraction based droplet microfluidic sensor for microplastic detection

Baixin Tong, PhD student, York University

Oral Presentation

Microplastics (MPs), defined as plastic particles smaller than 5 mm, are emerging pollutants that pose significant risks to human health and the environment. MPs originate from the degradation of larger plastic waste and direct disposal, penetrating biological barriers in the lungs and intestines, potentially causing harmful effects. To address these impacts, this study introduces a novel microfluidic droplet sensor leveraging Liquid Phase Exfoliation (LPE) for efficient MP separation, encapsulation, and analysis. The system extracts and detects MPs from water into an organic phase under diverse conditions, including varying salinity, particle size (0.2–10 μm), and chemical composition. Statistical reliability is enhanced by dividing samples into numerous droplets, each encapsulating a portion for repeated analysis. Comprehensive characterization is achieved using Raman and FTIR spectroscopy to determine particle size, quantity, morphology, and composition.

Cold Gas Thruster Design for a CubeSat Mission

Elham Baneshi, Master's student, University of Manitoba

Oral and Poster Presentation

For decades, the high cost of launching satellites meant that access to space was limited primarily to government agencies. However, the rise of commercial launch providers capable of deploying multiple payloads has significantly reduced costs and increased space mission accessibility. In response, the CubeSat standard was introduced to support faster development, lower mission costs, and more frequent access to space. Today, CubeSats are widely used by industry, academia, and government for applications such as ship tracking, communications, Earth observation, and scientific research.

As part of this growing wave of CubeSat innovation, the Little Innovator in Space Situational Awareness (LISSA) CubeSat, developed by the STARLab at the University of Manitoba. LISSA is a 6U platform designed to fly in tandem with the Redwing satellite to enhance space domain

awareness. To extend LISSA's capabilities, a cold gas thruster system is being developed as part of its AODCS subsystem, enabling potential collision avoidance, deorbiting, and limited orbital maneuvering.

This work presents the design and analysis of a cold gas thruster optimized for LISSA's strict volume, mass, and integration constraints. The system addresses key propulsion challenges faced by CubeSats, including the need to operate under limited power budget, achieve sufficient thrust level, and interface reliably with onboard electronics and structural subsystem. To address those challenges, a systematic approach is taken to configure the thruster, focusing on tank sizing to balance propellant capacity with available volume, valve selection to ensure fast response and low leakage under varying temperatures and pressures, and integration of propulsion components within the CubeSat's internal architecture. This project highlights the engineering trade-offs and practical challenges involved in developing compact propulsion systems and contributes to the advancement of flexible, mission-capable CubeSat platforms.

Assessment of KN95 mask filtering degradation and breathing detection : A Pilot Study

Julie Payette, PhD student, École de technologie supérieure

Oral Presentation

Detecting uric acid (UA) concentration is important for diagnosing and treatment of various diseases including renal, cardiovascular, and neurodegenerative diseases. The enzymatic biosensor for UA detection has been studied using bentonite (Bent) and multi-walled carbon nanotube (MWCNT). Using spray coating method, the bent-MWCNT nanocomposite solution was coated on screen-printed carbon electrode then the uricase enzyme (UOx) was immobilized. Electrochemical measurement was performed to compare peak values for the different composition of Bent-MWCNT solution. The stability was tested through flow injection system.

Examining Potential Bias in Optical Technologies

Kayrel Edwards, Post Doctoral Fellow, York University

Oral and Poster Presentation

Can we deliver a blueprint to develop ethical technologies towards erasing the racism in optical devices? Melanin pigment determines skin tone. The main objective of this project is to improve the design of infrared oximeters to help increase the sensitivity and performance of pulse and cerebral oximeters for darker skin. We will first measure the response of optical technologies as a function of tissue melanin content, to determine the extent of device racial bias. We have developed AI algorithms and fabricated artificial tissue models across the melanin spectrum to assess how melanin concentration variations affect optical readings in various everyday tools and medical devices, such as apple watches, cerebral oximeters, and fingertip pulse oximeters. Power loss measurements of red and Near Infrared (NIR) light through artificial tissue models made of chitosan and melanin, show that more than 90 % of light is lost when transmitted through dark skin (Melanin concentration > 10 µg/mg; or Fitzpatrick Type V-VI) compared to fairer skin. By developing new methods for enhancing NIR light transmission through dark skin, we aim to help increase the sensitivity of optical technologies for darker skin tones. To do this we will design an oximeter with improved sensitivity by (i) varying the source-detector distance, (ii) developing a better calibration curve and algorithm for adjusting light intensity to match skin tone, and (iii) varying the detector type (Si photodiode, Si photomultiplier, avalanche photodiode). Additionally, the addition of an optical clearing agent on top of skin might increase the penetration depth of NIR light for the optical devices, leading to improved sensitivity for all skin tones.

Modular Liver Bioreactor Integrated with 3D Bioprinted Scaffolds and Electrochemical Biosensors

Kinam Hyun, PhD student, University of Calgary

Oral Presentation

The liver, the largest internal organ in the human body, has a remarkable ability to regenerate. However, significant disease symptoms often do not appear until the liver reaches an irreversible state, such as liver failure, which is often fatal within a year. Currently, liver transplantation is the only effective treatment for patients with liver failure. Before transplantation, patients' symptoms must be continuously monitored, either by medical

personnel or supportive extracorporeal devices. In this research, a modular liver-on-a-chip is proposed, integrating 3D bioprinting and biosensor technologies to function as a bulk bioreactor in future liver support systems. The liver-on-a-chip is designed based on the liver lobule's architecture to provide optimal physiological relevance for liver cells. Liver cells are bioprinted into the housing of a microfluidic chip, forming a 3D hydrogel scaffold that allows the laminar flow of biological fluids, emulating both the hepatic cellular structure and the blood flow of the human liver. Electrochemical biosensors are integrated into the liver chip to continuously monitor biomolecule levels, such as albumin and urea, produced by liver cell metabolism. The biosensors are modified with nanocomposites to enhance sensitivity and stability in fouling and flowing environments. To achieve this goal, liver-on-a-chips were fabricated using an SLA-based 3D printer and tested. Gelatin methacryloyl (GelMA) and ornithine methacryloyl (OrnMA) were investigated as potential bioink materials. Bentonite and multi-walled carbon nanotubes (MWCNTs) were deposited on screen-printed carbon electrodes (SPCEs) and characterized for the liver biosensor. The developed modular liver-on-a-chip holds significant potential for advancing the development of liver bioreactors for liver support systems and for enabling in vitro analysis of liver physiology. The modularity of the chip and integrated biosensors will allow researchers to efficiently study liver functions with varying volumes of the liver.

Atomistic Quantum Transport Simulation of Stacked Graphene Nanosheet Field-Effect Transistors

Paul Park, Master's student, University of Waterloo

Oral Presentation

As transistors continue to scale down to meet the demand of faster and more effective devices, the scaling limit of the Moore's law is becoming apparent. To overcome this challenge, the industry has shifted from the tri-gate fin-shaped field effect transistors (FinFET) to the gate-all-around (GAA) nanosheet designs, which demonstrate greater electrostatic control reducing the short channel effects. GAA nanosheet FET have the advantage of being vertically stackable which can improve the ON-current but comes with the significant fabrication challenge of wrapping individual channels with a gate layer. Stacked nanosheet FET without the gate between the layers (GAP-FET), could potentially decrease the fabrication complexity while maintaining desirable device performance. The GAP-FET is a design that TSMC and Intel have reported on previously but, there is a lack of study on the potential and the underlying physics

of the GAP-FET design. I aim to understand the advantages and disadvantages of the GAP-FET with the use of a NEGF-Poisson model to simulate the quantum transport and the electrostatics of the GAP-FET design. In this study, graphene nanoribbon (GNR) is utilized as the channel material due to the material's excellent carrier mobility, thermal conductivity, and high saturation velocity.

Assessing the Feasibility of Additively Manufactured Reaction Wheels for Small Satellites

Ricky Gill, Master's student, University of Manitoba

Oral Presentation

As spacecraft missions become more advanced, future applications will demand even greater fine-pointing precision for accurate data collection. This growing need highlights the importance of developing advanced reaction wheel devices to meet increasingly stringent requirements in the aerospace industry. Modern reaction wheels are produced through traditional subtractive machining, limiting design flexibility and resulting in a time-consuming, error-prone, and highly variable balancing process. Due to their low inertia, small satellites are especially prone to dynamic and static reaction wheel imbalances, potentially leading to debilitating attitude jitter. Replacing traditional manufacturing methods with additive manufacturing provides a unique opportunity to reduce cost, time, and labor, while enabling the production of complex geometries. This research focuses on assessing the feasibility of using additively manufactured reaction wheels for CubeSats and small satellites. A series of Monte Carlo simulations are performed to estimate the static and dynamic imbalance of reaction wheel rotors manufactured via Laser Powder Bed Fusion. The findings suggest that metal additive manufacturing offers the necessary approach to produce the next generation of high-precision reaction wheels.

Development of spray-coated nanohybrid enzymatic biosensor

Seohyun Park, Master's student, University of Calgary

Oral Presentation

Biosensors are widely applicable in healthcare and diagnostics, enabling rapid and accurate detection of biological analytes. This study aims to develop a sensitive and stable enzymatic biosensor for uric acid detection using a spray-coated nanocomposite of bentonite (Bent) and multi-walled carbon nanotubes (MWCNTs). The proposed method enhances sensor

performance through uniform spray deposition and uricase immobilization via glutaraldehyde crosslinking. The biosensor will undergo electrochemical and surface characterization, antifouling evaluation, and flow injection testing for real-time monitoring. Preliminary results demonstrate successful sensor fabrication, optimized spray parameters, and high sensitivity at a 1:1 Bent/MWCNT ink composition.

A Microfluidic-Based Approach for the Controlled Synthesis of Homogeneous PEGylated Liposomes with Tunable Size and High Encapsulation Efficiency

Shima Akar, PhD student, University of Victoria

Oral Presentation

Liposomes are widely characterized and utilized in nanomedicine for drug delivery due to their biocompatibility, low toxicity, and ability to encapsulate both hydrophilic and hydrophobic molecules. Additionally, their surface can be modified to facilitate targeted drug delivery. However, conventional methods for liposome synthesis, such as ethanol injection and thin-film hydration, present limitations in scalability, reproducibility, and consistency, restricting their clinical and commercial applications. To address these challenges, a microfluidic-based platform has been developed, enabling the self-assembly of liposomes in a single step with high reproducibility. In this study, liposomes were self-assembled through the controlled mixing of egg yolk phosphatidylcholine, cholesterol, and DSPE-PEG2000, dissolved in ethanol, with HEPES buffer as the aqueous phase. DSPE-PEG2000 was incorporated into the formulation to enhance stability and prolong blood circulation time. A comparative parametric study was conducted to evaluate the effects of key synthesis parameters, including chip geometry, total flow rate, flow rate ratio, lipid concentration, and solvent-buffer composition, on liposome formation. Homogeneous liposomes were successfully produced, with sizes ranging from 60 nm, classified as small unilamellar vesicles (SUVs), to 150 nm, classified as large unilamellar vesicles (LUVs), and a polydispersity index (PDI) below 0.2. Encapsulation studies using Nile Red as a surrogate hydrophobic cargo demonstrated an encapsulation efficiency of 74%, with the liposomes maintaining stability for 45 days without significant changes in physicochemical properties. This study presents a robust and scalable high-throughput platform for liposome synthesis, offering precise control over size and encapsulation efficiency. The demonstrated approach holds potential for a wide range of drug delivery applications, providing a scalable solution for future clinical and industrial implementation.

AM-EDGE

Student Presentation Abstracts



Segregation and agglomeration of carbon nanotubes on auxetic and non-auxetic architected lattices for piezoresistive applications

Angel Mora Cordova, Post Doctoral Fellow, York University

Oral and Poster Presentation

The addition of carbon nanotubes (CNTs) into a polymer matrix results in a nanocomposite material with piezoresistive behavior. Architected materials possess unusual properties, such as auxeticity, and have been fabricated using nanocomposites to obtain sensors with added functionality. Usually, a homogeneous distribution of CNTs is desired to improve the piezoresistive response of nanocomposites. However, heterogeneous distributions of CNTs that affect their electrical behavior have been developed (segregation) or occur naturally during fabrication (agglomeration). Then, a computational study on the effect of CNT segregation and agglomeration on the piezoresistive response of architected materials is presented. Two types of architected materials are studied, viz., re-entrant (auxetic) and hexagonal (non-auxetic) two-dimensional lattices. Mechanical deformation is applied via a displacement boundary condition using finite element simulations. The piezoresistive curves and gauge factors of auxetic and non-auxetic architected materials are compared in terms of segregation and agglomeration of CNTs.

Magnetic Field-Assisted Additive Manufacturing of Iron-Reinforced PLA Composites

Arleth Suárez-Hurtado, Master's student, York University

Oral and Poster Presentation

Magnetorheological (MR) materials, such as ferromagnetic particle-reinforced composites, exhibit tunable mechanical properties under magnetic fields, crucial for innovative applications in automotive, aerospace, and medical devices. However, accurately modeling their behavior remains challenging due to the intricate interactions between the magnetic particles and the matrix. This research explores how applying a magnetic field during additive manufacturing, also known as 3D printing, can affect the alignment and distribution of magnetic particles, influencing the material's mechanical properties. Preliminary results show that magnetic fields significantly alter mechanical properties, including toughness and Young's modulus, suggesting the potential for real-time control during fabrication. Iron-reinforced polylactic acid (PLA) filament is magnetized during the fused filament fabrication (FFF). ASTM D638 Type IV specimens are printed under three conditions: without a magnetic field, above a single

samarium cobalt magnet, and between two samarium cobalt magnets. All samples were printed using 0- and 90-degree raster for anisotropic behavior evaluation. The effects of these different orientations on the material's mechanical properties and microstructure are examined using tensile testing and optical microscopy. The findings provide valuable insights into the influence of magnetic field direction and field strength on MR materials, which contribute to developing these materials for enhanced and tunable structural integrity.

Multiscale Computational Study of Phase-Specific Defect Behavior in Irradiated U-10Zr Alloy

Asmabi Thottathila, PhD student, University of Saskatchewan

Oral and Poster Presentation

Uranium 10 wt.% zirconium (U-10Zr) is a leading metallic fuel for fast reactors due to its high thermal conductivity and dense fissile content. The alloy exists in multiple solid phases: a high-temperature gamma (γ) phase with a body-centered cubic structure, which decomposes upon cooling into orthorhombic alpha (α)-U and intermetallic delta (δ)-UZr₂. The coexistence of these phases in service conditions raises a critical question: which phase offers the greatest resistance to radiation-induced damage? Fast neutron irradiation generates atomic displacement cascades that result in vacancies and interstitials. These point defects can cluster into voids and dislocation loops, contributing to swelling, embrittlement, and degradation of mechanical and functional properties. While previous studies have suggested that such defects reduce elastic stiffness and electronic conductivity in U-Zr systems, a systematic, phase-specific understanding remains limited. This study proposes a multiscale computational investigation to evaluate how irradiation-induced point defects affect the structural, thermal, and electronic behavior of α -, γ -, and δ -phase U-10Zr. Density functional theory (DFT) and ab initio molecular dynamics (AIMD) using VASP will be used to model defect formation energies, local atomic relaxations, and changes in electronic structure. Classical molecular dynamics simulations with LAMMPS will enable the exploration of larger-scale effects such as phonon transport and mechanical response. We will assess how uranium and zirconium vacancies and interstitials influence key material properties, including elastic constants, bulk and shear moduli, Debye temperature, Vickers hardness, thermal expansion, heat capacity, formation enthalpy, surface energy, thermal conductivity (both electronic and lattice contributions), and electronic properties such as band structure and density of states. By comparing the defect

tolerance and property degradation across the three phases, this work aims to identify the most irradiation-resistant phase of U-10Zr and provide insights that support the design of more robust nuclear fuels for advanced reactor systems.

Charpy impact on 3D-printed parts

Felipe Franco, PhD student, York University

Oral and Poster Presentation

This study investigates the Charpy impact on 3D-printed parts that use non-planar slicing techniques to address anisotropy and delamination issues found in traditional planar slicing. Five PLA and PETG specimen types were tested using the Charpy impact test as per ASTM D6110 standards. Results showed improved energy absorption attributed to elongated, irregular crack paths. Non-planar slicing also reduced anisotropy, suggesting further applications in industry.

Laser Powder Bed Fusion of Soft Magnetic Fe-6.5Si alloy

Masoud Ahmadniafeizabadi, PhD student, McMaster University

Oral and Poster Presentation

Fe-6.5%Si offers an optimal balance of high saturation magnetization and high electrical resistivity, resulting in low iron loss for AC magnetic applications. Despite these advantageous properties, its widespread adoption is hindered by high processing costs due to its inherent brittleness. Laser powder bed fusion (LPBF) presents a promising approach for processing the brittle Fe-6.5%Si alloy, as its high solidification cooling rate suppresses the formation of brittle ordered phases. This study investigates the influence of LPBF process parameters on densification, crack density, and the fraction of ordered phases in the microstructure. Optimal processing conditions were identified as a laser power of 200 W and a scanning speed of 800 mm/s, which ensured full fusion while minimizing the formation of brittle B2 phases. Additionally, mechanical alloying of the powder with 1% chromium (Cr) further improved the results by reducing crack intensity. Energy-dispersive X-ray spectroscopy (EDS) analysis revealed significant silicon (Si) segregation near cracks in the Fe-6.5%Si alloy, suggesting that elemental segregation in the mushy zone contributes to solidification cracking. However, Si segregation was not observed in the Fe-6.5%Si-1Cr alloy, confirming Cr's role in mitigating Si segregation during solidification. Furthermore, preheating the build platform to 200°C

effectively eliminated vertical cracks in the microstructure by reducing residual stresses and promoting equiaxed grain formation in the melt pools. This research demonstrates the potential of LPBF to process brittle Fe-6.5Si alloy to fabricate electric motor cores.

Development of Electrospun Biocompatible Vessels for Vascular Tissue Engineering

Mhd Youssef Demashkieh, Master's student, York University

Oral and Poster Presentation

This research addresses a significant gap in vascular tissue engineering, focusing on the development of capillary-like structures, particularly fenestrated capillaries crucial for efficient nutrient and waste exchange. The study introduces an optimized electrospinning process utilizing Polycaprolactone (PCL) and Polyethylene Glycol (PEG) to fabricate biocompatible, porous hollow fibers that mimic the microstructure of native capillaries. By refining electrospinning parameters and employing advanced imaging techniques, this project aims to enhance control over pore size and distribution, improving cell attachment and proliferation, thereby advancing the efficacy of tissue-engineered scaffolds.

Di-electrophoresis assisted microwave sensing (DAMS) for label-free detection of Metastatic malignancy: The concept

Nikhil Venkata Giri, PhD student, University of Waterloo

Oral and Poster Presentation

Cancer metastasis is responsible for more than >95% of cancer-related deaths in the world. Circulating tumour cells (CTCs) contribute to metastasis and directly reflect disease progression. Nevertheless, they are challenging to detect due to their disparate properties compared to normal cells. We demonstrate an unconventional label-free method utilising a microwave sensor to leverage the CTC's electrical properties. The CTCs are encapsulated within blood plugs and are indicated by the sensor's resonance shift. Positive dielectrophoresis (p-DEP) is utilized to enhance detection, which depends on the CTC size, electrical properties, and the magnitude of the change in the Electric Field as the blood plug arrives over the electrode. The maximum resonance shift obtained was Δf : 0.8MHz for a nondimensional plug length of $\frac{L_e}{L_d}$: 0.6. Additionally, for $\frac{L_e}{L_d}$: 0.6, we also demonstrate the sensor's ability to detect other types of cancer (non-metastatic breast and Metastatic colorectal). Finally, we account for

the interindividual variability in blood by testing sensor functionality under various blood properties.

**Mobile Application with Real-Time AI Exercise Feedback Improves Physiotherapy
Adherence and Recovery**

Pierre Gautreau, PhD student, York University

Oral and Poster Presentation

Poor adherence to prescribed physiotherapy exercises compromises recovery outcomes for musculoskeletal conditions and necessitates more effective solutions. This study evaluates the impact of a digital health tool that provides real-time AI exercise feedback, the Smart Physiotherapy Activity Recognition System (SPARS), and its companion mobile application, PT+, on patient exercise adherence and recovery outcomes in shoulder physiotherapy. SPARS uses inertial sensors in commercially available smartwatches to track exercise quantity and technique quality. PT+ provides real-time feedback reflecting individual exercise quality and tracks progress for patients. We conducted a comparative cohort study in which each participant was observed for 12 weeks, where the intervention group (n=24) received a smartwatch and tablet enabled with SPARS/PT+, while the control group (n=100) wore a smartwatch but did not have access to PT+. The study collected 6,498 patient-days of exercise data and 2,093 hours of movement records, which were analyzed using mixed-effects linear models to assess adherence and clinical outcomes. Findings indicate that real-time AI feedback improves participation adherence to at-home exercises and leads to more effective long-term recovery. Analyses of technique adherence and qualitative interviews with patients highlighted the motivational mechanisms driving engagement with AI-assisted physiotherapy, particularly providing a sense of accountability when tracking and sharing adherence measures. Overall, this research provides empirical evidence supporting the integration of a mobile application with real-time AI exercise feedback into physiotherapy practice, demonstrating the feasibility and benefits to improving at-home exercise adherence and recovery.

Computational Fluid Dynamics Analysis of Flows and Mixing Phenomena in an Elliptical Ladle

Rohit Tiwari, PhD student, McGill University

Oral and Poster Presentation

In secondary steelmaking, bottom argon stirring plays a critical role in homogenizing temperature and chemical composition within a melt of liquid steel. It also enhances slag–metal refining reactions and contributes to improved metal cleanliness. The intermixing phenomena induced by argon injection through porous plugs installed in the ladle bottom, as well as the overall stirring efficiency, can be assessed using 95% mixing times.

In this study, Computational Fluid Dynamics (CFD) based on quasi-single-phase modeling was carried out to compare the flow fields generated in an elliptical shaped industrial 120-tonne ladle using a single porous plug versus those produced by a dual-plug configuration. A comparative analysis of the single- and dual-plug configurations was conducted based on flow characteristics and wall shear stress distributions. The results demonstrated that the dual-plug configuration outperformed the current single-plug setup.

Determination of equivalent hydrogen concentrations in pipeline steels using gaseous and electrochemical charging

Tonye Alaso Jack, PhD student, University of Saskatchewan

Oral and Poster Presentation

Hydrogen embrittlement compromises pipeline steel integrity, and it is influenced by hydrogen uptake, retention and accumulation behavior within the steel. Understanding hydrogen uptake across different microstructures of high strength steels would require extensive testing. To simplify testing and make it more accessible, an equivalence in hydrogen concentration obtained using the gaseous and electrochemical charging methods must be established. This study examines hydrogen uptake in pipeline steels using both methods. Electrochemical permeation in 0.1 M NaOH was used to determine equivalent hydrogen fugacity similar to gaseous conditions and validated using thermal desorption analysis. The results confirm that equivalent hydrogen concentration can be derived from similar hydrogen activity on the steel surface, and recombination poison additions increased hydrogen fugacity at lower absolute overpotentials. Without poison addition, an overpotential of -0.7 V resulted in comparable

hydrogen concentrations to 10.34 MPa H₂ pressure. These findings provide a practical benchmark for testing similar pipeline steel microstructures.

Additive Manufacturing of High-Density NdFeB Magnets: The Role of Melting Mode Process Mapping

Xavier Walls, PhD student, Carleton University

Oral and Poster Presentation

The rising demand for high-performance NdFeB permanent magnets has exposed the limitations of conventional manufacturing techniques, which are often material-intensive, environmentally taxing, and constrained in design flexibility. Laser Powder Bed Fusion (LPBF) presents a compelling alternative, enabling the production of complex geometries with minimal waste and precise control over microstructure and magnetic properties. This study examines the impact of LPBF process parameters on the microstructural evolution and magnetic properties of NdFeB magnets. A dimensionless process mapping approach was used to optimize printing processing conditions to minimize defect formation and achieve high-density parts. The results show that dimensionless process mapping can be used to accelerate the process development for NdFeB magnets, leading to parts with reduced porosity and enhanced magnetic properties. The fabrication of a complex-shaped demonstrator further demonstrated the practical applicability of this method. Overall, this work highlights LPBF as a viable and sustainable pathway for producing advanced magnetic materials.

TherMET

Student Presentation Abstracts



Enhanced Lithium-Ion Adsorption and Diffusion on Vacancy-Defect-Engineered Two-dimensional Hafnium Disulfide (HfS₂) Monolayers

Dipali Nayak, Post Doctoral Fellow, University of Toronto

Oral presentation

The investigation of two-dimensional (2D) materials as electrode materials for lithium-ion battery (LIB) applications has gained considerable interest due to their exceptional structural, thermal and electrochemical properties. This work uses density functional theory calculations to explore the lithium-ion adsorption and diffusion characteristics of 2D pristine and vacancy-defect-engineered hafnium disulfide (HfS₂) monolayers. Hafnium (Hf) and sulfur (S) vacancies are introduced to examine the impact of these lattice defects on the electrochemical properties of the HfS₂ monolayer. These vacancies induce metallic behavior in the HfS₂ monolayer. Notably, Hf vacancies enhance lithium adsorption, indicating greater energy storage potential. The diffusion energy barrier with S vacancies is significantly lower than that of the pristine HfS₂ monolayer, enabling faster lithium-ion transport. These results highlight the effectiveness of vacancy-defect engineering in optimizing HfS₂ for high-performance LIB electrode applications and provide valuable insights into tailoring 2D transition metal dichalcogenide materials for battery energy storage.

Multi-Length-Scale Thermal Modeling Framework for Lithium-ion Battery Systems from Sub-cells to Cells, Modules, and Packs

Oscar A. Alvarez, Doctoral student, University of Toronto

Oral presentation

Lithium-ion batteries (LIBs) have become the preferred power source for electric vehicles (EVs) and stationary battery energy storage systems (BESS) due to their superior characteristics over other energy storage technologies. For optimal performance and lifespan, the temperature of LIBs must be maintained within a narrow range around 25-40°C while keeping spatial temperature uniformity (below 5°C) across hundreds of cells in BESS and EV battery packs. These battery systems exhibit hierarchical thermal transport across multiple length-scales from battery electrodes to sub-cell, cell, module, and pack levels. This work demonstrates a multi-length-scale framework for modeling thermal transport hierarchically, illustrating how changes in the design of battery components at smaller scales impact the thermal performance and reliability of BESS and EV battery systems. Hierarchical modeling and simulation tools,

seamlessly applicable across multiple length scales, are critically needed to advance the design and optimization of battery thermal management systems.