



Welcome to the

11th Annual Nano Ontario Conference & Exhibition

Virtual Conference

<https://www.nanoontario2021.com/>

November 4, 2021
8.35 AM - 7.30 PM EST

Hosted by



Land Acknowledgement

Toronto is in the 'Dish with One Spoon Territory'.

The Dish with One Spoon is a treaty between the Anishinaabe, Mississaugas and Haudenosaunee that bound them to share the territory and protect the land. Subsequent Indigenous Nations and peoples, Europeans and all newcomers have been invited into this treaty in the spirit of peace, friendship and respect.

Learn about the Truth and Reconciliation Commission (<http://trc.ca/>)

Support Residential School Survivors (<https://www.irsss.ca/donate>)

Message from the Chair of NanoOntario



Dear Participants,

It is with an immense pleasure for NanoOntario to celebrate the 11th edition of its annual conference. Last year we had to cancel this venue in light of the COVID-19 pandemic, which created overwhelming circumstances that affected all of us. This year, we decided to choose a virtual conference; hopefully, next year it will be, once again, 'like before'. The Gather Town online platform will be used for the conference enabling meetings within a fun environment.

Our two keynote speakers are Prof. **Catherine J. Murphy**, an inorganic chemist designing nanomaterials to be used for a variety of applications such as cellular imaging, chemical sensing and photothermal therapy, and Prof. **Prashant V. Kamat**, a physical and materials chemist developing new tools for light energy conversion. Both are worldwide stars who are currently leading inspiring research programs in nanoscale science.

In addition to the **oral and poster presentations**, a special **career panel** with professionals with a background or education in nanoscience, and representing a wide range of careers, is scheduled. Work search in post-pandemic time will definitely a challenge for many of our graduating students: this career panel will provide a few keys to facilitate interviews and connections to seek for a dream job.

Dr. Stefania Impellizzeri, Dr. Nariman Yousefi and Dr. Hadis Zarrin are the mastermind from Ryerson University who organized the excellent program for this 11th edition. I sincerely congratulate them for their leadership in organizing this one-day conference in a complex situation, thus ensuring that Ontario's excellence in nanoscale science and technology is actively represented by our researchers and students at the highest level.

François Lagugné-Labarthe

Chair of NanoOntario Inc.

Conference Organizers



Dr. Stefania Impellizzeri

Department of Chemistry and Biology

Photochemistry and Plasmonics, Molecular Switches,
Fluorescent Probes & Sensors, Molecular Computing,
Carbon Nanomaterials, Metal & Metal-Organic
Nanoparticles, Nanocatalysis

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Dr. Hadis Zarrin

Department of Chemical Engineering

Nano-Engineered Composites, 2D Nanomaterials,
Electrochemical Energy Storage & Conversion, Batteries,
Hydrogen, Supercapacitors, Environmental Remediation,
Smart Healthcare Wearable, Biosensors, Smart Coatings

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Dr. Nariman Yousefi

Department of Chemical Engineering

Advanced Multifunctional Nanomaterials, Polymer
Nanocomposites, Graphene & other 2D Nanomaterials,
Environmental Nanotechnology, Water Treatment,
Microplastics and Nanoplastics

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Special Thanks

Mary Susan Thomson, Project Manager

Melissa Saldutto, Project Assistant

Talha Mahmood, Volunteer

Samson Abioye, Volunteer

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Equity, Diversity & Inclusion

Science and society are stronger when we have a diverse, equitable and inclusive profession. Our goal for this conference is to create an inclusive and respectful environment that facilitates and supports participation from people of all ethnicities, genders, ages, abilities, religions, and sexual orientations. We know that making an explicit commitment to diversity enables excellence, innovation, and transformative action in current and future generations of professionals.

In ensure we achieve the highest standards of EDI, we have:

- Recruited presenters and panelists from diverse populations, backgrounds, and research areas, to increase diversity in thinking and perspective.
- Recruited qualified members of the organizers and judging committees such that the resulting populations are diverse with respect to gender, home institutions, geography, and research expertise.
- Ensure the application of EDI principles in the assignation of awards and honorable mentions.
- We want people to be comfortable being themselves and strive to build a culture where no assumptions or judgments are made on participants. We encourage the use of pronouns for all conference attendees.

Read more of NanoOntario commitment to EDI at <https://nanoontario.ca/diversity-in-nanoscience/>

Hosting Inclusive and Accessible Conferences

NanoOntario endorses the efforts made in order to ensure an inclusive and accessible conference environment. To anyone either currently organizing a conference or event, or planning to do so, we highly recommend the article by Ana Sofia Barrows, Mahadeo A. Sukhai, and Imogen R. Coe "So, you want to host an inclusive and accessible conference?" *FACETS* 6, 131-138, available open access at doi.org/10.1139/facets-2020-0017.

Code of Conduct

The 11th Annual Nano Ontario Conference & Exhibition is committed to providing a safe, productive, and welcoming environment for all participants. The conference provides an excellent opportunity for members and meeting attendees to connect, learn and expand and grow their careers. At all times, meeting attendees, volunteers and staff should act in accordance with the present Code of Conduct, dedicating themselves to the highest standards of personal honour and professional integrity, and accepting and defending the primacy of public well-being.

We all play a role in fostering a positive environment of trust, respect, open communication, and ethical behaviour. As such, we urge all our participants to:

- Being respectful of all individuals involved in the meeting including attendees, volunteers, management, and coordinators.
- Being respectful of rules and policies of the meeting.
- Making every effort to be professional, considerate, and collaborative.
- Being conscious of critiquing ideas, not individuals.
- Being respectful of each other in conversation, during oral and poster presentations, and during group and social events.
- Accepting that disruptive, harassing, or other inappropriate statements or behaviour toward an individual is unacceptable.
- Not engaging in unacceptable behaviour*

**Examples of unacceptable behavior:*

- Disruption or obstruction of any meeting activity or social events.
- Physical or verbal harassment, including sexual harassment, bullying, discrimination in any form, or abuse of any attendee.
- Intimidation, threats, or coercion.
- Conduct or knowingly creating a condition that threatens or endangers any person.
- Conduct that is, or is reasonably seen to be, humiliating or demeaning to another person.
- Aiding or encouraging others to act in a manner prohibited under these guidelines.
- Verbal comments based on gender, sexual orientation, disability, physical appearance and dress, body size, socioeconomic status, education background, marital status, and personal characteristics protected under the Charter of Rights and Freedoms (race, religion, national origin).
- Inappropriate use of nudity and/or sexual images in public spaces or in presentations.
- Threatening, stalking, and harassing of any attendee at the event or meeting, including speakers, volunteers, staff, service providers, and guests; unwelcome sexual advances; requests for sexual favours; harassment intended and communicated in a joking manner.

In addition, participants are asked to adhere to the following rules:

- The recording or transmissions of any education sessions, presentations, demos, videos, or content in any format is strictly prohibited.
- Disruption of presentations during sessions, in the exhibit hall, or at other events organized throughout the virtual meeting. All participants must comply with the instructions of the moderator.
- Any direct selling of products/services offered by speakers, industry partners, or consultants in any public area of the virtual platform is prohibited. Many of the engagement conversations are based around knowledge and expertise and are not categorized as a direct sales pitch.
- Selling must be conducted during mutually agreed upon private video, audio or text conversations.
- Participants should not copy or take screenshots of Q&A or any chat room activity that takes place in the virtual space.

We reserve the right to take any action deemed necessary and appropriate, including immediate removal from the meeting without warning or refund, in response to any incident of unacceptable behavior.

If you believe someone is violating the code of conduct, please contact any of the conference organizers or volunteers. All reports will be kept confidential.

Social Media Policy

You are NOT permitted to post about others' data and specific materials without expressed consent from the author.

You are encouraged to post general comments about the conference or publicly available information (e.g., title of the talk or abstract materials)

Tag @NanoOntario

Day Program

Eastern Time

- 8:00 – 8:30 **Arrival**
- 8:35 – 9:15 **Welcome & Introductory Remarks**
- 8:35 – 8:45 Welcome Message from Conference Organizers & Day Schedule
- 8:45 – 8:55 Remarks by Dr. Johannes Dyring, Asst. VP Business Development & Strategic Planning, Office of the VP Research and Innovation, Ryerson University
- 8:55 – 9:05 Remarks by Dr. François Lagugné-Labarthet, Chair of Nano Ontario
- 9:05 – 9:10 Remarks by Gord Harling, President and CEO of CMC Microsystems
- 9:10 – 9:15 Remarks by Dr. Ali Tabatabaei, Business Manager of SFR – Systems for Research
- 9:15 – 10:50 **Faculty Talks – Session 1**
- 9:15 – 9:35 Prof. Helen Tran (University of Toronto)
“From Molecular to Nano to Macro Design of Polymers for Bioelectronics”
- 9:40 – 10:00 Prof. Peter Mascher (McMaster University)
“Silicon-based Nanostructured Thin Films for Photonic Applications”
- 10:05 – 10:25 Prof. Cao Thang Dinh (Queen's University)
“Nanostructured Electrodes for CO₂ Conversion”
- 10:30 – 10:50 Prof. Hamed Shahsavan (University of Waterloo)
“Smart Materials for Small-Scale Bioinspired Soft Robots”
- 10:55 – 11:00 **Morning Break**
- 11:00 – 12:00 **KEYNOTE: Prof. Catherine J. Murphy (University at Illinois Urbana-Champaign)**
“Golden Nanotechnology: Intersections with Physics, Chemistry, Biology and Ecology”
- 12:00 – 1:00 **Lunch Break & Games**
- 1:00 – 2:00 **KEYNOTE: Prof. Prashant V. Kamat (University of Notre Dame)**
“How Nanostructures are Transforming Next Generation Photovoltaics”
- 2:00 – 3:10 **Faculty Talks – Session 2**
- 2:00 – 2:20 Prof. Drew Higgins (McMaster University)
“Developing and understanding atomically dispersed Ni-N-C catalyst nanomaterials for electrochemical CO₂ reduction”
- 2:25 – 2:45 Prof. Sylvie Morin (York University)
“Properties and Surface Chemistry of Nanostructured Electroactive Materials”
- 2:50 – 3:10 Prof. Olena Zenkina (Ontario Tech University)
“Coordination-based Multimetallic Multichromic Materials and Devices”
- 3:15 – 4:20 **Student/PDF Flash Talks Discussion – Session 1***
- 4:20 – 4:30 **Afternoon Break**
- 4:30 – 5:30 **Career Panel**
- 5:30 – 6:00 **Poster Session**
- 6:00 – 7:10 **Student/PDF Flash Talks Discussion – Session 2***
- 7:10 – 7:30 **Awards Announcements & Closing Remarks**

* If you are a Student/PDF Presenter, please check your designated session (attendance is required)



Keynote Speakers



Prof. Catherine J. Murphy

University of Illinois Urbana-Champaign

Dr. Murphy is Larry R. Faulkner Endowed Chair in Chemistry, and Head of the Department of Chemistry the University of Illinois Urbana-Champaign. Murphy's honors include the 2020 ACS Award in Inorganic Chemistry, the 2019 Remsen Award, the 2019 Linus Pauling Medal, the 2019 MRS Medal, the 2013 Carol Tyler Award of the International Precious Metals Institute, and the 2011 ACS Division of Inorganic Chemistry's Inorganic Nanoscience Award. She is a Fellow of the American Chemical Society, the Materials Research Society, the Royal Society of Chemistry, and of the American Association for the Advancement of Science. She was ranked #32 in Thomson Reuters Sciencewatch List of "Top 100 Chemists for the Decade 2000-2010" and #10 on their list of "Top 100 Materials Scientists of the Decade 2000-2010." In 2015, she was elected to the U.S. National Academy of Sciences and in April 2019 to the American Academy of Arts and Sciences.



Prof. Prashant V. Kamat

University of Notre Dame

Dr. Kamat is a Rev. John A. Zahm, C.S.C., Professor of Science in the Department of Chemistry and Biochemistry and Radiation Laboratory at the University of Notre Dame. Thomson-Reuters has featured him as one of the most cited researchers each year since 2014 (2016 -2021). He is currently serving as the Editor-in-Chief of ACS Energy Letters. He is a member of the advisory board of several scientific journals (Chemical Reviews, Journal of Colloid & Interface Science, ACS Applied Nanomaterials, NPG Asia Materials, Research on Chemical Intermediates, and Applied Electrochemistry). He was awarded the Honda-Fujishima Lectureship award by the Japanese Photochemical Society in 2006, the CRSI medal by the Chemical Research Society of India in 2011 and the Langmuir lectureship award in 2013. He is a Fellow of the Electrochemical Society (ECS), American Chemical Society (ACS) American Association for the Advancement of Science (AAAS) and Pravasi Fellow of the Indian National Science Academy.

Special Career Panel



Dr. Gregory Hodgson

Life Sciences
Consultant
Shift Health

Dr. Gregory Hodgson (PhD in Chemistry and MBA) has broad scientific experience in data analytics, nanotechnology, chemistry, and biomaterials R&D. His interests surround improving sustainability, addressing current challenges, and implementing emerging technologies across the health sector.



Dr. Camila Londoño

Director
*Ryerson Science
Discovery Zone*

Dr. Camila Londoño (PhD in Biomaterials and Biomedical Engineering) is the Director of the SDZ, an incubator focused on people and early-stage ideas and ventures. Her work is focused at connecting with members of Ryerson and the broader community to teach evidence-based innovation and providing experiential learning opportunities. The SDZ also works to support ideators and startups in their early stages of growth and validation.



Dr. Kazim Agha

Partner & Patent
Agent
Ridout & Maybee

Dr. Kazim Agha (PhD in Chemistry) is partner and patent agent at Ridout & Maybee LLP. Kazim is also the Director of Local Sections of the Chemical Institute of Canada and a Board Member of the Chemical Society of Canada. He is engaged with the American Chemical Society, presenting on IP and as Chair-elect of the Small Chemical Business Division. He is Chair of the Patent Agent Training Committee of the Intellectual Property Institute of Canada.

How to Join the Event / Technical Information

The conference is hosted in Gather Town and can be accessed using this link: <https://gather.town/app/L7Bs4iP8irRwzkX8/Nano%20Ontario>. **Make sure you are using a computer or laptop and accessing the Gather Town platform through the Google Chrome browser ([download Chrome](#)) or the Chromium browser.** To familiarize yourself with the platform, take a look at the introductory guide at this link: <https://www.reunivous.com/guide>.

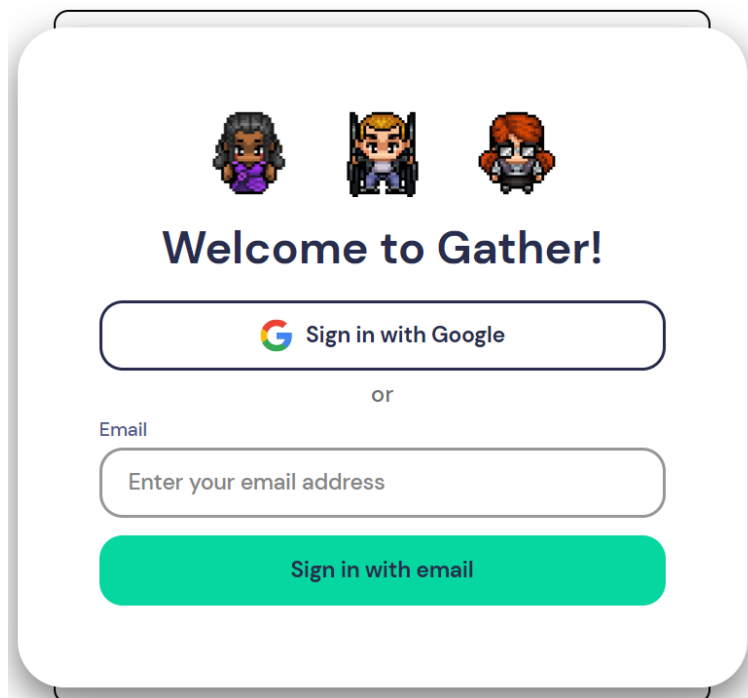
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This Gather space has a guest list. Please sign in or create an account with your email address to continue.

Sign In

If you want all your account/data to be deleted after the duration of the event, check this box (will delete all data associated with this account!): ☐

Click OK, and then you'll be asked to enter your email. Please use the exact same email you used to register for the event. Ignore the "sign in with Google" option.



Three pixel art avatars are shown at the top.

Welcome to Gather!

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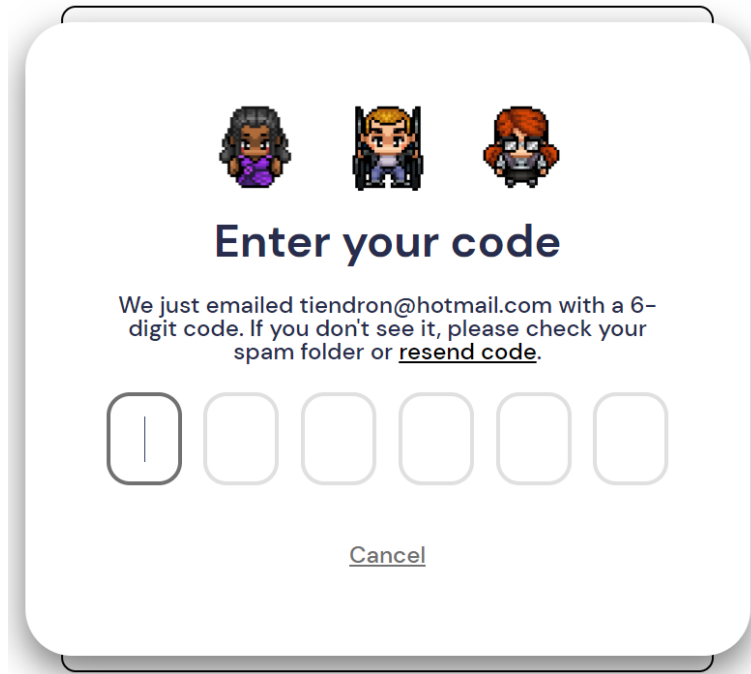
or

Email

Enter your email address

Sign in with email

You'll receive an email with a code from login@mail.gather.town. Please enter this code into the box as shown in the screenshot below, and you are in!



We want the participants to be comfortable being themselves and strive to build a culture where no assumptions or judgments are made on participants. We encourage the use of pronouns for all conference attendees.

Screen sharing will be enabled for live presenters at the time of their talk. If you are using a MAC, you will need to follow these instructions to enable screensharing:

<https://help.practicebetter.io/hc/en-us/articles/360035679611-Screen-Sharing-on-macOS>

If you require or desire Live Captioning, instructions on how to enable it in Chrome can be found at the bottom of this Gather article titled "Enable Live Captioning Tools":

<https://support.gather.town/help/accessibility>

Student/PDF Flash Talks Discussion – Session 1 (3:15 – 4:20 PM)

Presenter's Name	Title of Presentation
Connor Randall	Surface Chemistry of Acetic acid on Copper (II) Oxide Particles for CO ₂ Electrochemical Reduction Conditions using ATR-FTIR Spectroscopy
Wisam Mohammed	Room for Improvement: Performance Assessment of Electrochemical Sensors in Low-Cost Air Quality Monitoring
Ahmed M. Eid	Insights into CO ₂ reduction reaction surface intermediates: bulk aqueous phase ATR-FTIR study
Jason Hsu	Control Experiments for CO ₂ Electrochemical Reduction on CuO Nanoparticles: Thermodynamic and Kinetic Studies of Bicarbonate and Formate Surface Chemistry with CuO Nanoparticles
Aviya Akari	Photoinduced Luminescence Enhancement of Hydrophilic 'Caged' Carbons Dots
Paramita Bhattacharyya	Tunable Thin Film Optical Filter for Standard Photovoltaics
Sathya Srinivasan	Aptamer and nanomaterial based biosensors for the detection of Alpha-synuclein
Nayomi Camilus	Role of tyrosine analogues on the photophysical properties of carbon dots
Jesse Dondapati	Photoelectrochemical degradation of phenolic pollutants at nanoporous titanium dioxide
Allison Salverda	Effect of Reduced Graphene Oxide on the Tantalum Iridium Oxide Catalyst for Electrochemical Water Splitting

Student/PDF Flash Talks Discussion – Session 2 (6:00 – 7:10 PM)

Presenter's Name	Title of Presentation
Michael Furlan	N-Heterocyclic Carbene Self-Assembly on Au(111) and Cu(111)
Joachim Jelken	Wide-field Raman microscopy with STORM post-processing: A powerful approach to increase spatial resolution and acquisition speed in Raman imaging
Maria Olivia Aviles	Exploring the hidden features in 2D Transition metal Dichalcogenides
Nan Liu	Microwave-assisted synthesis of opto-magnetic nanomaterials
Brahim Ahammou	Characterization of Silicon Nitride Thin Films Deposited by PECVD using Microstructures
Nina M. Culum	Surface-Enhanced Raman Spectra for the Diagnosis of Ovarian Cancer
Lavinia Trifoi	Facile Supramolecular Strategy to Construct Solid Fluorophore@Metal-Organic Framework Composites
Emille Rodrigues	Hyperspectral Imaging: a powerful tool for nano-bio interaction studies
Benjamin Baylis	Force Spectroscopy Mapping of the Effect on the Stiffness and Deformability of Modified Phytoglycogen Nanoparticles
Greg van Anders	Shape and Interaction Decoupling for Colloidal Pre-Assembly

List of Abstracts & Presenters

Prof. Helen Tran (University of Toronto)

[@Helen_chem](#)

“From Molecular to Nano to Macro design of Polymers for Bioelectronics”

Next-generation electronics will autonomously respond to local stimuli and be seamlessly integrated with the human body, opening the doors for opportunities in environmental monitoring, advanced consumer products, and health diagnostics for personalized therapy. For example, biodegradable electronics promise to accelerate the integration of electronics with health care by obviating the need for costly device-recovery surgeries that increase infection risk. Moreover, the environmentally critical problem of discarded electronic waste would be relieved. The underpinnings of such next-generation electronics is the development of new materials with a wide suite of functional properties beyond our current toolkit. Organic polymers are a natural bridge between electronics and soft matter, where the vast chemical design space allows tunability of electronic, mechanical, and transient properties. Our research group leverages the rich palette of polymer chemistry to design new materials encoded with information for self-assembly, degradability, and electronic transport. In this talk, we will provide an overview of our current projects.

Prof. Peter Mascher (McMaster University)

[@Peter Mascher](#)

"Silicon-based Nanostructured Thin Films for Photonic Applications"

(w/h A. Abdelal, F. Azmi, B. Ahammou, Y. Gaoy)

In order for Si-based materials to be used in solid-state lighting (SSL) and silicon photonics schemes it is necessary to have precise control of the optical emission from these materials. This can be accomplished through the use of rare earth dopants such as Ce, Tb, and Eu to obtain blue, green, and red emissions, respectively. After a brief review of the latest developments in the field, this talk will focus on the luminescence of undoped and rare earth (Ce, Tb, Eu) doped silicon oxides, nitrides, and carbides. Silicon carbonitrides (SiC_xN_y) in particular, have attracted interest for the manufacturing of materials with robust mechanical properties and promising optical features. This is a consequence of their unique properties inherited from the combined properties of binary substructures, silicon carbide (SiC), silicon nitride (SiN), and carbonitride (CN). We will correlate important process parameters with the observed luminescence and will discuss some of the challenges in developing electrically driven lighting cells suitable for SSL and in particular, for the development of widely tuneable Si-based light sources to be integrated into silicon based electronic systems.

Prof. Cao Thang Dinh (Queen's University)

"Nanostructured Electrodes for CO₂ Conversion"

Electrochemical CO₂ conversion to fuels and chemicals, powered by renewable electricity, offers a path to address simultaneously the CO₂ emission problem and the intermittency issue of renewable energy sources. The transformation of renewable electricity and CO₂ into chemical fuels, which can be readily integrated into current infrastructures, provide a long-term and large-scale solution for renewable energy storage. Converting CO₂ into chemical feedstocks can enable the sequestration of CO₂ into long-lifetime products such as polymers. A critical component in electrochemical CO₂ conversion systems is the gas diffusion electrode because it governs CO₂ conversion performance, including product selectivity, energy efficiency and system stability. A gas diffusion electrode comprises a catalyst layer deposited onto a porous hydrophobic substrate, i.e., the gas diffusion layer. Typically, CO₂ molecules diffuse through the nanoporous networks of both gas diffusion and catalyst layers and reach the surface of the catalyst particles where they are transformed into desired products. Thus, the structures and compositions of both catalyst and gas diffusion layers play crucial roles in electrochemical CO₂ conversion. In this talk, I will discuss the development of nanostructured gas diffusion electrodes for electrochemical CO₂ conversion to fuels and chemicals.

Prof. Hamed Shahsavan (University of Waterloo)

"Smart Materials for Small-Scale Bioinspired Soft Robots"

Development of microscale devices and robots is a multidisciplinary theme that links different fields of research, such as biology, materials science, instrumentation and control, and artificial intelligence. During the last decade, this theme of research has played a significant role in the understanding, development and application of microscale medical devices and robots. In this regard, the structural materials that can be scaled down by various microfabrication techniques and integrate sensing, actuating and powering tasks in constructs with less number of components are highly desired. In this seminar, I will show the importance of soft stimuli-responsive and shape programmable materials in the design and fabrication of microscale robots and devices. I will introduce a class of soft materials with the shape-change programmability that can be remotely stimulated by a variety of cues, such as heat, light, electrical and magnetic fields, at different scales. I will also present opportunities to create novel solutions or augment existing capabilities of microscale robotic systems with an emphasis on their future biomedical applications.

Prof. Drew Higgins (McMaster University)

"Developing and Understanding Atomically Dispersed Nickel-Nitrogen-Carbon Catalyst Nanomaterials for Electrochemical CO₂ Reduction"

(w/h D. Koshy)

For electrochemical CO₂ conversion into fuels and chemicals to become viable component of future sustainable energy infrastructures, the development of catalysts that are active, selective, stable and inexpensive is required. In this talk I will discuss research efforts towards the discovery and development of atomically dispersed nickel-nitrogen carbon catalysts for electrochemical CO₂ reduction. I will discuss the synthetic methods to prepare these materials, along with highlighting the structure-property-performance relationships established from electrochemical performance measurements and rigorous materials characterization.

"Properties and Surface Chemistry of Nanostructured Electroactive Materials"

Addressing pressing issues such as climate change and the need for alternative energy sources can be solved through the use of electrochemical technology. It already plays an important role in energy storage and conversion devices such as fuel cells and batteries. Hydrogen is viewed as one of the energy carriers of the future as it is environmentally friendly, inexhaustible and possesses high energy density. At present, hydrogen is mainly produced from steam methane reforming and coal gasification, which lead to carbon dioxide emission. Water electrolysis is an efficient and sustainable way to produce hydrogen. However, the practical application of water electrolysis has been limited due to its high cost.

Water splitting involves two half-reactions, hydrogen evolution reaction and oxygen evolution reaction (OER). The OER is kinetically sluggish and hence associated with a high overpotential. Cobalt spinel oxides are good candidates for O_2 production due to their excellent catalytic properties, controllable composition, structure and morphology. Spinel oxides of the type $M_xCo_{3-x}O_4$ (where $M = Ni, Cu, Mn, Zn, Fe$) are known to possess enhanced electrocatalytic activity and stability. However, their performance is not always consistent, and to understand their behaviour my group systematically investigated series of binary and ternary spinel oxides. We have prepared various spinel oxides, and employed X-ray photoelectron spectroscopy to probe the surface of the electrode materials. This allows to understand the structure, composition and oxidation state of the metal ions at the surface of these materials in relation to their electrocatalytic properties. The high-resolution spectra for Co, Cu and Ni allow the determination of Co^{2+}/Co^{3+} , Cu^+/Cu^{2+} and Ni^{2+}/Ni^{3+} ratio for these materials as a function of the electrode material composition. Our result will show the importance of detailed surface characterization when reporting catalyst performances.

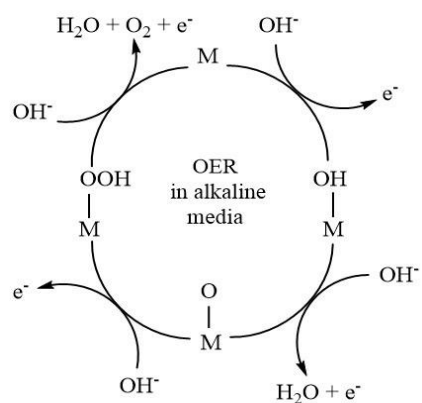


Figure 1 OER scheme in alkaline media showing the four-electron transfer steps.

Prof. Olena Zenkina (Ontario Tech University)

[@Olena Zenkina](#) | [@Zenkina lab](#)

“Coordination-based Multimetallic Multichromic Materials and Devices”

(w/h E. Bradley Easton, N. Laschuk)

Electrochromic (EC) devices based on transition metal complexes that do not require noble metals benefit from lower cost and colour tunability via molecular design. Although there is great progress in the development of well defined EC metal complexes, the design of relevant multicoloured EC films remains a challenging task limited so far by metalorganic polymers. We have demonstrated a strategy that allows the creation of efficient and robust monolayer-based EC materials on surface-enhanced indium tin oxide-based and fluorine-doped tin oxide screen printed supports. We have observed that making minor changes to the ligand structure can produce materials with a wide range of colour variations. Furthermore, we showed that tuning of the nature and porosity of the conductive surface support could lead to materials with extra-ordinary coloration efficiencies and ultra-long stability.

Here we report the deposition of different metal complexes on surface-enhanced support and probing the ability to selectively address metal ions in these complexes to reach multiple colour-to-colour transitions within one film. We were able to sequentially switch between multiple coloured states and to demonstrate effective “colour mixing” on the surface by application of various deposition strategies. Finally, we explored the symmetric architecture of the EC devices and demonstrated how this strategy reduces operating voltages and prevents the degradation of the materials.

Araniy Santhireswaran (Ryerson University)

[@SfnImpellizzeri](#) | [@CostinAntonescu](#) | [@Botelho Lab](#)

"Application of Metal-Enhanced Fluorescence for Imaging of Biological Systems"

(w/h S. A. Soha, G. K. Hodgson, M. G. Sugiyama, C. N. Antonescu*, R. J. Botelho*, S. Impellizzeri*)

Fluorescence microscopy has widespread implications in cell biology through highly specific labeling and visualization of dynamic components in live biological samples. Despite this, fluorescence microscopy also poses challenges caused by high light intensity and prolonged exposure time, such as photobleaching, phototoxicity, photo-instability, and autofluorescence, all of which may cause unwanted artifacts in acquired images and poor analysis. These constraints could be potentially overcome with Metal-Enhanced Fluorescence (MEF), a phenomenon by which the presence of colloidal metal nanoparticles enhances fluorescence intensity by altering fluorophore decay rates or increasing the number of excited fluorophores. However, its application in the visualization of live-cell samples remains unexplored.

Our research thus far has demonstrated that the fluorescence intensity of lysosomal markers DQ-BSA and BODIPY-cholesterol are enhanced in the presence of silver nanoparticles (AgNP), within RAW 264.7 murine macrophages, along with an improved signal-to-noise ratio. Moreover, when using AgNP at reduced light exposures and laser intensities, the enhanced signal-to-noise ratio and fluorescence intensity allow for efficient tracking of lysosomal dynamics. We have observed increased lysosomal dynamics in cells treated with AgNP and imaged at lower exposures and laser intensities. This indicates that MEF can be used to mitigate phototoxic effects, stemming from prolonged exposure to high intensity light, that would otherwise inhibit lysosomal dynamics. In addition, our research has shown that the presence of AgNP in the lumen of the lysosome enhances fluorescence of lysosomal transmembrane proteins that are GFP-tagged on the cytosolic side, such as LAMP1-GFP. This illustrates that fluorescence enhancement by MEF is not limited to probes within the lysosomal lumen and can be applied to surface membrane markers as well. In conclusion, our results suggest that MEF holds vast applications in biological systems, not only improving signal-to-noise ratios in live-cell imaging but also overcoming the current limitations of fluorescence microscopy.

Denis Therien (Western University)

[@TherienDenis](#) | [@Lagugne](#)

“Enhanced Nonlinear Optical Response of Dye-Sensitized MoS₂ Monolayer Flakes”

(w/h P. Farhat, F. Lagugné-Labarthet)

Transition metal dichalcogenides (TMDs) are 2D materials that exhibit peculiar optical properties such as second harmonic generation (SHG). The intensity of the SHG signal depends on the number of layers of the TMD flakes and the crystalline phase of the individual layers. Furthermore, organic molecules such as Rhodamine 6G (R6G) have been used as sensitizers to further improve the photoresponse of MoS₂ flakes. R6G enhances the photoresponse and the nonlinear properties of the MoS₂ due to a charge transfer effect upon excitation of the organic dye.

In this study, MoS₂ flakes were prepared by chemical vapor deposition (CVD). Confocal Raman spectroscopy was employed to confirm the flakes are in their 2H crystal phase, which is SHG active. The variation of the polarized SHG signal in monolayers and bilayers was then imaged with SHG microscopy at the scale of a single flake. The flakes were then coated with the R6G organic dye and the enhancement of the SHG was measured.

Finlay Dingman Peterson (Trent University)

[@MarticSanela](#)

"Role of Guanosine on Photophysical Properties of Carbon Dots"

(w/h M. Mitti, R. Naccache, S. Martic)

Carbon dots (CDs) are carbon-based nanomaterials with versatile optical properties, high photostability and solubility. CDs have excellent biocompatibility as well as low cytotoxicity. Their photoluminescent properties are dependent on size, excitation wavelength, and functionalization. Hence, CDs are ideally suited as optical probes for variety of biomolecules. In this project, the solution photophysical properties of CDs were evaluated in the presence or absence of a nucleoside, specifically, guanosine, by using UV-vis and fluorescence spectroscopy. A dual-fluorescent CDs exhibit fluorescence emission at both, blue and red wavelengths. The CD-based fluorescence emission was quenched in the presence of guanosine, but the quenching was highly dependent on the excitation wavelengths used. The fluorescence intensities varied in the presence of guanosine in a concentration dependent manner. Using a fluorescence quenching assay, a linear response was observed at low concentrations in the micromolar range and an upward curvature at higher concentrations indicating both dynamic and static quenching processes. The data indicate CDs are valuable biological probes for the detection of nucleic acid building blocks.

Stephen Robinson-Enebeli (University of Waterloo)

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“Effective Wavelength Data Arrangement for Time-Resolved Laser-Induced Incandescence Inference”

(w/h K. Daun)

Time-resolved laser-induced incandescence (TiRe-LII) is used to characterize the size, volume fraction, and thermophysical properties of gas-borne nanoparticles. The technique involves heating nanoparticles in a probe volume of aerosol to incandescent temperatures with a laser pulse, then measuring the spectral incandescence, at several wavelengths, as the nanoparticles return to the ambient gas temperature. Estimates of aerosol properties depend on two sub-models: a spectroscopic model, which relates the observed spectral incandescence to the temperature and number density of the nanoparticles, and a heat transfer model that relates the temperature decay rate to the nanoparticle size distribution and thermophysical properties of the aerosol.

The most common Qol inference method in the literature involves determining the optimal set of Qols that regress the simulated temperature decay rates, determined using the heat transfer model, to the experimental pyrometric temperature decay of the nanoaerosol, determined by estimating the absorption properties of the nanoparticle using Rayleigh approximation. However, the Rayleigh approximation is not valid for metal nanoparticles. Instead, the Qols are inferred by regressing simulated spectral incandescence, determined from the heat transfer and spectroscopic models, where the absorption properties of the nanoparticles are estimated by Mie theory, to the experimental spectral incandescence. Though there are a few ways to combine the data from each wavelength range, in the context of noise, that can lead to inferred Qols with narrower uncertainties. For example, for a two-colour detection system, the data from each detection channel can be individually regressed (signal stacking), or, to reduce the data dimension, the ratio of the data can be used instead, while carefully choosing the least noisy channel as the denominator of the ratio. In this work, we examine three data arrangements, including signal stacking and data ratio with interchanged denominators using data from a two-colour detection system. The residual norms and uncertainties of the Qols across each method are calculated. It was found that although signal stacking uses an increased data dimension, it produces the least residual norm.

Nicholas van Heijst (University of Guelph)

"Binding of Proteins to Native and Acid Hydrolyzed Phytoglycogen Nanoparticles"

(w/h M. Grossutti and J. Dutcher)

Phytoglycogen (PG) is a compact, highly branched and naturally occurring polymer produced in the kernels of sweet corn. Because of its softness, mechanical integrity, nontoxicity and digestibility, it is ideally suited for applications within the human body such as personal care and the targeted delivery of bioactive compounds. Acid hydrolysis can be used to digest the PG particles in a controlled way, reducing both its size and density. These changes can enhance its ability to deform and penetrate effectively within the human body, potentially increasing its effectiveness as a bioactive delivery vehicle. We used Surface Plasmon Resonance imaging (SPRi) to measure the binding of Concanavalin A (ConA) protein molecules to native and acid hydrolyzed PG nanoparticles immobilized on the SPR sensor surface. We measured comparable binding affinities of ConA to native and acid hydrolyzed PG nanoparticles, indicating that acid hydrolysis is an effective way to reduce the particle size and density without compromising its ability to bind ConA.

Stanislav Musikhin (University of Waterloo)

"In-situ Investigation of Gas-Phase Graphene Synthesis through Fourier Transform Infrared Spectroscopy"

(w/h P. Fortugno, T. Endres, T. Dreier, C. Schulz, K.J. Daun)

Gas-phase synthesis of free-standing graphene is a promising way to produce high-quality material in industrial quantities. Yet, currently, there is no comprehensive understanding of the gas-phase kinetics leading to graphene formation, hence the search for optimal synthesis parameters is mainly driven by a trial-and-error approach. Such optimization is cost-ineffective, as any modification of process conditions can cause a change in product quality that would require expensive, time-consuming, and often intrusive ex-situ material investigation, such as Raman or electron microscopy.

Here, we propose Fourier-Transform Infrared Spectroscopy (FTIR) as an in-situ diagnostic tool for gas-phase graphene. Line-of-sight absorption spectra measured using an FTIR reveal gaseous species formed during the process, thereby elucidating the graphene formation mechanism.

In this work, aerosols of crumpled few-layer graphene and graphitic soot were formed via gas-phase microwave-plasma synthesis using various precursors, and produced particles were extensively characterized ex-situ. FTIR experiments were performed during synthesis and obtained absorbance spectra were then used to quantify the gas temperature and gaseous species concentrations in both aerosols. Results were additionally compared with chemical kinetics simulations. Potential species markers that indicate a shift from graphene production towards soot and their role in graphene formation are discussed.

Emily Steele (Queen's University)

"Metal Clusters as Next Generation Solar Harvesting"

(w/h T. Levchenko, C. Crudden, K. Stamplecoskie)

We're in the middle of a climate crisis, and time is running out. Global demand for energy is rising, but we still depend heavily on the fossil fuels. Renewables like hydro, wind and solar are the future of power, yet issues like durability and cost prevent us from further exploiting these resources. Solar power is particularly promising, but has some issues. Solar cells are made up of layers, each serving its own role. One of the most important layers is responsible for absorbing the light but once this layer degrades, the entire panel must be replaced, which is extremely costly.

This cost goes down dramatically if the layer is more durable. The key is finding the right material and the right conditions. We believe the best material for absorbing light in solar cells are metal clusters. Clusters are an emerging class of nanomaterials: metal atoms at the core and surrounded by protecting groups. They're not big enough to act like bulk metals, yet small enough to have really unique properties, like long lasting excited states and strong emission. Another characteristic of clusters is their tunability: changing the metal, the number of atoms in the core, or the ligands of the cluster can have big impacts on the properties.

Some of the clusters that are most promising are gold clusters with carbene ligands. While traditional ligands use sulfur-metal bonds to attach, carbenes can be ever stronger. Our clusters have shown incredible loading onto solar cells, overcoming one of the greatest hurdles in the field, getting something to stick to the surface. Through measuring the loading, the power output of the cells, and the performance over time, we're making great strides towards finding better materials for solar harvesting.

Connor Randall (Wilfrid Laurier University)

[@Connor Randall](#)

"Surface Chemistry of Acetic acid on Copper (II) Oxide Particles for CO₂ Electrochemical Reduction Conditions using ATR-FTIR Spectroscopy"

(w/h M. Houche, Y. Abu-Ledbeh, H. Al-Abadleh)

The burning of fossil fuels, cement production, animal husbandry and many other essential processes today have created a massive influx of carbon dioxide (CO₂) gas into the atmosphere. CO₂ is a greenhouse gas, meaning that it traps heat emitted from the surface of the Earth and irradiates it back toward the Earth instead of allowing some of the heat to escape into space. This results in global warming which is becoming a pressing issue as global temperatures steadily increase. This rise in average global temperature could dramatically change the natural order of Earth with many unforeseen consequences. Thus, it is imperative to reduce the amount of CO₂ in the atmosphere. CO₂ reduction to small hydrocarbon molecules using metal and metal oxide catalysts is a promising method of achieving this goal. The main issue with CO₂ reduction is the lack of product selectivity. Little surface chemistry research of CO₂ reduction with metal and metal oxide catalysts is known. It is not fully understood how the reaction intermediates interact with the surface, and what factors affect these interactions. This study focuses on a section of the CO₂ reduction mechanism involving the thermodynamics and kinetics of acetate as a potential intermediate and reaction product. Our goal is to study the thermodynamics and kinetics of acetate interactions on copper (II) oxide nanoparticles, using attenuated total internal reflection spectroscopy (ATR-FTIR) at pH7. These experiments are considered 'control' studies before applying potential to a system containing CO₂-saturated solutions. Our studies are significant because they will aid in optimizing conditions and developing metal and metal oxide catalysts to increase the efficiency of the CO₂ electrochemical reduction.

Wisam Mohammed (Wilfrid Laurier University)

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"Room for Improvement: Performance Assessment of Electrochemical Sensors in Low-Cost Air Quality Monitoring"

(w/h H. Al-Abadleh, L. Neil, N. Shantz, T. Townend, A. Adamesceu)

Air pollutant levels reached an all-time low in Southern Ontario, Canada during COVID-19 related restrictions. To maintain these low levels, monitoring of ambient pollutants needs to occur at the neighbourhood scale. The Region of Waterloo in Ontario, Canada is the third fastest growing region with only one provincial monitoring station located in a city park in Kitchener, ON. In September 2020, we installed a network of low-cost sensors outside elementary schools in Kitchener, ON located near different types of emission sources. These low-cost sensors use electrochemical sensors to detect nitrogen oxides (NO and NO₂), ground level ozone (O₃), and carbon monoxide (CO) levels outside each location. Additionally, these low-cost sensors were equipped with Non-Dispersive Infrared (NDIR) sensors to detect carbon dioxide (CO₂) levels and an optical particle counter (OPC) to detect ambient particulate matter below 2.5 microns (PM_{2.5}) levels. This talk will present data on the performance of these sensors relative to those from research grade equipment. Furthermore, we will highlight the current limitations these sensors pose on the accurate detection of ambient pollutants, specifically for the electrochemical sensor, from one year of data collection. Our studies are significant because they highlight the need for new advancements in air quality sensor development using nanotechnology.

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"Insights into CO₂ Reduction Reaction Surface Intermediates: Bulk Aqueous Phase ATR-FTIR Study"

(w/h M. Houache, Y. Abu-Lebdeh, H. A. Al-Abadleh)

Carbon dioxide (CO₂) is the primary greenhouse gas emitted through human activities. Rising levels of CO₂ are of significant concern in modern society as they are reaching alarming emission rates. Various methods were utilized to control CO₂ emission such as capture and sequestration, yet such methods have saturation/permanency limits. CO₂ reduction is an appealing process to produce feedstock chemicals and alternative fuels. The key step to convert CO₂ into an electro-fuel is the chemical transformation of CO₂ molecule into reduced carbon species through intermediates such as formate (HCO₂⁻) and bicarbonate (HCO₃⁻). This process is slow and requires the use of metal and metal oxide catalysts. This study focuses on investigating the surface chemistry of these intermediates with copper oxide (CuO) nanoparticles using ATR-FTIR spectroscopy. The first part of these studies aims at characterizing the structures of HCO₂⁻ and HCO₃⁻ in solution as a function of pH and quantify their molar extinction coefficient (ϵ) in mid IR. These structural and optical properties will aid in characterizing surface complexes, binding affinity, and kinetics of adsorption with CuO nanoparticles in the second part of our experiments. Our studies are significant because they are considered 'control' experiments that will provide molecular-level insights into role of CuO in catalyzing CO₂ electrochemical reduction.

Jason Hsu (Wilfrid Laurier University)

"Control Experiments for CO₂ Electrochemical Reduction on CuO Nanoparticles: Thermodynamic and Kinetic Studies of Bicarbonate and Formate Surface Chemistry with CuO Nanoparticles"

(w/h M. Houache, Y. Abu-Lebdeh, H. A. Al-Abadleh)

Global climate change caused by increasing levels of CO₂ from human activities affects the ecosystem and civilization as we know it. Therefore, processes to decrease CO₂ levels are of high interest. One process of CO₂ removal is electrochemical reduction using metal and metal oxide catalysts. By using metals such as copper or silver as catalysts, CO₂ can be reduced to other useful hydrocarbons. Methanol, ethylene, or formic acid are all possible products from CO₂ reduction. However, the current issues with CO₂ electrochemical reduction have to do with the selectivity of different metals to certain products as each one can produce multiple types of hydrocarbons. Our studies aim to understand the fundamental mechanism of surface interactions between formate and bicarbonate and CuO nanoparticles. These two compounds have been identified as the most common intermediates in CO₂ electrochemical reduction using copper based materials. Using in situ ATR-FTIR spectroscopy, we obtained structural information on formate and bicarbonate surface complexes, measured the adsorption thermodynamics, and quantified the desorption kinetics at pH 7. Our results are significant as they provide details on the binding affinity of these intermediates, which will inform our interpretation when an electrical potential is applied to this reaction.

Michael Furlan (Queen's University)

"N-Heterocyclic Carbene Self-Assembly on Au(111) and Cu(111)"

(w/h A. McLean, C. Crudden)

At the nanoscale, self-assembled monolayers (SAMs) have become one of the preferred methods for fabricating functional surfaces. Current applications range from lab-on-chip biosensors to corrosion prevention and frictional coatings. However, the general adoption of this technique has been inhibited by the thermal and chemical instability of the most ubiquitous surface anchor, the thiol. Recently, N-heterocyclic carbenes (NHCs) have emerged as viable alternatives, owing to their increased bonding strength, ease of synthesis, and diverse chemical functionality. Given their recent introduction into this field, several fundamental questions pertaining to their adsorption and factors controlling their self-assembly remain unanswered.

As an understanding of NHC self-assembly has evolved, the importance of 'wingtip' groups has been elucidated. Bulkier wingtip groups compel upright binding of the NHC, whereas smaller wingtip groups allow for flat-lying and upright species, sometimes in coexistence. It has also been demonstrated that the stability and prevalence of a SAM is dependent on CH- π , π - π interactions between adjacent molecules along with the surface-molecule interaction, mediated by the wingtip group. Thus, Benzyl (Ph - CH₂- R) wingtip groups are expected to drive upright, densely packed SAMs on coinage metal surfaces.

The results shown in my presentation characterize the 1D and 2D Self-assembly of 1,3-dibenzylbenzimidazole (NHCBz) on Au(111) and Cu(111). Repeated experiments demonstrate that the self-assembly of NHCBz on Au(111) is frustrated whereas NHCBz readily self-assembles on Cu(111); first in a surface-bound, densely packed, and disordered phase. Secondly, in an upright, adatom-bound, ordered, and locally chiral phase.

Joachim Jelken (University of Western Ontario)

"Wide-field Raman Microscopy with STORM Post-Processing: A Powerful Approach to Increase Spatial Resolution and Acquisition Speed in Raman Imaging"

(w/h L. Mazaheri, M. O. Avilés, S. Legge, F. Lagugné-Labarthe)

Here, we report on the development of a wide field Raman microscope which significantly improves the speed of acquisition at selected spectral range with spatial resolution in the range of ~200 nm over large field of view. This is achieved by post processing the acquired Raman images with a stochastic optical reconstruction microscopy (STORM) protocol. In STORM the specific blinking of fluorophores is used for their spatial localization. Here, the local intensity fluctuations of the Raman signal enable the localization of the molecules which is utilized to improve the spatial resolution. Several different approaches were presented in the past decades such as tip-enhanced Raman or confocal Raman spectroscopy with the same goal to further increase the spatial resolution of vibrational spectroscopy measurements. However, these point-scanning techniques often require long acquisition times thus limiting the size of the scanned area. In the wide-field STORM-Raman approach this limitation can be overcome by acquiring Raman images at specific spectral ranges over a large time-series which is faster. We demonstrate the potential of this approach on distinct samples such as patterned silicon, polystyrene microspheres on silicon wafer and graphene on silicon/silicon dioxide substrate.

Aviya Akari (Ryerson University)

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"Photoinduced Luminescence Enhancement of Hydrophilic 'Caged' Carbon Dots"

(w/h S. Impellizzeri)

Over the last years, carbon dots (CDs) have quickly emerged as outstanding 'green' nanoprobcs for fluorescence imaging and microscopy, and are gradually replacing conventional organic dyes and inorganic quantum dots in a diversity of biomedical applications. In this context, the identification of mechanism to photoactivate the fluorescence of CDs can translate into the development of photoactivatable probes with improved performance for super-resolution bioimaging. This class of probes are weakly or non-fluorescent, but can be photochemically converted to a fluorescent state when illuminated at an appropriate wavelength. One strategy to activate the fluorescence is based on photoinduced cleavage of appropriate functional groups. Ortho-nitrobenzyl (2NB) groups have been often used to quench the fluorescence of complimentary fluorescent dyes, or even semiconductor quantum dots. The chemical conjugation (to the dye's skeleton) or surface functionalization (of semiconductor nanoparticles) with 2NB can effectively "cage" the fluorophore, rendering it inactive until pulsed with ultraviolet light, which frees the parent species along with a nitrosocarbonyl product.

Herein, we reported an easy synthetic method for the bottom-up synthesis of CDs, and experimental protocol to couple 2-nitrobenzyl groups to our hydrophilic CDs. We demonstrated that 2NB groups could be used to quench the luminescence of hydrophilic carbons dots and reported the photochemical and photophysical properties of the resulting nanostructured composites.

Maria Olivia Aviles (University of Western Ontario)

“Exploring the hidden features in 2D Transition Metal Dichalcogenides”

(w/h C. Lambin, F. Lagugné-Labarthe)

Transition metal dichalcogenides (TMDs) are 2D semiconductor or metallic materials, that have shown interesting mechanical, electrical, and optical properties. MoS₂ and WS₂ are the most stable semiconductors in TMDs family displaying direct bandgap for a monolayer and transforming into an indirect bandgap as the layer number increases. VS₂ has a metallic and conductive characteristic that makes it of particular interest in the field of high performance batteries. TMDs can be synthesized in many ways, such as hydrothermal and electrochemical, but only the atmospheric pressure chemical vapor deposition (APCVD) is the most reliable technique producing flakes of high crystallinity. In addition, APCVD enables the synthesis of TMDs ranging from monolayer to several layers of thickness. The grown flakes need to be characterized to determine their chemical and surface properties. For the latter a high spatial resolution technique is required such as atomic force microscopy (AFM). In addition, Raman Spectroscopy is a powerful tool for the optical and chemical characterization. Tip-Enhanced Raman Spectroscopy (TERS) combines the benefits of these two techniques. Local surface plasmon resonance generated at the vicinity between the AFM tip and the sample, gives rise to a lightning rod effect enhancing the local electric field which is confined at the tip apex and which is used to provide better spatial resolution.

In this work, we report on selected TMDs such as WS₂, MoS₂ and VS₂ grown by APCVD synthesis and on their spectroscopic characterization.

“Microwave-Assisted Synthesis of Opto-Magnetic Nanomaterials”

(w/h E. Hemmer)

Sodium metal fluorides (NaMF_x , M = metal ion) have received considerable attention because of their unique magnetic, optical, ferroelectric, and electrochemical properties. For instance, NaLnF_4 (Ln = lanthanides) materials have been suggested for a wide range of applications including the fields of biomedicine, optoelectronics, and solar energy conversion. NaMnF_3 particles have been studied for their potential applications as bioimaging contrast agents, ferromagnets, and active material for batteries. The growing attention toward such materials has prompted the development of novel synthesis methods for a more reliable and efficient access to these systems. In this regard, microwave-assisted approaches provide unique advantages over traditional synthesis methods (solvothermal, co-precipitation and thermal decomposition) reliant on convectional heating: namely, significantly shorter reaction durations, more rigid reaction conditions, and thus a higher degree of reproducibility.

We here report the microwave-assisted synthesis of NaGdF_4 nanoparticles and NaMnF_3 sub-micron particles as candidates for magnetic resonance imaging (MRI). Herein, T1 contrast is generated thanks to the paramagnetic properties of the Gd^{3+} and Mn^{2+} ions, respectively. Tuning of the metal-ion-ratio (using metal trifluoroacetates as precursors) was found key when seeking control over morphology and crystalline phase. For instance, NaMnF_3 particles were obtained with tunable morphologies, yielding rods and ribbons in addition to the commonly seen plate-like structures by varying the Na^+ -to- Mn^{2+} ratio. The selective synthesis of NaGdF_4 in either of its crystalline phases (cubic α or hexagonal β) by adjustment of the Na^+ -to- Gd^{2+} ratio allowed the influence of host crystallinity on the T1 contrast behaviour to be investigated, unveiling superior performance of cubic-phase NaGdF_4 nanoparticles. The developed microwave-assisted approach further allows for doping of these nanoparticles with luminescent lanthanide ions to endow the probes with upconverting capabilities, ultimately yielding opto-magnetic multimodal probes.

Nina M. Culum (University of Western Ontario)

"Surface-Enhanced Raman Spectra for the Diagnosis of Ovarian Cancer"

(w/h T. T. Cooper, G. A. Lajoie, T. Dayarathna, S. H. Pasternak, J. Liu, Y. Fu, L.-M. Postovit, F. Lagugné-Labarthet)

Extracellular vesicles (EVs) are a complex group of membrane-bound vesicles released into biofluids by cells. EVs are of particular research interest since their molecular contents are reflective of their parent cell and can be used as biomarkers in early and minimally invasive cancer diagnostic applications. Surface-enhanced Raman spectroscopy (SERS) is a highly sensitive technique that has been widely used in recent years for the characterization of cancer-derived EVs. Although ovarian cancer is the most lethal gynecological malignancy, SERS studies of EVs released from ovarian cancer cells have been largely underexplored, especially compared to other cancer types such as breast, lung, prostate, and pancreatic cancer. In this study, we have fabricated gold nanohole arrays as SERS substrates for the capture and characterization of ovarian cancer (OvCa)-derived EVs. For the first time, to our knowledge, we have characterized EVs isolated from two established OvCa cell lines (OV-90 and OVCAR3) by SERS, as well as from two primary OvCa cell lines (EOC6 and EOC18) and one human immortalized ovarian surface epithelial (hIOSE) cell line as a control. Principal component analysis was used to reduce the complexity of the spectra acquired. The scores generated were subsequently used as classifiers in a logistic regression-based machine learning algorithm, with which we achieved high (~ 99 %) accuracy, sensitivity, and specificity in the discrimination of cancer-derived EVs from the normal control. The proof-of-concept results presented herein are a great step towards the quick, facile, and non-invasive diagnosis of ovarian cancer.

Lavinia Trifoi (Ryerson University)

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"Facile Supramolecular Strategy to Construct Solid Fluorophore at Metal-Organic Framework Composites"

(w/h G. K. Hodgson, N. P. Dogantzis, S. A. Soha, R. M. Dayam, C. N. Antonescu, R. J. Botelho, R. Stephen Wylie and S. Impellizzeri*)

Fluorescence microscopy enables the visualization of complex biological systems and processes. However, the utilization of organic dyes as bioimaging agents presents several challenges such as stability in biological environment, reduced photostability, and lower quantum yields. Substantial effort has gone into the improvement of the photophysical properties of biocompatible fluorescent molecules (fluorophores). We have designed and fabricated a supramolecular nanosystem consisting of a highly emissive fluorescein derivative encapsulated within the zeolitic imidazolate metal organic framework, ZIF-8. Confinement of the fluorescein inside the MOF leads to increased dye photostability and quantum yield, longer lifetime, and better organization of the chromophores, meanwhile providing a convenient solution to issues related to scarce solubility or aggregation induced quenching (AIQ) phenomena. Furthermore, the fluorophore@MOF composite can be internalized by mammalian macrophage cells and transported to lysosomes without disrupting cell viability. In principle, this simple protocol can evolve into a general strategy for intracellular delivery of functional molecular components for targeted bioimaging or theranostic applications.

Brahim Ahammou (McMaster University)

"Characterization of Silicon Nitride Thin Films Deposited by PECVD using Microstructures"

(w/h C. Levallois, J.-P. Landesman and P. Mascher)

This work investigates a new approach to evaluate the Young's modulus of dielectric thin films based on micro-beam buckling. We have deposited amorphous silicon nitride (a-SiN) thin films by plasma-enhanced chemical vapor deposition (PECVD) with different compressive stress levels from -98MPa to -360MPa. We determined the mechanical properties of the films ex-situ by profilometry to evaluate the residual stress using the wafer curvature method. We will discuss the fabrication and characterization of the microbeams. First, we defined the microstructures using reactive ion etching of a-SiN films, and subsequently, we released them from the silicon substrate using a standard wet etching process. The deflection profiles of the microbeams were measured using a confocal microscope. We will discuss the analytical relationship between the residual stress of the film and the released shape of a doubly clamped microbeam and how we can deduce the Young's modulus of the thin film. Through this discussion, we try to understand better the elastic properties of thin films and complete the results obtained by nanoindentation. Investigations are still in progress to extend this method to the characterization of tensile dielectric films.

Paramita Bhattacharyya (McMaster University)

[@Paramita Bhattacharyya](#)

"Tunable Thin Film Optical Filter for Standard Photovoltaics"

(w/h P. Bhattacharyya, R. Kleiman, and P. Mascher)

Electric vehicles (EVs) are becoming a trendy alternative to conventional vehicles for transitioning to low carbon energy sources. However, most EV designs suffer from recurring problems like lower driving range per charge. Consequently, the EV needs more recharges, and we spend an overall longer time charging the vehicle. Again, EVs have a dependency on the traditional grid. Thus, we suggest adding thin, flexible, and easily integratable CIGS solar cells to the car's body to help charge while driving or parking. However, aesthetically, solar-integrated electric vehicles are less attractive due to the visible panels.

Solar panels are generally blue or black, depending on panel type. We need to remember that the success of any new product depends on how well it gets accepted in the market. If we can not make this solution appealing to the customers, we might not stand a chance.

Our idea is to create optical filters for solar cells that will act as an anti-reflective coating and make them colorful. We modeled a notch filter using a non-uniform quarter-wave stack structure for this purpose. Our requirement is a very narrow reflection in the visible range with maximum transmission for the rest of the solar insolation. Materials used in this filter should also be transparent to the incident spectrum. Thus, this design uses silicon nitride as the high refractive index material and silicon dioxide as the low refractive index material. We have created a notch as narrow as 20nm with around 96% reflection in the high reflection region. This design shows a very low transmission loss of not more than 10% for most regions. We used OptiLayer for the optimization process. Our next focus is to reduce the number of layers in our design and proceed with fabrication.

Emille Rodrigues (University of Ottawa)

"Hyperspectral Imaging: a Powerful Tool for Nano-Bio Interaction Studies"

(w/h E. Hemmer)

Hyperspectral imaging (HSI) is an analytical technique, that consists in mapping a region of interest while simultaneously collecting a spectral information from each one of the pixels of the image. This generates a set of data called hyperspectral cube that allows for a detailed study of structure-property relationships of the mapped region. Interestingly, this versatile technique can be applied in a broad range of applications with a variety of samples. From macro-scale applications such as mapping the composition of the surface of the earth and different human and animal tissues until the micron-scale applications such as the study of inorganic crystals and nano-bio interactions in cells. In our research group, we have developed and study the interactions of different surface-modified luminescent lanthanide-based upconverting nanoparticles (UCNPs) with cells, and small animal models such as zebra fish embryos. The UCNPs were synthesized by an easy microwave assisted thermal decomposition approach. Post-synthesis surface modification was achieved making use of newly developed methodologies with different biopolymers as well as traditional ligand-removal protocol. By using the HSI technique, we assessed how the surface chemistry of UCNPs resulted in different uptake behavior depending on the type of biological model used: macrophages, neurons or zebra fish embryos. The possibility to use near infrared (NIR) excitation and the characteristic spectral signature of the UCNPs in the biological media allows for outstanding bioimaging capabilities: no photodamage to the cells and embryos in addition to unmistakable identification of the probe signal. Ultimately, such findings can help the understanding of nano-bio interactions of luminescent nanoparticles and the further development of UCNPs as bioimaging probes.

Greg van Anders (Queen's University)

"Shape and Interaction Decoupling for Colloidal Pre-Assembly"

(w/h L. Baldauf, E. G. Teich, P. Schall, G. van Anders, L. Rossi)

Creating materials with structure that is independently controllable at a range of scales requires breaking naturally occurring hierarchies. Breaking these hierarchies can be achieved via the decoupling of building block attributes from structure during assembly. Here, we demonstrate both geometric and interaction decoupling in pre-assembled colloidal structures of cube-like particles with rounded edges. Through computer simulations and experiments, we show that compressing a small number of such cubes in spherical confinement results in clusters with highly reproducible structures that can be used as mesoscale building blocks to form the next level of structural hierarchy. These clusters demonstrate geometric decoupling between particle shape and cluster structure; namely, for clusters of up to nine particles, the colloidal superballs pack consistently like spheres, despite the presence of shape anisotropy and facets in the cubic-like particles. We confirm that cluster structure is also decoupled from inter-particle interaction, showing that the same structures arise from the spherical confinement of both non-magnetic and magnetic colloidal cubes with strong dipolar interactions. To highlight the potential of these superball clusters for hierarchical assembly, we demonstrate, using computer simulations, that clusters of six to nine particles can self-assemble into high-order structures that differ from those of similarly shaped particles without pre-assembly. These results demonstrate decoupling for anisotropic building blocks that can be further exploited for hierarchical materials development.

Sathya Srinivasan (Carleton University)

"Aptamer and Nanomaterial based Biosensors for the Detection of Alpha-synuclein"

(w/h M. C. DeRosa)

Alpha-synuclein (α -synuclein) is a protein, encoded by the SNCA gene, where α -synuclein pathology is believed to be a hallmark of Parkinson's disease (PD). It is abundant in the brain, smaller amounts in the heart, muscle and other tissues. Alpha-synuclein aggregates (high concentration) to form insoluble oligomeric and fibrils in pathological conditions known as Lewy bodies. Among the many treatment strategies that have been developed to circumvent PD neurodegeneration. In this study, aptamer and nanomaterial-based conjugates were used for the detection of α -synuclein. Aptamers are stable, single stranded DNA or RNA oligonucleotides exhibiting high affinity, and specificity toward their targets. Aptamers have been proposed as alternatives to antibodies in many different applications with considerable interest in aptamer-based biosensors among the scientific community. The first approach consisted of selective label-free turn-on aptasensors for the specific detection of α -synuclein in the presence of G-quadruplex binding agent berberine. The second approach utilized adsorption-desorption based colorimetric aptasensors for the detection of α -synuclein using metal nanoparticles. Fluorescence, circular dichroism and melting temperature (T_m) analysis supported the binding specificity results, illustrating the potential of these aptasensor methods for improving detection limits. These approaches are rapid, inexpensive, and time efficient with the potential to become the basis for future biosensor devices (lateral flow assay).

Nayomi Camilus (Trent University)

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"Role of Tyrosine Analogues on the Photophysical Properties of Carbon Dots"

(w/h S. Martic)

Tyrosine (Tyr) is an important aromatic amino acid that is involved in maintaining a positive nitrogen balance in the human body. Currently, there are various methods to detect Tyr but they are not as advantageous as using nanomaterials. One type of nanomaterials, carbon dots, exhibit low toxicity and desirable photophysical properties for biosensing applications. The photophysical properties of dual-fluorescing carbon dots were tested using UV-vis and fluorescence spectroscopy. The Tyr amino acid titrations were carried out and fluorescence was monitored. The fluorescence intensity was quenched depending on the amino acids used. In the 0.005-0.105 mM concentration range of Tyr and phosphotyrosine, no fluorescence quenching was observed. However, quenching was observed with nitrotyrosine. Data indicate that water soluble carbon dots are ideal for biosensing application, and for mechanistic studies of their interactions with biomolecules towards functional materials.

Benjamin Baylis (University of Guelph)

"Force Spectroscopy Mapping of the Effect on the Stiffness and Deformability of Modified Phytoglycogen Nanoparticles"

(w/h J. R. Dutcher)

Phytoglycogen is a glucose-based polymer that is produced by sweet corn in the form of compact nanoparticles with an underlying dendritic architecture. Their porous structure and deformability combined with their non-toxicity and digestibility make them ideal for applications in personal care, nutrition and biomedicine. Phytoglycogen nanoparticles can be modified using chemical procedures including acid and enzyme hydrolysis, as well as mechanical techniques such as extrusion. These modifications reduce the size of the nanoparticles and can also affect their overall morphology and stiffness. We have used atomic force microscopy (AFM) force spectroscopy to collect high resolution maps of the height and Young's modulus of modified phytoglycogen nanoparticles, and we compare these results to those obtained on native phytoglycogen. Acid and enzyme hydrolysis produced particles with significantly different morphology and stiffness due to the ability/inability for hydrolysis to occur within the particles. Measurements of particles modified using increasing specific mechanical energy (SME) input during extrusion revealed a plateau in particle size with an initial increase in particle modulus for low SME and subsequent decrease in modulus for higher SME providing unique insight into the effect of extrusion on the particle structure and stiffness. These measurements highlight the tunability of the physical properties of phytoglycogen nanoparticles using simple modification procedures.

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"Photoelectrochemical Degradation of Phenolic Pollutants at Nanoporous Titanium dioxide"

(w/h Aicheng Chen)

Phenolic pollutants are ubiquitous in aquatic environments primarily due to discharges directly from industries like pulp and paper, resin, and petrochemical productions. There is an urgency to eliminate such pollutants from wastewater prior to its discharge into natural water resources. However, they often resist the conventional physical, chemical, and biological treatments. Titanium dioxide (TiO_2) has been widely used in advanced oxidation processes due to its unique properties such as high stability, low costs, biological compatibility, and chemical inertness. The objectives of the present study are two-fold: (i) to investigate the photoelectrochemical (PEC) degradation of substituted phenols at the nanoporous TiO_2 electrode; and (ii) to identify the most influential groups of phenolic descriptors (electronic, quantum mechanical, topological etc.,) on the degradation kinetics at the nanoporous TiO_2 .

The nanoporous TiO_2 were directly grown on bulk Ti plate and characterized by field emission scanning electron microscopy, X-ray diffraction spectroscopy and X-ray photoelectron spectroscopy. The PEC degradation of 22 phenolic pollutants at the modified nanoporous TiO_2 were carried out and monitored using the UV-visible spectroscopy, where their degradation rate constants were determined. A supervised machine learning approach was employed to build a quantitative structure–property relationship (QSPR) model to identify significant descriptors responsible for the efficient PEC degradation at the nanoporous TiO_2 .

Allison Salverda (University of Guelph)

"Effect of Reduced Graphene Oxide on the Tantalum Iridium Oxide Catalyst for Electrochemical Water Splitting"

(w/h J. S. Dondapati, A. Chen)

There is a great interest in the development of advanced electrocatalysts for efficient water splitting to address the pressing environmental and energy issues. A tantalum-iridium oxide ($\text{Ta}_2\text{O}_5\text{-IrO}_2$) coating is considered to be a benchmark electrocatalyst for the oxygen evolution reaction under acidic conditions. Here we report on the effect of two-dimensional reduced graphene oxide (rGO) on the catalyst activity and stability of the $\text{Ta}_2\text{O}_5\text{-IrO}_2$ thin film towards electrochemical water oxidation. A novel $\text{Ta}_2\text{O}_5\text{-IrO}_2\text{-rGO}$ coating on a titanium substrate with a variety of different amounts of rGO were prepared. Scanning electron microscopy, X-ray photoelectron spectroscopy, X-ray diffraction, and energy dispersive X-ray spectroscopy were used to characterize the morphology and composition of the prepared coatings. The electrochemical activities of the prepared $\text{Ta}_2\text{O}_5\text{-IrO}_2\text{-rGO}$ electrodes were studied by various electrochemical methods (e.g., cyclic voltammetry, linear sweep voltammetry, and electrochemical impedance spectroscopy). The effect of the incorporation rGO into the oxide layer on the activity and stability of the $\text{Ta}_2\text{O}_5\text{-IrO}_2$ catalyst is compared and discussed.