CARBON TO METAL COATING INSTITUTE
at Queen's University

ANNUAL REPORT 2025-26

About Us

Made possible by a $24 million grant from the New Frontiers Research Fund - Transformation program, the Carbon to Metal Coating Institute (C2MCI) at Queen's University is an international research, innovation, and education institute focused on developing cutting edge solutions to prevent the corrosion of metals and enable their manipulation and stabilization on nanometer scales.

Land Acknowledgement

C2MCI acknowledges that our centre of operation at Queen's University is situated on traditional Anishinaabe and Haudenosaunee territory. We are grateful to be able to live and learn on these lands. To acknowledge this traditional territory is to recognize its longer history, one predating the establishment of the earliest European colonies. It is also to acknowledge this territory's significance for the Indigenous Peoples who lived and continue to live upon it, and whose practices and spiritualities were tied to the land and continue to develop in relationship to the territory and its other inhabitants today.

We encourage you to explore the programs, funding opportunities and initiatives that are helping to build a campus that embraces reconciliation and encourages all members of the Queen's community to learn about Indigenous ways of knowing.

On The Cover

This year's cover features an image of a patterned metal surface with precise deposition of NHCs to promote selective growth of zinc oxide on dielectric surfaces. This image was taken by Dr. Jordan Bentley, C2MCI HQP based at Western University.

To learn more, please view the associated article, **"Self-Assembled Monolayers of Triazolylidenes on Gold and Mixed Gold/ Dielectric Substrates"** as published in the Journal of the American Chemical Society (Volume 147, Issue 7).

Table of Contents

Scientific Director's Message

This has been another fantastic year for the C2MCI. Thanks to the hard work and creative ideas of our team members, over the past year we have published an impressive 16 papers across the three subgroups and filed 10 new patent applications. Our HQP have taken up exchanges and internships not only with academic partners but also with industry, and we are expanding our list of collaborators in new and exciting ways.

All research areas have produced exciting results, resulting in industry-led and funded partnerships that promise to bring our research into the real world. From cancer targeting to tuberculosis treatment, corrosion resistance, extension of metal lifespans, and improved semiconductor microelectronic assembly, the work we are doing at C2MCI is having a big impact on the world.

Through the launch of the International Research Network last year, four new research projects were initiated. One of these projects, led by Drs. Vinayak Singh and Kelly Chibale (page 14) has made great strides in screening a variety of our nanoclusters (NCs) of varying sizes and compositions for their ability to inhibit the effects of mycobacterium tuberculosis. Preliminary results show positive hits, indicating that some NCs have antibacterial potential. If these results are verified through further planned studies, this would be considered a major advancement in the treatment of tuberculosis.

As always, this work would not be possible without the amazing members of the C2MCI. Our students, postdoctoral researchers, and faculty team are the key to our success. Guidance from our core team and extended group of collaborators is and always has been a critical element of our success. I would also like to thank our administrative C2MCI team. Led by Jyoti Kotecha, and including Megan Ariki, Dr. Tetyana Levchenko, Mark Aloisio, Hannah Fitzpatrick and Dr. Emily Albright, we would not be nearly as far advanced as we are without our dedicated, passionate admin team. I also greatly appreciate the continual, enthusiastic support of the institute and our goals from our Vice-Principal Research Dr. Nancy Ross, Mr. Charles Sumbler and their team, our outstanding Executive Advisory Board members and the members at partner organizations. I am extremely lucky to have such a talented and enthusiastic group of C2MCI team members and supporters.

Dr. Cathleen M. Crudden
C2MCI Scientific Director

Managing Director's Message

Thank you to all who have contributed to the C2MCI's success over the past year. As the C2MCI continues to grow, our focus has been on expansion of our research, outreach, and training programs. On the international front, we have expanded our relationship with RIKEN: Japan's largest scientific research organization for basic and applied science, covering physics, biology, medicine, engineering, and computing. Negotiations related to establishing a Memorandum of Understanding are underway to allow post-doctoral researchers, faculty and staff exchange opportunities between the C2MCI and RIKEN. We are excited to share that funding of post-doctoral exchanges related to this initiative will be provided by the Queen's Vice-Principal Research Office.

Related to expanding our research program, our members have secured research contracts with international industrial collaborators and a JST-ASPIRE grant that will spur new collaborations between Canada and Japan. To learn about these, see page 20. In addition to this, a number of additional grant applications were submitted and are currently under review. These include a Postdoctoral Canada Impact+ Research Training Award, a Canada Impact+ Research Chair, an NSERC CREATE, two New Frontiers in Research Fund (NFRF) – Exploration grants and two NSERC Research Tools and Instruments (RTI) Grants. We anticipate these applications will be successful and look forward to hearing announcements from funding agencies this summer.

Expansion of our research relies on acquiring advanced research infrastructure. To facilitate this, two multi-million-dollar Canada Foundation for Innovation (CFI) applications were awarded this past year to core team members Dr. Paul Ragogna ($5.27M) and Dr. Yolanda Hedberg ($9.7M). This success will allow us to better equip state-of-the-art facilities at Western and Queen's and venture into new areas related to the development of metal coatings for nuclear energy (hydrogen) storage and transportation, as well as materials development for orthopedic and dental implants. To learn more, see page 21.

Key initiatives this year included hosting events to initiate discussions with industry and government partners. These events aimed to align our research to address real-world needs related to microchip manufacturing,corrosion protection, and chemical and biological threat detection.

Jyoti Kotecha
C2MCI Managing Director

Year by Numbers

$4.3 Million in Operational Funding

$4M New Frontiers in Research Fund - Transformation

$300K Queen's University Vice-Principal Research

54	Faculty Members across 19 institutions	102	Highly Qualified Personnel	40	HQP & Faculty Awards
6	HQP Internships across 5 countries	23	Seminars & Workshops	50	Global Partners
35	Lifetime NFRF-Funded Research Publications	5	Patents Issued	13	Patent Applications Pending
10	International Teams across 9 countries	6	Affiliated Projects	34	Members Graduated
69	Research Presentations across 10 countries	2	Mitchell Ignite Award Recipients	162	N-Heterocyclic Carbenes (NHCs) Catalogued
12	New Collaborators	7	EDII-Focused Events	5	United Nations Sustainable Development Goals

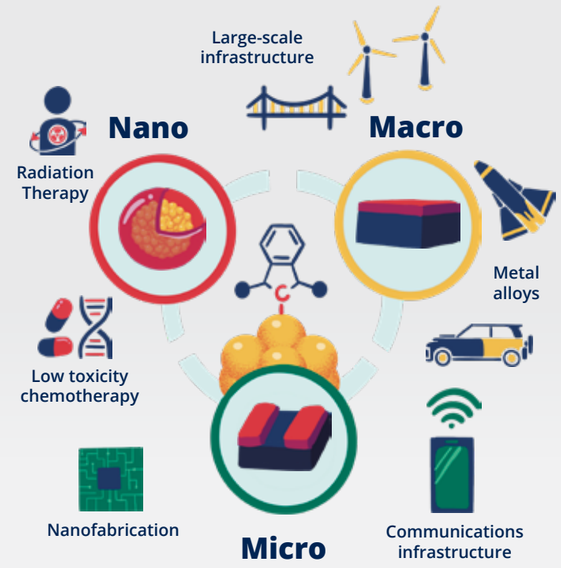
14 Research Disciplines

Art Conservation · Biology · Biomedical · Chemistry · Chemical Engineering · Civil Engineering · Computing · Mechanical Engineering · Molecular Science · Oncology · Physics · Pharmacology · Physiology · Surgery

Overview of Research

The Carbon to Metal Coating Institute (C2MCI) is an international, interdisciplinary institute of research, innovation, and education excellence made possible by a $24 Million grant from the **New Frontiers in Research Fund - Transformation program**.

From automobiles, to bridges, airplanes, green energy infrastructure, microelectronics and precision therapeutics, it is difficult to imagine modern life devoid of metals. However, as most metals are unstable in oxygen rich environments, all metal infrastructure requires costly inspection, repair, and corrosion mitigation efforts.



Our goal is to develop a novel metal coating strategy that will have impact on all length scales.

Global Reach

Our network of partners include global academic research leaders from the disciplines of chemistry, physics, engineering, and medicine.

Global partners are located across Canada, the USA, the United Kingdom, Finland, Japan, and Germany. Outreach and research projects have expanded to include Africa and Israel.

Mission

The C2MCI aims to achieve global leadership in interdisciplinary research, innovation, and education. In doing so, our research makes meaningful contributions to the UN Sustainability Development Goals (SDG 3, 9, 11, 12, 17).

Our research is focused on benefiting society through novel carbon to metal coatings at the nano, micro and macro scale.

Team of Experts

Our consortium of industry partners supports scale up and knowledge mobilization.

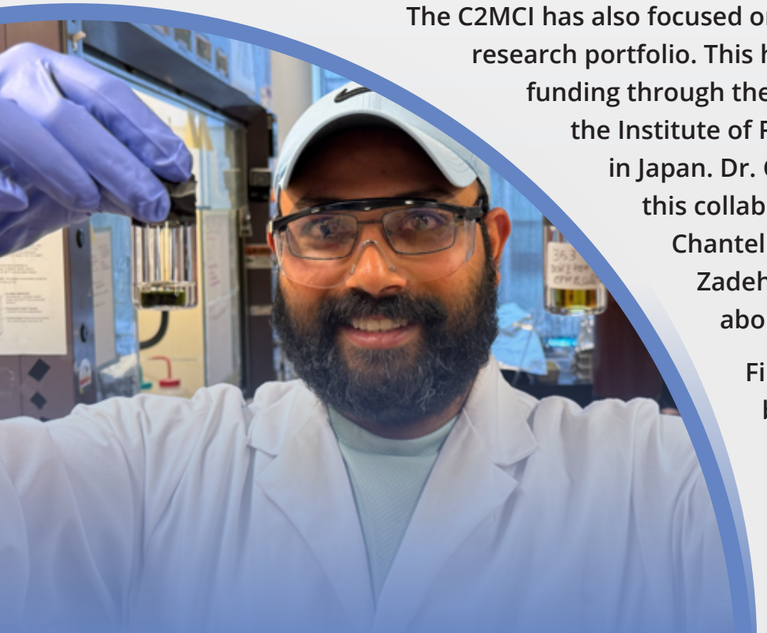
- 9 Canada Research Chairs
- 11 International Team Members
- 10 Government Partners / National Labs
- 7 Oncologists & Clinicians
- 10 Early Career Researchers
- 10 Industry Partners

Research Spotlight

Over the past year, the C2MCI team has made exceptional progress towards our goals. Our team has expanded our library of molecular coating materials (N-heterocyclic carbenes, NHCs) to over 135 derivatives and 115 biologically relevant nanoclusters (NCs). These materials continue to demonstrate broad utility across applications ranging from corrosion-resistant coatings and advanced semiconductor manufacturing to precision cancer therapeutics.

Institute work this year has led to 5 issued patents, with an additional 13 pending patent applications. Guided by our Research Translation and Commercialization Committee (RTC), we have ramped up outreach to industry partners in the past year. These outreach activities led to the launch of our semiconductor R&D interest group. With representation from Canadian industry, government, and the Canadian Semiconductor Council, we hope to expand the number of industry sponsored research projects over the next 2-3 years. Additionally, we have made substantial progress related to scale-up and testing of our materials and methods for the microchip manufacturing sector, leading to our first research project sponsored by a major international semiconductor partner.

With the launch of the International Research Network in 2024, four projects received seed funding. One of these projects, led by Drs. Kelly Chibale and Vinayak Singh from the University of Cape Town in South Africa, has reported tremendously successful initial results. Using NCs provided by Dr. Chantelle Capicciotti and Dr. Cathleen Crudden's teams, the South African team has tested their use for tuberculosis eradication and found that the NHC-stabilized NCs are significantly more effective than current standards, prompting further in-detail studies. To learn more, see page 14.



The C2MCI has also focused on expanding its international research portfolio. This has led to new collaborative funding through the JST-ASPIRE program with RIKEN, the Institute of Physical and Chemical Research in Japan. Dr. Cathleen Crudden is leading this collaboration, which also includes Dr. Chantelle Capicciotti, Dr. Farnaz Heidar-Zadeh and Dr. Taleana Huff. To learn about this new initiative, see page 20.

Finally, over the past year we have been successful in receiving a number of new grants and securing funding to build research infrastructure. To learn about these new grants, see page 21.

Research Highlights

Macro

This year, the Macro team advanced the application of N-heterocyclic carbene (NHC) coatings for corrosion protection and surface functionalization of industrially relevant metals, resulting in 7 peer-reviewed publications (see page 62). They demonstrated both immersion and electrochemical deposition approaches to anchor NHCs on mild steel, achieving reproducible coatings that significantly enhance corrosion resistance.

Mechanochemical methods for the functionalization of copper powders were introduced as a sustainable route to produce oxidation-resistant metal precursors for additive manufacturing. Expanding beyond metals, NHCs were applied as clickable molecular anchors for functionalizing glassy carbon and electrode surfaces, enabling new electrochemical applications with significant potential in sensing.

The team has also developed and patented a new class of NHC-containing polymers for the coating and protection of metal surfaces. A diverse library of copolymers were synthesized and tested on gold and copper substrates using immersion, spray, and electrodeposition methods.

Following the successes achieved in the first half of this grant related to protecting copper and steel with NHCs, we initiated a new project with art conservation collaborators at Queen's University focused on applying these advances to the protection of outdoor metal sculptures. This year, the team began developing two complementary NHC-based coating systems designed for the sustained preservation of copper alloys and mild steel-based artworks.

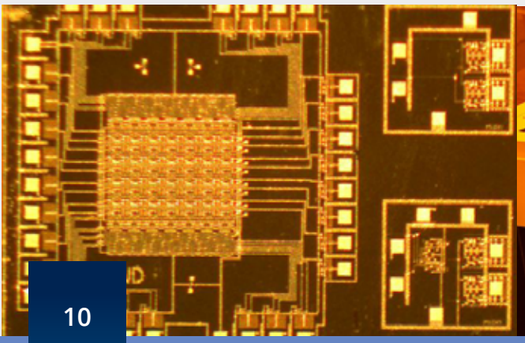
Research Highlights

Micro

Team Micro focused on advancing atomic-scale understanding and control of N-heterocyclic carbene (NHC)-based surface processes for microelectronic applications. Across 4 peer-reviewed publications, the team reported major advances in understanding and controlling self-assembly on metal and hybrid metal/insulator substrates, establishing new structure–property relationships and mechanistic insights. The team demonstrated the formation of high-density, thermally robust monolayers on gold and mixed gold/dielectric interfaces, including a new class of triazole-based monolayers with exceptional selectivity and stability.

Team Micro has also introduced a vapor-phase process enabling atomic-scale smoothing of metallic surfaces without chemical etchants, representing a major step toward angstrom-level precision in microfabrication, which resulted in a patent filing and a subsequent publication. Complementary studies revealed dynamic surface restructuring and multiple bonding modes that underpin the versatility of NHCs as molecular ligands. Together, these studies provide foundational understanding and practical methodologies for stable, tunable, and selective molecular films that address critical challenges in semiconductor manufacturing and nanoscale materials engineering.

For semiconductor and microelectronic applications of NHC-based self-assembled monolayers, the target substrates are often more reactive metals such as copper, cobalt, and ruthenium. However, conventional precursors for NHC deposition may present challenges for these systems due to the co-production of water, which may be an undesirable by-product in some cases. To overcome this limitation, our Micro team developed a new stable, water-free precursor that enables selective deposition of a molecular adduct of an NHC with dihydrogen, which serves as a unique molecular precursor even on reactive metal surfaces. A provisional patent on this work was filed in April 2025 and a publication is forthcoming.



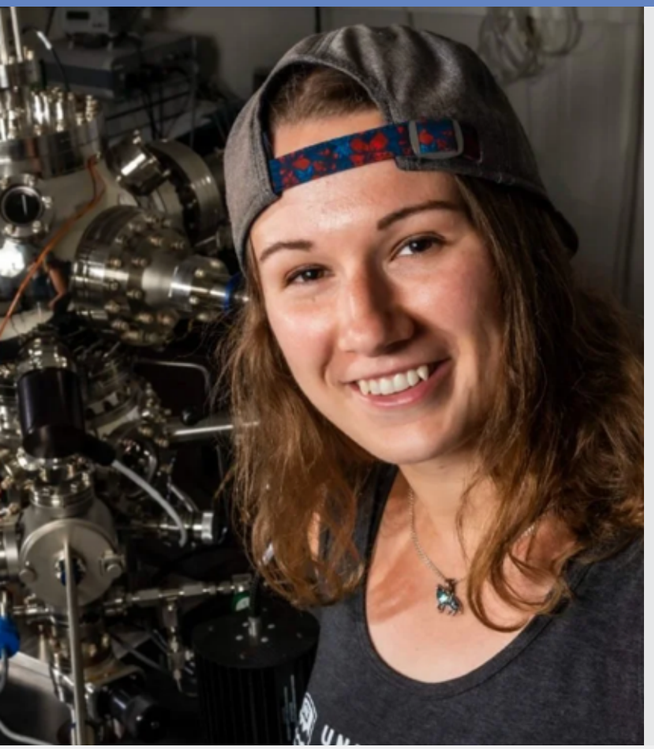
Nano

This year, the Nano team has produced 5 peer-reviewed publications showcasing advancement of the design, synthesis, and modelling of NHC-protected gold nanoclusters (NCs) for biomedical applications. Among these, the team developed the first AMBER-compatible molecular dynamics force field for NHC-Au NCs, enabling predictive simulation of their structural and optical properties. Experimental studies established robust synthetic and post-functionalization strategies to precisely tune the surface chemistry of NHC-Au NCs, achieving water-soluble, biocompatible, and highly luminescent NCs stable under physiological conditions.

The team also reported the first application of Au NCs as radiosensitizers for cancer treatment, establishing a foundation for future comparisons with NHC-Au systems. Complementary investigations examined protein and amino acid interactions with gold nanoparticles of varying sizes, providing fundamental insights into nanoparticle stability and biocompatibility in biological media. Building on these advancements, ongoing work is focused on optimizing NHC-stabilized Au NCs for targeted imaging and therapeutic applications.

In addition, team Nano has shown that these NHC-Au NCs generate strong X-ray–excited optical luminescence, making them promising candidates for activating photosensitizers in X-ray–induced photodynamic therapy (X-PDT). This approach holds significant potential for treating deep-seated tumors using clinically relevant X-ray sources, which will be the focus of the team in the coming years. In parallel, ongoing exploration of ligand design and modification studies will correlate with enhanced fluorescence quantum yield and photostability to advance their potential targeting specificity and therapeutic efficacy, focusing on single-dose photodynamic therapy (PDT) and image-guided theranostics.

Institute Highlights



Welcoming New Faculty

We are very pleased to announce the addition of a new faculty member to the C2MCI community: **Dr. Taleana Huff**! Dr. Huff is a specialist in surface science and nanophysics, focusing on investigating atomically precise structures, molecular assemblies, and surface reactivity. Her research spans chemistry and physics, and her insights have already furthered current project objectives.

We are truly excited to be working with Dr. Huff and look forward to future projects.

Dr. Huff was hired as part of the Bruce Mitchell family gift to Queen's, and we thank them for this generous donation.

Research & Publication Progress

Exceptional progress on the research front has led to 15 new publications (page 62) featured in top tier peer reviewed journals. Our most recent publication from the C2MCI's Nano team described an exciting update from our cancer-targeting studies showing the incredible cluster luminescence identified in in vivo subjects as reported by Dr. Gang Zheng's team.

Published results confirm that our clusters are attaching to tumours and are effectively being cleared from the body. The intense luminescence enhances visualization of tumours, allowing for more accurate monitoring of tumour size reduction. We look forward to pursuing this research further and are optimistic that tests in human subjects will proceed in the future.

Industry & Partner Discussions

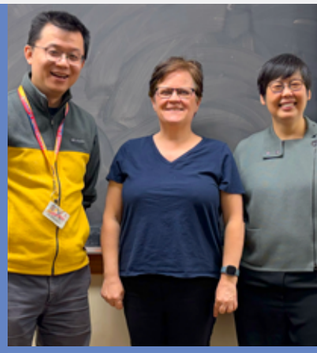
The C2MCI hosted two separate events to facilitate discussions with industry and government partners interested in our novel discoveries. Our first event was related to improved microchip manufacturing, and the other related to coatings with applications in corrosion resistance and as sensors for chemical and biological threat detection.

Participants for these events included:

- Canadian Semiconductor Council
- Kingston Economic Development Corporation
- Impact Chemistry
- Qnity
- RXN HUB
- Syensqo
- Centre de Collaboration MiQro Innovation (C2MI)
- Canadian Microelectronics Corporation
- Federal and provincial agency representatives supporting semiconductor manufacturing
- Researchers from various Defence Research and Development Canada (DRDC) centres, the Royal Military College of Canada, and the National Research Council

The events ignited much interest and have led to the formation of the C2MCI Semiconductor R&D Interest Hub and the C2MCI-DRDC Research Discussion Group.

Following the success of the C2MCI-DRDC meeting, we hosted Dr. Nora Chan from the BioThreat Defence Section in Suffield, Alberta to deliver a hybrid seminar on defence against pathogens research. Dr. Chan has established a collaboration with Drs. Cathleen Crudden and Zhe She on unique biodetection capabilities at Queen's and DRDC. Discussions to facilitate technology assessment, support integration with national and international partners, and create HQP internship opportunities are ongoing.



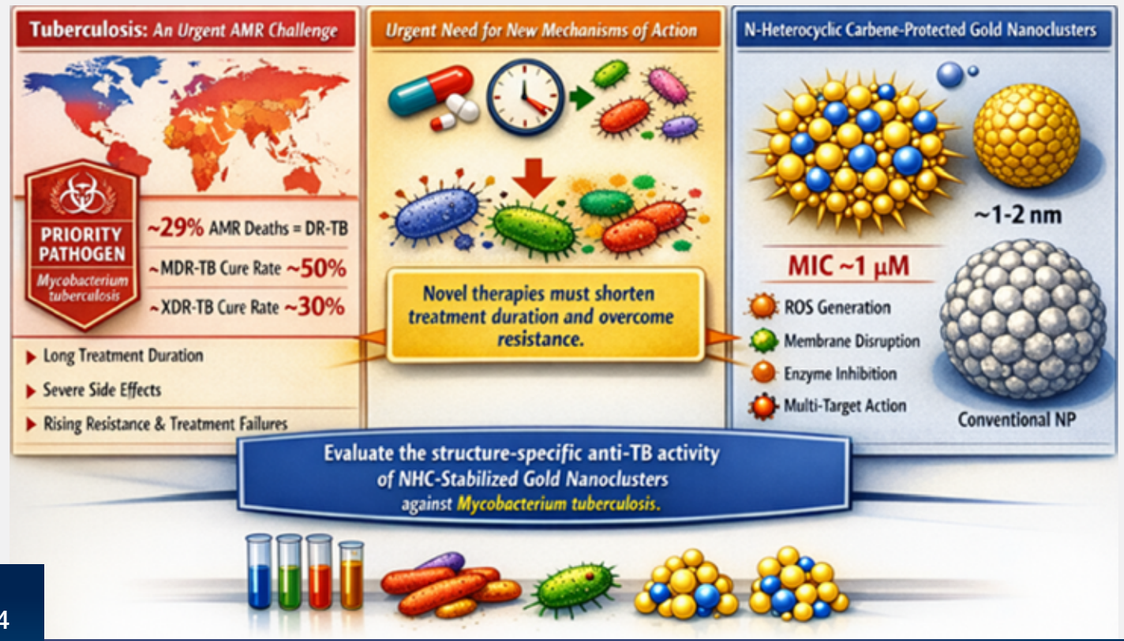
Evaluating anti-tubercular activities of novel nanoclusters

Principal Investigator:	**Dr. Kelly Chibale & Dr. Vinayak Singh (University of Cape Town, South Africa)**
C2MCI Collaborator:	**Dr. Chantelle Capicciotti (Queen's University)**

Abstract

Antimicrobial resistance (AMR) is one of the paramount health perils that has emerged in the 21st century. The global increase in drug-resistant strains of various bacterial pathogens compelled the World Health Organization (WHO) to develop a priority list of AMR pathogens that includes Mycobacterium tuberculosis (Mtb), which causes tuberculosis (TB).

Drug-resistant TB (DR-TB) accounts for ~ 29% of deaths attributable to AMR. Despite the availability of drug regimens, the current cure rate of multi-drug resistance TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) treatment regimens is 50% and 30%, respectively. These regimens are of a long duration, display serious adverse effects, are associated with poor patient adherence, and further acquisition of drug resistance often results in treatment failure. Therefore, new anti-TB drugs with novel mechanisms of action are desperately needed to be included in novel MDR-TB and XDR-TB treatment regimens to shorten treatment duration and prevent resistance.



Abstract (cont'd)

Among antibacterial nanomaterials, NHC-stabilized nanoclusters have emerged as potential game changers. The aim of this project is to assess NHC-protected nanoclusters of varying structures and size's ability to inhibit the growth of Mtb which is the cause of TB.

Research Progress

Preliminary screening of 16 NHC–stabilized gold nanoclusters from the C2MCI library were tested. Six of these were identified to have significant inhibitory activity against replicating Mtb, showing low micromolar minimum inhibitory concentration. These hits span multiple structural classes, indicating a tuneable structure–activity relationship (SAR) profile.

Moving forward, planned work includes mechanistic studies to investigate uptake, reactive oxygen species generation, and membrane effects; expanded SAR through second generation nanocluster design; and selectivity profiling via cytotoxicity and Gram negative/positive panel assays. Advanced biological testing—including intracellular Mtb assays, timekill kinetics, and activity against non-replicating Mtb—are in progress to further validate and prioritize the most promising nanocluster candidates.

Overview

On October 18th 2024, the C2MCI launched its International Research Network. The launch of the network was initiated with a focus on building new collaborations with researchers across the globe to support research aligned to Queen's commitment to United Nations Sustainable Development Goals (SDG 3, 9, 11, 12, & 17).

Following the launch of the International Research Network, the C2MCI awarded competitive research funding to four teams, each valued at $50K over 2 years for proof-of-concept projects. Funded projects include examining NHC-based nanoclusters for tuberculosis and cancer treatment, using NHCs as key materials for modified electrochemical energy conversion and storage, and investigating NHCs for corrosion protection of renewable energy infrastructure in marine environments.

International Research Network Highlights

Smart multifunctional coatings for corrosion protection of renewable energy infrastructure in marine environments

Principal Investigator:	**Dr. Emeka Oguzie (Federal University of Technology Owerri, Nigeria)**
C2MCI Collaborator:	**Dr. Yolanda Hedberg (Western University)**

Abstract

The global energy transition relies on reducing greenhouse gas emissions through renewable energy (RE) deployment (solar, wind, etc.) and large-scale carbon capture, utilization, and storage (CCUS) innovations. Floating photovoltaic (FPV) systems are gaining attention due to land constraints and efficiency losses in land-mounted PVs at high temperatures. Similarly, the marine industry—responsible for substantial greenhouse gas emissions—is under pressure to decarbonize, with CCUS offering key opportunities. However, corrosion of metallic components in saline environments remains a major barrier to durability and reliability.

This research aims to develop smart multifunctional coatings with anti-corrosion, superhydrophobic, self-healing, and antifouling capabilities for protecting aluminum and carbon steel in marine settings.

Research Progress

Significant progress has been made in computational modelling. Density functional theory (DFT) and molecular dynamics (MD) simulations have been completed to screen and optimize inhibitor–metal organic framework (MOF) –nanocomposite coating formulations for aluminum and carbon steel surfaces in saline environments. The simulations evaluated adsorption energies, interfacial charge transfer,

Research Progress (cont'd)

diffusion behavior, and hydrophobicity to identify the most stable coating architectures. The computational phase is now concluding, and preliminary experimental runs have commenced, including coating synthesis, electrochemical corrosion testing (EIS, Tafel, and salt spray), and surface characterization to confirm anti-corrosion, self-healing, and superhydrophobic performance predicted by modelling.

N-heterocyclic carbene-modified metal surfaces for electrochemical energy conversion and storage

Principal Investigator:	**Dr. Peter Ngene (Utrecht University, Netherlands)**
C2MCI Collaborator:	**Dr. Zhe She (Queen's University)**

Abstract

Li-ion batteries (LIBs) have become the primary energy storage solution for portable electronic devices, electric vehicles, and smart grids and as such are the cornerstone of a wireless and environmentally friendly society. Although LIBs are the most attractive batteries due to their light weight, hence good energy density, they are limited by their high cost, potential for explosion and degradation over time, and there is need to improve their energy density to meet the requirement for extended device run-time and longer driving range for electric vehicles.

Lithium-metal anode batteries are promising alternatives to the current LIBs due to their higher energy density and improved safety, especially when combined with solid electrolytes. However, their implementation has been hindered by poor reversibility of lithium plating and stripping, leading to high surface area "mossy" lithium deposits and undesirable side reactions that cause battery explosions. In addition to interest in LIBs, there is a need to improve copper–based electrocatalysts for electrochemical reduction of carbon dioxide into useful chemicals and fuels. A major challenge for Cu and other electrocatalysts is the severe structural degradation during the reaction. The electronic modification and surface functionalization will undoubtedly improve both the selectivity and stability of Cu.

This project aims to investigate N-heterocyclic carbenes (NHCs) modification of metal electrode surfaces as a novel approach to tune their properties in electrochemical applications, specifically in anode-free Li-ion batteries and electrocatalysts.

Research Progress

During this period, a promising NHC has been identified and shipped for testing in spring. Further results will be featured next year.

Chalcogen–NHC platforms for nanomedicine and advanced surface protection

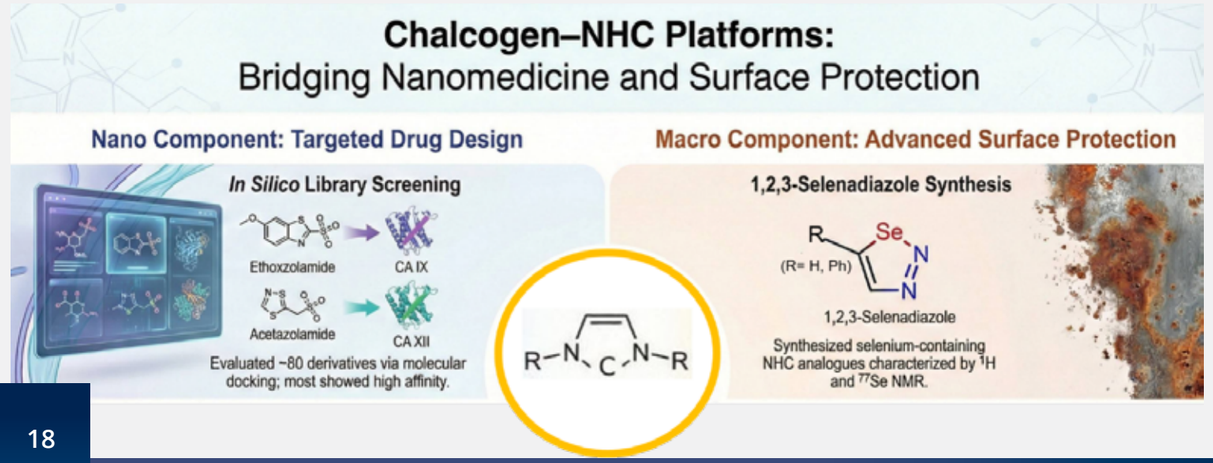
Principal Investigator:	**Salma Elmallah (Arab Academy for Science, Technology and Maritime Transport, Egypt)**
C2MCI Collaborator:	**Dr. Lucia Lee (Queen's University)**

Abstract

This project explores the rational design of chalcogen-functionalized N-heterocyclic carbene (NHC) systems as adaptable platforms spanning nano- and macro-scale applications. The strong σ-donor character of NHCs and their ability to form robust, well-defined metal–carbon bonds enables precise control over surface composition and stability. On the nano scale, NHC-stabilized gold nanoclusters will be engineered as chemically defined scaffolds and functionalized with sulfur- and selenium-containing anticancer agents, affording nanoconjugates with controlled architecture and tunable physicochemical properties for targeted drug delivery.

On the macro scale, we are investigating selenium-based NHC derivatives capable of forming stabilizing chalcogen-bond-driven networks on metal surfaces. Exploiting the directionality and adjustable strength of chalcogen interactions, these systems are designed to enhance film cohesion and corrosion resistance.

Together, the project establishes chalcogen–NHC chemistry as a unifying molecular strategy linking nanomedicine and advanced surface protection.



Research Progress

Progress has advanced in parallel across both the anticancer and materials-focused aspects of the project. A library of over 80 chalcogen-containing ethoxzolamide and acetazolamide derivatives have been successfully designed and computationally evaluated against standards, with the majority demonstrating favourable binding profiles. These results enabled the initiation of synthesis and characterization of selected lead compounds, alongside structured student training and laboratory setup.

In parallel, selenium-based NHC analogs have been successfully synthesized and characterized. These compounds were found to be temperature sensitive, but we anticipate that coordination to a metal center will provide greater stability. Ongoing coordination studies and crystallization of gold-bound complexes mark the next key phase.

Industry Projects

Project Title — Confidential

Principal Investigator:	**Dr. Cathleen Crudden (Queen's University)**
Co-Principal Investigators:	**Dr. Seán Barry (Carleton University) & Dr. Paul Ragogna (Western University)**

Funding

$126K over 1 year

International Training Program Project

CoMBiS (Carbon-based material-biology interface science)

Principal Investigator:	**Dr. Kenichiro Itami (RIKEN, Japan)**
C2MCI Lead:	**Dr. Cathleen Crudden**

Abstract

Supported by the Japan Science and Technology Agency's Adopting Sustainable Partnerships for Innovative Research Ecosystem (JST-ASPIRE) program, the aim of CoMBiS is to pioneer a new scientific field by controlling the interfaces formed between "biomolecules" or "materials" such as metals, carbon, and inorganic substances, and carbon-based molecules ("carbon molecules") through interactions unique to carbon molecules. By achieving a molecular-level understanding of each interface, this research will design carbon molecules that bridge the otherwise incompatible worlds of biomolecules and materials, ultimately creating a new class of unconventional substances with transformative potential in both materials science and the life sciences.

This research seeks to seamlessly "connect" the interfaces of materials science—from biology-related fields to materials engineering—through carbon molecules, delivering major breakthroughs in both fundamental and applied research. CoMBiS aims to open an unprecedented new research domain by promoting international collaborative research led by world-class experts in molecular nanocarbon science, supramolecular chemistry, structural biology, and gold–carbene interface chemistry.

Through this program, the Crudden, Heidar-Zadeh, Huff and Capicciotti groups will be accepting students from Japan and sending their HQP to Japan and partner groups in Germany and Spain. The program will run for at least three years and the first student exchanges are already in place.

Research Infrastructure Grants

The Canada Foundation for Innovation Innovation Fund (CFI-IF) represents one of the federal government's most significant investments in research infrastructure, equipping leading scholars with advanced tools to address complex national and global challenges. Receipt of CFI-IF funding is highly competitive and signals exceptional research excellence, leadership, and national relevance.

Canadian Barrier Coatings Initiative (CBCI): Protection of metallic surfaces through molecular-level innovation

Principal Investigator:	**Dr. Paul Ragogna (Western University)**
Collaborators:	**Dr. Cathleen Crudden (Queen's) & Dr. Janine Mauzeroll (McGill)**
Funding:	**$5.27M — CFI Innovation Fund**

This initiative seeks to develop transformative corrosion prevention strategies using metallophilic organic coatings that bind strongly to metal surfaces, offering protection across a wide range of materials and scales. The project aims to deliver durable, cost-effective, and environmentally responsible solutions to corrosion while enabling new "bottom-up" manufacturing approaches relevant to microelectronics. For the C2MCI, this funding supports the expansion of advanced analytical infrastructure at Queen's, directly enabling the scale-up, optimization, and commercialization of novel coating materials.

Advancing Canada's sustainability by mitigating hydrogen-promoted degradation

Principal Investigator:	**Dr. Yolanda Hedberg (Western University)**
Collaborators:	**Dr. Cathleen Crudden & Dr. Mark Daymond (Queen's University)**
Funding:	**$9.7M — CFI Innovation Fund**

This research addresses the critical challenge of hydrogen embrittlement, a process that weakens metals and poses significant risks for hydrogen storage and transportation systems central to Canada's clean energy transition. The team will develop novel analytical methods to directly detect hydrogen in materials, establish a mechanistic understanding of degradation processes, and design advanced hydrogen-resistant coatings.

For the C2MCI, this work is closely aligned with our expertise in carbon-to-metal coatings, enabling the development of next-generation materials that enhance the safety and reliability of hydrogen technologies. The establishment of new facilities at Queen's further positions the Institute at the forefront of sustainable materials research and supports Canada's ambitions under its national hydrogen strategy.

Affiliated Projects

Affiliated research projects play an integral part in our research program. These projects supplement the costs of our research, and also expand our understanding of details not encompassed within the main framework of our research.

One of the affiliated research projects that we are embarking upon is an NSERC Alliance grant led by Dr. Viola Birss at the University of Calgary and industry partner CardiAI. Drs. Crudden and She are working with Dr. Birss on the project entitled “Development of a sensitive and dynamically responding electrochemical pathogen sensor platform technology.”

European Research Council
Dynamic Nanocluster – Biomolecule Interfaces
PI: Dr. Hannu Häkkinen — €2.5 Million, 2024-2029

U. S. Department of Energy
Molecular and Atomic EngineeRing of Interfacial Electro-catalytic Environments (MARIE)
PI: Dr. Kelsey Storzinger | Co-PI: Dr. Cathleen Crudden — $3.6 Million, 2023-2026

NSERC Alliance
Development of a Sensitive & Dynamically Responding Electrochemical Pathogen Sensor Platform Technology
PI: Dr. Viola Birss — $900,000, 2024-2026

NSERC CREATE
Excellence in Canadian corrosion education through internationalization, equity, and interdisciplinarity
PI: Dr. Yolanda Hedberg — $1.65 Million, 2021-2027

Excellence in HQP Training

The C2MCI Training Program continues to provide an integrated, interdisciplinary environment that equips our highly qualified personnel (HQP) with the scientific expertise and professional competencies needed to thrive across academic, industrial, and entrepreneurial career paths.

Building on the program’s core pillars (interdisciplinarity, mentorship, advanced technical training, industry engagement, and EDII principles), this year’s activities further strengthened both scientific depth and community connectivity.

Throughout 2025–2026, the C2MCI hosted a monthly scientific seminar series featuring invited speakers whose research aligns with the Institute’s focus areas. Delivered virtually and recorded for accessibility, these seminars fostered cross-disciplinary dialogue and enabled HQP to engage with leading experts from around the globe.

In addition to virtual programming, numerous in-person seminars were hosted throughout the year across C2MCI-affiliated institutions. Of particular note, Dr. Daniela Loock delivered a seminar at the Department of Chemistry at Queen’s University titled “12,000 Sensors Under the Sea,” highlighting collaborative research between the C2MCI and Ocean Networks Canada, a globally recognized ocean observatory that operates extensive subsea sensor networks to monitor oceanographic and environmental processes in real time.

In October, the C2MCI was proud to return as a sponsor of the annual Queen’s Graduate Chemistry Society (QGCS) Symposium, this year themed “Making Bonds & Breaking Boundaries.” As part of our sponsorship, the C2MCI co-hosted and broadcast the keynote lecture delivered by Dr. Hanadi Sleiman (McGill University), titled “DNA Nanostructures: From Design to Targeted Cancer Therapy,” that exposed HQP to cutting-edge research at the interface of chemistry, nanotechnology, and medicine.

Together, these initiatives continue to advance the C2MCI’s mandate of delivering comprehensive, accessible, and forward-looking training opportunities that prepare our trainees to assume leadership roles in their future careers.

HQP Leadership Committee

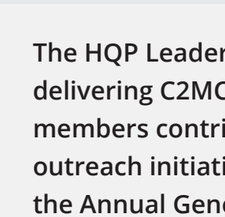
Comprised of graduate students and postdoctoral fellows from across the Institute, the HQP Leadership Committee provides valuable input on program priorities while offering its members meaningful leadership and organizational experience.

The HQP Leadership Committee continues to play an important role in shaping and delivering C2MCI's training and outreach programming. Over the past year, committee members contributed to the planning and implementation of C2MCI training events and outreach initiatives (page 33) and supported the coordination and facilitation of activities at the Annual General Meeting (page 37).

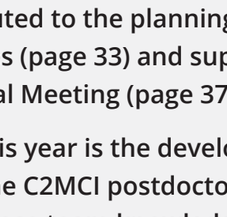
A new initiative this year is the development of HQP-led workshops. Designed to highlight the expertise of the C2MCI postdoctoral researchers and graduate students, these sessions aim to promote cross-team knowledge exchange and complement the existing components of the training program. The committee has worked closely with the administrative team to prepare the first round of HQP-led workshops for in-person delivery at the 2026 AGM. Following the AGM, these workshops will continue as part of the 2026–2027 virtual seminar and workshop series, broadening participation and ensuring sustained engagement across partner institutions.

Through active involvement in research discussions, outreach planning, and interdisciplinary collaboration, committee members strengthen communication among sub-projects and help cultivate a supportive, collaborative training environment. Their continued leadership enhances both the scope and impact of C2MCI's professional development programming.

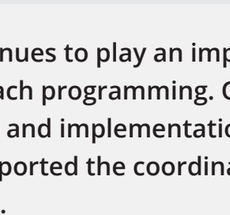
2025-26 Committee Members



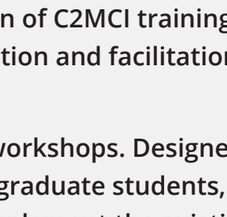
Ahmadreza Nezamzadeh
Crudden Group
Queen's University



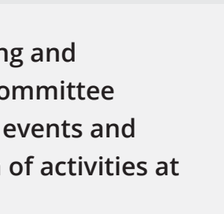
Anastasia Messina
Crudden Group
Queen's University



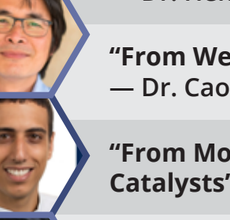
Daniel Reddy
Oleschuk Group
Queen's University



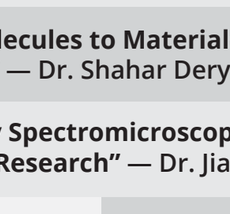
Eden Goodwin
Barry Group
Carleton University



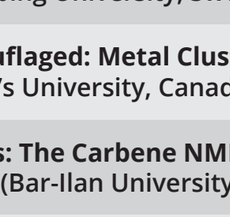
Garima Garg
Ragogna Group
Western University



Hetvi Shah
Zheng Group
University Health Network

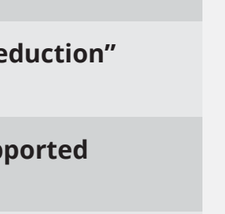


Jordan Bentley
Ragogna Group
Western University



Marshall Yang
Hedberg Group
Western University

Monika Snowdon
Crudden Group
Queen's University



Narges Hajighasemi
Hedberg Group
Western University

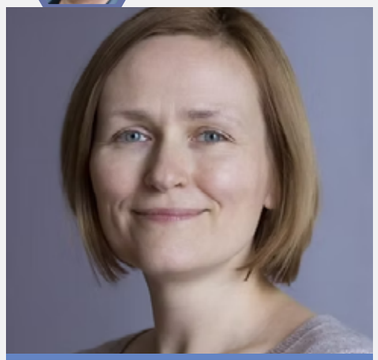
Seminar Series Presentations

"Chemical Vapor Deposition Using Free Electrons"
— Dr. Henrik Pedersen (Linköping University, Sweden)

"From Well-defined to Camouflaged: Metal Clusters in CO_2 Electroreduction"
— Dr. Cao Thang Dinh (Queen's University, Canada)

"From Molecules to Materials: The Carbene NMR Fingerprint of Supported Catalysts" — Dr. Shahar Dery (Bar-Ilan University, Israel)

"Soft X-ray Spectromicroscopy at the Canadian Light Source and Applications in Materials Research" — Dr. Jian Wang (University of Saskatchewan, Canada)



2025-26 HQP Leadership Committee Chair
Dr. Tetyana Levchenko

"Spectroscopy and Kinetics Investigations on Metal Nanocluster Electrochemiluminescence"
— Dr. Zhifeng Ding (Western University, Canada)

"Synchrotron X-ray Spectroscopy of Nanoclusters and Nanoalloys"
— Dr. Peng Zhang (Dalhousie University, Canada)

"Into the Infrared: Machine Learning-Guided Design of DNA Scaffolds for Atomically Precise Silver Nanoclusters"
— Dr. Stacy Copp (University of California, Irvine, US)

Thank you to all who attended our Virtual Seminar Series presentations!

Research Exchanges

One of the core components of the C2MCI training program is to provide opportunities for our trainees to conduct research at complementary research facilities. This year, several of our HQP were able to participate in research exchanges.

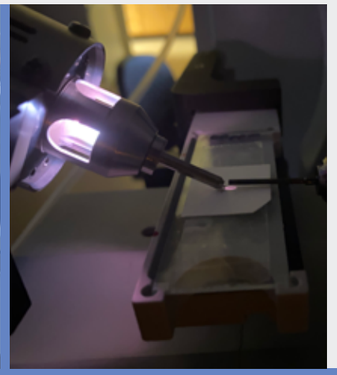
Daniel Reddy — New York, USA

With support from the Queen's University – Faculty of Arts and Science's International Research Collaborations Fund and the Pittcon/American Chemical Society – Division of Analytical Chemistry's (ACS) Summer Graduate Fellowship, I completed a research visit in summer 2025 in the laboratory of Dr. Jacob T. Shelley (Alan Paul Schulz Career Development Professor) in the Department of Chemistry and Chemical Biology at Rensselaer Polytechnic Institute (RPI) (Troy, New York USA). As a fun fact, RPI is the only university in the world with an IBM quantum computer!

While at RPI, I adjoined some of the microfluidic systems from my PhD work at Queen's University with the Shelley group's flowing atmospheric pressure afterglow (FAPA) – mass spectrometer (MS) setup, with some exciting results to be published soon in our manuscript, "Spot on: A Laser Micromachining-Based Approach to Improve Dried Matrix Spot Preparation with Analytical Demonstrations Using Ambient Desorption/Ionization Mass Spectrometry."

This experience solidified the power of networking and chemistry as a globally connected science; I met Dr. Shelley at my first-ever conference as a grad student at Queen's, the 2022 Southeastern Regional Meeting of the ACS in sunny San Juan, Puerto Rico. Dr. Shelley and I presented in the same session, stayed in contact, received the grants to support my research visit, and now will continue working together beyond my time at Queen's. Go to conferences and meet people; one interaction changed my career certainly for the better!



Dr. Antoine Juneau — Nagoya, Japan

Going to work in Dr. Crudden's satellite lab in Nagoya was the perfect excuse to finally visit Japan. A Japan Society for the Promotion of Science (JSPS) grant made it possible, and it turned into a very unique experience both professionally and personally.

The research was, of course, a natural extension of my work at McGill. Working on NHC-stabilized metal nanoclusters at ITbM let me lean into my background in NHC chemistry while learning about inorganic and organic synthesis. Experiencing another lab's workflow also gave me a fresh perspective on my own research habits, good and bad.

People often say that three months is about the minimum time needed to really settle into a new workplace and get used to a new country. In that sense, the timing was great. The internship was short, but long enough to learn a lot and to get a realistic sense of what day-to-day life in Japan looks like (including 2-liter cans of Asahi Extra Dry and earthquake evacuation drills). The team at ITbM was very welcoming, and the shinkansen made almost every city in Japan reachable for weekend sightseeing. Being in academia uniquely allows for this kind of exchange with a high level of freedom, and I would highly recommend it.



HQP Research Grant Awards

Direct metal-surface alignment of semiconducting carbon nanotubes via carbene-iptycene relay chemistry for nanoelectronics

Dr. Monika Snowdon, Kailai Wang, Thilini Suduwella, Dr. Antoine Juneau

Abstract

This Micro project focuses on achieving highly aligned arrays of semiconducting single-walled carbon nanotubes (s-SWCNTs) directly on metallic electrodes to minimize contact resistance in next-generation nanoelectronics. While the alignment relay technique (ART) has been successful on dielectrics, this research utilizes NHCs to form robust, covalent bonds with noble metals like gold. Over a “design-build-test” cycle, an undergraduate researcher will synthesize novel NHC-iptycene anchors designed for stable metal attachment.

Following synthesis, the student will use ART to align these iptycenes on gold surfaces, using AFM-IR and Raman Spectroscopy to verify molecular orientation and nanotube chirality. Finally, the project culminates in the fabrication of functional top-contact Field-Effect Transistors (FETs) at NanoFabrication Kingston (NFK). This work represents the first application of ART on metallic surfaces, enabling high-performance transistors and biological sensors.

Investigating the in-insect stability and biotransformation of gold nanoclusters for advanced sensing

Dr. Monika Snowdon, Dr. Ahmadreza Nezamzadeh Ezhieh, Jason Gandrapu, Dr. Parimah Aminfar

Abstract

This project, led by Dr. Monika Snowdon and Dr. Ahmadreza Nezamzadeh Ezhieh investigates the interaction between NHC-stabilized gold nanoclusters and the complex enzymatic environment of insect larvae. Inspired by recent findings that insect guts can perform unique chemical transformations, the team is exploring whether these robust clusters undergo surface modifications or remain ultra-stable as luminescent probes.

By utilizing advanced photonics and mass spectrometry, the research aims to discover a “Biological Toolkit” for tailoring nanomaterial surfaces for medical drug delivery. Additionally, these clusters offer a low-toxicity, UV-detectable method for tracking agricultural pests. This interdisciplinary effort unites researchers across diverse career stages and backgrounds, prioritizing the training of highly qualified personnel and equitable collaborative practices.

Effect of glucose functionalization of gold nanoclusters on intratumoural transport kinetics

Dr. Emily Steele, Isaac Chan, Daisy Nebel, Andrew Laluk

Abstract

Gold nanoclusters (NCs) are promising agents for cancer therapy, but uncertainty surrounding their accumulation in tumours restricts clinical translation. This project investigates how to improve intratumoural transport by targeting glucose transporters, which are overexpressed in many cancers, using glucose-functionalized NCs (Glc-NCs). NC movement within tumours is governed by diffusion and advection, which can be modelled to determine key transport parameters like diffusivity and fluid velocity. Tumour conditions—such as high interstitial fluid pressure and a dense extracellular matrix—hinder NC penetration and may trap them at the periphery.

Using dynamic contrast-enhanced computed tomography (DCE-CT) and a biomimetic gel model, this study aims to compare bare and glucose-coated NCs. Key physicochemical properties (size, surface charge, hydrophilicity) and transport behaviour will be measured to establish structure–activity relationships. These insights aim to clarify transport mechanisms and guide the design of more effective NC-based therapies.

Overview

The HQP Research Grant Competition is a funding opportunity for C2MCI HQP members to generate their own research project aligned with the mandate of the C2MCI. Successful project proposals received $20K in research funding. Project funding includes the recruitment of undergraduate summer research assistants to aid with the proposed research projects.

HQP Research Grant Awards

Conductive N-Heterocyclic Carbene polymeric coatings for advanced electronic interfaces

Dr. Ravinder Singh, Dr. Monika Snowdon, Dr. Ahmadreza Nezamzadeh Ezhieh

Abstract

This research project aims to develop a new class of conductive polymeric coatings that utilize NHC anchors to achieve robust surface adhesion on metallic substrates. Current organic coatings often suffer from poor stability and limited bonding strength. While traditional materials offer high conductivity, they lack the strong covalent bonding provided by NHC anchors. This research will utilize a carbon-carbon cross-coupling strategy to polymerize imidazole-functionalized monomers, creating a conjugated backbone that maintains electronic transport while ensuring stable interfacial properties. The project will employ aerosol spray deposition for material efficiency and verify surface integrity using X-ray photoelectron spectroscopy and electrochemistry.

Expected to be the first integration of covalent NHC-metal anchoring with intrinsically conductive matrices, these films hold significant potential for long-term neural implants, biosensing, and high-performance molecular electronics.

Peptide-conjugated NHC-protected gold nanocluster as a dual-targeting cancer and antimicrobial PDT platform

Dr. Giulia Kassab, Dr. Angus Sullivan, Dr. Tiffany Ho, Dr. Juan Chen

Abstract

Previous collaborative work between Dr. Zheng and Dr. Crudden demonstrated that NHC-protected gold nanoclusters (AuNCs) exhibit excellent photodynamic and radiosensitizing therapeutic potential. However, this successful response was only achieved in vivo using intratumoral injection, due to a pharmacokinetic profile that does not favour tumour accumulation. To address this limitation, we are investigating functionalizing AuNCs with antimicrobial peptides that exhibit antibacterial, anticancer, and immune modulating effects. The team will synthesize the peptide-AuNC conjugates, followed by purification and characterization. Then, their biological performance will be evaluated by comparing cellular uptake and PDT efficacy with unfunctionalized AuNCs in Staphylococcus aureus, Pseudomonas aeruginosa, and PANC02 pancreatic cancer cells.

Overall, this work will establish a modular peptide-functionalization strategy for the rational design of peptide–AuNCs. If successful, this strategy could expand the therapeutic potential of AuNCs, eventually leading to improved treatment efficacy and robust therapeutic outcomes in both cancer and infection.

Equity, Diversity, Inclusivity & Indigeneity Initiatives

Over the past year, the C2MCI has made significant strides in advancing Equity, Diversity, Inclusion, and Indigeneity (EDII). We hosted and participated in key workshops and presentations that fostered meaningful discussions and actionable change. New EDII initiatives have been rolled out through the launch of various outreach programs aimed at elementary and high school students who identify as Black or Indigenous (page 36).

To recognize the excellence of our HQP, in 2025 we launched the C2MCI Research Excellence Award. Valued at $5K, this award recognizes the research excellence of HQP from equity-deserving groups and HQP who contribute to EDII initiatives within the Institute. A total of 14 C2MCI Research Excellence Awards were announced at the 2025 Annual General Meeting (see page 38), and we look forward to announcing more recipients at the 2026 AGM.

This year, the *EDII Catalyst* live podcast series received a visual redesign and distribution expansion to all major streaming platforms. In addition to rereleasing earlier episodes in the new format, the podcast series featured an additional 6 guests from diverse backgrounds and explored diverse pathways and perspectives in STEM, featuring various conversations on accessibility, international research experiences, and leadership in science communication and entrepreneurship. Some of these podcast episodes were co-hosted by recipients of the EDII Fellowship Award as champions within our institute.

Lastly, we thank everyone that participated in the C2MCI EDII study. The resulting manuscript has been submitted and we hope to share publication details with you very soon.

Bridging Science and Community: Leading Change in STEM for Equity and Inclusion
Dr. Josephine Tsang (Executive Director - Chemical Institute of Canada) — August 2025

Innovating Change: From STEM Research to Entrepreneurial Leadership
Dr. Morgan Lehtinen (Executive Director, RXN HUB) — September 2025

Going Through Research, One Step at a Time
Dr. Blaine Fiss (Killam Postdoctoral Fellow, Dalhousie University) — October 2025

Transforming Campus Culture Through Equity & Inclusion
Dr. Mona Rahman (Research Awards Officer, Queen's University) — February 2026

Allyship in STEM
Dr. Seán Barry (Professor & Department Chair, Carleton University) — March 2026

Under Pressure: Stress, Substances and Graduate Student Reactions
Dr. Kim Hellemans (Associate Dean of Science, Carleton University) — April 2026

EDII Fellowship Award Testimonials

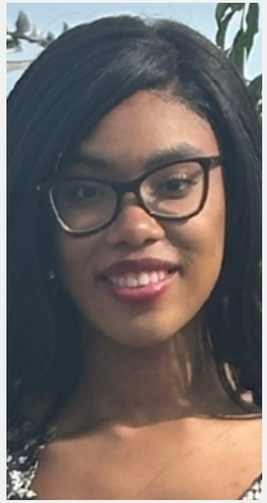
The EDII Fellowship Award was launched in 2022 and is used to support the recruitment and professional development needs of HQP from equity deserving groups. Up to ten EDII Fellowships are available annually on a competitive basis. Each award is valued at $10K.

This year, we continued our efforts to support diversity within our team by awarding an additional 13 EDII Fellowship Awards to HQP.

Hetvi Shah **PhD Candidate, Zheng Group**

The EDII Fellowship Award has had a meaningful impact on both my personal and professional growth. It gave me the space to focus not only on my academic responsibilities, but also on leadership and advocacy work that is deeply important to who I am as a person.

With this support, I was able to dedicate more time and energy to initiatives centered on equity, representation, and uplifting people of colour in STEM while continuing to grow as a researcher and leader. Being able to engage fully in these spaces strengthened my confidence, reaffirmed my values, and allowed me to show up more authentically in my work. I am deeply grateful for this support and the role it has played in shaping my journey in STEM.



Renée Farrell **MSc Candidate, Crudden Group**

Receiving the C2MCI EDII Fellowship Award at the start of my MSc has provided valuable support during my early graduate studies. I'm using the funds to cover conference and professional development costs, which can be difficult to prioritize alongside living expenses. The award has given me the flexibility to prepare submissions for the Canadian Societies for Chemistry and Chemical Engineering 2026 Conference and Exhibition and to connect more with the broader research community.

As a Black woman in chemistry, this support helps me increase my visibility and participate more fully in academic spaces where diverse voices are underrepresented. The fellowship reduces the need to choose between financial constraints and opportunities to advance my research and career. I'm grateful for this support and for C2MCI's commitment to helping trainees from diverse backgrounds stay engaged and build their presence in the field.

Outreach Initiatives

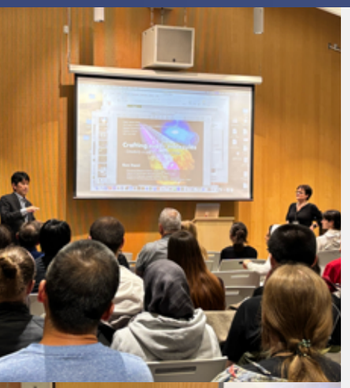
The C2MCI continued to prioritize impactful community engagement throughout 2025–26, with a sustained focus on promoting scientific literacy, broadening participation in STEM, and showcasing the societal relevance of materials and coatings research. Through a combination of recurring flagship programs and new partnerships, the Institute expanded the reach and diversity of its outreach activities while maintaining strong alignment with its educational and knowledge-mobilization mandate.

Science Rendezvous

C2MCI maintained a strong presence at Science Rendezvous 2025, a science-focused festival for families held each May, by hosting coordinated booths simultaneously in Kingston (led by Queen's team members) and London (led by Western team members). Building on previous years' success, the exhibits retained core interactive demonstrations to ensure continuity while incorporating localized content and updated research highlights.

The booths once again attracted a broad audience of families, students, and educators, offering hands-on activities that illustrated concepts such as corrosion prevention, functional coatings, and nanomaterials. These demonstrations helped connect fundamental research to real-world applications across sectors including energy, healthcare, transportation, and microelectronics, reinforcing the Institute's commitment to accessible and engaging science communication.

Outreach Initiatives



Public Lectures

As part of the 2025 AGM, C2MCI launched a three-part public lecture series titled “Nanoscience at the Interface of Chemistry and Biology.” Held in the evening at the Central Branch of the Kingston Frontenac Public Library, the free lectures were designed for a broad, non-specialist audience and attracted strong community interest.

The series featured three internationally renowned scientists: Dr. Tatsuya Tsukuda (University of Tokyo), who presented “Golden Superatoms: Artificial Elements for New Materials Chemistry”; Dr. Kenichiro Itami (RIKEN), who spoke on “Crafting Supermolecules: Creativity is Just Connecting Things”; and Dr. Takashi Yoshimura (Nagoya University), who explored “The Secrets of Biological Clocks.” Together, the talks highlighted how advances in nanoscience and molecular design inform fields ranging from materials chemistry to biological systems.

The series showcased leading researchers while advancing C2MCI’s mission to make cutting-edge science accessible to the public.

Summer of Science

C2MCI continued its active involvement in the Arthur B. McDonald Canadian Astroparticle Physics Research Institute’s Summer of Science program, which integrates undergraduate research training with community outreach through a summer camp for middle and high school students from Kingston and surrounding areas. Institute trainees designed and delivered learning modules and hands-on activities for campers while also conducting supervised research projects, strengthening mentorship and outreach components as well as research.

As part of the program, C2MCI hosted laboratory tours featuring interactive demonstrations and guided discussions, providing high school student participants with early exposure to research environments and modern materials science techniques.

Conferences & Community Engagement

In July, C2MCI hosted laboratory tours for participants of the Women+ in Physics Canada (WIPC+) Conference, held at Queen’s University. This national event supports women and gender minorities in physics and related fields, and the tours offered attendees an opportunity to explore interdisciplinary research at the interface of chemistry, materials science, and physics. The initiative contributed to a welcoming and inclusive research culture while highlighting potential pathways for collaboration and career development in advanced materials research.

To further broaden its outreach scope, C2MCI also participated in the Fall Harvest Alumni Gathering during Queen’s Homecoming 2025. As part of a curated display organized by the Vice-Principal Research Portfolio, the Institute joined the Arthur B. McDonald Canadian Astroparticle Physics Research Institute and the Sinclair Cancer Research Institute to present the impact of Queen’s Tier 1 Research Centres and Institutes. This event enabled engagement with alumni and community stakeholders, strengthening visibility of C2MCI’s research mission and societal contributions.

Science Literacy Week

During Science Literacy Week in October, C2MCI co-organized a series of public-facing events in collaboration with the McDonald Institute and Ocean Networks Canada. Framed around this year’s theme, “From Sea to Space,” the workshops targeted high school and early undergraduate students and featured three interactive learning blocks.

Through lectures, demonstrations, and hands-on activities, participants explored how astrophysicists harness the waters of the Pacific Ocean and the ice of the South Pole to study our universe, as well as how protective carbon-based coatings are being tested under some of the world’s most challenging marine conditions in advanced ocean observatory systems across the Pacific. The day concluded with a public lecture by Dr. Nahee Park followed by guided tours of research facilities, including C2MCI laboratories, providing community members with direct insight into ongoing scientific work and infrastructure at Queen’s.

Outreach Initiatives

Black Youth in STEM

In partnership with the Black Youth in STEM (BYiS) program at Queen's University's Smith Engineering, C2MCI hosted a dedicated full-day workshop in November titled, "Metals, Corrosion, and Coatings: A Chemistry Adventure for Curious Minds" with hands-on activities followed by laboratory and facilities tours for students from Grades 5–12.

The session introduced participants to key chemistry topics, including oxidation and reduction reactions, corrosion and its prevention, and common characterization techniques such as X-ray crystallography, nuclear magnetic resonance, and electron microscopy. Delivered in an inclusive and supportive learning environment, this initiative fostered curiosity, confidence, and early engagement with STEM pathways among underrepresented youth.

Excellence made possible by our volunteers

Collectively, these initiatives reflect C2MCI's continued commitment to sustained, inclusive, and high-impact outreach. By maintaining established programs while expanding into new collaborative and community-oriented activities, the Institute strengthens its role as a bridge between cutting-edge research and the broader public, inspiring the next generation of scientists and innovators.

We deeply appreciate the contributions of everyone who volunteered their time and passion to make this year's outreach program possible.

Annual General Meeting

The 2025 Annual General Meeting was packed with international speakers from across Africa, Japan, USA and Europe. We were honoured to host Dr. Rye Barberstock, who delivered a land acknowledgement to those in attendance. His insightful presentation helped attendees better understand the purpose of land acknowledgements and how to honour the land and those who came before us. Dr. Maydianne Andrade was our EDI plenary speaker, and she presented an engaging talk on "Unconscious Bias, Fair Assessment, and Inclusive Research Cultures."

The plenary speaker for the Nano subgroup was Dr. Tatsuya Tsukuda, presenting a talk entitled "Gold Superatoms: Artificial Elements at Nanoscale." We were also very pleased to welcome Drs. Kenichiro Itami (RIKEN) and Takashi Yoshimura (Nagoya University) to present on their research; Dr. Itami presented "Toward unexplored 'carbon' functions" and Dr. Yoshimura presented "Understanding the mysteries of biological rhythms." Dr. Kandabara Tapily from Tokyo Electron Ltd. was our Micro speaker, presenting "Trends, Challenges and Opportunities in the Semiconductor Industry." Dr. David Heldebrant attended from the Pacific Northwest Laboratories as our Macro speaker, presenting "Reactive separations to upcycle waste carbon."

As part of the AGM, we hosted our first ever public lecture at the Main Branch of the Kingston Frontenac Public Library. Drs. Tsukuda, Itami and Yoshimura presented their research to a packed general audience. We were very pleased to be able to bring these superb researchers to Kingston and have them speak in this capacity.

The AGM also provided an opportunity to officially launch C2MCI's International Research Network. To commemorate the launch, we were honoured to have Drs. Vinayak Singh (University of Cape Town, South Africa), Peter Ngene (Utrecht University, Netherlands), Salma Elmallah (Arab Academy of Science, Egypt), and

[continued on the following page] ...

Annual General Meeting

Adewale Adewuyi (Redeemer's University, Nigeria) who all travelled to Kingston to meet with C2MCI members and present their projects. To learn more about these projects, see page 14.

A key highlight of the 2025 AGM was the industry panel discussion aimed at broadening our HQP's understanding of the commercialization process, how to work with industry, and how to protect our intellectual property. Moderated by Dr. Christian Moreau, panel guests included Dr. Kandabara Tapily (TEL-US), Dr. Morgan Lehtinen (RXN Hub), Executive Advisory Board members Dr. Paul Smith (Perimeter Institute) and Dr. David Thompson (Intel), as well as Ricardo Smalling (Queen's Legal Counsel).

In addition to the keynote program, three technical workshops were delivered by Dr. Cathleen Crudden, Dr. J. Hugh Horton, and Dr. Maryam Sabooni Asre Hazer. These sessions provided focused, hands-on training in atomic layer deposition (ALD) methodologies, X-ray photoelectron spectroscopy (XPS) analysis, and applications of machine learning in materials research, equipping HQP with practical skills directly relevant to their ongoing projects.

Finally, the inaugural EDII Research Excellence Fellowships ($5K each) were awarded at our gala dinner, which was a wonderful opportunity to acknowledge the outstanding research accomplishments of our equity-deserving members and those who champion EDII within the STEM community.

We extend our sincere congratulations to the following recipients of the EDII Research Excellence Fellowships: Mark Aloisio, Dr. Parimah Aminfar, Maram Bakiro, Eden Goodwin, Seyedeh Marzieh Kalantarian, Dr. Tetyana Levchenko, Dr. Justin Lomax, Anastasia Messina, Dr. Ravinder Singh, Dr. Monika Snowdon, Dr. Thilini Malsha Suduwella, Dr. Zhiqiang Wang, Dr. Marshall Yang, and Elham Zeinizade.

Award Highlights

Shortlisted, 2025 Falling Walls Science Breakthrough of the Year in Physical Sciences — Dr. Cathleen Crudden

Dr. Crudden was one of ten researchers worldwide recognized by the Falling Walls jury for work with the potential to drive global progress in science and society.
This international recognition highlights her discovery of durable organic coatings that protect critical metals and metal products from degradation and breakdown.

Canada Research Chair Renewals — Drs. Hedberg, Levasseur, Paul

Three of our faculty members have had their status as Canada Research Chairs renewed for a second term of 3 years—the maximum allowable term for Tier 2 CRCs. This is a testament to the quality and impact of their research.

Polanyi Prize — Dr. Rachel Baker

The prestigious Polanyi Prizes are awarded annually in honour of John C. Polanyi, who won the 1986 Nobel Prize in Chemistry for his research in chemical kinetics. The prizes are awarded to early-career researchers in Ontario who are either continuing postdoctoral work or have recently gained a faculty appointment. Dr. Baker's research in pioneering greener approaches in chemical manufacturing secured her award.

The Chemical Society of Japan Award for 2025 — Dr. Tatsuya Tsukuda

The Chemical Society of Japan Award is one of Japan's most prestigious chemistry honours, recognizing outstanding, pioneering, and fundamental research achievements in chemistry. This recognition has been awarded to Dr. Tsukuda on the basis of his work in the creation of gold-based superatomic materials.

Award Highlights

National Research Foundation A-rating — Dr. Kelly Chibale

Dr. Kelly Chibale, a member of our International Research Network, has received an A-rating from South Africa's National Research Foundation. This is a prestigious designation recognizing a researcher as a leading international scholar in their field. It signifies that peers unequivocally recognize the high quality and impact of the researcher's recent work and is a key benchmark for global competitiveness.

Agnes Benidickson Tricolour Award — Daniel Reddy

PhD candidate Daniel Reddy is one of four students being inducted into the prestigious Tricolour Society this year. The Agnes Benidickson Tricolour Award is one of the oldest and most respected student honours at Queen's University. The award recognizes students for valued and distinguished service, leadership, character, and community impact.

Kingston Young Professionals 40 Under 40 — Dr. Emily Albright

This recognition celebrates the exceptional achievements and contributions of individuals under the age of 40 who are making a significant impact in their profession and the greater Kingston community. This initiative aims to recognize and honour talented, innovative and inspiring young leaders who are shaping the future of Kingston. The C2MCI team is extremely proud of Emily and the work she has contributed.

- **2025 Award of Merit from the Federation of Chinese Canadian Professionals** — Dr. Gang Zheng
- **Canadian Society for Chemical Engineering (CSChE) Lectureship Award** — Dr. Cao-Thang Dinh
- **University Health Network STARS21 (Strategic Training in Transdisciplinary Radiation Science for the 21st Century) Scholarship & Centre for Pharmaceutical Oncology (CPO) Scholarship** — Hetvi Shah (HQP)

Jyväskylä University Foundation Scientific Breakthrough Award — Dr. María Francisca Matus

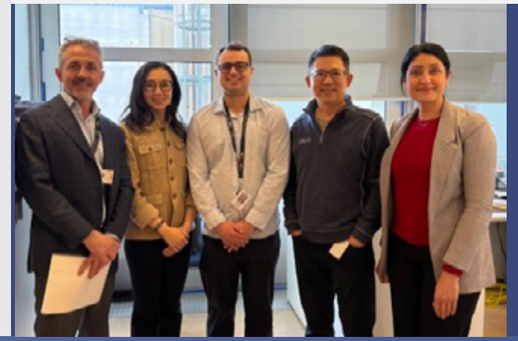
Dr. Matus received this award for the establishment of a new research orientation that combines computational nanosciences and bioinformatics, concentrating on the simulation of atomic-scale interaction of metal nanoparticles and biomolecules. Initiating a new research orientation as a young researcher is a particularly rare and meritorious achievement.

Fellowships

- **Fellowship in Royal Society of Canada** — Dr. Amir Fam
- **The Chemical Institute of Canada Fellowship** — Dr. Jim McLellan
- **American Society of Tropical Medicine and Hygiene (ASTMH) Distinguished International Fellow** — Dr. Kelly Chibale

U. R. Evans Award 2026 — Dr. Arjan Mol

This award, given by the Institute of Corrision, honours outstanding and sustained contributions to corrosion science. Dr. Mol's exceptional achievements exemplify the spirit and legacy of this award.



We extend our sincere congratulations to all award recipients for their outstanding achievements! The C2MCI has a wonderful group of people working toward our goals, and we are delighted that so many have been recognized for their contributions over the past year.

Values & Strategic Indicators of Success

Respect & EDII

The C2MCI is committed to embedding equity, diversity, inclusion and Indigeneity (EDII) principles in all Institute activities to enrich our research, champion diversity and improve opportunities for equity-deserving groups.

Interdisciplinary Collaboration

The C2MCI seeks to facilitate collaboration across complementary disciplines of chemistry, engineering, biomedicine, physics, and health science and beyond. This collaboration enables the enhancement of research and training outcomes in STEM fields in order to produce cutting-edge solutions for the improved stability of metal infrastructure, microelectronics manufacturing, and precision radiation therapies.

Research & Training Excellence

The C2MCI aspires to excellence in research and training. We accomplish this through global interdisciplinary collaborations that address knowledge gaps in areas relevant to our research directions. Our research and training efforts benefit society through research outcomes and through the outstanding trainees who graduate from our program.

Innovation

The C2MCI is focused on advancing fundamental knowledge and creating direct innovations that benefit society. To accomplish this, we work collaboratively with academia, industry, government, the healthcare sector, and not-for-profit agencies on the local, national, and global scale.

These partnerships aim to develop materials and manufacturing processes that improve the longevity of metal-based infrastructure, decrease the environmental impact of processes involving metals at the macro and micro scale, and improve human health through innovations in nanomedicine.

Through this, the C2MCI is securing Canada's place as a leader in innovations related to corrosion, semiconductor manufacturing and nanomedicine.

GOAL: Demonstrated impact in solving mission-critical problem(s) through carbon to metal coating strategies

- Peer-reviewed publications and patents documenting research advances
- Interactions/partnerships with end users and adoption of technology for commercial applications
- Clinical application of materials in precision radiation therapies
- Research output addressing United Nations Sustainable Development Goals

GOAL: Build a global interdisciplinary research community

- Number of collaborations demonstrated through multi-institutional or international authored peer-reviewed publications and patents
- Global institute membership and research activity
- Evidence of collaborative projects and successful funding applications
- Recruitment of top international researchers to participate in seminars and events
- Generation of transferable standard operating procedures and protocols across membership

GOAL: Research excellence

- High impact publications, patents and presentations
- Commercialization impact demonstrated though patents, licensing, industry hiring HQP; creation of spin-offs related to outputs
- Company buy-in through joint research grants (e.g., NSERC Alliance, Mitacs and/contracts)
- National & global recognition evidenced by awards to members

GOAL: Excellence in interdisciplinary STEM education & training

- Student participation in multidisciplinary projects
- Number of graduates transitioning into relevant jobs and/or hired by partners
- Number of internships and exchange opportunities available
- HQP authorship of publications, patents and presentations
- Number of HQP awards received

GOAL: Improved EDII outcomes for STEM fields

- Improved EDII metrics for PI and HQP participation relative to field norms
- EDII metrics for Institute partners
- Number of sponsored/supported EDII-focused events
- EDII-based awards received by team members

Impact Summary

Economic

- **Macro:** Maintenance and construction costs are estimated at $2.5 trillion/ year globally with off-shore green technology costs estimated at >$100 billion. Developing anti-corrosion coatings will reduce these costs substantially, encouraging the move to green energy.
- **Micro:** Creating improved manufacturing processes will secure Canada's leadership in the microelectronic industry creating Canadian jobs.
- **Nano:** Improved precision therapeutics may result in decreased treatment times and lost workdays for patients and caregivers.

Social

- **Improved environmental health** — Potential to decrease greenhouse gas (GHC) emissions and reduce the leaching of contaminants from corroding metals into the environment. This will make a meaningful contribution to the UN Sustainability Development Goals (SDG 3, 9,11,12 & 17).
- **Improved cancer outcomes —** Nano-level research will result in improved precision therapeutics, decreased time required for treatment, and improved outcomes for cancer patients.

Global Reach

- **Advancing science and creating innovations beneficial to society —** Achieved through collaboration with global partners to develop materials and manufacturing processes, enhance infrastructure, improve environmental and human health, and secure Canada's place as a leader in carbon coating innovations.

Research & Training Excellence

- **Interdisciplinary research —** Interdisciplinary global membership collaborations to address critical issues through the generation of scientific knowledge and the development of innovations that benefit society.
- **Training the next generations of scientists —** Through our global interdisciplinary reach, we are preparing the next generation of leaders in STEM disciplines for success in academia and industry.

Executive Advisory Board

The C2MCI is governed by an Executive Advisory Board (EAB) who oversee the development and delivery of the organizational strategic plan, performance management, financial oversight, and risk management. The EAB also provides high-level counsel to the Scientific Management Committee (SMC) on progress towards meeting objectives, milestones, and deliverables of the funded New Frontiers Research Fund-Transformation (NFRF-T) research program.

Dr. Nancy Ross (Chair)
Vice-Principal Research
Queen's University

Dr. Cathleen Crudden
Scientific Director,
C2MCI

Dr. Janet Dancey
Director,
Canadian Cancer Trials Group (CCTG)

Fouad Elgindy
Executive Director,
Principal Gifts
Queen's University

Dr. Kenichiro Itami
Chief Scientist,
RIKEN

Jyoti Kotecha
Managing Director,
C2MCI

Dr. Arjan Mol
Editor-in-Chief,
Corrosion Science,
TU Delft

Dr. Janine Mauzeroll
NFRF-T & Member
SMC

Dr. Paul Ragogna
NFRF-T & Member
SMC

Dr. Kanda Tapily
Director of Technology Development
Tokyo Electron Ltd. (TEL)

Dr. Gang Zheng
NFRF-T & Member
SMC

Administrative Team

Dr. Cathleen Crudden **Scientific Director**

Dr. Crudden is the founding director of the C2MCI and leads the New Frontiers Transformation Research program. Her research interests include investigating the use of carbon–based molecules as ligands for self-assembled monolayers on gold and other metals, and in catalysis, chirality, and materials chemistry.

Jyoti Kotecha **Managing Director**

Jyoti began her research career as an analytical chemist in the UK. She is a career research administrator who has developed research institutes, led teams and secured tri-council grants. At the C2MCI, she leads the development of strategic initiatives, works with faulty to build key stakeholder collaboration, and secures research funding.

Megan Ariki **Coordinator - Partnership Agreements & Operations**

Megan has over 15 years' experience working alongside faculty at Queen's. At the C2MCI, Megan is responsible for developing and managing agreements, leading AGM organization, managing financial transactions, coordinating award nominations, and providing administrative support.

Dr. Tetyana Levchenko **Research, Training, & Outreach Coordinator**

Dr. Levchenko joined the Crudden lab as an NSERC Postdoctoral Fellow, where her work centered on the synthesis and characterization of carbene-stabilized metal nanoclusters for applications in catalysis and biomedicine. At the C2MCI, she coordinates a variety of programs including research seminars, workshops, internships, and educational programming for students.

Hannah Fitzpatrick **Communications Coordinator**

Hannah is a graphic designer and communications specialist with a passion for efficient communication. At the C2MCI, Hannah maintains communication channels, supports strategic communications development, and collaborates with the Vice Principal Research portfolio to support Queen's Research Centres and Institutes (RCIs) to stakeholders.

Mark Aloisio **Project Manager (Temporary)**

Mark is currently finishing his PhD with Dr. Crudden, where he has worked with a range of teams designing and synthesizing ligands for the C2MCI and beyond. As Project Manager, Mark leads the coordination of interdisciplinary research teams and supports complex research projects and EDII-focused projects, including a podcast that amplifies diverse voices in STEM.

Dr. Emily Albright **Project Manager (On Leave)**

Dr. Albright earned her PhD in Materials Chemistry from Queen's University. She has extensive research experience in the Nano subgroup theme, and has used this experience to help drive our research projects forward. Her portfolio includes HQP training and implementing EDII strategies at the C2MCI.

Team Updates

The administrative team has expanded this year to welcome Hannah Fitzpatrick as our new Communications Coordinator and Dr. Tetyana Levchenko as our new Research, Training and Outreach Coordinator! Hannah is an expert in communication who has elevated our external profile through improvements in our communication and marketing strategy to ensure real-time sharing of achievements with external stakeholders and funders.

Dr. Levchenko is a valued researcher with enthusiasm for outreach. Since joining the central team, she has hosted various youth in STEM outreach workshops and has formalized a collaboration with the Queen's Smith School of Engineering Black Youth in STEM program.

Finally, we extend congratulations to Dr. Emily Albright on the birth of her son Miles! We welcome Mark Aloisio, who has stepped into the role of Project Manager during Emily's maternity leave.

Scientific Leadership Team

Dr. Cathleen Crudden **Canada Research Chair**

Professor, Queen's University, Department of Chemistry. Expert in catalysis, organic and materials synthesis, and the intersection of organic chemistry and materials science. Primary author of key metallophilic materials papers & patents.

Dr. Janine Mauzeroll

Professor, McGill University, Department of Chemistry. Expert in electrochemical methods to study drug resistance in cancer chemotherapy. Develops new in-situ instruments, experimental and numerical methodologies for characterizing electro-chemical interfaces.

Dr. Gang Zheng **Canada Research Chair**

Professor, University of Toronto; Associate Research Director, Princess Margaret Hospital. Expert in nanomedicine, molecular imaging and photodynamic therapy, focusing on developing clinical translatable technologies to fight cancer.

Dr. Yolanda Hedberg **Canada Research Chair**

Associate Professor, Western University, Department of Chemistry. Expertise: Health aspects of metallic materials from macro to nano scale, including corrosion processes of relevance for allergic diseases, cancer, neurodegenerative diseases, and environmental pollution.

Dr. Christian Moreau **Canada Research Chair**

Professor, Concordia University, Department of Mechanical and Industrial Engineering. Expert in sprayed barrier coatings, cold spray processing, surface engineering, aerospace.

Dr. Chantelle Capicciotti **Canada Research Chair**

Associate Professor, Queen's University, Departments of Chemistry, Biomedical & Molecular Sciences, and Surgery. Expert in chemical biology, bioconjugation strategies, and developing clinical precision medicine tools to understand the roles of complex carbohydrates and other biomolecules in health and disease.

Dr. Paul Ragogna

Professor and Associate Dean of Science (Research), Western University, Department of Chemistry/Chemical & Biochemical Engineering. Expert in main group element chemistry and advanced barrier coatings.

Research Faculty

Macro

Dr. Mark Biesinger

Director, Surface Science Western, Adjunct Research Professor, Department of Chemistry, Western University. Expert in X-ray photoelectron spectroscopy (XPS).

Dr. Michael Cunningham

Professor and Ontario Research Chair in Green Chemistry and Engineering, Department of Chemical Engineering, Queen's University. Expert in CO Switchable Polymers for Coatings Applications.

Dr. Paul Duchesne

Assistant Professor, Department of Chemistry, Queen's University. Expert in novel heterogeneous catalyst materials & use of spectroscopy techniques to better understand the behaviour of these catalysts under realistic operating conditions.

Dr. Amir Fam

Professor and Vice-Dean Research, Department of Civil Engineering, Queen's University. Expert in structural engineering using fiber reinforced polymer (FRP) reinforcements and bio-based composites in new construction and retrofitting aging bridges and buildings.

Dr. Joe Gilroy

Professor, Department of Chemistry, Western University. Expert in the design and synthesis of inorganic and polymeric materials.

Dr. David Heldebrant

Staff Scientist, Pacific Northwest National Laboratories. Expert in green chemistry, is examining NHCs to protect stainless steel pipelines carrying carbon capture solvents.

Dr. Steve Holdcroft

Professor, Department of Chemistry, Simon Fraser University. Expert in polymeric and oligomeric imidazolium ions, which are immediate precursors to NHCs.

Research Faculty

Dr. Philip Jessop **Canada Research Chair**

Professor & Head of the Chemistry Department, Queen's University. Expert in organic & inorganic chemistry, carbon dioxide as a trigger for switchable systems, water-solute separations, and biomass conversion & separation.

Dr. Emy Kim

Assistant Professor of Artifacts Conservation, Master of Art Conservation Program, Queen's University. Expert in sacrificial coatings on modern and contemporary outdoor sculpture; loss compensation and adhesion of plastics.

Dr. Annie Levasseur **Canada Research Chair**

Professor, Department of Construction Engineering, École de technologie supérieure. Expert in life cycle analyses for all processes under development. She is actively collaborating with Moreau and other Canadian coating researchers as part of the Green–Seam NSERC Strategic Network.

Dr. James McLellan

Professor and Academic Director, Dunin-Deshpande Queen's Innovation Centre, Department of Chemical Engineering, Queen's University. Expert in developing techniques to support dynamic modelling, analysis, estimation, monitoring and control of chemical processes and commercialization.

Dr. Heng-Yong Nie

Senior Research Scientist, Surface Science Western, Adjunct Research Professor, Department of Physics and Astronomy, Western University. Expert in developing analytical approaches to studies in soft materials, mainly using time-of-flight secondary ion mass spectrometry (ToF-SIMS) and atomic force microscopy (AFM).

Dr. James Noël

Professor, Department of Chemistry, Western University. Expert in corrosion with experience from Ontario Hydro and Atomic Energy of Canada Ltd. He is Associate Editor for the journal *Corrosion*, and chairs both the Education committee and Corrosion Division of the Electrochemical Society.

Dr. Suraj Persaud **UNENE Research Chair**

Assistant Professor, Department of Mechanical and Materials Engineering, Queen's University. Expert in mechanics of materials, nuclear materials, and corrosion.

Dr. Zhe She

Assistant Professor, Department of Chemistry, Queen's University. Expert in micro and nanostructures, assessing electrochemical properties of thin films and Scanning Probe Microscopy techniques.

Dr. Vera Tai

Assistant Professor, Biology Department, Western University. Expert in ecotoxicology of new chemical coatings to prevent corrosion.

Micro

Dr. Chris Baddeley

Professor, School of Chemistry, University of St Andrews. Expert in surface science and microscopy, whose experience in protecting copper surfaces from corrosion will be critical in studying macroscopic corrosion.

Dr. Séan Barry

Professor, Chair of the Department of Chemistry, Carleton University. Expert in chemical vapour deposition (CVD) and atomic layer deposition (ALD).

Dr. J. Hugh Horton

Professor, Department of Chemistry, Queen's University. Expert in surface science including atomic force microscopy, chemical force microscopy, X-ray photoelectron spectroscopy, and surfaceIR techniques.

Dr. Taleana Huff

Assistant Professor, Department of Chemistry, Queen's University. Expert in surface characterization techniques including scanning tunneling microscopy, qPlus atomic force microscopy, and angstrom-resolved tip-enhanced Raman spectroscopy.

Dr. Lijia Liu

Assistant Professor, Department of Chemistry, Western University. Expert in luminescent nanomaterials, and synchrotron X-ray spectroscopy.

Research Faculty

Dr. Peter McBreen

Associate Professor, Department of Chemistry, Laval University. Expert in surface spectroscopy and scanning tunneling microscopy.

Dr. Nick Mosey

Professor and Associate Dean (Research), Department of Chemistry, Queen's University. Expert in developing chemical simulation methods for gaining atomic-level insights into the properties and behaviour of molecules and materials.

Dr. Ralf Tonner-Zech

Professor, Wilhelm-Ostwalt-Institute for Physical and Theoretical Chemistry, Universität Leipzig. Expert in the application of quantum chemical and solid state theory methods to the study of chemical and physical properties of molecules, surfaces and solids.

Nano

Dr. Rachel Baker

Assistant Professor, Robins Family Professorship of Engineering Chemistry, cross-appointed to the Department of Chemistry, Queen's University. Expert in carbon-neutral/negative chemical processes, renewable electricity and sustainable building block materials.

Dr. Oana Birceanu

Assistant Professor, Department of Physiology and Pharmacology, Western University. Expert as a comparative physiologist and toxicologist, who is interested in how environmental stressors impact aquatic organisms.

Dr. Catherine Coolens

Associate Professor, University of Toronto, Department of Radiation Oncology; Staff Medical Physicist, Radiation Medicine Program, Princess Margaret Cancer Centre – University Health Network. Expert in Metastatic Brain Tumor, Radiation Induced Meningioma, Brain Tumor, and Familial Ventricular Tachycardia.

Dr. Cao Thang Dinh Canada Research Chair

Assistant Professor, Department of Chemical Engineering, Queen's University. Expert in renewable fuels and chemicals, carbon dioxide conversion, catalysis, electrochemical engineering, energy storage, nanofabrication, & energy systems.

Dr. Zhifeng Ding

Professor, Department of Chemistry, Western University. Expert in development and applications of multimodal electrochemical and spectroscopic characterization techniques, chemical and electrochemical preparation of luminescent nanocrystals, and pharmaceutical analysis of biologic fluids, drug transfer, and ionic liquids.

Dr. Hannu Häkkinen

Professor, Department of Chemistry, University of Jyväskylä. Expert in computational nanoscience who is essential to predict surface effects of NHCs on metals and nanomaterials.

Dr. Farnaz Heidar-Zadeh

Assistant Professor, Department of Chemistry, Queen's University. Expert in mathematical tools, numerical algorithms, and computer software to qualitatively and quantitatively predict the outcome of chemical phenomena using strategies from quantum chemistry and machine learning.

Dr. Marianne Koritzinsky

Associate Professor, Princess Margaret Cancer Centre (PMCC)/University of Toronto. Expert in radiation biology, identification of molecular targets in cancer therapy.

Dr. Keith Lawson

Assistant Professor of Surgery and Medical Biophysics, University of Toronto; Division of Urology, Department of Surgery, UHN; Urologic Surgeon and Scientist, Princess Margaret Cancer Centre. Expert in overcoming the solid tumor microenvironment, mapping the genetic architecture of inflammatory cell death, and developing novel humanized model systems.

Research Faculty

Dr. Lucia Lee

Assistant Professor, Department of Chemistry, Queen's University. Expert in main-group supramolecular interactions, focusing on metal-coordination chemistry, catalysis and chemical biology.

Dr. Parvin Mousavi

Professor and Director, School of Computing, Queen's University. Expert in image-aided, computer-assisted diagnosis of disease and machine learning for diagnosis for cancer.

Dr. Richard Oleschuk

Professor, Department of Chemistry, Queen's University. Expert in developing mass spectrometry (MS) instrumentation, interfaces and methods for diagnostic imaging/surface analysis.

Dr. Arghya Paul **Canada Research Chair**

Associate Professor, Department of Chemical and Biochemical Engineering, Western University. Expert in advanced cell-instructive materials and biotherapeutics.

Dr. Kevin Stamplecoskie

Associate Professor, Department of Chemistry, Queen's University. Expert in nanocluster chemistry and photophysics, works with core members to study nanoclusters in medical applications.

Dr. Tatsuya Tsukuda

Professor, Department of Chemistry, The University of Tokyo. Expert in nanosynthesis and characterization. His work is critical in the preparation of precision nanomaterials.

Dr. Brian C. Wilson

Professor, Princess Margaret Cancer Centre/University of Toronto. Expert in X-ray photodynamic therapy, laser biophysics, lasers, optical technologies, photosensitizers, photodynamic therapy, diagnostic techniques.

International Research Network

Dr. Kelly Chibale

Professor & Neville Isdell Chair in African-centric Drug Discovery and Development, Department of Chemistry, University of Cape Town - South Africa. Expert in global health drug discovery, asymmetric synthesis utilising sulfur and organolanthanide chemistry as well as the total synthesis of natural and designed biologically active molecules.

Dr. Salma Elmallah

Assistant Professor, Arab Academy for Science, Technology and Maritime Transport - Egypt. Expert in molecular science, organic and medicinal chemistry with a focus on designing and synthesizing new drug molecules.

Dr. Kenichiro Itami

Chief Scientist, RIKEN and Visiting Professor, ITbM, Nagoya University - Japan. Expert in in organic chemistry, synthetic chemistry, molecular nanocarbon science, catalytic chemistry, materials science, and chemical biology.

Dr. Peter Ngene

Associate Professor, Department of Chemistry, Utrecht University - Netherlands. Expert in the physico-chemical properties of inorganic nanomaterials and thin films, focusing on energy conversion and storage, heterogeneous catalysis, and chemical sensors.

Dr. Emeka Oguzie

Professor, Federal University of Technology-Ouwerri - Nigeria. Expert in the areas of electrochemistry/electrochemical technology, environmental & occupational hazards management and corrosion.

Dr. Vinayak Singh

Chief Research Officer, Drug Discovery and Development (H3D) Centre, University of Cape Town - South Africa. Expert in infectious diseases and developing novel therapeutic strategies to combat priority pathogens.

Highly Qualified Personnel Membership

Team Macro

Crudden Group
Mark Aloisio
Brandon Brendel
Duke D'Amato
Kamilla Konstanz
Dana Nanan
Ahmadreza Nezamzadeh

Holdcroft Group
Ravinder Singh

Moreau Group
Yazdan Arhami
Faranak Barandehfard
Payank Patel
Yinyin Zhang

She Group
Kailai Wang

Hedberg Group
Robert Addai
Maedeh Barzmehri
Bruce Guan
René Daniel Pütz
Waruni Senanayake
Peter Slovensky
Zhiqiang Wang
Marshall Yang
Dmitri Zagidulin

Heldebrant Group
Phillip Koech

Levasseur Group
Souhaila Bendahmane
Ahmad Diraki

Noël Group
Jian Chen
Elham Salehi Alaei

Mauzeroll Group
Clara Argentino
Maxime Arseneau
Isabelle Beaulieu
Sarah Collins
Antoine Juneau
Jashanpreet Kaur
Yuanjiao Li
León Zendejas Medina
Vikram Singh
Jessica Soares Guimaraes Selva
Thilini Suduwella

Ragogna Group
Garima Garg
Ellie (Wai Tung) Shiu

Team Micro

Baddeley Group
Federico Grillo
Michael-John Treanor

Barry Group
Maram Bakiro
Eden Goodwin

Huff Group
Jamie Black
Emmett Desroche

Crudden Group
Mark Aloisio
Dana Nanan
Ahmadreza Nezamzadeh

Ragogna Group
Jordan Bentley
Garima Garg
Joshua Ing
Giang Pham
Marco Quintanilla-Riviere
Ellie (Wai Tung) Shiu

Team Nano

Capicciotti Group
Art Ahmedi
Nicole Boileau
Klaus Effenberger
Xiaojing Guo
Rachel Heaney
Youjin Kim
Ella Millenaar
Maryam Momeni Moqadam
Duong Nguyen
Olivia Roland
Alina Weaver-Rodriguez

Ding Group
Zhenzhong Cai
Ian Lee
Tianyu Wei

Heidar-Zadeh Group
Neeladitya Chowdhury
Omid Hosseinzadeh
Negar Molavi

Lee Group
Kayla Boire

Tsukuda Group
Sarita Kolay
Shinjiro Takano

Coolens Group
Isaac Chan
Tasnim Rahman
Brendan Samaroo
Emily Steele

Häkkinen Group
Sami Malola
Maria Francisca Matus
Maryam Sabooni Asre Hazer

Koritzinsky Group
Matthew Horn

Oleschuk Group
Mina Alidoust
Daniel Reddy
Rachel Wood

Wilson Group
Tiffany Ho

Zheng Group
Juan Chen
Lili Ding
Giulia Kassab
Nahyun Kwon
Yulin Mo
Hetvi Shah
Angus Sullivan
Ellie Yang
Elham Zeinizade

Crudden Group
Hannah Aubin
Jason Fu
Jason Gandrapu
Morgan Guyan
Sakiat Hossain
Jaekwan Kim
Killian Krapp
Andrew Laluk
Tetyana Levchenko
Anastasia Messina
David Orbach
Kumar Siddhant
Monika Snowdon

Hedberg Group
Seyedeh Marzieh Kalantarian
Peter Slovensky
Zhiqiang Wang
Bohan Zhang

Lawson Group
Patrick Policicchio

Stamplecoskie Group
Parimah Aminfar
Christine Hoskin
Debalina Mondal

Partners

Industry

Government & Not-for-Profit

Academic

Financial Statement

Revenue

Research Projects	$4,000,000.00
Overhead Funds	$273,800.00
Queen's VPR	$100,000.00
Total Revenue	**$4,373,800.00**

Expenses

Salaries & Benefits	$508,246.49
Research Transfers	$3,395,210.00
HQP and EDII Awards	$145,000.00
2025 Annual General Meeting	$57,631.56
Travel	$17,833.11
Technical Equipment	$27,332.77
Facilities User Fees	$13,255.19
Chemicals & Supplies	$8,126.37
IT & Software Equipment	$15,141.02
Marketing & Advertising	$43,280.66
Other Expenses	$3,936.37
Total Expenses	**$4,234,993.54**
Surplus (Deficit)*	**$138,806.46**

**Committed funds*

Patent List

Issued

Methods of Forming Carbene-Functionalized Composite Materials
Cathleen Crudden. J. Hugh Horton, Mina Narouz, Joseph Padmos — *Patent Number: 11,008,291, United States, issued 2021/05/18*

Carbene-Functionalized Composite Materials
Cathleen Crudden, Iraklii Ebralidze, J. Hugh Horton, Christene Smith, Olena Zenkina — *Patent Number: 11,383,266, United States, issued 2022/07/12*

Carbene-Functionalized Composite Materials
Cathleen Crudden, Iraklii Ebralidze, J. Hugh Horton, Christene Smith, Olena Zenkina
Patent Number: 2,921,610, Canada, issued 2023/08/01

Carbene-Functionalized Composite Materials (Continued)
Cathleen Crudden, Iraklii Ebralidze, J. Hugh Horton, Christene Smith, Olena Zenkina — *Patent Number: 11,801,528, United States, issued 2023/10/31*

Etching Metal Using N-Heterocyclic Carbenes
Brian Miriampillai, Abrar Alrashed, Cathleen Crudden, J. Hugh Horton, Christopher Baddeley, and Christian Larrea — *Patent Number: 11,840,766, United States, issued 2023/12/12*

Filed

Etching Metal Using N-Heterocyclic Carbenes
Abrar Alrashed, Christopher Baddeley, Cathleen Crudden, J. Hugh Horton, Christian Larrea, Brian Mariampillai — Serial Number: 3,026,196 (Canada, filed 2017/06/01)

Method of Selective Deposition of Small Molecules on Metal Surfaces
Seán Barry, Cathleen Crudden, Eden Goodwin, Peter Gordon, Justin Lomax, Peter McBreen, Paul Ragogna, Ishwar Singh, Alex Veinot, Tianchi Zhang — *Serial Number: 18/137,538 (United States, filed 2023/04/23), 3,249,893 (Canada, filed 2023/04/23)*

Electrochemical Deposition of N-Heterocyclic Carbenes
Jennifer McLeod, Zhe She — *Serial Number: 18/522,335 (United States, filed 2023/11/29), 3,221,436 (Canada, filed 2023/11/29)*

Mesoionic Carbenes
Cathleen Crudden, Ahmadreza Nezamzadeh Ezhieh, Dianne Lee, Ali Nazemi, Ishwar Singh, Alex Veinot — *Serial Number: PCT/CA2024/051437 filed 2024/10/31*

Peptide-Protected Gold Nanocluster and Use in Photodynamic Therapy
Parimah Aminfar, Juan Chen, Kevin Stamplecoskie, Seyedehgoonay Yousefalizadeh, Gang Zheng — *Serial Number: 18/736,918 (United States, filed 2024/04/07), 3,241,285 (Canada, filed 2024/04/07)*

Water-Soluble N-Heterocyclic Carbene Nanoclusters
Chantelle Capicciotti, Cathleen Crudden, Florian Handel, Viveka Kulkarni, Andrew Laluk, Renee Man, Masakazu Nambo, Angus Sullivan, Hong Yi — *Serial Number: 19/488,914 (United States, filed 2025/12/01), 3,294,154 (Canada, filed 2024/05/30)*

Metal Nanoclusters and Methods of Using Same
Emily Albright, Cathleen Crudden, Tetyana Levchenko, Masakazu Nambo, Hong Yi — *Serial Number: 19/488,917 (United States, filed 2025/12/01), 3,294,160 (Canada, filed 2024/05/30)*

Method of Selective Deposition of Triazolylidenes on Metallic Surfaces
Jordan Bentley, Cathleen Crudden, Justin Lomax, Dana Nanan, Paul Ragogna, Alex Veinot — *Serial Number: PCT/CA2025/051508 (filed 2025/11/12)*

N-Heterocyclic Carbenes Deposition on Copper Powder Surface
Golnoush Asadiankouhidekordi, Jashanpreet Kaur, David LePage, Yuanjiao Li, Andre Liberati, Janine Mauzeroll, Christian Moreau, Vinyak Singh, Jessica Soares Guimarães Selva — *Serial Number: 19/094,176 (United States, filed 2024/03/28)*

N-Heterocyclic Carbene Polymeric Coatings
Jessica Bosso, Cathleen Crudden, Joseph Gilroy, Yolanda Hedberg, Steven Holdcroft, Lila Laundry-Mottiar, Janine Mauzeroll, Christian Moreau, Chase Radford, Paul Ragogna, Waruni Senanayake, Ravinder Singh, Peter Slovensky, Monika Snowdon, Jessica Soares Guimarães Selva, Marshall Shuai Yang — *Serial Number: PCT/CA2026/050389 (filed 2026/03/12)*

Methods of Restructuring and Smoothing Metallic Surfaces by N-Heterocyclic Carbenes
Chris Baddeley, Maram Bakiro, Seán Barry, Ines Bertaso, Cathleen Crudden, Matthew Davies, Emmett DesRoche, Eden Goodwin, Federico Grillo, Mikko Karttunen, Christian Larrea, Paul Ragogna, Michael-John Treanor, Francesco Tumino — *Serial Number: PCT/CA2025/050474 (filed 2025/04/02)*

Air-Tolerant and Water-Free N-Heterocyclic Carbene Precursor for Carbene-Functionalized Materials
Cathleen Crudden, Emmett DesRoche, Francesco Tumino, Zeng Rong Wong — *Serial Number: PCT/2026/050326 (filed 2026/03/02)*

Photochemical Functionalization of N-Heterocyclic Carbenes both Unbound and on Metal Surfaces
Mark Aloisio, Cathleen Crudden, Anastasia Messina, Alana Rose Meyer, Dana Nanan, Tehshik Yoon — *Serial Number: 63/826,261 (United States, filed 2025/06/18)*

NFRF-Funded Publications

Accelerated size-focusing light activated synthesis of atomically precise fluorescent Au2(Lys-Cys-Lys) clusters
Parimah Aminfar, Travis Ferguson, Emily Steele, Emerson M. MacNeil, María Francisca Matus, Sami Malola, Hannu Häkkinen, Paul N. Duchesne, Hans-Peter Loock, Kevin G. Stamplecoskie
Nanoscale 2023, 16, 205 | 1 Dec 2023 | doi.org/10.1039/D3NR04793H

N-heterocyclic carbene adsorption states on Pt(111) and Ru(0001)
Tianchi Zhang, Sonali B. Khomane, Ishwar Singh, Cathleen M. Crudden, Peter H. McBreen
Physical Chemistry Chemical Physics 2024, 26, 4083 | 5 January 2024 | doi.org/10.1039/D3CP03539E

N-Heterocyclic Carbene-Stabilized Atomically Precise Metal Nanoclusters
Emily L. Albright, Tetyana I. Levchenko, Viveka K. Kulkarni, Angus I. Sullivan, Joseph F. DeJesus, Sami Malola, Shinjiro Takano, Masakazu Nambo, Kevin Stamplecoskie, Hannu Häkkinen, Tatsuya Tsukuda, Cathleen M. Crudden
Journal of the American Chemical Society 2024, 146, 9, 5759–5780 | 19 February 2024 | doi.org/10.1021/jacs.3c11031

Monitoring alterations in a salt layer's deliquescence properties during the atmospheric corrosion of a metal surface using a quartz crystal microbalance
Arthur Situm, Mohammad Sabeti, November Schmidt, Dmitrij Zagidulin, Mehran Behazin, James J. Noël
Corrosion Science 2024, 229, 111845 | 1 April 2024 | doi.org/10.1016/j.corsci.2024.111845

Intensified metallic effect and improved tribocorrosion resistance through microwave-based fabrication of metallic powder coatings
Wei Liu, Marshall Yang, Xinping Zhu, Yufu Wei, Yolanda Hedberg, Hui Zhang, Jesse Zhu
Progress in Organic Coatings 2024, 189, 108218 | 27 January 2024 | doi.org/10.1016/j.porgcoat.2024.108218

Toll like receptor-based electrochemical sensors via N-heterocyclic carbene-modified surfaces: towards improved sensing of DNA molecules
Dianne S. Lee, Mir Pouyan Zarabadi, Hridaynath Bhattacharjee, Lin Qi, Jennifer F. McLeod, Kasra Saeedfar, Ishwar Singh, April Woods, Anastasia Messina, Viola I. Birss, Cathleen M. Crudden, Zhe She
Materials Advances 2024, 5, 6063 | 18 April 2024 | doi.org/10.1039/D4MA00188E

Defining the nature of adventitious carbon and improving its merit as a charge correction reference for XPS
Lauren H. Grey, Heng-Yong Nie, Mark C. Biesinger | *Applied Surface Science* 2024, 653, 159319 | 30 April 2024 | doi.org/10.1016/j.apsusc.2024.159319

Deposition of N-Heterocyclic Carbenes on Reactive Metal Substrates—Applications in Area-Selective Atomic Layer Deposition
Justin T. Lomax, Eden Goodwin, Mark D. Aloisio, Alex J. Veinot, Ishwar Singh, Wai-Tung Shiu, Maram Bakiro, Jordan Bentley, Joseph F. DeJesus, Peter G. Gordon, Lijia Liu, Seán T. Barry, Cathleen M. Crudden, Paul J. Ragogna
Chemistry of Materials 2024, 36, 5500 | 28 May 2024 | doi.org/10.1021/acs.chemmater.4c00412

Metal-ligand bond in group-11 complexes and nanoclusters
Maryam Sabooni Asre Hazer, Sami Malola, Hannu Häkkinen
Physical Chemistry Chemical Physics 2024, 26, 21954 | 9 July 2024 | doi.org/10.1039/D4CP00848K

Energetics and Redox Kinetics of Pure Ferrocene-Terminated N-Heterocyclic Carbene Self-Assembled Monolayers on Gold
Lin Qi, Robert M. Mayall, Dianne S. Lee, Christene Smith, April Woods, Mina R. Narouz, Alexander Hyla, Hridaynath Bhattacharjee, Zhe She, Cathleen M. Crudden, Viola Ingrid Birss
Langmuir 2024, 40, 17367 | 6 August 2024 | doi.org/10.1021/acs.langmuir.4c01446

If the Crown Fits: Sterically Demanding N-Heterocyclic Carbene Promotes the Formation of Au(8)Pt Nanoclusters
Joseph F. DeJesus, Samuel I. Jacob, Quan Manh Phung, Koichi Mimura, Yoshitaka Aramaki, Takashi Ooi, Masakazu Nambo, Cathleen M. Crudden
Journal of the American Chemical Society 2024, 146, 23806 | 14 August 2024 | doi.org/10.1021/jacs.4c04873

Tuning photoluminescence properties of Au clusters by surface modification and doping: lessons from case studies of icosahedral Au13
Dennis Alexander Buschmann, Haru Hirai, Tatsuya Tsukuda
Inorganic Chemistry Frontiers 2024, 11, 6694 | 9 September 2024 | doi.org/10.1039/D4QI01773K

N-Heterocyclic Carbene Overlayers on Mild Steel
Lila Laundry-Mottiar, Thilini Malsha Suduwella, Waruni G. K. Senanayake, Matthew J. Turnbull, Antoine Juneau, Ekrupe Kaur, Mark D. Aloisio, Thiago M. Guimarães Selva, Jeffrey D. Henderson, Heng-Yong Nie, Mark Biesinger, James J. Noel, Yolanda S. Hedberg, Cathleen M. Crudden, Janine Mauzeroll
Chemistry of Materials 2024, 37, 76 | 24 December 2024 | doi.org/10.1021/acs.chemmater.4c01804

NFRF-Funded Publications

Impact of Ligand Structure on Biological Activity and Photophysical Properties of NHC-Protected Au(13) Nanoclusters
Viveka K. Kulkarni, Emily L. Albright, Elham Zeinizade, Emily Steele, Juan Chen, Lili Ding, Sami Malola, Shinjiro Takano, Kristen Harrington, Nahyun Kwon, Tetyana I. Levchenko, Masakazu Nambo, Tatsuya Tsukuda, Hannu Häkkinen, Kevin Stamplecoskie, Gang Zheng, Cathleen M. Crudden
Journal of the American Chemical Society 2025, 147, 4017 | 22 January 2025 | doi.org/10.1021/jacs.4c12072

Diving into Unknown Waters: Water-Soluble Clickable Au(13) Nanoclusters Protected with N-Heterocyclic Carbenes for Bio-Medical Applications
Angus I. Sullivan, Emily A. Steele, Shinjiro Takano, Elham Zeinizade, Juan Chen, Sami Malola, Kumar Siddhant, Hannu Häkkinen, Kevin G. Stamplecoskie, Tatsuya Tsukuda, Gang Zheng, Cathleen M. Crudden
Journal of the American Chemical Society 2025, 147, 4230 | 22 January 2025 | doi.org/10.1021/jacs.4c14240

N-Heterocyclic Carbene Deposition on a Copper Powder Surface Using Mechanochemistry
Jéssica S. G. Selva, Yuanjiao Li, Jashanpreet Kaur, Antoine Juneau, Ahmad Diraki, Souhaila Bendahmane, Jeffrey D. Henderson, Mark D. Aloisio, Anastasia Messina, Ahmadreza Nezamzadeh, Camilo J. Viasus Pérez, Mark C. Biesinger, Annie Levasseur, Cathleen M. Crudden, Janine Mauzeroll
ACS Applied Materials & Interfaces 2025, 17, 10004 | 29 January 2025 | doi.org/10.1021/acsami.4c13890

Self-Assembled Monolayers of Triazolylidenes on Gold and Mixed Gold/Dielectric Substrates
Dana A.R. Nanan, Justin T. Lomax, Jordan Bentley, Lindsay Misener, Alex. J. Veinot, Wai-Tung Shiu, Lijia Liu ,Paul J. Ragogna, Cathleen M. Crudden
Journal of the American Chemical Society 2025, 147, 5624 | 9 February 2025 | doi.org/10.1021/jacs.4c11125

Forming N-heterocyclic carbene monolayers: not all deposition methods are the same
Aruna Chandran, Nathaniel L. Dominique, Gurkiran Kaur, Vincent Clark, Phattananawee Nalaoh, Lilian Chinenye Ekowo, Isabel M. Jensen, Mark D. Aloisio, Cathleen M. Crudden, Netzahualcóyotl Arroyo-Currás, David M. Jenkins, Jon P. Camden
Nanoscale 2025, 17, 5413 | 24 January 2025 | doi.org/10.1039/D4NR04428B

Atomically-precise Au(22)(Lys-Cys-Lys)(16) nanoclusters for radiation sensitization
Elham Zeinizade, Goonay Yousefalizideh, Parimah Aminfar, Matthew Horn, Lili Ding, Layla Pires, Alina Jaglanian, Lucie Malbeteau, Kristen Harrington, Carla Calçada, Mohamad Dukuray, Brian C. Wilson, Marianne Koritzinsky, Juan Chen, Kevin G. Stamplecoskie, Gang Zheng
Journal of Nanobiotechnology 2025, 23, 185 | 7 March 2025 | doi.org/10.1186/s12951-025-03256-7

Effect of Nanoparticle Size on Cysteine—Gold Surface Interactions
S. Marzieh Kalantarian, Peter Slovenský, Zhiqiang Wang, Valentin Romanovski, Elena Romanovskaia, Maroš Halama, Michael Auinger, Heng-Yong Nie, Yolanda S. Hedberg
Particle & Particle Systems Characterization 2025, 42, 70001 | 19 March 2025 |doi.org/10.1002/ppsc.202400230

Atomic Layer Restructuring of Gold Surfaces by N-Heterocyclic Carbenes over Large Surface Areas
Eden Goodwin, Matthew Davies, Maram Bakiro, Emmett DesRoche, Francesco Tumino, Mark D. Aloisio, Cathleen M. Crudden, Paul J. Ragogna, Mikko Karttunen, Seán T. Barry
ACS Nano 2025, 19, 15617 | 16 April 2025 | doi.org/10.1021/acsnano.4c17517

N-Heterocyclic carbene-promoted copper powder conditioning for thermal spray applications
Jashanpreet Kaur, Golnoush Asadiankouhidehkordi, Vikram Singh, Andre C. Liberati, Ahmad Diraki, Souhaila Bendahmane, Mark D. Aloisio, Payank Patel, Jeffrey Henderson, Fadhel Ben Ettouil, Cathleen M. Crudden, Mark Biesinger, Annie Levasseur, Christian Moreau, Janine Mauzeroll
Journal of Materials Chemistry A 2025, 13, 22745 | 13 May 2025 | doi.org/10.1039/D4TA07631A

Carbodiphosphorane as an Electron-Donating Ligand for Gold Nanoclusters
Taro Shigeta, Shinjiro Takano, Tatsuya Tsukuda
Langmuir 2025, 41, 25, 16180 | June 16 2025 | doi.org/10.1021/acs.langmuir.5c01355

Analysis of N-Heterocyclic Carbenes and Their Monolayers by X-ray Photoelectron Spectroscopy: Peak-Fitting, Effects of Molecular Architecture and Impact of Possible Impurities
Ahmadreza Nezamzadeh, Ekrupe Kaur, Mark D. Aloisio, Dana A. R. Nanan, Yolanda S. Hedberg, Cathleen M. Crudden, Mark C. Biesinger
The Journal of Physical Chemistry C 2025, 129, 14177 | 28 July 2025 | doi.org/10.1021/acs.jpcc.5c03111

Tuning the Surface Chemistry of NHC–Protected Au13 Nanoclusters Via a Robust Amide Coupling Procedure
Andrew L. D. M. Laluk, Dennis A. Buschmann, Shinjiro Takano, Angus I. Sullivan, Parimah Aminfar, Kevin Stamplecoskie, Tatsuya Tsukuda, Cathleen M. Crudden
Chemical Science 2025, 16, 18278 | 31 July 2025 | doi.org/10.1039/D5SC02951A

High-Density Self-Assembled Monolayers of N-Heterocyclic Carbenes on Au(111)—Observation of Normal and Mesoionic Bonding Modes
Michael Furlan, Patrick Melix, Mark D. Aloisio, Robert Jahn, Alastair B. McLean, Ralf Tonner-Zech, Cathleen M. Crudden
Chemistry of Materials 2025, 37, 15, 5753 | 31 July 2025 | doi.org/10.1021/acs.chemmater.5c00886

Aggregation, stabilization, and binding between bovine serum albumin and gold nanoparticles of varying sizes
Seyedeh Marzieh Kalantarian, Zhiqiang Wang, Zoltan Wolfgang Richter-Bisson, Ivan Barker, Michael Auinger, Heng-Yong Nie, Yolanda Susanne Hedberg
Colloids and Surfaces A: Physicochemical and Engineering Aspects 2025, 726, 137914 | 2 August 2025 | doi.org/10.1016/j.colsurfa.2025.137914

Optimizing Anti-Corrosive Properties of Polyester Powder Coatings Through Montmorillonite-Based Nanoclay Additive and Film Thickness
Marshall Shuai Yang, Chengqian Xian, Jian Chen, Yolanda Susanne Hedberg, James Joseph Noël
Corrosion and Materials Degradation 2025, 6, 39 | 25 August 2025 | doi.org/10.3390/cmd6030039

Mechanisms of N-Heterocyclic Carbene Complex Lattice Formation
Emmett DesRoche, Felipe Crasto de Lima, Ryan R. K. Groome, Michael Furlan, Francesco Tumino, Alex Inayeh, Mark D. Aloisio, Ishwar Singh, Alex J. Veinot, Roberto H. Miwa, Cathleen M. Crudden, Alastair B. McLean
ACS Nano 2025, 19, 31417 | 25 August 2025 | doi.org/10.1021/acsnano.5c06139

Development of an AMBER-Compatible Force Field for Gold Nanoclusters Protected by N-Heterocyclic Carbenes
María Francisca Matus, Maryam Sabooni Asre Hazer, Sami Malola, Hannu Häkkinen
Journal of Chemical Theory and Computation 2025, 21, 12121 | 9 September 2025 | doi.org/10.1021/acs.jctc.5c00945

Benzimidazolium hydrogen carbonate salts—Investigation of thermal properties in the context of small molecule inhibitors
Eden Goodwin, Jordan N. Bentley, Maram Bakiro, Mark D. Aloisio, Justin Lomax, Ishwar Singh, Alex J. Veinot, Ahmadreza Nezamzadeh, Paul J. Ragogna, Cathleen M. Crudden, Seán T. Barry
Journal of Vacuum Science & Technology A 2025, 43, 062403 | 30 September 2025 | doi.org/10.1116/6.0004886 | **Editor's Pick**

N-heterocyclic carbenes as clickable molecular anchors for electrochemical surface functionalization of metals and glassy carbon
Antoine Juneau, Ahmadreza Nezamzadeh, Béatrice Laberge, Anastasia Messina, Justin Lomax, Thilini M. Suduwella, Jashanpreet Kaur, Vikram Singh, Mark D. Aloisio, Paul J. Ragogna, Cathleen M. Crudden, Janine Mauzeroll
Chemical Science 2025, 16, 20422 | 3 October 2025 | doi.org/10.1039/D5SC03908H

Electrodeposition of N-heterocyclic carbene on mild steel surfaces
Vikram Singh, Thilini M. Suduwella, Anastasia Messina, Antoine Juneau, Mark D. Aloisio, Cathleen M. Crudden, Janine Mauzeroll
Journal of Materials Chemistry A 2025, 13, 37604 | 8 October 2025 | doi.org/10.1039/D5TA05828G

Beyond wingtips: backbone alkylation affects the orientation of N-heterocyclic carbenes on gold nanoparticles
Ahmadreza Nezamzadeh, Shayanta Chowdhury, Gaohe Hu, Nathaniel L. Dominique, Emmett DesRoche, Sakiat Hossain, Mark D. Aloisio, Michael Furlan, Ryan R. K. Groome, Kayla Boire, Alastair B. McLean, Lasse Jensen, Jon P. Camden, Cathleen M. Crudden
Chemical Science 2026, 17, 6717 | 12 January 2026 |doi.org/10.1039/d5sc05986k

N-heterocyclic Carbenes as Adhesion Promoters on Aluminum Alloy 6061
Jashanpreet Kaur, Vikram Singh, Alban Morel, Amélie Ruest, Mark D. Aloisio, Cathleen M. Crudden, Janine Mauzeroll
Advanced Materials Interface 2026, 13, e00719 | 28 January 2026 | doi.org/10.1002/admi.202500719

Combined electrodeposition and electropolymerization method to produce surface-bound polystyrenyl NHC thin films
Jessica L. Bosso, Justin T. Lomax, Garima Garg, Wai-Tung Shiu, Jordan N. Bentley, Matthew J. Turnbull, Monika R. Snowdon, James J. Noël, Cathleen M. Crudden, Joe B. Gilroy, Paul J. Ragogna
Chemical Science | 10 March 2026 | doi.org/10.1039/d6sc00603e

Presentations

Oral Presentations

Research and Potential Industrial Applications of N-Heterocyclic Carbenes (NHCs)
Idongesit Nwachukwu, Marshall Yang, Peter Slovensky, Yolanda Hedberg — AMPP Canada Conference, Saskatoon, Canada, April 2025

Research and Potential Industrial Applications of N-Heterocyclic Carbenes (NHCs)
Idongesit Nwachukwu, Marshall Yang, Peter Slovensky, Yolanda Hedberg — *AMPP Canada Conference*, Saskatoon, Canada, April 2025

Metal Powders Conditioning Using N-Heterocyclic Carbenes to Generate Corrosion-Resistant Thermally Sprayed Coatings
Jashanpreet Kaur, Golnoush Asadiankouhidehkordi, Vinyak Singh, Andre Liberati, Ahmad Diraki, Souhaila Bendahmane, Mark Aloisio, Payank Patel, Jeffrey D. Henderson, Fadhel Ben Ettouil, Cathleen Crudden, Mark Biesinger, Christian Moreau, Janine Mauzeroll — *247th ECS Meeting*, Montreal, Canada, May 2025

Investigation of N-heterocyclic carbene on Alloy Surfaces as an Adhesion Promoter
Jashanpreet Kaur, Vinyak Singh, Alban Morel, Amélie Ruest, Mark Aloisio, Cathleen Crudden, Janine Mauzeroll — *247th ECS Meeting*, Montreal, Canada, May 2025

Developing Surface-Based Bioanalytical Techniques Towards Environmental and Clinical Applications
Zhe She — *247th Electrochemical Society Meeting*, Montreal, Canada, May 2025, Invited Talk

Predictive Modeling of Anti-Corrosion Efficiency of N-heterocyclic Carbenes on Mild Steel
Thilini Suduwella, Antoine Juneau, Ahmadreza Nezamzadeh, Cathleen Crudden, Janine Mauzeroll — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

N-Heterocyclic Carbene Deposition on a Copper Powder Surface Using Mechanochemistry
Jessica Soares Guimaraes Selva, Janine Mauzeroll — *Mech'cheM 2025*, Montpellier, France, June 2025

Metal nanoclusters and How Molecular Composition Can Tune Their Photophysical Properties
Kevin Stamplecoskie — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025 — **Keith Laidler Award Lecture**

Development of NHC-Based Coating for Surface Protection and Nanofabrication Application
Kailai Wang, Tianxiao Ma, Mark Aloisio, Zhe She, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Luminescent Metal Nanoclusters: Structure Tunable Photophysical Properties
Kevin Stamplecoskie — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Advances in NHC Self-Assembled Monolayers: From Structural Engineering to Stability and Functional Applications
Tianxiao Ma, Kailai Wang, Mark Aloisio, Zhe She, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Heterometallic nanoclusters ligated by N-heterocyclic carbenes: metal- and ligand-dependent properties
Tetyana Levchenko, Emily Steele, Omar Lopez Estrada, Zhiqiang Wang, Juan Chen, Shinjiro Takano, Hannu Häkkinen, Kevin Stamplecoskie, Yolanda Hedberg, Gang Zheng, Tatsuya Tsukuda, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Effect of L-cysteine and serum albumin on the stability of differently sized gold nanoparticles probed by X-ray absorption spectroscopy
Zhiqiang Wang, Seyedeh Marzieh Kalantarian, Narges Hajighasemi, Tetyana Levchenko, Heng-Yong Nie, Cathleen Crudden, Gang Zheng, Catherine Coolens, Yolanda Hedberg — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Late Stage Functionalization of Gold Nanoclusters Through Halide Alkyne Exchange
Morgan Guyan, Angus Sullivan, Andrew Laluk, Parimah Aminfar, Shinjiro Takano, Juan Chen, Kevin Stamplecoskie, Tatsuya Tsukuda, Gang Zheng, Masakazu Nambo, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Presentations

Employing Photochemistry for Spatially Precise Modifications of Ultra-Stable N-Heterocyclic Carbene Self-Assembled Monolayer Au Platforms
Anastasia Messina, Dana Nanan, Mark Alisio, Alana Rose Meyers, Tehshik Yoon, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Organic Chemistry Principles for the Preparation of Nanomaterials for Applications in Photodynamic Therapy
Tetyana Levchenko, Crudden Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Self-Assembled Monolayers of Triazolylidenes for Area-Selective Atomic Layer Deposition
Dana Nanan, Justin Lomax, Jordan Bentley, Lindsay Misener, Alex Veinot, Ellie (Wai Tung) Shiu, Paul Ragogna, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Beyond Wingtips: The Influence of Backbone Alkylation on the Orientation of N-Heterocyclic Carbenes on Gold Nanoparticles
Ahmadreza Nezamzadeh, Shayanta Chowdhury, Gaohe Hu, Nathaniel L. Dominique, Emmett DesRoche, Sakiat Hossain, Michael Furlan, Ryan R. K. Groome, Mark Aloisio, Kayla Boire, Alastair McLean, Lasse Jensen, Jon P. Camden, Cathleen Crudden — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Atomically precise gold-based nanoclusters as model catalysts
Tatsuya Tsukuda — *Cluster Meeting 2025*, Prague, Czech Republic, June 2025

Gold superatoms – artificial elements at nanoscale
Tatsuya Tsukuda — *International Symposium on Atomically Precise Metal Nanoclusters*, Pohang, South Korea, June 2025

Gold superatoms – artificial elements at nanoscale
Tatsuya Tsukuda — *International Symposium on Atomically Precise Metal Nanoclusters*, Seoul, South Korea, June 2025

I'm In the Band, Man: D-Band Tuning for Metal Selectivity
Seán Barry — *Warwick Atomic Layer Processing Workshop 2025*, Warwick, England, July 2025

Engineering NHC-stabilized Gold Nanoclusters for Photodynamic and Radio Therapy
Tetyana Levchenko — Tokyo, Japan, July 2025

Photophysical Properties of Carbene-Protected Chemically-Precise Nanoclusters
Emily Steele, Angus Sullivan, Tetyana Levchenko, Cathleen Crudden, Kevin Stamplecoskie — *NanoOntario*, Toronto, July 2025

Excited State Dynamics and Photophysical Properties of Au13(NHC)5X23+ Nanoclusters
Emily Steele, Tetyana Levchenko, Viveka Kulkarni, Angus Sullivan, Cathleen Crudden, Kevin Stamplecoskie — *Methods and Applications in Fluorescence (MAF)*, Montreal, Canada, August 2025

Assessing the Stability, Excited-State Dynamics, and Singlet Oxygen Generation of $[Au_{13}(NHCCO_2H)_5Br_2]^{3+}$ Nanocluster
Parimah Aminfar, Andrew Laluk, Cathleen Crudden, Kevin Stamplecoskie — *Methods and Applications in Fluorescence (MAF)*, Montreal, Canada, August 2025

Organometallic Chemistry in Catalysis and Materials Science
Cathleen Crudden — Beijing, China, August 2025

Organometallic Chemistry in Catalysis and Materials Science
Cathleen Crudden — Nankai, China, August 2025

The power of organometallics: The development of novel cross coupling chemistry and nanocluster catalysis
Cathleen Crudden — *ISHHC*, Hangzhou, China, August 2025

N-Heterocyclic Carbenes–Self Assembled Monolayers, Nanoclusters and Catalysts for Valorization of Carbon Dioxide
Cathleen Crudden — *Sinopec*, Beijing, China, August 2025

Ligand-Induced Photophysical Modulation of Au13 Nanoclusters: A Comparative Study of Electron Donor and Acceptor Effects
Debalina Mondal, Kumar Siddhant, Cathleen Crudden, Kevin Stamplecoskie — *International Symposium on Monolayer Protected Clusters (ISMP)*, India, September 2025

Advancing Corrosion Education: A Comprehensive Review of the Summer Corrosion Science Institute's Events
Saman Nikpour, René Daniel Pütz, Narges Hajighasemi, Yolanda Hedberg — *EUROCORR 2025*, Stavanger, Norway, September 2025

Two Years of Connecting Corrosionists Worldwide: The CORmentor International Mentorship Program
René Daniel Pütz, Saman Nikpour, Narges Hajighasemi, Yolanda Hedberg — *EUROCORR 2025,* Stavanger, Norway, September 2025

Influence of different gold-doped carbon electrodes on interactions with L-cysteine – a comparative study of glassy carbon and paraffin-impregnated graphite electrode
Peter Slovenský, Seyedeh Marzieh Kalantarian, Maros Halama, Yolanda Hedberg — *248th ECS Meeting*, Chicago, USA, October 2025

The Effect of Pre-Treatment on Steel-Topcoat Interface Using Three Complementary Non-Destructive Techniques
Zhiqiang Wang, Marshall Yang, Mark Aloisio, Justin Lomax, Paul Ragogna, Arjan Mol, Cathleen Crudden, Yolanda Hedberg — *248th ECS Meeting*, Chicago, USA, October 2025

The power of organometallics: From catalysts to self-assembled monolayers to atomically precise nanoclusters
Cathleen Crudden — *RSC Eastern Ontario Symposium*, Kingston, Ontario, September 2025

NHC-Protected Gold Nanoclusters for Cancer Imaging and Therapy
Gang Zheng — *Pacifichem*, Honolulu, USA, December 2025

Combining glyco-engineering and bio-orthogonal chemistry: from probing glycan-protein interactions to novel nanomedicine development
Chantelle Capicciotti, Jack Babulic, Madeleine Cook, Youjin Kim, Thanh Nguyen, Olivia Roland, Daisy Nebel — *Pacifichem*, Honolulu, USA, December 2025 — Invited Talk

Poster Presentations

N-heterocyclic carbene (NHC)-protected gold nanoclusters for cancer imaging and therapy
Juan Chen, Elham Zeinizade, Viveka Kulkarni, Angus Sullivan, Brian C. Wilson, Marianne Koritzinsky, Cathleen Crudden, Gang Zheng — *AACR Annual Meeting 2025*, Chicago, USA, April 2025

Ligand-Induced Photophysical Modulation of Au13 Nanoclusters: A Comparative Study of Electron Donor and Acceptor Effects
Debaline Mondal, Kumar Siddhant, Kevin Stamplecoskie, Cathleen Crudden — Canadian Society for Chemistry Conference and Exhibition, Ottawa, Canada, June 2025 — Award Recipient

Conditioning of Metal Powders using N-heterocyclic Carbenes and Life Cycle Assessment for Industrial Applications
Jashanpreet Kaur, Golnoush Asadiankouhidehkordi, Vinyak Singh, Andre Liberati, Ahmad Diraki; Souhaila Bendahmane, Mark Aloisio, Payank Patel, Jeffrey D. Henderson, Fadhel Ben Ettouil, Cathleen Crudden, Mark Biesinger, Annie Levasseur, Christian Moreau, Janine Mauzeroll — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Influence of N-heterocyclic Carbene on the Functional Properties of Alloy Surfaces
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Deposition of N-Heterocyclic Carbenes on Metallic Powder Surfaces Using Mechanochemistry
Sarah Collins, Jessica Soares Guimaraes Selva, Anastasia Messina, Cathleen Crudden, Janine Mauzeroll — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

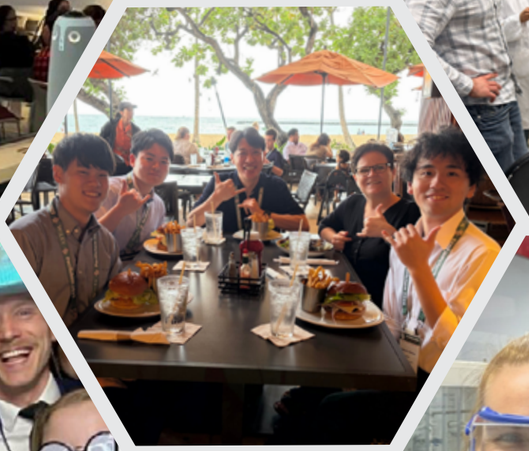
A critical examination of corrosion and electrochemistry-related outreach experiments
Narges Hajighasemi, Marshall Yang, Robert Addai, Yolanda Hedberg — *Canadian Society for Chemistry Conference and Exhibition*, Ottawa, Canada, June 2025

Investigating the Colloidal Stability of 50 nm Gold Nanoparticles via DLS for Electrochemical Applications
Bohan Zhang, Zoltan Richter-Bisson, Peter Slovenský, Yolanda Hedberg — *The Electrochemical Society Canadian Section Fall Meeting 2025*, London, Ontario, October 2025

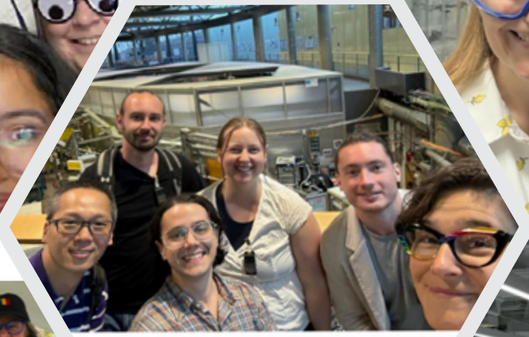
Electrochemical Insights into Nitrate-Enhanced Biofilm-Mediated Corrosion of Mild Steel by Bacillus licheniformis
Maedeh Barzmehri, Marshall Yang, Yolanda Hedberg — *The Electrochemical Society Canadian Section Fall Meeting 2025*, London, Ontario, October 2025

Photo Gallery



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