

WIN

2020-2021

ANNUAL REPORT



UNIVERSITY OF
WATERLOO



OUR PEOPLE

101 faculty members
since 2020

15 research chairs

1 industry seminar

2 distinguished lectures

5 academic seminars

SCHOLARLY TALKS

11 entrepreneurship seminars

11 DEPARTMENTS

- › Applied Mathematics
- › Biology
- › Chemical Engineering
- › Chemistry
- › Civil and Environmental Engineering
- › Electrical and Computer Engineering
- › Mechanical and Mechatronics Engineering
- › Physics
- › School of Environment, Enterprise, and Development
- › School of Pharmacy
- › Systems Design Engineering

RESEARCH

8,136

papers published

since 2008, Scopus/SciVal

241,633

citations

since 2008, Scopus/SciVal

NANOFELLOWSHIPS

13 rounds of nanofellowship competitions

30 nanofellowships awarded
2020-2021

466 nanofellowships awarded
since 2008

INTERNATIONAL

35 international partners in fifteen countries

27 International publications from WIN-initiated partnerships



A MESSAGE FROM THE **EXECUTIVE DIRECTOR**



SUSHANTA MITRA
EXECUTIVE DIRECTOR

One year ago, the whole world was thrust into a serious threat, unlike anyone has seen in generations. The impact of the coronavirus on medical, economic and social systems around the world has been detrimental, causing unspeakable hardship and costing many lives. The word “unprecedented” has been used again and again in the past year to describe the suffering and consequences of the pandemic where few alive today have seen a public health crisis such as this.

But what I have found to be truly unprecedented, and remarkable, is how fast the scientific community rose to meet the challenges... not only those presented by pandemic, but also the new challenges that we all had to deal with. I am so proud of how WIN members and our community found ways to continue our important work – be it in teaching, research, and staying connected.

Through new online platforms, WIN hosted several workshops and events virtually. The first was the International Workshop in Nanotechnology for a Sustainable Future in November 2020, with almost 250 audience members from 15 countries. This conference launched the Network for Sustainable Nanotechnology (N4SNano) to provide a forum on best policies and practices for applications of nanotechnology solutions for the world’s toughest challenges outlined by United Nations, Sustainable Development goals (see pages 36-38). WIN also hosted the Bibliometrics and Research Impact Conference (BRIC) in April 2021 which was a resounding success and seeing increased attendance and engagement from people from around the world compared to previous years.

WIN continued to support commercialization activities remotely, helping many existing and newly created companies. We developed a new exciting relationship with several organizations in Eindhoven Netherlands, spearheaded by the region’s economic development agency Brainport Eindhoven (see page 42 of the report). WIN also assisted commercialization activities, helping research groups in the areas of advanced biosensors (Professor Mustafa Yavuz, ECE), electron microscopy/spectroscopy (Professor German Sciaini, Chemistry), and novel methods for manufacturing thin films (Professor Kevin Musselman, MME), to mention a few. We also continued to support our innovative nanotechnology spinoff companies. One such spinoff, NERv, grew considerably during the pandemic (read more on pages 26-27).

Nanotechnology is truly an enabling technology, “unprecedented” in its ability and potential to drive radical and positive change to improve the status quo. And we have shown how we can pull together as a strong community, to go beyond what we thought was possible only a few months ago. If this is what evidence of what we can achieve when faced with challenges, there is no limit to our potential.

STAFF AND GOVERNANCE

WIN MANAGEMENT AND ADMINISTRATION

Sushanta Mitra	Executive Director	Isabella McKenzie	Operations and Marketing Coordinator
Lisa Pokrajac	Assistant Director, Research Programs	Aman Somel	Financial Officer and Space Coordinator
Oleg Stukalov	Business Development Manager		

BOARD OF DIRECTORS

CHAIR

Charmaine Dean	Vice-President, University Research, University of Waterloo
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Lora Field	Team Leader, Cleantech and Advanced Manufacturing Branch, Ontario Investment Office
Karin Hinzer	Professor, Electrical and Computer Engineering, University of Ottawa
Na Young Kim	Professor, Electrical and Computer Engineering, University of Waterloo
Holger Kleinke	Professor, Chemistry, University of Waterloo
Bob Lemieux	Dean, Faculty of Science, University of Waterloo
Sushanta Mitra	Executive Director, Waterloo Institute for Nanotechnology (WIN), University of Waterloo
Carolyn Ren	Professor, Mechanical and Mechatronics Engineering, University of Waterloo
David Sinton	Professor, Mechanical and Industrial Engineering, University of Toronto
Pearl Sullivan	Dean, Faculty of Engineering, University of Waterloo
or designate	
Shirley Tang	Associate Dean Research, Faculty of Science, and Professor, Chemistry, University of Waterloo
Boxin Zhao	Professor, Chemical Engineering, University of Waterloo

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CHAIR

Linda Nazar	Professor, University of Waterloo, Canada
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Kazuhito Hashimoto	President, National Institute for Materials Science (NIMS), Japan
Eugenia Kumacheva	Professor and Canada Research Chair in Advanced Functional Materials, University of Toronto, Canada
Richard Martel	Professor and Canada Research Chair in Electrically Conductive Nanostructures and Interfaces, Université de Montréal, Canada
Sushanta Mitra	Executive Director, Waterloo Institute for Nanotechnology (WIN), University of Waterloo

Ajay Sood	President, Indian National Science Academy, Professor, Indian Institute of Science, India
Chen Wang	Former Director General of National Center for Nanoscience and Technology, China
Sir Mark Welland	Deputy Vice-Chancellor; Master of St. Catharine's College, Director of Maxwell Centre, University of Cambridge, United Kingdom
Albert van den Berg	Distinguished Professor, University of Twente and Scientific Director of MESA+, Netherlands

SPACE COMMITTEE

CHAIR

Vivek Maheshwari Professor, Department of Chemistry, Faculty of Science

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Chris Kleven QNC Facility Technician, Provost Office
 Isabella McKenzie Operations Assistant, Waterloo Institute for Nanotechnology (WIN)
 Sushanta Mitra Executive Director, Waterloo Institute for Nanotechnology (WIN)
 Scott Nicoll Manager, Space Planning, Provost Office
 Michael Pope Professor, Department of Chemical Engineering, Faculty of Engineering
 Aman Somel Financial and Administrative Assistant, Waterloo Institute for Nanotechnology (WIN)

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 Tom Dean Director of Technical Operation, Department of Chemical Engineering
 Chris Kleven QNC Facility Technician, Provost Office
 Isabella McKenzie Operations Assistant, Waterloo Institute for Nanotechnology (WIN)
 Leonardo Simon Professor, Department of Chemical Engineering
 Aman Somel Financial and Administrative Assistant, Waterloo Institute for Nanotechnology (WIN)

SPECIAL PROJECTS AND RESEARCH COMMITTEE (SPARC)

CHAIR

John Thompson Senior Associate Vice-President, Office of Research

MEMBERS

Bernie Duncker Associate Vice-President of Interdisciplinary Research, Office of Research
 David Clausi Associate Dean of Research and External Partnerships, Faculty of Engineering
 Lisa Pokrajac Assistant Director, Research Programs, Waterloo Institute for Nanotechnology (WIN)
 Shirley Tang Associate Dean of Research, Faculty of Science
 Zbig Wasilewski Professor, Department of Electrical and Computer Engineering, Faculty of Engineering



RESPONSE TO

TRUTH AND RECONCILIATION

In 2015, the Truth and Reconciliation Commission of Canada (TRC) released its findings and 94 Calls to Action to redress the residential schools' legacy and advance reconciliation. The Calls to Action are directed at all levels of government, the private sector and to Canadians as a whole.

In response to this, Waterloo Institute for Nanotechnology has adopted a territorial acknowledgement to commence all events and in written documents to the general public. WIN has also altered its organizational structure, removing the concept of hierarchy to a circular structure, where everyone's thoughts and ideas are heard and respected. This reflects the values and ethos of First Nations and Indigenous Peoples as inspired by Dr Gregory Cajete who stated: "Thinking outside the box, living within the circle."

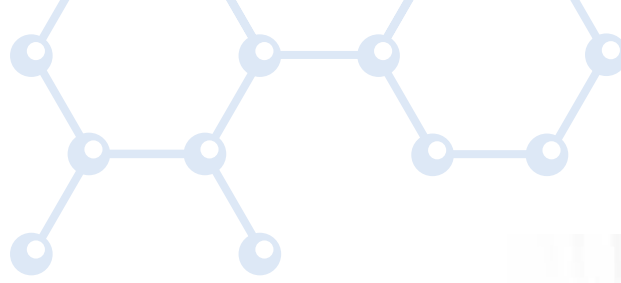
WIN has also engaged Canada's First Nations Communities to offer new solutions nanotechnology can bring, including clean and safe drinking water, and sustainable and affordable energy. Here, WIN researchers will be the listener, learner and mentor – working closely with the community to co-create appropriate technologies for our partners.

Additionally, WIN is working with GreenHouse a social impact incubator focused on sustainability for social and environmental change from St Paul's College, and the Waterloo Indigenous Student Centre (WISC). A student training program is being developed, involving co-operative education placements in WIN research laboratories, planning to hire both Indigenous and non-

Indigenous youths to work on projects focused on social innovation. At the completion of the project, students will participate in an "Elevator Pitch" competition, earning seed funding to support their social enterprise.

Finally, WIN is honoured and humbled to welcome Cynthia Wesley-Esquimaux, PhD, as the first Indigenous member of WIN's Board of Directors. Wesley-Esquimaux was appointed as an "Honourary Witness" for the Truth and Reconciliation Commission of Canada and serves as Chair for Truth and Reconciliation in Canada at Lakehead University, where she served as Vice-Provost, Indigenous Initiatives, for three years. She was also the inaugural Nexen Chair for Indigenous Leadership at the Banff Centre for Arts and Creativity and remains a faculty member within the Indigenous Learning program. Additional duties include serving as Chair of the Governing Circle for the National Centre for Truth and Reconciliation at the University of Manitoba, and Chair of the Teach for Canada non-profit that recruits qualified teachers for remote northern First Nations in Ontario and Manitoba. Cynthia also co-founded the Canadian Roots Exchange out of the University of Toronto, where she taught Indigenous studies and social work for eight years.

With these new practices, partnerships and Board Member, the benefits to WIN are immeasurable – by receiving increased knowledge and understanding of Indigenous practices and wisdom, WIN can become a model for other research institutions, and create a positive example for our communities.



A MESSAGE FROM THE **CHAIR OF THE BOARD OF DIRECTORS**



DR. CHARMAINE DEAN
VICE PRESIDENT,
RESEARCH AND INTERNATIONAL

The worldwide public health crisis over the last 16 months has led to extraordinary global challenges and along with medical, economic, and social systems, university research was also impacted.

Like our frontline workers and others who rose to the challenge, University of Waterloo researchers have collaborated across disciplines to impart their expertise in managing this unprecedented event. At the Waterloo Institute for Nanotechnology (WIN), researchers used nanotechnology to improve coatings for personal protective equipment, develop efficient rapid testing approaches, and formulate safe vaccine delivery methods.

As the world begins to emerge from the pandemic and look forward, WIN remains committed to addressing long term issues and tackling future challenges. WIN's Research Priorities for the Next Five Years: A Town Hall Conversation is planned as a hybrid event – online and with an in-person option based on public health guidelines. Other events will continue, primarily through virtual platforms, to foster continued engagement with internal and external partners.

With the Institute's four thematic areas mapped to the United Nations' Sustainable Development Goals, WIN is leading the International Network for Sustainable Nanotechnology

(N4SNano). As one of the N4SNano founding members, along with the University of California, Los Angeles, MESA+ Institute for Nanotechnology in the Netherlands, and the University of Sydney Nano Institute in Australia, WIN is driving a better understanding of sustainable nanotechnology for a just, equitable and sustainable world.

Equity, Diversity and Inclusion (EDI) are a priority for the University and at WIN. As part of the commitment to EDI, WIN welcomed its first Indigenous Board member, Dr Cynthia Wesley-Esquimaux. Her guidance is shaping WIN's engagement process with Indigenous communities and co-creating technologies to empower the communities Waterloo serves. Notably, consultation with Professor Tizazu Mekonnen, a black-identified member of WIN, allows the Institute's leaders and staff to review internal funding programs and Nanofellowship processes to understand existing systemic barriers and how they can be removed to create better opportunities for everyone.

I look forward to a continued partnership of working with WIN's Executive Director, Sushanta Mitra, and his team to further nanotechnology research locally, nationally, and globally.

THEME LEADS AND CO-LEADS

Thematic leads and co-Leads offer guidance and advice on the best ways to support and promote each research theme, particularly in terms of funding opportunities and external academic, industry or international partnerships for each of the four theme research groups at WIN. Below lists each lead (or working group member) with links to their research profile at WIN.

Theme leads and co-leads were identified to work closely with WIN staff to offer guidance and advice on the best ways to support and promote each research theme, particularly in terms of funding opportunities and external academic, industry or international partnerships



- › **Professor John Honek**
Chemistry (cross-appointed with Pharmacy)
Research interests: bionanotechnology, mechanistic enzymology; recombinant DNA and biophysical methods; medicinal chemistry and molecular modeling
- › **Professor Yuning Li**
Chemical Engineering (cross-appointed with Chemistry)
Research interests: molecular engineering of polymer/transparent semiconductors for organic electronics (OTFT, OPV, DSC, OLED) and low temp-process conductive inks on plastic substrates
- › **Professor Carolyn Ren**
Mechanical and Mechatronics Engineering
Research interests: micro/nano-fluidics; lab-on-a-chip; protein separation; live-colony detection
- › **Professor Michael Tam**
Chemical Engineering
Research interests: sustainable nanomaterials, nano-structured systems for drug/pesticide delivery; polymer-surfactant interactions; magnetic nanoparticles for novel separation processes; functional cellulose nanomaterials for agriculture, biomedical, environmental and personal and homecare applications
- › **Professor Hany Aziz**
Electrical and Computer Engineering
Research interests: organic electronic and optoelectronic materials and devices; flexible and printable electronics
- › **Professor Boxin Zhao**
Chemical Engineering
Research interests: fundamental and practical aspects of adhesion, wetting, and friction of soft bio-nanomaterials



CONNECTED DEVICES

- › **Professor Vassili Karanassios**
Chemistry
Research interests: micro- and nano-analytical chemistry and instrumentation
 - › **Professor Na Young Kim**
Electrical and Computer Engineering
Research interests: large-scale solid-state quantum computer; quantum simulator for quantum information processing and communications
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NEXT GENERATION ENERGY SYSTEMS

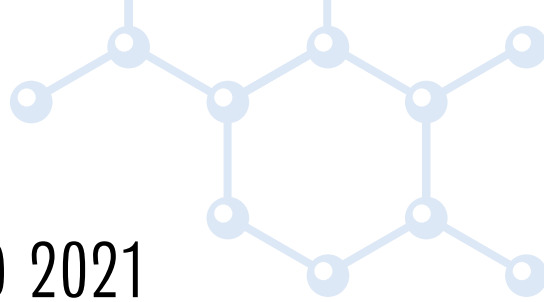
- › **Professor Linda Nazar**
Chemistry (cross appointed with Electrical and Computer Engineering)
Research interests: nano-materials for the design of rechargeable lithium-ion batteries
 - › **Professor Eihab Abdel-Rahman**
Systems Design Engineering
Research interests: dynamics of micro and nano systems; micro power generators; MEMS and NEMS; atomic force microscopes
 - › **Professor Michael Pope**
Chemical Engineering
Research interests: directed assembly of graphene-based nanocomposites; supercapacitors; next generation batteries; electrochemical sensors, electrocatalysts; thin films and membranes
-



THERAPEUTICS AND THERANOSTICS



- › **Professor Karim S. Karim**
Electrical and Computer Engineering
Research interest: silicon thin-film applied research; microelectronic circuits; device and process development for large area electronics
- › **Professor Alfred Yu**
Electrical and Computer Engineering
Research interest: nanodroplets and nanoparticles as agents for ultrasound imaging contrast enhancement and drug carriers for therapeutic ultrasound



SELECTED 2021

RESEARCH HIGHLIGHTS

SMART AND FUNCTIONAL MATERIALS



INDUSTRY,
INFRASTRUCTURE
AND INNOVATION

Nature Materials V19 I 10 (IF: 38.66;

Citations: 4; FWCI: 2.09); Title: “Ultrastable monodisperse polymer glass formed by physical vapour deposition”; Authors: Raegen, A.N. | Yin, J. | Zhou, Q. | **Forrest, J.A.**

Advanced Materials V32 I2 (IF: 27.4; Citations: 6; FWCI: 3.22);

Title: “Magneto-Memristive Switching in a 2D Layer Antiferromagnet”; Authors: Kim, H.H. | Jiang, S. | Yang, B. | Zhong, S. | Tian, S. | Li, C. | Lei, H. | Shan, J. | Mak, K.F. | **Tsen, A.W.**

Chemical Engineering Journal V392 Article no. 124821 (IF: 10.65; Citations: 16; FWCI: 6.56); Title: “Shape recoverable and mechanically robust cellulose aerogel beads for efficient removal of copper ions”; Authors: Tang, C. | Brodie, P. | Li, Y. | Grishkewich, N.J. | Brunsting, M. | **Tam, K.C.**

CONNECTED DEVICES



INDUSTRY,
INFRASTRUCTURE
AND INNOVATION

Nature Communications V11 I1 (IF: 12.12; Citations: 7; FWCI: 3.1); Title: “Micro triboelectric ultrasonic device for acoustic energy transfer and signal communication”; Authors: Chen, C. | Wen, Z. | Shi, J. | Jian, X. | Li, P. | **Yeow, J.T.W.** | Sun, X.

Journal of Materials Chemistry V8 I27 (IF:11.3; Citations: 3; FWCI: 1.2); Title: “Maximizing piezoelectricity by self-assembled highly porous perovskite-polymer composite films to enable the internet of things”; Authors: Khan, A.A. | Rana, M.M. | Huang, G. | Mei, N. | Saritas, R. | Wen, B. | Zhang, S. | Voss, P. | Rahman, E.-A. | Leonenko, Z. | Islam, S. | **Ban, D.**

ACS Applied Materials and Interfaces V12 I22 (IF: 8.76; Citations: 3; FWCI: 1.37); Title: “Polymer-Controlled Growth and Wrapping of Perovskite Single Crystals Leading to Better Device Stability and Performance”; Authors: Saraf, R. | Mathur, A. | **Maheshwari, V.**

NEXT GENERATION ENERGY SYSTEMS



AFFORDABLE AND
CLEAN ENERGY

Nature Energy V5 I1 (IF: 46.5;

Citations: 5; FWCI: 4.46);

Title: “Water Balancing”; Authors: **Chen, Z.**

Energy and Environmental Science V13 I7 (IF: 30.29; Citations: 7; FWCI: 3.01); Title: “A new halospinel superionic conductor for high-voltage all solid state lithium batteries”; Authors: Zhou, L. | Kwok, C.Y. | Shyamsunder, A. | Zhang, Q. | Wu, X. | **Nazar, L.F.**

Chemistry of Materials V32 I 11 (IF: 9.58; Citations: 3; FWCI: 1.46); Title: “Insights into Multiphase Reactions during Self-Discharge of Li-S Batteries”; Authors: Wen, G. | Rehman, S. | Tranter, T.G. | Ghosh, D. | **Chen, Z.** | **Gostick, J.T.** | **Pope, M.A.**

THERAPEUTICS AND THERANOSTICS



GOOD HEALTH
AND WELL-BEING

Angewandte Chemie – International

Edition V59 I 25 (IF: 12.96; Citations:

14; FWCI: 5.04); Title: “Dual Enhancement of Gold Nanocluster Electrochemiluminescence: Electrocatalytic Excitation and Aggregation-Induced Emission”; Authors: Peng, H. | Huang, Z. | Deng, H. | Wu, W. | Huang, K. | Li, Z. | Chen, W. | **Liu, J.**

Biomaterials B249 Article no. 120011 (IF:10.32; Citations: 8; FWCI: 4.05); Title: “Fucoïdan functionalization on poly (vinyl alcohol) hydrogels for improved endothelialization and hemocompatibility”; Authors: Yao, Y. | Zaw, A.M. | Anderson, D.E.J. | Hinds, M.T. | **Yim, E.K.E.**

Sensors and Actuators V308 Article no. 127645 (IF: 7.1; Citations: 2; FWCI: 1.23); Title: “Towards a transdermal membrane biosensor for the detection of lactate in body fluids”; Authors: Wang, Y. | Ausri, I.R. | Wang, Z. | Derry, C. | **Tang, X.S.**



BIBLIOMETRIC AND RESEARCH IMPACT COMMUNITY (BRIC)

INTERNATIONAL CONFERENCE, APRIL 27–29, 2021 HOSTED BY WIN, VIRTUAL EVENT

The Bibliometrics and Research Community (BRIC) started in 2017 to provide a forum to discuss bibliometric and research impact support services, and has grown into an international event. A conference has been held every year since 2017 (except in 2020 which was postponed due to the pandemic) and this year the conference was hosted by WIN with presentations from 26 speakers and attended by over 130 people.

Bibliometric analysis is important for universities and research centres, and WIN was one of the first at UWaterloo to use these tools for research impact. This allows WIN to make informed tactical decisions such as allocating funding and resources, and to foster new academic relationships. This has led to strategic national and international partnerships at WIN, and the creation of strong interdisciplinary teams to tackle significant global challenges as outlined by the United Nations Sustainable Development Goals.

WIN Assistant Director Research Programs, Lisa Pokrajac, presented “The Use of Bibliometrics at the Waterloo Institute for Nanotechnology” illustrating the use of SciVal tools for publication output and impact that is calculated for all WIN members and each of the four key research themes at WIN.

SCHOLARLY OUTPUT

Publications, Citations and Impact

WIN members have an impressive record of publications in reputable scientific journals, with an equally impressive number of citations.

BIBLIOMETRIC ANALYSES

WIN has championed bibliometric analyses within the University of Waterloo through the use of tools such as SciVal and Scopus (Elsevier). In this way, WIN can identify key strengths based on global comparative indices such as field-weighted citation impact (FWCI*) and collaborations. The FWCI is calculated based on all publications by WIN members taking into account all categories of peer-reviewed journals.

Total Publications, Citations and Collaborations

2015 to 2020, based on SciVal (Scopus) data

GROUP	PUBLICATIONS	CITATIONS	FWCI*	COLLABORATIONS		
				NATIONAL	INTERNATIONAL	INDUSTRY
WIN Members (total)	3,780	72,437	1.60	11.4%	50.3%	4.2 %
Smart and Functional Materials	2,332	45,829	1.57	10.0%	49.4%	3.6%
Connected Devices	1,617	20,222	1.21	11.8%	45.7%	4.3%
Next Generation Energy Systems	1,334	39,127	2.14	8.9%	50.5%	5.0%
Therapeutics and Theranostics	1,509	26,169	1.48	12.7%	50.7%	2.6%

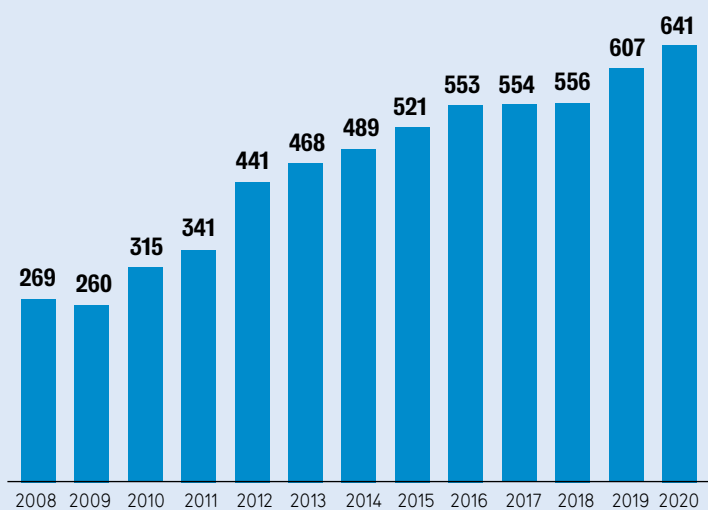
*FWCI: Field-weighted citation impact compares the number of citations received by a researcher with the average number of citations received by all other similar publications indexed in the Scopus database (ie: a score of 1.44 means the publications have been cited 44% more times than average)

Our numbers in 2020

# PUBLICATIONS	# CITATIONS	FWCI	% PUBS TOP 10%
641	2480	1.58	27.5%



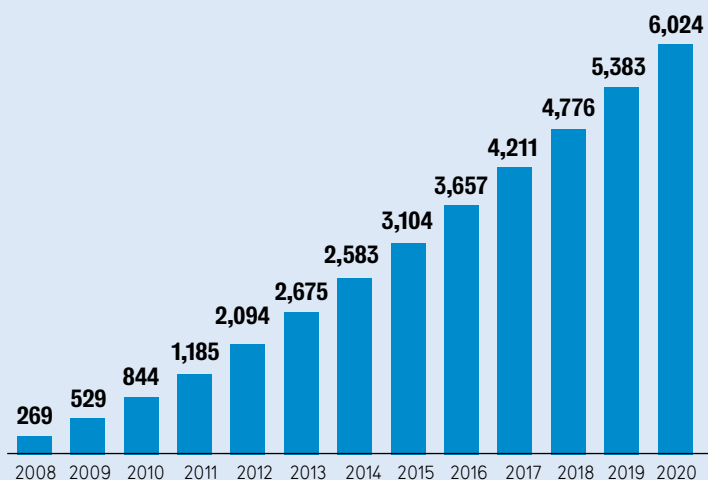
Total Publications by WIN Members



WIN Publications in High Impact Factor Journals

Nature Reviews Materials	74.7
Chemical Reviews	54.3
Nature Energy:	46.5
iScience	41.85
Chemical Society Reviews:	40.4
Nature Materials:	38.7
Energy and Environmental Science	30.3
Advanced Materials	27.4
Joule	27.1
Advanced Energy Materials	25.3

Cumulative publications by WIN members



Most Frequently Selected Journals for WIN Papers

Langmuir	15 (IF 3.56)
ACS Applied Materials and Interfaces	14 (IF 8.76)
Analytical Chemistry	12 (IF 6.79)
Nano Energy	11 (IF 16.6)
Macromolecules	11 (IF 5.92)
Scientific Reports	8 (IF 4.0)
Nanotechnology	8 (IF 3.55)
Angewandte Chemie	8 (IF 12.9)
Advanced Energy Materials	7 (IF 25.3)

INTERDISCIPLINARY RESEARCH FUNDING PROGRAM (IRFP)

PROJECT HIGHLIGHTS

Since 2018, WIN has promoted interdisciplinary collaboration to spark new ways of thinking. Finding new solutions require a multi-faceted approach, especially to fight large-scale problems. WIN created the Interdisciplinary Research Funding Program (IRFP) to support “high-risk/high-reward” discovery research that includes more diversified teams – including social sciences and economics – needed for high-profile networks and large national and international fundings schemes in STEM.

In January 2020, the second call for the Interdisciplinary Research Fund Program (IRFP) was announced to seed innovative research that leads to big impacts in the following three key targeted global challenges: (a) climate change; (b) reduction of global waste; and (c) biodiversity loss. These topics were chosen in direct alignment with the United Nations Sustainable Development Goals to tackle the most persistent and critical challenges our society faces today.

This round was also aligned with the 2020 New Frontiers in Research Fund Transformation Competition (NFRF-T) to incent and support applications to this program.



Three projects were awarded for the 2020 WIN-IRFP competition:

1 Reducing Carbon Dioxide Emissions from Electricity and Transportation Sectors by Smart Electrochemical Energy Materials and Systems

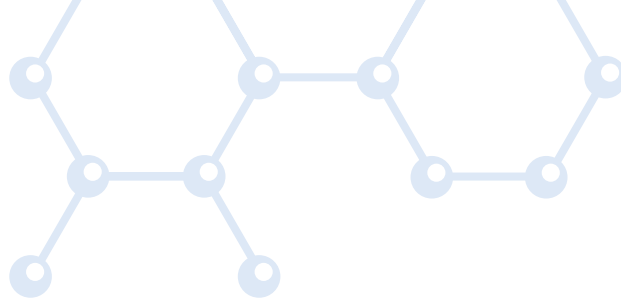
- › PI Zhongwei Chen (Department of Chemical Engineering) for \$150,000

2 Developing a Multi-billion Dollar Solar Panel Recycling Industry in Canada

- › PI Ting Tsui (Department of Chemical Engineering) for \$50,000
- › Co-PI Siva Sivorthaman (Department of Computer and Electrical Engineering)
- › Co-PI Yuning Li (Department of Chemical Engineering)
- › Co-PI Steven Young (School of Environment, Economics and Development)

3 Overcoming the Inertia of Petroculture by Transforming the Biomass Conversion Technology

- › PI Anna Klinkova (Department of Chemistry) for \$25,000
- › Co-PI Goretty Dias (School of Environment, Economics and Development)



MEASURING SUCCESS IN INTERDISCIPLINARY RESEARCH – KEY PERFORMANCE INDICATORS (KPI)

WIN is the first research institute at UWaterloo to create a list of metrics – key performance indicators or KPI – to define expectations and deliverables. In this way, WIN and its members hold themselves accountable for the activities and results of these endeavors.

For the WIN IRFP, the following KPI were defined and expected after one year of project completion:

- i. Application to major funding programs to a minimum of a ten-fold increase in initial seed funding amount (i.e. \$50,000 IRFP to gain external funding totalling at least \$500,000 CAD)
- ii. At least one established national or international collaboration (or increase scope of network)
- iii. At least two publications with cross-faculty authors in reputable peer-reviewed journals
- iv. Invitations to give presentations at significant national or international conferences

The first recipients of the IRFP were awarded in 2018, as listed below:

- › **John Honek** (Chem) and Ken Stark (Kin), “Hydrophobic Engineering of Nanodimensional Protein Capsules for Therapeutics” for \$99,031
- › **Karim Karim** (ECE) with **Peter Levine** (ECE) and Robin Duncan (Kin), “An Innovative New Micro-CT System For Cardiovascular Imaging Research” for \$100,000
- › **Germán Sciaini** (Chem) and Michaela Devries-Aboud (Kin), “Mapping Lipid and Mitochondria Depots in Fully Hydrated Tissue with Nanometer Resolution” for \$50,000
- › **Luis Ricardez Sandoval** (ChE) and Ricardo Fukasawa (Appl Math), “A Novel Theoretical Framework for the Prediction of Non-equilibrium Systems: a combinatorial approach” for \$50,000

2020 marked one year after projects were to be completed using the support funding. A survey was circulated to each group, requesting a summary of activities. Each group has either met or is in the process of meeting each of the KPI for major funding, increased network scope, joint publications and invitations to conferences, as seen in the following summary table:

KPI	HONEK	KARIM	RICARDEZ SANDOVAL	SCIAINI
Application to major funding program	Canadian Institutes for Health Research (CIHR)	Collaborative Health Research Program (CHRP): \$750k	New Frontiers in Research Fund (NFRF) for \$250,000	Canadian Foundation for Innovation-Innovation Fund application for \$1.82M and to NFRF
Increased scope of network	Simon Fraser, Western U, McMaster	U British Columbia, U Ottawa	Hebei U China	Agreement for Canadian Centre for Electron Microscopy (CCEM) users; Strickland Photonics Centre
Two or more publications with cross-faculty co-authors	Publication for Current Nanoscience	IEEE Transactions on Electron Devices: “Monolithic Amorphous-Selenium/CMOS single-photon-counting X-ray detector”	J Comp Phys, ACS Cat, J Catalysis	Am J Physiol Endocrinol Metab: “Sex differences in IMCL metabolism during acute bout of moderately intense aerobic exercise”
Present findings at reputable conferences	Canadian Chemical Society (postponed in 2020)	SemiCon West 2020 MedTech session; Canadian Lipoprotein Conference; IEEE International Electron Devices Meeting (IEDM)	Plan for American Institute of Chemical Engineers (AIChE) or Advances in Chemical Engineering	Canadian Society for Exercise Physiology

NEW TO THE WIN MEMBERSHIP

IN 2020

ELIZABETH WECKMAN

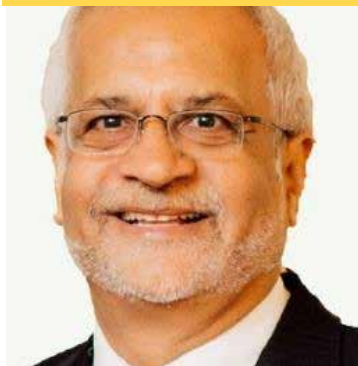


PROFESSOR, MECHANICAL AND
MECHATRONICS ENGINEERING

Professor Weckman's research focuses on the development of improved diagnostic techniques and their use in detailed measurement of reacting turbulent flows and fires, with applications to fire safety. She leads the Fire Research Group at UWaterloo, with projects in fire science to better understand the behaviour of full-scale fires, flammability and performance of materials and products, fire initiation and spread, and methods for fire detection and suppression.

Professor Weckman earned her BSc, MSc and PhD in Mechanical Engineering at the University of Waterloo.

JATIN NATHWANI



PROFESSOR, CIVIL AND
ENVIRONMENTAL ENGINEERING,
ONTARIO RESEARCH CHAIR,
PUBLIC POLICY FOR SUSTAINABLE
ENERGY, FOUNDING EXECUTIVE
DIRECTOR, WATERLOO INSTITUTE
FOR SUSTAINABLE ENERGY (WISE),
UNIVERSITY OF WATERLOO

Professor Nathwani's research interests include energy policy developments, entrepreneurial business innovations for sustainable energy solutions, life-cycle risk management of energy systems, decision-frameworks for managing life safety risks and assessment of strategies and policy instruments for achieving environmental objectives. He has contributed to national and global strategic planning initiatives for sustainability of energy options, including smart energy networks and grids. He currently leads a 'Global Change Initiative – Affordable Energy for Humanity' to address the challenge of enabling universal access.

Professor Nathwani earned his BSc, MSc and PhD in Chemical Engineering from the University of Toronto, and joined UWaterloo in 2007.

**EARLY CAREER
RESEARCHERS:
EACH NEW MEMBER
JOINED UWATERLOO
AND WIN IN 2020-21**

TIZAZU MEKONNEN



ASSISTANT PROFESSOR,
CHEMICAL ENGINEERING

Professor Mekonnen's research focuses on the rational design of sustainable polymer and nanomaterial systems for a range of industrial, engineering, and advanced materials applications, and his group seeks to advance the sustainability and functionality of polymers.

Professor Mekonnen earned his PhD in Bioresource Engineering at the University of Alberta in 2013 and a Masters of Science in Chemical Engineering at Addis Ababa University in 2009.

HAMED SHAHSAVAN



ASSISTANT PROFESSOR,
CHEMICAL ENGINEERING

Professor Shasavan's research interests involve developing a variety of soft, stimuli-responsive, and programmable materials. In addition, he is interested in emerging fabrication strategies for the manufacturing of small-scale mobile robots and devices, such as direct laser writing, and micro-scale 4D printing.

Professor Shasavan obtained his PhD in Chemical Engineering-Nanotechnology from the University of Waterloo in 2017. Before joining UWaterloo, he held a post-doctoral position at the Max Planck Institute for Intelligent Systems, and was a visiting scientist at the Smart Photonic Materials (SPM) research group at the University of Tampere, Finland.

XIAOYU WU



ASSISTANT PROFESSOR,
MECHANICAL AND MECHATRONICS
ENGINEERING, DIRECTOR OF GREENER
PRODUCTION@WATERLOO

Professor Wu's research group combines expertise in thermal science, materials engineering, and techno-economics to provide sustainable solutions for energy conversion and chemical production, such as hydrogen production, carbon-capture and utilization, biomass and hydrocarbon valorization.

He has published papers in journals such as Progress in Energy and Combustion Science, the Proceedings of the Combustion Institute, AIChE Journal and ChemSusChem. He serves as the Guest Associate Editor in Frontiers in Energy Research for a theme collection of "Sustainable Hydrogen for Energy, Fuel and Commodity Applications."

Professor Wu earned his PhD at Massachusetts Institute of Technology (MIT), where he also completed a postdoctoral fellowship.

COVID-19 RESEARCH PROJECTS

In 2020, the Government of Canada called out to scientists and engineers to combat the global crisis with funding programs such as the NSERC Alliance COVID-19 Research Competition, and the Mitacs Accelerate COVID-19 Program. Many WIN members rose to the challenge, being granted awards to develop new diagnostic techniques, faster and more efficient rapid testing devices, and improved anti-microbial coatings for personal protective equipment (PPE).

INNOVATION AND INFRASTRUCTURE

SMART AND FUNCTIONAL MATERIALS

CLEAN WATER AND SANITATION

GOOD HEALTH AND WELL-BEING

CLEAN WATER AND SANITATION

CONNECTED DEVICES

INNOVATION AND INFRASTRUCTURE

SUSTAINABLE CITIES AND COMMUNITIES

SUSTAINABLE CITIES AND COMMUNITIES

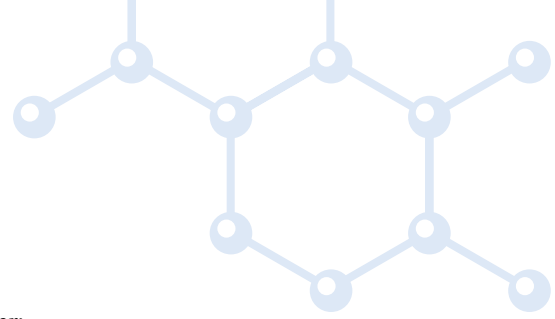
CLIMATE ACTION

NEXT GENERATION ENERGY SYSTEMS

AFFORDABLE AND CLEAN ENERGY

GOOD HEALTH AND WELL-BEING

THERAPEUTICS AND THERANOSTICS



Below lists some of the projects, with their findings within the last year:

WIN MEMBER	PROJECT TITLE	FUNDING AGENCY
Hopkins, Scott (ChE)	Ultraviolet Photodissociation (UVPD) Spectroscopy of DMS-selected COVID-19 peptide residues	NSERC Alliance COVID-19
<p>PROJECT SUMMARY: This project characterizes peptide residues of SARS-CoV-2 spike proteins using differential mobility spectroscopy (DMS), mass spectrometry (MS), and laser spectroscopy. This work was published as the cover article in the Journal of the American Society for Mass Spectrometry. The next phase of study will determine photodissociation properties of amino acids and DMS-MS analysis of peptide residues from spike proteins to determine photofragmentation behaviour and virus protein structure.</p>		
Liu, Juewen (Chem)	Development of localized surface plasmon resonance biosensor for COVID-19 antibodies in blood	NSERC Alliance COVID-19
<p>PROJECT SUMMARY: Together with Sushanta Mitra and Nicoya Lifescience, this project is developing a localized surface plasmon resonance biosensor for SARS-CoV-2 detection using plasmonic colour responses from different types of gold nanostructures.</p>		
Mitra, Sushanta (MME)	Characterization of nano-bubble enabled disinfection system for COVID-19	NSERC Alliance COVID-19
<p>PROJECT SUMMARY: Working with the industry partner, Econse Water Purification Systems Inc, the project aims to retool their existing ozonized water treatment unit to kill COVID-19 viral loads on surfaces.</p>		
Mitra, Sushanta (MME)	Development of paper-based Rapid Diagnostic Kit for COVID-19	Mitacs Accelerate COVID-19
<p>PROJECT SUMMARY: In collaboration with Juewen Liu and working with industry partner, ChitoLytic Inc., the team is the first of its kind paper based sustainable rapid COVID-19 testing kit.</p>		
Musselman, Kevin (MME)	Development of COVID-19 antiviral coatings for N95 respirators	NSERC Alliance COVID-19
<p>PROJECT SUMMARY: N95 respirator fabrics were coated with antiviral cuprous oxide layers using spatial atomic layer deposition and tested using human coronavirus 229E (as a surrogate to SARS-CoV-2). The project was awarded a CFI-EOF COVID-19 grant to build a roll-to-roll spatial atomic layer deposition system for antiviral coating for fabrics.</p>		
Tam, Michael (ChE)	COVID-19: Development of Sustainable and Compostable Face Masks for Enhanced Protection Against COVID-19 Virus Particles	NSERC Alliance COVID-19
<p>PROJECT SUMMARY: A filter membrane was prepared from plant-based sustainable materials, produced using a scalable paper-making process. The filters have super-hydrophobic properties preventing the virus from entering the human respiratory system. The next step is to introduce anti-microbial function to the filter to completely deactivate viruses and bacteria.</p>		
Yavuz, Mustafa (MME)	Real-time COVID-19 detection in wastewater from long-term care homes	NSERC Alliance COVID-19
<p>PROJECT SUMMARY: A critical photo-nano-electromechanical systems technology for smart hybrid water sensors is being developed with project sponsor Mantech Inc of Guelph and the Nano- and Micro-Systems Research Lab (NMSL) at UWaterloo. This sensor will have the ability to predict and detect diseases, using nanoplasmonic arrays integrated to printable circuit boards. The sensor will allow real time continuous monitoring with high-accuracy at low cost, and will be tested at Mount Sinai Hospital.</p>		
Norman Zhou (MME)	Antiviral Treatments for the Development of Enhanced PPE, HVAC Filtrations Technologies, and Prevention of Pathogen Transfer on High-Touch Surfaces	Mitacs Accelerate COVID-19
<p>PROJECT SUMMARY: To develop novel antiviral coatings that can be applied porous and non-porous surfaces, and integrated into paints and films to provide residual disinfection properties in many commercial applications.</p>		

NANOTECHNOLOGY IN THE FIGHT AGAINST COVID-19

The Coronavirus crisis has caused millions of deaths worldwide, and the numbers in many parts of the world are increasing at alarming rates. The medical community is working at lightning speed to develop effective vaccines to help stop the spread of life-threatening infection. However, even within fully vaccinated communities, people may still become infected with the virus, often showing no symptoms and transmit to others unknowingly. These "carriers" are dangerous to the health and welfare of the community and have the potential to start new waves of infection. Rapid and massive-scale testing can alleviate this and is highly recommended by the World Health Organization (WHO).



Nanotechnology offers a solution – Professors Carolyn Ren from the Department of Mechanical and Mechatronics Engineering and Emmanuel Ho from the School of Pharmacy have teamed up to develop such a testing system for rapid point-of-care (PoC) diagnosis for the virus that causes COVID-19. This will be easy to use at home and within the community and can be produced inexpensively for large-scale implementation. This is truly an interdisciplinary effort, combining Professor Ren's expertise in microwave micro-fluidics engineering, and Professor Ho's in-depth knowledge and expertise in viral immunology and clinical nanomedicine.

The project "Development of a Microwave Enabled Bio-Nano-Microfluidic Device for Point-of-Care Diagnosis of COVID-19", in collaboration with Professor Keith Fowke of the University of Manitoba was awarded \$265,000 CAD over three years from the Canadian Institutes of Health Research program. This aims to develop a palm-sized instrument consisting of battery-powered circuitry and a microwave-microfluidic device with a sensor surface modified with functionalized gold nanoparticles that specifically recognize the SARS-CoV-2 virus. A test can be done within 30 minutes including sample preparation, which is completed by

“As an engineer, I am constantly looking for new partners in new fields of applications. Within the WIN community, it was easy for me to find partners in life sciences for this. WIN has made this collaboration possible.”

PROFESSOR CAROLYN REN
DEPARTMENT OF MECHANICAL
AND MECHATRONICS ENGINEERING

stirring a nasal swab containing a buffer solution. If the sample contains the virus, it will be captured by the functionalized gNPs coated, giving a change in the microwave spectrum. The microwave circuitry will record and analyze the spectrum and give a yes/no answer via a light indicator.

This technology promises to be faster and much more reliable than the rapid testing technology that is currently available. The team also aims to keep costs low so the platform can be readily used in situations where urgent testing is needed, such as in hospitals and airports. The team also hopes the system can be mass-produced cheaply for use in developing countries.

“We make a great team. We can only change the status quo if we try something new. WIN has opened more opportunities for its researchers – WIN helped us facilitate that.”

PROFESSOR EMMANUEL HO, SCHOOL OF PHARMACY

INSTITUTES PARTNER TO CREATE EDUCATION
TOOLS FOR EXPLAINING TO THE PUBLIC

HOW A DNA-BASED VACCINE IS DELIVERED THROUGH A NASAL SPRAY

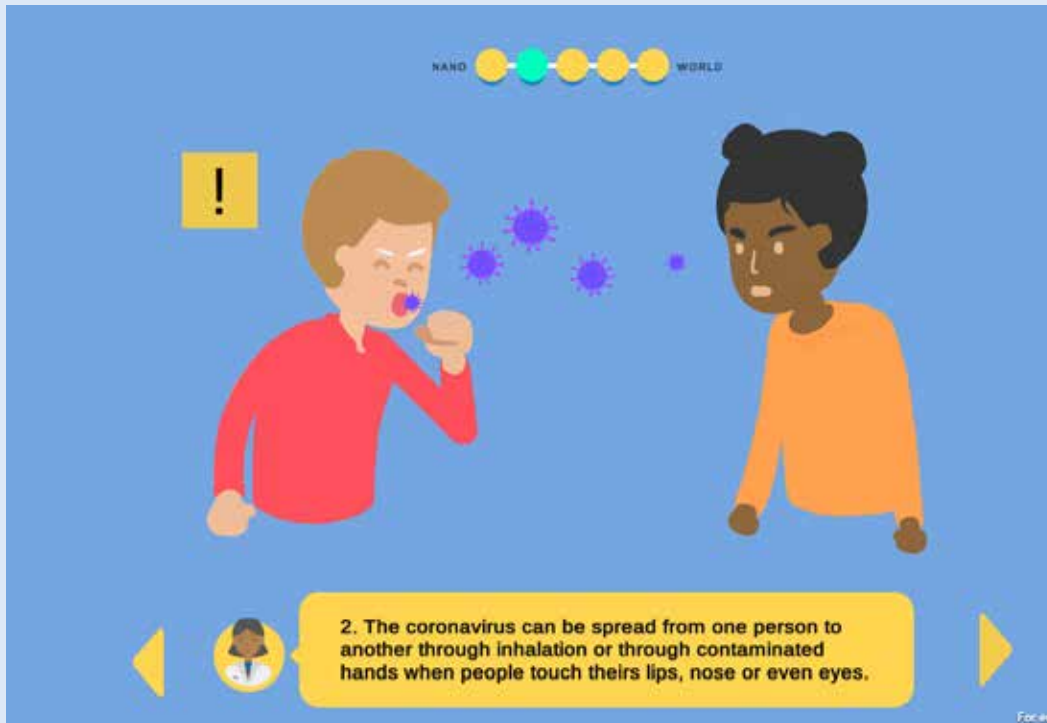
HOW CAN NANOTECHNOLOGY
HELP FIGHT THE PANDEMIC?

To answer this question, the Waterloo Institute for Nanotechnology (WIN) partnered with the Games Institute (GI) to create a playful online education app. This project aims to explore and explain to the public how nanotechnology is used in our everyday lives using digital visual storytelling and game technology.

For the first joint WIN-GI effort, the research of WIN members Roderick Slavcev, Emmanuel Ho and Marc Aucoin on DNA-based nasal vaccine sprays is showcased. For this, WIN collaborated with Faculty of Arts Professor Lennart Nacke's Human-Computer Interaction (HCI) and Games Group to design the online

app. The project visually shows how the DNA-based vaccine nasal spray will enter the body to create an immune response in people. This is the first of many similar projects between WIN and GI designed to highlight aspects of key theme areas of nanotechnology and how it impacts our lives daily.





The vaccine will work by using engineered bacteriophages (natural viruses that infect and kill bacteria but is harmless to humans), which will be used as a carrier of genetic material. When this reaches cells in targeted tissues, it will cause them to produce a virus-like particle (VLP) that will stimulate an immune response. The VLP will look similar to the structure of SARS-CoV-2 but is harmless. This similarity will activate the body's natural immune response to protect against viral infections comparable to VLPs, including SARS-CoV-2. It will also bind to receptors the virus would bind to, limiting the possible sites for transmission. By causing these changes in the body, the vaccine will build immunity against COVID-19 and decrease the severity of infections in progress – serving as both a therapeutic and a vaccine.

The cartoon depicted above is one of many screens of the interactive game to teach the concept of applications of nanotechnology to the general public. The tool was developed by interaction designers from the Stratford School of Interaction Design and Business, the Department of Systems Design Engineering, and the School of Public Health.

RESEARCH SUPPORT INITIATIVES

CANADA FOUNDATION FOR INNOVATION INNOVATION FUND (CFI-IF)



The Canada Foundation for Innovation (CFI) invests in research facilities and equipment in Canada's universities, colleges, research hospitals, and not-for-profit organizations. These federal funds are allocated to "help build and sustain Canada's research landscape to attract and retain the world's top talent, retain the next generation of researchers, support private sector innovation and create high-quality jobs that strengthen Canada's position in today's economy."

www.innovation.ca

For the 2020 CFI-IF competition, WIN dedicated \$1M for nanotechnology infrastructure and supported PIs to ensure high-quality for success, including a project charter to outline objectives and share responsibilities for competing the application. WIN and its Special Projects and Research Committee (SPARC) were involved in review and editing.

For the 2020 round, the project titled "Waterloo Centre for Electrochemical Energy Storage and Conversion", led by Linda Nazar of the Department of Chemistry, with Co-PIs

Zhongwei Chen and Michael Pope, both from the Department of Chemical Engineering, was awarded \$2.089 M CAD with an \$800,000 CAD allocation from the WIN envelope.

This project addresses the need for aggressive research in advanced energy storage to meet global demands to develop innovative and inexpensive new-generation energy storage batteries. A UWaterloo-based centre for energy conversion and storage involves significant renovation to accommodate a dry room and several significant hardware and equipment purchases. Congratulations to the team, and we look forward to the promising outcomes of this Centre at UWaterloo!

THE QUANTUM- NANO CONNECTION



Quantum science and nanotechnology go hand-in-hand. New functional nanomaterials are designed to enable quantum phenomena – to develop new devices that are smaller, lighter, self-powered and much more efficient, replacing larger electronics and opening up a vast array of application possibilities. The future of technology resides in the very small, with quantum and nanotechnology researchers leading the way.

In February 2021, WIN hosted an **International Workshop on Quantum Materials & Quantum Devices** with Indian Institute of Science Bangalore (IISc-Bangalore) Quantum Materials & Devices Division. Four WIN members who are also joint members of the Institute for Quantum Computing (IQC) participated, including Na Young Kim (Electrical & Computer Engineering), Guoxing Miao (Electrical & Computer Engineering), Adam Wei Tsen (Chemistry), and Youngki Yoon (Electrical & Computer Engineering). Kevin Musselman (Mechanical & Mechatronics Engineering) and Zbigniew Wasilewski (Electrical & Computer Engineering), also participated; although they are not members of IQC, they work extensively with quantum materials.

This workshop was designed to kick-start productive and impactful collaboration with IISc-Bangalore, which is well known for the high calibre of research in this field. The workshop featured Vibhor Singh, Varun Raghunathan, Jaydeep Basu, Abhishek Singh Kausik Majumdar and Mayank Shrivastava, each of whom are prominent IISc-Bangalore researchers in this field.

The workshop spanned two days, from February 17-18, 2021, with over 112 audience members in attendance from WIN, IQC and IISc-Bangalore.

To incent collaboration, WIN and IISc will sponsor a joint seed-funding competition later in 2021. Many of the presentations were recorded and posted on WIN's YouTube channel for viewing.



IQC Institute for
Quantum
Computing

WIN-IQC

RESEARCH COLLABORATION



WIN and IQC researchers have teamed up to work on a next-generation trapped ion system for quantum computing. Professor Sushanta Mitra from the Department of Mechanical & Mechatronics Engineering partnered with Professor Na Young Kim from the Department of Electrical and Computer Engineering to develop a nature-inspired system.

Trapped Ion (TI) devices are leading candidates for building qubits for quantum computing. Existing methods of creating TI require very expensive and time-consuming methods such as designing complex micro/nano fabricated devices and laser sources to cool ions to trap them. Inspired by the transport of water molecules in naturally-occurring proteins, the team invented a new and simple way to trap ions inside artificial water channels. This method removes the need to use bulky lasers and labour-intensive fabrication techniques, instead creating an unparalleled potential of a scalable, multi-qubit system.

Professor Kim sees the direct connection between the quantum and nano worlds. “In principle and by nature, Quantum and Nano are inseparable. Many of us between WIN and IQC are already working closely

together in various interdisciplinary research projects. We all strive for sustainable and scalable quantum science and technologies by integrating chemical, computer, electrical, material, mechanical and system engineering expertise. We are very eager to see the impact of artificial intelligence and machine learning techniques on theoretical and experimental quantum areas of research, where WIN and IQC meet again. In addition, we look forward to the impact of quantum technologies on real-world problems ranging from bio-medical, pharmaceutical, material and manufacturing sectors, where WIN and IQC share strong networks.”

This project is funded by a competitive federal grant, the New Frontiers in Research Excellence – Exploration Stream.

SCOTT INWOOD



“Innovations arising from bringing together diverse interdisciplinary skills, such as between the WIN and IQC investigators in this case, often yield highly disruptive technologies. We are invigorated to be supporting this commercialization effort that is further backstopped by collaboration with ORNL’s expertise and unique experimental infrastructure”, remarked Scott Inwood, Director of WatCo’s operations.



AQUABITS INC: CREATION OF A START-UP COMPANY

In partnership with the Waterloo Commercialization Office (WatCo), Professors Mitra and Kim have created a start-up company based on this technology, Aquabits Inc. WatCo works with research innovators to provide intellectual property and commercialization support to translate disruptive technologies to the commercial marketplace. Aquabits and Professor Mitra’s team will continue its deep partnership with Oak Ridge National Laboratories (ORNL) USA to develop the platform technology to achieve a simple design with low power-consumption, a scalable architecture with full connectivity among qubits for multiple operations to be used in quantum-computers, quantum-sensing and quantum-information applications.



NANOTECHNOLOGY HELPS MAKE SURGERIES SAFER!

DID YOU KNOW THAT ALMOST 35% OF ALL ABDOMINAL SURGERIES HAVE POST-OPERATIVE COMPLICATIONS?

Even worse, complications arising from abdominal surgeries can carry up to a 26% mortality rate. These numbers are staggering! Despite the advances that modern medicine has made, these surgeries remain a significant safety concern. How might this problem be solved with nanotechnology? This is the question that Youssef Helwa and Amr Abdelgawad asked themselves while studying Nanotechnology Engineering at the University of Waterloo.



It certainly helped that Youssef's mother is a surgeon as he investigated every aspect of the problem to understand why the statistics are so poor. He had a chance to look at it from the unique perspective of a surgeon who must deal with complications like these on a weekly basis. His research concluded that one of the deadliest complications is due to internal leakages of luminal fluids known as anastomotic leakage, which typically goes undetected and may result in septic shock. It can take up to two to three days to diagnose, in which time a cascade of other complications may have already begun. The friends narrowed down the problem and began to develop a biosensor. They eventually

determined that specific biomarkers in a patient may be measured to help predict the onset of such complications. When the team conceived the first design of their sensor, they decided it was time to start a company, and NERv Technology Inc was founded in 2014.

Shortly after, it became evident that miniaturization of such sensors would require R&D work in a nanofabrication facility. This was when Youssef decided to continue his studies and sensor development through his Masters program in Electrical Engineering under the supervision of WIN member Professor Bo Cui. In 2016, Youssef received a WIN Nanofellowship and subsequently

completed his studies in 2017. Amr furthered his studies in the Masters in Business, Entrepreneurship and Technology Management (MBET) program at UWaterloo's Conrad School of Entrepreneurship and Business.



It took several years of hard work, and many iterations of the sensor design. Initial designs envisioned the sensor to be implantable and miniature, with wireless signal transmission through the human body to an external receiving device, such as a smartphone. Experiments even included testing with animal tissue to model how a live human tissue would attenuate the sensor's signal.

When a working prototype was finally on the horizon, the team began to closely network with surgeons in the local research hospitals. This was when they discovered that having a wireless, implantable sensor approved by medical authorities, such as the USFDA as well as Health Canada, would be difficult and expensive. The team decided to pivot, going back to the drawing board, and worked on a completely new design. After several different iterations, the team made the sensors to be wearable rather than implantable. While the principles of sensor detection remained the same, the final design is nothing like the first prototypes. With the help of existing drainage systems in hospitals, the sensors could draw bodily liquids from the abdominal cavity through the implanted catheter and out into a collection box. If the sensor detects early signs of a complication, it alerts the healthcare providers.

NERv would later go on to win several international startup competitions, including the Entrepreneurship World Cup, and secure two rounds of private investment. The company recently raised \$2.65M USD in seed investment round and grew from four to 24

employees over the past two years. The company also moved recently to a new medical startup innovation hub called Medical Innovation Xchange (MIX), located in the redesigned section of the former Christie Digital building (Kitchener). With the new investment and new home, the company just began Phase 2 Clinical Trials with 250 patients expected to be enrolled across several US and Canadian institutions, including centers such as the Cleveland Clinic.

“We are very excited to have NERv Technology becoming a resident of our hub,” says Elliot Fung, Executive Director of MIX, who was recently recruited from Ontario Health, where he served as Vice President, Innovation and Strategic partnerships. “It evolved around Intellijoint Surgical, one of the fastest-growing companies in Canada, MIX now consists of six resident companies and fourteen partners, all medical device companies from the Waterloo Region”, Elliot continued.



The future is bright for NERv Technology Inc with Youssef and the team paving the way for many others. Other medical device companies with involvement from WIN members include LeNano Diagnostics (Shirley Tang, Chemistry), KA Imaging (Karim Karim, ECE), and most recently BioGraph Sense Inc (Mustafa Yavuz, ECE).



UNDERGRADUATE NANOTECHNOLOGY ENGINEERING

The Nanotechnology Engineering (NE) program provides practical education in key areas of nanotechnology, including the fundamental chemistry, physics and engineering of nanostructures and nanosystems, as well as the theories and techniques used to model, design, fabricate or characterize them.

Students in this Bachelor of Applied Sciences undergraduate program receive a comprehensive education in the rapidly developing field of nanotechnology, allowing them to work across conventional disciplines in many industry sectors. This is the first accredited undergraduate nanotechnology engineering program. Since the program's beginnings, over 50% of graduates have continued education through graduate studies, with a large proportion admitted to the world's top 10 universities, e.g. MIT, Harvard, Stanford,

and others. NE graduates are also well known for their entrepreneurial skills, with over 40 companies created and sustained over a five year period.

Though the program shares its home with WIN, the relationship between these students and our institute goes beyond a location. Many of WIN's international and industry partnerships resulted in co-op placement for NE students.

Anyone interested in hiring a Nanotechnology Engineering student during their co-op term should forward inquiries to Jenn Coggan, at jcoggan@uwaterloo.ca

WATERLOO NANOTECHNOLOGY CONFERENCE

In 2015, an ambitious group of Nanotechnology Engineering students founded the Waterloo Undergraduate Nanotechnology Conference (WUNC). This conference was initially run by undergraduate students and as of 2018, sprouted a collaboration between undergraduate and graduate students in nanotechnology, changing its title to Waterloo Nanotechnology Conference (WNC). This student-run conference is supported by WIN and through this partnership, the conference invites top academics, industrialists, entrepreneurs and government officials.

Though 2020 was a difficult year for events, WNC's organizers remained driven to deliver a personal experience with their mission as a conference in mind. Amidst these uniquely challenging times, they wished to provide a sense of strength and unity for those affected and moved their conference online. In November 2020, WNC celebrated its sixth anniversary bringing together students, employers, researchers, and entrepreneurs around a common interest in nanotechnology. They virtually explored how nanotechnology is used in industry, its advances in innovative research, and its use to power new ventures. The conference featured several esteemed speakers including Professor Robert Langer from the Massachusetts Institute of Technology and Professor Edward Sargent from the Edward S. Rogers Sr. Department of Electrical and Computer Engineering at the University of Toronto, he holds a Canada Research Chair in Nanotechnology.



COLLABORATIVE NANOTECHNOLOGY GRADUATE PROGRAM

Launched in 2010, the Collaborative Graduate Nanotechnology Program allows students to pursue a Master's or Doctoral degree in nanotechnology in one of the six departments: Chemistry, Physics, Chemical Engineering, Electrical and Computer Engineering, Mechanical and Mechatronics Engineering, and Systems Design Engineering. In this program, faculty, students and industry work together – learning, pursuing innovative ideas and research, and inspiring each other towards technological innovation, social benefit and economic growth. Although WIN is not involved in the design and the content of this collaborative graduate program, several WIN members participate in teaching courses offered under this program.

WIN strives to provide these new graduate students and postdoctoral fellows with a supportive community environment by managing key and office allocations, ensuring a welcoming main office for students to seek assistance, support their academic success through Nanofellowships and foster their extracurricular activities through the Waterloo Institute for Nanotechnology Graduate Student Society (WINGSS). Core course modules address foundational elements of nanotechnology, while a wide range of nanotechnology elective courses allow students to customize their education and broaden their perspective.

WINGSS

Since its inception in 2014, WINGSS has increased networking and collaboration between graduate students pursuing nanotechnology research (over 200 graduate students across science and engineering). WIN has enabled this club to flourish via financial support (approximately \$10,000 CAD in total since 2014) as well as collaborate directly with the club via ideas and processes on how to promote and facilitate events.





NANOFELLOWSHIPS

Each year WIN holds the Nanofellowship competition, to recruit new students from Canadian and international universities, as well as retain exceptional talent from University of Waterloo's undergraduate science and engineering programs. These scholarships are made possible by an endowment fund donated by Doug Fregin, and are valued at \$10,000 CAD. In 2020 WIN received 96 applications, and 30 students were awarded a fellowship. The Nanofellowships are awarded to outstanding students conducting nanotechnology research aligned with WIN's four thematic areas, as well as research that is connected to the United Nations Sustainable Development Goals.

The Annual Nanofellowship Competition Awards Ceremony was also held in November 2020, as part of the WIN Research Celebration (read more on page 40). Instead of a poster for this online celebration, the students prepared a short video presentation of their research projects and the students, faculty and audience members were invited to stay online for discussions about their projects.

Student presentations can be viewed on WIN's YouTube channel.

2020 RECIPIENTS

- › Abdullah Alshehri
- › Delaney Anderson
- › Irfani Rahmi Ausri
- › Robert Bennett
- › Trevor Blaikie
- › Lauren Blanc
- › Elham Davoodi
- › Pablo Daniel Enrique
- › Tao Guo
- › Stephen Harrigan
- › Zhe Huang
- › ZhiCheng Huang
- › Christian Ieritano
- › Asif Abdullah Khan
- › Bohdan Khromets
- › Ahmad Malik Lakhani
- › Lingzi Ma
- › Sirshendu Misra
- › Ryan Moreira
- › Stanislav Musikhin
- › Michael Noden
- › Tyler Or
- › Morgan Robinson
- › Resul Saritas
- › Supratik Sarkar
- › Thomas Storwick
- › Chunxia Tang
- › Avery To
- › Zhen Zhang
- › Laidong Zhou

“This award has given me a lot of encouragement, inspiring me with determination to pursue PhD studies at UWaterloo.”

ZHE HUANGY

“It is my honor to be selected as one of the Nanofellowship winners. I greatly appreciate you for this generous fellowship; it will definitely help me throughout my research.”

ELHAM DAVOODI

WIN NANOFELLOWSHIP COMMITTEE 2020-21

This committee was created to steward the fair and optimal disbursement of funds for the annual competition and to increase transparency of the selection process. Its members include:

Nanofellowship Committee Chair, and Dean's Representative, Faculty of Engineering: **Yuning Li** (Chemical Engineering)

Assistant Vice President Graduate Studies: **Shawn Wettig** (Pharmacy)

Associate Dean Graduate Studies, Faculty of Engineering: **Siva Sivoththaman** (Electrical and Computer Engineering)

Associate Dean Graduate Studies, Faculty of Science: **Martin Ross** (Biology)

Dean's Representative, Faculty of Science: **Xiaosong Wang** (Chemistry)

The WIN Nanofellowship Adjudication Committee consisted of the above-mentioned members, with the following designates:

Designate for the Associate Dean Graduate Studies, Faculty of Engineering: **Eihab Abdel-Rahman** (Systems Design Engineering)

Designate for the Associate Dean Graduate Studies, Faculty of Science: **Anna Klinkova** (Chemistry)

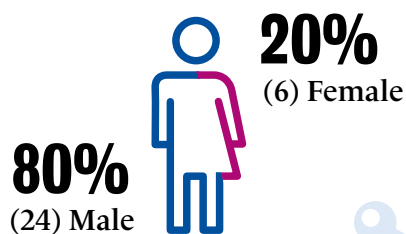
NANOFELLOWSHIP WINNERS – STATISTICS

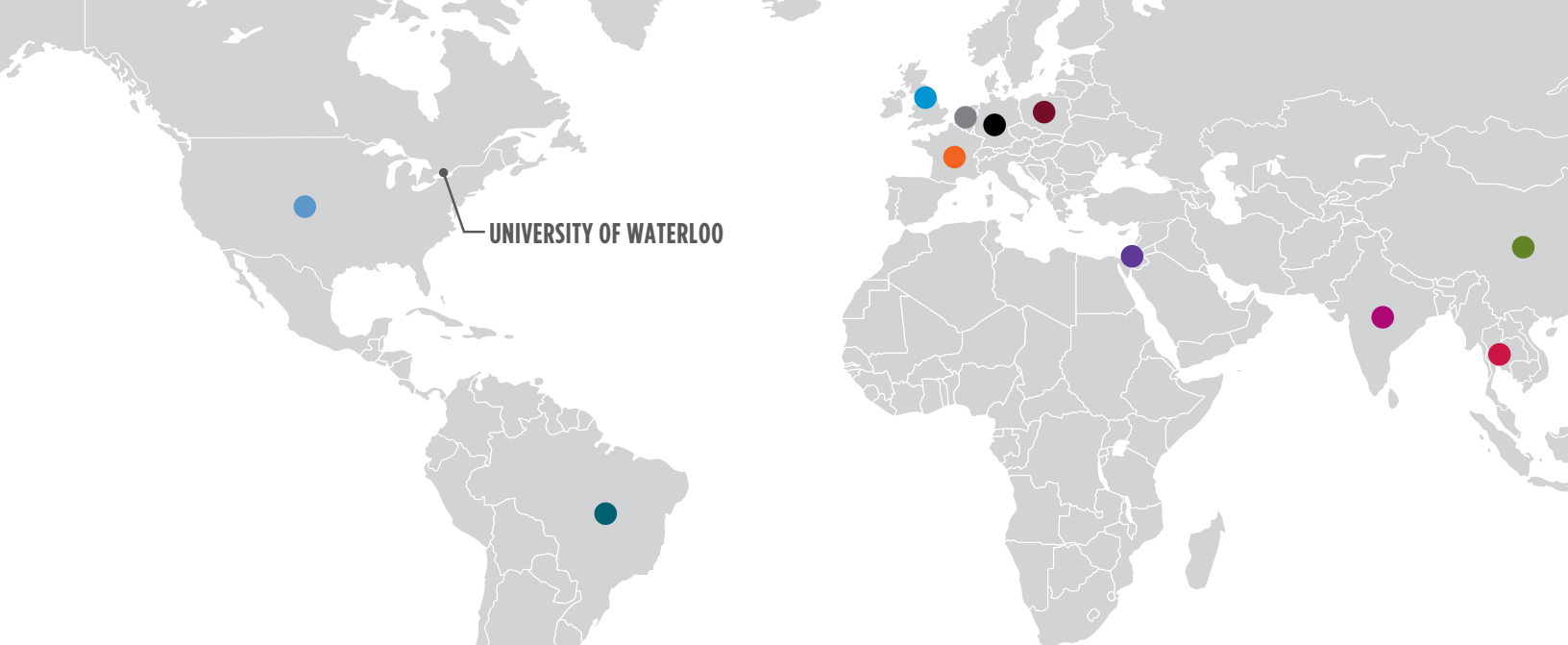
CITIZENSHIP	APPLICANTS	AWARDEES
Canadian	33 (34%)	13 (44%)
International	48 (50%)	16 (53%)
Permanent resident	2 (2%)	1 (3%)
Total	96	30

DEGREE PROGRAM	APPLICANTS	AWARDEES
PhD	65 (68%)	21 (70%)
MASc/MSc	28 (29%)	9 (30%)
Not Specified	3 (3%)	

DEPARTMENT	APPLICANTS	AWARDEES
Chemical Engineering	14 (14.58%)	5 (17%)
Chemistry	30 (31%)	10 (33%)
Electrical and Computer Engineering	23 (23.96%)	4 (14%)
Mechanical and Mechatronics Engineering	15 (15.68%)	6 (20%)
Pharmacy	2 (2.08%)	1 (3%)
Physics and Astronomy	8 (8.33%)	3 (10%)
Systems Design Engineering	2 (2.08%)	1 (3%)
Not Specified	2 (2.08%)	–
Total	96	30

Gender:

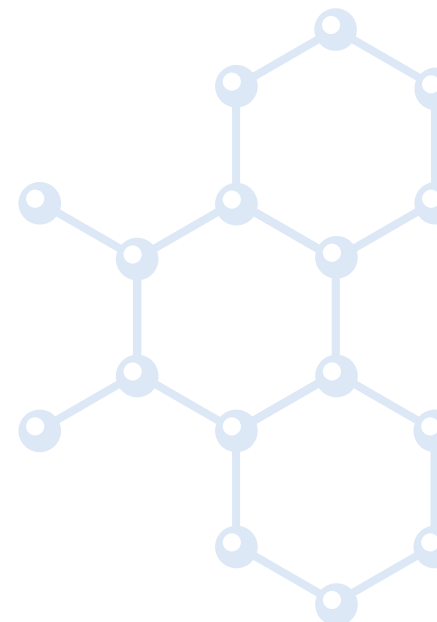


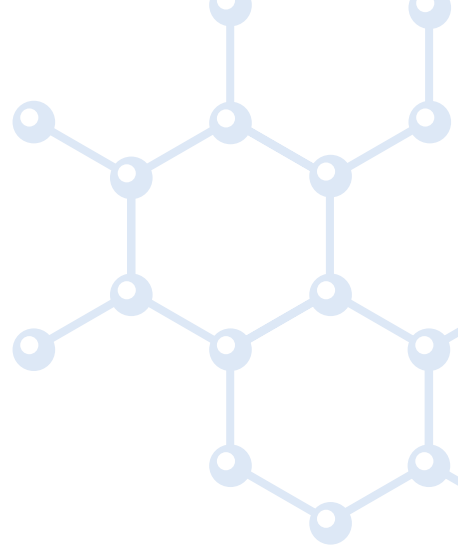
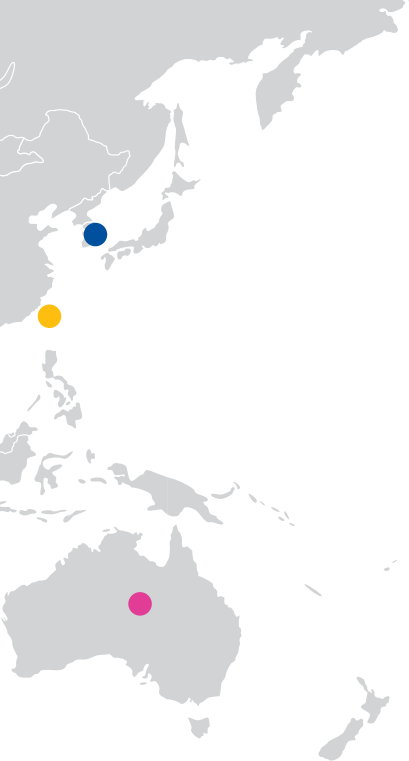


INTERNATIONAL

For international activities, 2020 brought a great deal of restrictions for international travel, but we were able to maintain healthy relationships and create several new ones.

- AUSTRALIA** ● University of Sydney Institute for Nanotechnology (Sydney Nano)
- BRAZIL** ● Brazilian National Nanotechnology Laboratory (LNNano);
Federal University of ABC (UFABC)
- CHINA** ● Soochow University (SU)
Suzhou Industrial Park (SIP)
Tsinghua University
Chinese Academy of Sciences National Center for Nanoscience and Technology
- FRANCE** ● Université de Bordeaux
- GERMANY** ● Center for Nano Integration Duisburg-Essen (CENIDE)
- INDIA** ● Indian Institute of Science (IISc)
Indian Institutes of Technology – Bombay (IITB);
Kharagpur (IITKGP)
Delhi (IITD)
Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)
University of Calcutta
- ISRAEL** ● Technion-Israel Institute of Technology
- NETHERLANDS** ● University of Twente, MESA+ Institute for Nanotechnology
- POLAND** ● MISMap College of the University of Warsaw
- SOUTH KOREA** ● Korean Advanced Nano Fab Centre
- TAIWAN** ● Academia Sinica (AS)
National Taiwan University (NTU)
National Tsinghua University (NTHU)
National Chiao Tung University (NCTU)
National Cheng Kung University (NCKU)
National Program on Nanotechnology (NPNT)
- THAILAND** ● National Nanotechnology Center, Thailand (NANOTEC)
- UNITED KINGDOM** ● University of Cambridge
University of Bristol
- UNITED STATES** ● Oak Ridge National Laboratories





AUSTRALIA

WIN is working closely with the University of Sydney Nanotechnology Institute (Sydney Nano), whose researchers participated in the International Workshop on Nanotechnology for a Sustainable Future and is a founding member of N4SNano.

BRAZIL

An Agreement in Research Cooperation was finalized with Brazil's Federal University of ABC (UFABC) in January 2021, allowing for faculty and student mobility, joint research and publications and other related activities. Brazil UFABC has a sustainable materials and energy initiative, as well as biomedical/technology research, all of which are strong research areas at UW. It also is home to the largest nanotechnology research and graduate program in Brazil.

CHINA

The Agreement for Cooperation Regarding Doctoral Studies commenced in September 2020 with a scholarship of \$10,000 CAD per year for four years, and the Postdoctoral Fellowship Program for \$40-45,000 CAD per year for three years was also initiated.

GERMANY

WIN continues to support the Deutsche Forschungsgemeinschaft International Research Training Groups (DFG-IRTG) in Germany grant to allow for the NSERC-CREATE submission for the Canadian side. WIN is happy to report that CENIDE was invited to submit a full proposal in September 2021, and WIN will support the corresponding NSERC application for the May 2022 submission deadline.

INDIA

WIN hosted the International Workshop on Quantum Materials & Quantum Devices with the Indian Institute for Science, Bangalore (IISc Bangalore). Details on the workshop are found on page 23.

NETHERLANDS

WIN partnered with Brainport Developments in Eindhoven Region along with PhotonDelta and HighTechXL, inking an agreement for technology development (see page 42).

MESA+ from the University of Twente continues to be a strong and valued partner, participating in the International Workshop on Nanotechnology for a Sustainable Future, and is a founding member of N4SNano (see pages 36-38).



INTERNATIONAL WORKSHOP 2020

ON NANOTECHNOLOGY FOR A SUSTAINABLE FUTURE

In November 2020, the Waterloo Institute for Nanotechnology (WIN) hosted the “International Workshop on Nanotechnology for a Sustainable Future”.

WIN constantly strives to be an exemplar in cross-disciplinary research, to break down barriers and create a 360-degree view of critical research problems. This virtual workshop served to define technological challenges and societal impacts, and assembling well-balanced teams to lead to a just and sustainable society.

The workshop featured 26 speakers from five countries spanning four continents, and was attended by 244 people from 15 countries.

The participating institutions had well-defined priority theme areas for 2020-2021 and were discussed during the following five technical sessions, each mapped to one or more UNSDG:

WORKSHOP SESSIONS

- › Session 1: Nanotechnology and Society, Policy and Science Diplomacy (UN SDG #8, 10, 16, 17)
- › Session 2: Industry and Innovation (UN SDG #9, 11)
- › Session 3: Energy and Environment (UN SDG #7, 13)
- › Session 4: Devices and Technology for Healthcare (including COVID-19) and Communications/Photonics (UN SDG #3, 9, 11)
- › Session 5: Resource Management and the Circular Economy (UN SDG #6, 11, 12, 13, 17)

UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS:



The workshop was opened by UW's Vice President of Research and International Dr Charmaine Dean. Co-organized by the Consulate of the Netherlands in Canada, Her Excellency Ines Copoolse, Ambassador of the Netherlands in Canada also gave welcoming remarks, and was joined by NSERC President Alejandro Adem, Japan Science & Technology Agency President Michinari Hamaguchi, University of Sydney Nanotechnology Institute Director Benjamin Eggleton and ACN Nano Editor-in-Chief Paul Weiss who also welcomed the audience.

INVITED LECTURES – INTERNATIONAL

- › **Albert van den Berg**, co-Scientific Director, MESA+ Institute for Nanotechnology, Netherlands: “Nano4Society”
- › **Jun’ichi Sone**, Principal Fellow, Centre for Research and Development Strategy, JST Japan: “R&D Strategy of Nanotechnology and Materials for a Sustainable Future in Japan”
- › **Steven Maguire**, Professor of Strategy, Innovation and Entrepreneurship University of Sydney Business School, Sydney Nano Member: “Integrating Social Sciences with Nanosciences for a Sustainable Future”
- › **Marc Fortin**, Vice President, Research Partnerships, NSERC: “The Role of NSERC is Supporting and Shaping the Canadian Research Ecosystem”

INVITED LECTURES – CANADIAN

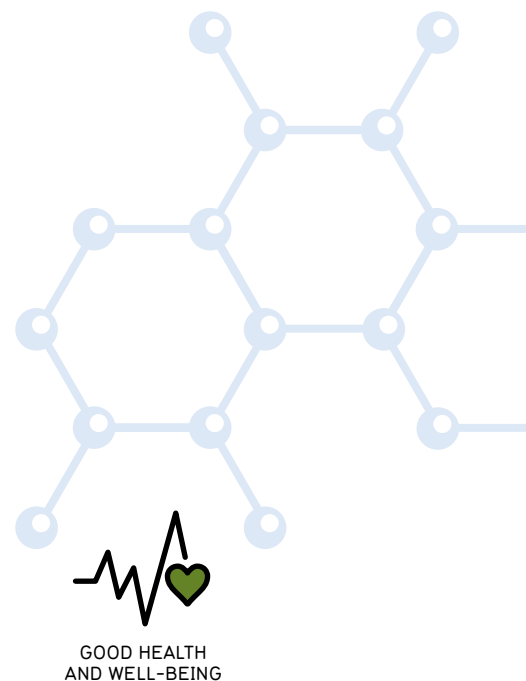
- › **Elicia Maine**, Professor of Innovation and Entrepreneurship, Beedie School of Business, Simon Fraser University: “Enabling Nanotechnology Solutions for a Sustainable Future: Endowing University Spinoffs Pre-Formation”
- › **David Sinton**, Professor, Department of Mechanical and Industrial Engineering, University of Toronto: “Electrochemical Systems for CO2 Conversion to Products”
- › **Warren Chan**, Director, Institute for Bioengineering, University of Toronto: “Challenge of Delivering Nanoparticles to Solid Tumors”

WIN SPEAKERS

- › **Linda Nazar**, Professor, Department of Chemistry, “Unravelling the Complexities of Electrochemical Energy Storage at the Nanoscale”
- › **Karim Karim**, Executive Director of Centre for Bioengineering and Biotechnology, Department of Electrical and Computer Engineering, “Reveal Dual Energy Detector”
- › **Goretty Dias**, Professor School of Environment, Enterprise and Development, “Circularity, Resources, and Technology: Achieving Sustainable Development”
- › **Jatin Nathwani**, Executive Director of Waterloo Institute for Sustainable Energy, Department of Civil and Environmental Engineering, “Sustaining a Clean Energy Transition Beyond COVID”

INTERNATIONAL NETWORK

FOR SUSTAINABLE NANOTECHNOLOGY



The International Network for Sustainable Nanotechnology (N4SNano) is a consortium of leading organizations in the field of nanotechnology representing institutes, universities, non-profit and governmental agencies.



Founding members of the Network are from the Waterloo Institute for Nanotechnology (WIN) in Canada, MESA+ Institute for Nanotechnology from the Netherlands, the University of Sydney Nano Institute (Sydney Nano), and the University of California Los Angeles (UCLA). The Japan Science and Technology Agency (JST) has been a supporting member since its inception.

The Network's vision is to be recognized as a global leader, innovator, educator, influencer and thought-leader. Its mission is to create a collaborative network of nanotechnology institutes and centres, industry, government agencies, not-for-profit organizations, and the end-user community, to champion nanotechnology solutions for a sustainable future.

N4SNano's mandate involves addressing global challenges and engaging in outreach and knowledge mobilization activities in all major continents to promote nanotechnology in relation to the UNSDGs. An annual World Summit is being organized as a forum for world experts in nanotechnology and applications in relation to the UNSDGs to share ideas, learn about specific needs of different regions and the policies adopted by different governments to implement new technologies to address societal needs.

In winter 2022, the Network will host a virtual event to bring all Network partners together and invite the global community to attend. The first World Summit will focus on UNSDG #3 – Good Health and Well-Being. The World Summit is planned for 2022.

An editorial piece for ACS Nano will focus on “Nanotechnology for a Sustainable Future: Addressing Global Challenges with the International Network4Sustainable Nanotechnology”.

WIN RISING STAR AWARDS 2020

As Canada's largest nanotechnology institute, WIN actively celebrates emerging leaders in nanoscience and nanotechnology. Individuals from across the world, whose research aligns with one or more of WIN's thematic areas and UNSDGs, are eligible for the WIN Rising Star Award in Nanoscience and Nanotechnology.

In 2020, two outstanding researchers were recognized as WIN Rising Stars: Drew Higgins from McMaster University and Robert Hoye from Imperial College London. They were both invited to give keynote presentations virtually at the WIN Rising Star and Research Leaders Gala in November 2020. Both of their keynotes are available on WIN's YouTube Channel.

The WIN Rising Star Award provides a \$5,000 cash honorarium to bring the Rising Star to WIN to meet researchers and students, give guest lectures and seminars, and commence potential collaboration. Because of COVID-19 travel restrictions in 2020, both researchers will visit WIN when in-person gatherings at UWaterloo resumes.



ROBERT HOYE

is a Lecturer and Royal Academy of Engineering Research Fellow in the Department of Materials at Imperial College London. He leads the Energy Materials & Devices Group, which focuses

on the development of functional thin films for next-generation energy systems. His work has led to the realisation of new classes of semiconductors that could tolerate defects, and their demonstration in photovoltaics, photoelectrochemical cells and light-emitting diodes. He has also developed new techniques to manufacture the active layers in devices at scale. His work has gained interest from several companies, who have formed partnerships with his team.



DREW HIGGINS

is an Assistant Professor in Chemical Engineering at McMaster University, where his research focuses on the development and

understanding of electrocatalyst materials and electrode structures for sustainable electrochemical energy technologies, including fuel cells, electrolyzers, batteries and supercapacitors. His team also conducts in situ / operando characterization of electrochemically active materials, nanomaterial development, and understanding and integration into sustainable electrochemical energy devices.

WIN RESEARCH CELEBRATION

As with most events in 2020, WIN's Annual Research Celebration looked a bit different. The event honours all our WIN community and was held virtually on November 24, 2020.

Along with the WIN Rising Stars, the WIN Research Celebration recognizes our Nanofellowship award winners (see page 32 for full list) and outstanding faculty researchers who have made significant contributions during the 2019-2020 fiscal year. These contributions include:

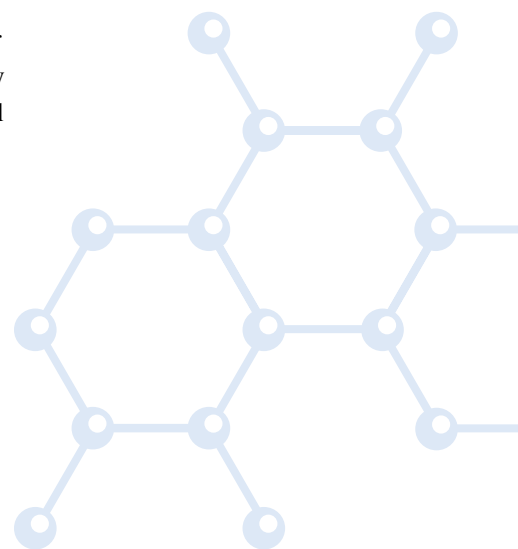
- a) Any individual or group receiving major grants with a value equal to or greater than \$500,000
- b) Major national or international awards
- c) Published books or other major scholarships and creativity

For 2020, the following WIN members were recognized:



This event will be held annually, to continue to recognize the outstanding achievements of WIN members.

- > Hany Aziz
- > Zhongwei Chen
- > Michel Gingras
- > Emmanuel Ho
- > Vassili Karanassios
- > Zoya Leonenko
- > Juewen Liu
- > Linda Nazar
- > Carolyn Ren
- > Derek Schipper
- > Zbigniew Wasilewski
- > Shawn Wettig
- > Yimin Wu
- > John Yeow
- > Aiping Yu
- > Alfred Yu



WIN BUSINESS DEVELOPMENT

NEW INDUSTRY PARTNERSHIPS

17 WIN faculty

2 Non-WIN faculty

16 new industry introductions

7 project initiated (grants, contracts)

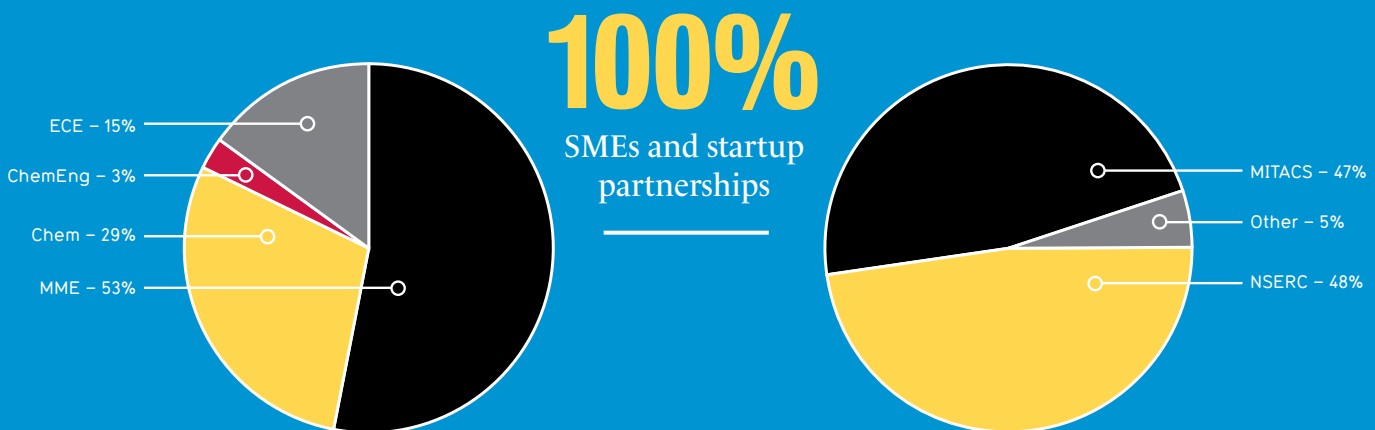
5 funded

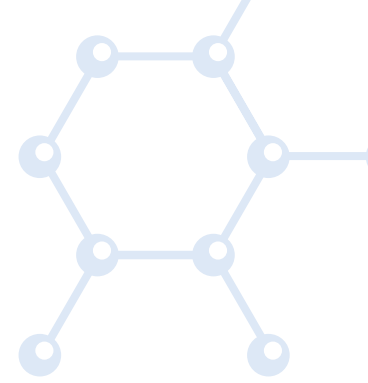
>\$1.5M
funding applied for

\$405K
approved (>\$150K*)

*Compared to 2019-2020

Seventeen WIN faculty members and two non-WIN faculty were introduced to 16 new prospective industry partners. Five of these new relationships were converted into funded projects that brought in \$405,000 of research money (compared to just over \$150K in 2019-20). The majority of these projects were with faculty from the Department of Mechanical and Mechatronics Engineering. All industry partners were SMEs at different stages of their businesses. MITACS and NSERC were equally represented this year (47% and 48%, respectively), with 5% coming through direct research contracts.





BRAINPORT EINDHOVEN ECO-SYSTEM

In Spring 2019, WIN hosted a delegation from Eindhoven in the Netherlands organized by the regional economic development agency Brainport Development. The Region of Waterloo and the City of Eindhoven have significant similarities in terms of the density of startup companies, with both named the smartest cities in the world.

Moreover, Eindhoven is home to several world-leading electronics companies and developed an ecosystem of world-leading nanotechnology enterprises.

A match-making event was organized to bring together ecosystem partners in Eindhoven and WIN-affiliated startup companies. The event was hosted virtually in November 2020. Over 20 participants attended, including representatives from eight startup companies from both sides. Brainport introduced WIN to several eco-system partners in Eindhoven:



photondelta.com

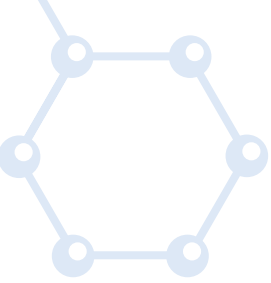
PhotonDelta is a public-private partnership and an investment fund supporting companies with integrated photonics technologies in the Netherlands. It is open to invest in Canadian startups.



hightechxl.com

HighTechXL is a business incubator dedicated to the commercialization of cutting edge technologies via startup creation based on inventions made in academia and in industry. The organization provides initial pre-seed investment and brings together executives into a new venture.

After this event, University of Waterloo's Office of Research, Brainport, PhotonDelta, HighTechXL and WIN signed an MOU in March 2021. This was followed by the announcement of the joint seed funding program with a \$90,000 contribution from WIN, with a focus on commercialization and moving research developments to higher technology readiness levels with Brainport eco-system partners. The program is also suitable for research-based spinoff companies affiliated with WIN. HighTechXL is now connected via UWaterloo's technology transfer office, WatCO.



LANDING PAD TOKYO



In April 2020, WIN spearheaded an MOU between the University of Waterloo and Landing Pad Tokyo (LPT), a subsidiary of the Japanese Industry Promotion Association (JIPA). LPT’s mandate is to match the technological needs of its Japanese-member SMEs with those of Canadian startups. During the 2020-21 reporting period, over ten WIN- and UW-affiliated startups were introduced to Japanese partners.

WIN Startup Catalyst Program: WIN created an advisory team consisting of Adrien Côté (Executive Director of Velocity) and John Dick (Director of Concept), Professors Roderick Slavcev (Pharmacy; Director of Translational Initiatives for Faculty of Science, Director of Science Innovation Hub) and Eric Prouzet (Chemistry; entrepreneur, and entrepreneurship teacher). Based on consultations, WIN will focus its startup supports on two activities:

Activity 1: Support entrepreneurial students (with priority given to Masters, and PhD students, and postdoctoral fellows) and faculty researchers at very early stages in close partnership with Concept, Science Innovation Hub (formerly Velocity Science), and WatCO (technology transfer office).

Activity 2: Continue helping existing UWaterloo-affiliated nanotechnology spinoffs companies with business matchmaking using WIN national and international connections in the Netherlands, Japan, and China and others as they develop.

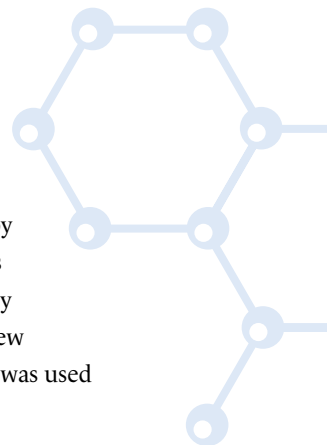


NANOTECH JAPAN CONFERENCE AND EXPO

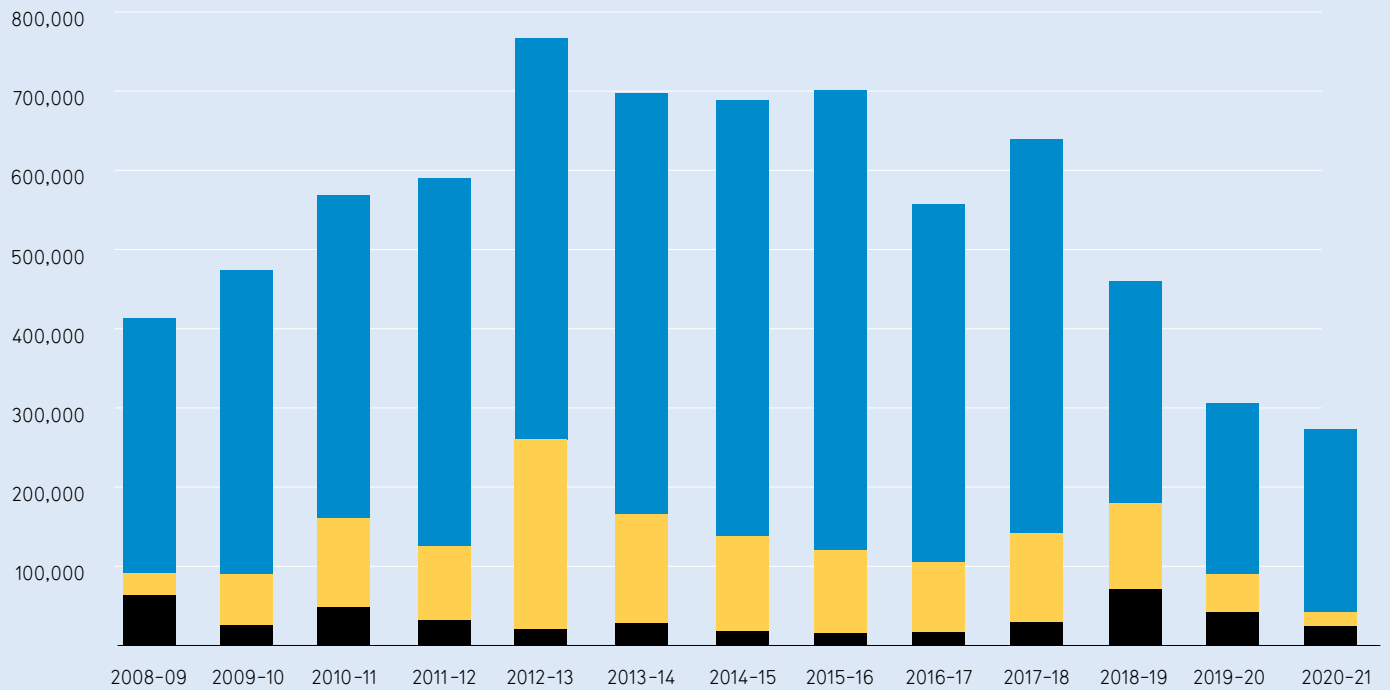
Canadian participation in this event was once again led by NanoCanada. Originally planned for January 2021, it was rescheduled for December 9-11. WIN was accompanied by 10 participants - WIN faculty members who developed new technologies and startup companies. An online platform was used to reach out to other participants.

Hannover Messe: During the week of April 12-16, WIN participated in the virtual edition of Hannover Messe, the world’s largest manufacturing trade event. WIN was part of the Canadian delegation at Hydrogen + Fuel Cells EUROPE exhibition section. A dozen new contacts were made with German and Austrian companies in the area of fuel cells, and discussions are taking place for recruiting sponsors for World Fuel Cells Conference 2021, hosted by WIN in August 2021.

Notable partnerships: In June 2019, WIN hosted an optoelectronics delegation from Huawei, where several faculty members presented their research expertise. As an outcome, Huawei established a contract research agreement with Professor Hany Aziz valued at \$493,000 for three years. Several more faculty members were introduced to Huawei, with discussions progressing to drafting sponsored research agreements.



BUDGET



LIFE IN THE QNC

42

WIN professor
research
laboratories

3

Lounges

3

Meeting
Rooms

41

Student
Offices

1

Rooftop
Patio

1

Seminar
Room

4

Kitchens

“WIN is responsible for managing the space and infrastructure on the “nano” side of the Mike & Ophelia Lazaridis Quantum Centre”

Due to the ongoing pandemic the QNC, usually bustling with 200+ students, was quiet for the 2020 year with only 43 students accessing the research laboratories and offices to continue the important research, some even to assist in COVID-19 related projects. We are proud our community came together and persisted through this uncertain time.

The exterior of the Mike & Ophelia Lazaridis Quantum-Nano Centre is modeled after the hexagonal structure of graphene.

ACKNOWLEDGEMENT OF TRADITIONAL TERRITORY

We acknowledge that the University of Waterloo is located on the traditional territory of the Neutral, Anishnaabeg, and Haudenosaunee people. The University is situated on the Haldimand Tract, the land promised to the Six Nations that includes 10 kilometres on each side of the Grand River.



WATERLOO INSTITUTE FOR NANOTECHNOLOGY
200 UNIVERSITY AVE. W., WATERLOO, ON, CANADA N2L 3G1



@WINano



@uwnano



@win-waterloo-institute-for-nanotechnology

nano.uwaterloo.ca