UW - TU Joint Workshop on Materials and Devices

Mar 4, 2026 7:00 PM - 8:30 PM (EST)

Mar 5, 2026 9:00 AM - 10:30 AM (JST)

Online

UNIVERSITY OF WATERLOO
WATERLOO INSTITUTE FOR nanotechnology
TOHOKU UNIVERSITY

UW - TU Joint Workshop on Materials and Devices

University of Waterloo
Waterloo Institute for Nanotechnology (WIN)

The Waterloo Institute for Nanotechnology (WIN) is Canada's largest nanotechnology institute, and an innovation powerhouse in the four key thematic research areas of smart and functional materials, connected devices, next generation energy systems and therapeutics and theranostics.

Housed in the custom-built Mike and Ophelia Lazaridis Quantum-Nano Centre (QNC), WIN scientists and engineers have access to state-of-art research infrastructure to support their endeavours. Aligning their research interests with the United Nations Sustainable Development Goals, WIN members are creating new materials and system to improve the economy, the environment, our health and welfare, and society as a whole.

Tohoku University
Semiconductor Technology Co-creation (STC2)

The Semiconductor Technology Co-creation (STC2) at Tohoku University is a collaborative initiative focused on advancing semiconductor technologies through interdisciplinary research and international partnerships. Tohoku University is one of Japan's leading research universities, renowned for its contributions to materials science, electronics, and advanced manufacturing.

With world-class facilities including the NanoTerasu synchrotron radiation facility and leading research institutes such as the Advanced Institute for Materials Research (AIMR), the Research Institute of Electrical Communication (RIEC), and the Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University provides an exceptional environment for cutting-edge research in nanotechnology, quantum devices, and semiconductor technologies.

Workshop Purpose

- Expand research engagement between WIN and Tohoku University (TU)
- Identify complementary expertise for future collaboration
- Explore new research themes in materials, devices, and semiconductors
- Build momentum toward the UW-TU Joint Seed Funding Framework

Agenda

Mar 4, 2026, 7:00 PM - 8:30 PM (EST)
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Time	Event	Speaker
EST : 19:00 - 19:06 (6 min) JST : 09:00 - 09:06 (6 min)	Opening Remarks	Prof. Sushanta Mitra Prof. Kentaro Totsu
EST : 19:06 - 19:13 (7 min) JST : 09:06 - 09:13 (7 min)	Phase contrast nano-CT using sub-10 micron pixel direct coversion X-ray detectors	Prof. Karim Karim, University of Waterloo
EST : 19:13 - 19:20 (7 min) JST : 09:13 - 09:20 (7 min)	A 3D printable all-solid-state Li-ion battery	Prof. Itaru Homma, Tohoku University
EST : 19:20 - 19:27 (7 min) JST : 09:20 - 09:27 (7 min)	AI-driven sensor networks, quantum-inspired NEMS/THz devices, and multifunctional microsystems	Prof. Mustafa Yavuz, University of Waterloo
EST : 19:27 - 19:34 (7 min) JST : 09:27 - 09:34 (7 min)	Cutting-Edge Synthesis of 1D and 2D Atomic Layer Materials	Prof. Toshiaki Kato Tohoku University
EST : 19:34 - 19:41 (7 min) JST : 09:34 - 09:41 (7 min)	Biomaterials nanotopography for regenerative medicine applications	Prof. Evelyn Yim University of Waterloo
EST : 19:41 - 19:48 (7 min) JST : 09:41 - 09:48 (7 min)	Semiconductor Quantum Technologies Using Artificial Nanostructures and Emerging Materials	Prof. Tomohiro Otsuka Tohoku University
EST : 19:48 - 19:55 (7 min) JST : 09:48 - 09:55 (7 min)	Functional oxide materials as proton conductors and memristors	Prof. XiaoYu Wu University of Waterloo
EST : 19:55 - 20:02 (7 min) JST : 09:55 - 10:02 (7 min)	Fabrication and Electical Validation of Ultimately Scaled 2D Transistors Toward THz ICT, Supported by Operando X-ray Nanospectroscopy	Prof. Hirokazu Fukidome Tohoku University
EST : 20:02 - 20:30 (28 min) JST : 10:02 - 10:30 (28 min)	Discussion, wrap-up, confirmation of next steps identifying specific research projects	All participants

Tohoku University Presenters

Itaru Honma

Professor
Director, Centre for Mineral Processing and Metallurgy, Institute of Multidisciplinary Research for Advanced Materials (IMRAM)

A 3D printable all solid state Li-ion battery

3D printing technologies have been adapted to enable all solid-state lithium-ion battery (LIBs) fabrication, allowing flexible designs such as scalable 3D shapes. We studied quasi-solid state electrolytes composed of ionic liquids and silica nanoparticles, that show liquid-like mobility within solid state matrix. The electrolyte maintains its structural integrity and high Li-ion conductivity, enabling quasi-solid state (QSS) Li-ion batteries.

Keywords : All solid state Li- ion battery, Nanomaterials, 3D printing, Battery manufacturing

Toshiaki Kato

Professor
Department of Electronic Engineering, Graduate School of Engineering/ Advanced Institute for Materials Research (AIMR)

Cutting-Edge Synthesis of 1D and 2D Atomic Layer Materials

Atomic layer materials exhibit extraordinary electronic, optical, and quantum properties arising from their reduced dimensionality and tunable symmetry. We develop advanced synthesis strategies for both 1D and 2D atomic layer materials with atomic-scale structural precision. Using plasma-assisted chemical vapor deposition, we have achieved scalable integration growth of graphene nanoribbons with controlled width and alignment, establishing a platform for low-dimensional carbon electronics [1,2]. Building on this capability, we have discovered a new catalyst that enables selective growth of (6,5) carbon nanotubes, providing a pathway toward chirality-pure nanotube production [3]. We further extend our structural engineering approach to transition metal dichalcogenides (TMDs), achieving Janus engineering and curvature-induced structural transformation [4,5]. Beyond materials synthesis, we are advancing these materials into quantum devices, such as Josephson junctions and superconducting hybrid structures, to explore next-generation quantum functionalities. [1] Nature Nanotechnology, 7 (2012) 651-656. [2] Nature Communications, 7 (2016) 11797-1-10. [3] ACS Nano, 18 (2024) 23979-23990. [4] ACS Nano, 18 (2024) 2772–2781. [5] ACS Nano, 19 (2025) 34918–34927.

Keywords : Nanotechnology, Materials, microsystems

Tohoku University Presenters

Tomohiro Otsuka

Associate Professor
Advanced Institute for Materials Research (AIMR)/
Research Institute of Electrical Communication (RIEC)

Semiconductor Quantum Technologies Using Artificial Nanostructures and Emerging Materials

Semiconductor qubits are considered one of the candidates for realizing large-scale quantum computing, and silicon-technology-based quantum chips have recently seen rapid progress. Further improvements in performance and functionality require not only the optimization of conventional device structures but also the incorporation of emerging materials that expand controllability and quantum properties. This presentation introduces qubit devices based on artificially engineered nanostructures and discusses material characteristics that strongly influence quantum behavior. It further outlines the potential for advancing quantum devices through the use of new materials and highlights research directions that may foster collaboration between materials science and quantum-device research communities.

Keywords : Nanotechnology, Materials, Semiconductors, optical and atomic physics

Hirokazu Fukidome

Associate Professor
Research Institute of Electrical Communication (RIEC)

Fabrication and Electical Validation of Ultimately Scaled 2D Transistors Toward THz ICT, Supported by Operando X-ray Nanospectroscopy

Next-generation information and communication technologies (ICT) demand radical advances in device performance and energy efficiency, including power amplification in the THz regime. I study ultimately scaled transistors, with an emphasis on fabrication and electrical validation, aiming for high energy efficiency and order-of-magnitude gains in output power. By orthogonally integrating graphene and transition-metal dichalcogenides (TMDs), I achieve sub-nanometer effective gate lengths and channel thicknesses (<1 nm) without advanced lithography and demonstrate DC transistor operation. To support optimization and reliability, I use operando X-ray nanospectroscopy under electrical bias—an approach I developed—to map electronic and chemical states with elemental selectivity at synchrotron facilities such as NanoTerasu (situated in the campus of Tohoku University) and SPring-8. This workflow links fabrication, operation, and in-device diagnostics, providing quantitative feedback for nanoscience-guided design toward future THz ICT.

Keywords : Nanotechnology, Materials, Thin-film surfaces and interfaces

University of Waterloo Presenters

Karim Sallaudin Karim

Professor
Department of Electrical and Computer Engineering

Phase contrast nano-CT using sub-10 micron pixel direct conversion X-ray detectors

This talk will describe the development of a phase contrast nano-CT with sub-micron spatial resolution that was directly enabled by a previously reported in-house developed direct conversion 8-um pixel X-ray detector. The nano-CT enables phase contrast imaging that enhances visualization of structures at the nano scale that are traditionally transparent to X-rays. The nano-CT opens up new applications for biomedical research, materials science, electronics, and non-destructive testing where the system excels in detailed 3D visualization of fine structures across multiple disciplines.

Mustafa Yavuz

Director
Graduate Nanotechnology Program
Professor
Department of Electrical and Computer Engineering

The Nano and Micro Systems Lab (NMSL) at the University of Waterloo, led by Dr. Mustafa Yavuz, is advancing metal–insulator–metal (MIM) terahertz (THz) tunneling diode technology through the innovative use of defective functional materials. Building on Dr. Yavuz's extensive research in nanoscale manufacturing, PECOD and NEMS sensors, quantum and plasmonic devices, and high-frequency electronics, the group is redefining how intrinsic material defects can be engineered as performance-enhancing features rather than limitations. Recent NMSL work demonstrates that controlled defect states in ultrathin oxides and 2D materials can significantly improve tunneling efficiency, device nonlinearity, and THz response—capabilities that are increasingly critical for AI hardware acceleration, next-generation chemical/biological sensing platforms, and compact THz communication systems. These advances position MIM-THz tunneling diodes as foundational components for future intelligent, fast, and resilient microsystems. Through collaboration with colleagues at Tohoku University, the Waterloo team aims to unify materials innovation, atomic-scale device engineering, and system-level integration. Together, the research groups seek to push forward new architectures for AI-driven sensor networks, quantum-inspired NEMS/THz devices, and multifunctional microsystems that can operate reliably in extreme environments and high-frequency domains.

University of Waterloo Presenters

Evelyn Yim

Canada Research Chair in Nanomaterials for Regenerative Medicine (Tier 1)
Professor
Department of Chemical Engineering

Biomaterials nanotopography for regenerative medicine applications

Biological cell niche comprises of biochemical and biophysical signals. An ideal scaffold for tissue engineering application should mimic the microenvironment and present the appropriate biochemical and biophysical cues such as topographies and rigidity to regulate cellular responses. Our research group is interested in studying the interfacial interactions of cells with the extracellular substrate and how to apply this knowledge to stem cell differentiation and tissue engineering applications. We are also interested to explore application of novel materials for tissue engineering applications. In this presentation, nanotopography-modulation on cell behaviors for applications in small diameter vascular grafts and corneal tissue engineering will be presented as examples of applying nanotopography in regenerative medicine applications.

XiaoYu Wu

Associate Professor
Department of Mechanical and Mechatronics Engineering

Functional Oxide materials as proton conductors and memristors

My research group fabricates functional oxide membranes and studies the transport mechanisms of charged species in perovskite oxide materials for applications such as fuel cells and memristors. Because the conductivities of these oxide materials can be controlled by the oxygen vacancy concentration inside the lattice, their conductance states can be continuously tunable and non-volatile. This enables the use of oxide materials in applications such as memristors towards in-memory or neuromorphic computing. Yet the sensitivity of perovskite materials to moisture, oxygen and thermal environmental may cause material- and device-degradation.