21ST CANADIAN SEMICONDUCTOR SCIENCE AND TECHNOLOGY CONFERENCE

August 25–27, 2026 | University of Ottawa

Conference Proceedings

CSSTC 2026

csstc2026.uottawa.ca



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Welcome! Bienvenue!

Dear participants,

We were delighted to welcome 232 participants from across Canada and abroad to the 21st Canadian Semiconductor Science and Technology Conference (CSSTC). This strong participation was complemented by an exceptional level of engagement from our community, with 27 sponsors, including 15 exhibitors, contributing to the success of this year's conference. The program featured 77 posters and 72 oral presentations, including 2 keynote presentations, 3 plenary talks, and 20 invited presentations. It also included 2 tutorials and 1 panel discussion. The conference sessions covered a wide range of topics, such as epitaxy, materials, characterization, electronics, sensors, solar energy, photonics, micro-electromechanical systems, low dimension, quantum, nano, organic semiconductors, and additive manufacturing.

CSSTC began in 1982, when the first meeting in this biennial series, then known as the Canadian Semiconductor Technology Conference (CSTC), was organized in Ottawa by the National Research Council Canada (NRC). NRC was the main organizer and sponsor for CSTC until 2005. Since then, the event has been held in various locations across Canada.

We were pleased to welcome the conference back to Ottawa this year and grateful for the renewed support of the NRC.

This year's host, the University of Ottawa, is located in the heart of Canada's capital. With more than 50,000 students, 12,000 professors, researchers and staff, 300,000 alumni, and over 550 programs in 10 faculties, it is the world's largest bilingual university. It also ranks among Canada's top five universities for research intensity and plays a key economic role in the National Capital Region.

We hope you enjoyed an inspiring conference filled with stimulating scientific discussions, meaningful networking opportunities, and new discoveries.

Chères participantes, chers participants,

C'est avec grand plaisir que nous avons accueilli 232 personnes provenant de partout au Canada et de l'étranger au 21e Congrès canadien sur la science et la technologie des semi-conducteurs (CSSTC). Cette forte participation s'est accompagnée d'un engagement exceptionnel de notre communauté, avec 27 commanditaires dont 15 exposants qui ont contribué au succès du congrès de cette année. Le programme a compris 77 affiches et 72 présentations orales, dont 2 conférences d'honneur, 3 conférences plénières et 20 présentations invitées, ainsi que 2 tutoriels et 1 table ronde. Les séances du congrès ont porté sur un large éventail de sujets, notamment l'épitaxie, les matériaux, la caractérisation, l'électronique, les capteurs, l'énergie solaire, la photonique, les microsystèmes électromécaniques, les semi-conducteurs de basse dimension, quantiques, nanométriques et organiques, ainsi que la fabrication additive.

CSSTC a vu le jour en 1982, lorsque la première rencontre de cette série biennale, alors connue sous le nom de Canadian Semiconductor Technology Conference (CSTC), a été organisée à Ottawa par le Conseil national de recherches du Canada (CNRC). Le CNRC a été le principal organisateur et commanditaire de la CSTC jusqu'en 2005. Depuis, l'événement a eu lieu dans diverses villes du Canada.

Nous avons été heureux d'accueillir de nouveau le congrès à Ottawa cette année et reconnaissants du soutien renouvelé du CNRC.

L'hôte de cette année, l'Université d'Ottawa, est située au cœur de la capitale du Canada. Avec plus de 50 000 étudiantes et étudiants, 12 000 professeures et professeurs, chercheuses, chercheurs et membres du personnel, 300 000 diplômées et diplômés, ainsi que plus de 550 programmes répartis dans 10 facultés, elle est la plus grande université bilingue au monde. Elle figure également parmi les cinq universités canadiennes les plus intensives en recherche et joue

Karin Hinzer
CSSTC 2026 Conference Chair
CSSTC Advisory Board Chair

Boris Lamontagne
CSSTC 2026 Program Chair

Ottawa, September 29, 2026

un rôle économique clé dans la région de la capitale nationale.

Nous espérons que vous avez profité d'un congrès inspirant, riche en discussions scientifiques stimulantes, en occasions de réseautage enrichissantes et en nouvelles découvertes.

Karin Hinzer
Présidente du congrès CSSTC 2026
Présidente du comité consultatif du CSSTC

Boris Lamontagne
Président du comité de programme de CSSTC 2026

Ottawa, le 29 septembre 2026

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Exhibit

The exhibit took place on Tuesday, August 25, and Wednesday, August 26, from 10 a.m. to 6 p.m. Exhibitors were:

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GENTEC GENSTAR TECHNOLOGIES

Optiwave

VPC VACUUM PRODUCTS CANADA absolute solutions solutions absolues

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Awards Recipients

Best Poster Awards

Axonal Networks Best Poster Award: **Rubaya Absar**, University of Waterloo, “Impact of Control Pulse Distortions on Spin Qubit Performance in Silicon Quantum Dot Systems”

Axonal Networks Best Poster Award: **Romain Marcelino**, Polytechnique Montréal, “Edge-Dependent Raman Response of Hyperbolic Phonon Polaritons In GaSe”

Oxford Instruments Best Poster Award: **Javed Iqbal**, Institut national de la recherche scientifique, “Trap-State Dynamics in Epitaxial GaN Quantum Defects Grown by PAMBE”

Best Oral Presentation Awards

C2MI Best Oral Presentation Award: **Shiva Ashoori**, Carleton University, “Novel Organic Electrolyte-Gated Field Effect Transistors with Polycaprolactone”

C2MI Best Oral Presentation Award: **Olivier Romain**, Université de Sherbrooke, “Spin Qubit Measurement Using Multimode RF Reflectometry”

Oxford Instruments Best Oral Presentation Award: **Jasleen Kaur Jagde**, Dalhousie University, “Strain-Induced Quantum Emission in Monolayer WSe_2 Deposited onto InP Nanowires”

Award Sponsors

Keynote Presentations

Teledyne Evolution: From Sensing to Decision Support

Stephane Martel (Keynote)

Teledyne MEMS (Canada)

Abstract: Teledyne MEMS, operating the two largest semiconductor fabs in Canada, will be presenting its most recent activities in the development and commercialization of a variety of sensors in a wide range of applications. Mr. Martel will be covering both the internal imaging sensors development where Teledyne is fully vertically integrated and the MEMS foundry activities where Teledyne acts as a pure play MEMS foundry. We will review some specific applications in different markets such as deep space exploration, healthcare, AI infrastructures and industrial inspections.

Bio: Stephane Martel received the B. Eng. degree in Electrical Engineering from Sherbrooke University in 1997 and the M.A.Sc. degree in Physical Engineering from Montreal's Ecole Polytechnique in 1999. Mr. Martel joined Teledyne DALSA Semiconductor (TDS) foundry in 1998 as a Process Integration engineer and led multiple R&D projects for TDS. In 2003, Mr. Martel was promoted to the position of Manager of the Process Integration group supervising the foundry process development work. In 2012, Mr. Martel was appointed as Director of the Project Management Office (PMO), in charge of New Technology and New Product Introduction (NTI & NPI processes) for the MEMS foundry. In 2023 the Product Engineering and Test & Inspection groups were added to his scope, as well as the responsibility to manage the internal to Teledyne business. In 2026, he was appointed as the Vice-President of R&D and Strategic Partnerships for Teledyne MEMS. In this position, he manages a large portfolio of external development projects as well as long-term R&D projects for Teledyne MEMS involving collaboration with universities and research institutes.

From Scientific Excellence to Strategic Impact: Evolving Research Infrastructure to Strengthen Canadian Innovation

Mohamad Nasser-Eddine (Keynote)

Canada Foundation for Innovation (Canada)

Abstract: In an era defined by intensifying global competition, shifting strategic supply chains, and the rapid emergence of new technologies, research infrastructure is playing an increasingly critical role in Canada's economic prosperity and technological sovereignty. This presentation will explore the evolving role of the Canada Foundation for Innovation (CFI) through its renewed vision and the priorities outlined in its recently updated strategic plan. Beyond funding leading-edge equipment and facilities, the CFI is focused on maximizing the impact of public investments by enabling broader and more equitable access to research infrastructure, strengthening alignment with the Government of Canada's strategic priorities, and accelerating benefits for society and the economy. The presentation will highlight new approaches aimed at democratizing access to advanced technology platforms and specialized facilities, particularly for researchers, emerging institutions, industry partners, and regional innovation ecosystems. It will also examine the growing role of research infrastructure in supporting strategic sectors such as semiconductors, quantum technologies, artificial intelligence, clean technologies, life sciences, and advanced manufacturing. Drawing on the recent directions associated with the Innovation Fund 2027 (IF2027), this presentation will discuss how infrastructure investments can simultaneously support scientific excellence, industrial competitiveness, highly qualified talent development, and the generation of lasting socioeconomic benefits for Canadians. Finally, it will offer a perspective on how Canada's research infrastructure model can continue to evolve to address the scientific, economic, and geopolitical challenges of the coming decades.

Bio: As the CFI's Vice President of Programs and Planning, Mohamad Nasser-Eddine leads the strategic design and delivery of national research infrastructure investments that enable world-class science and innovation across Canada.

With more than 26 years of experience spanning academia, government and funding organizations, he now operates at the intersection of science, policy and leadership. He actively influences and advances the CFI's mandate, guiding the evolution of Canada's research and innovation ecosystem, while also driving measurable economic and societal impact to make that ecosystem a strong and sustainable one.

Internationally, he represents Canada as an ad hoc expert to the European Strategy Forum on Research Infrastructures, including its Strategy Working Group on Environment, where he

contributes to advancing global collaboration and sustainability priorities in research infrastructure.

Throughout his career, Mohamad Nasser-Eddine has led transformative initiatives to enhance the impact of large-scale research investments, promote inclusive access to cutting-edge facilities, and advance responsible approaches to research assessment. He is particularly committed to fostering the next generation of talent, emphasizing the development of "T-shaped" skills that combine deep expertise with interdisciplinary capacity.

He holds a PhD in chemistry and an executive MBA in technology management and began his career as a research scientist specializing in drug delivery systems.

Plenary Presentations

Advances in Semiconductors and Heterogeneous Integration for Computing, Photonics and Quantum Technologies

Emmanuel Ollier (Plenary)

CEA-Leti (France)

Abstract: The push toward sub-2nm transistor nodes and innovative device architectures is essential to meet the performance demands in the AI era. Yet, this alone is no longer sufficient. The soaring computational needs of cloud servers and edge-AI call for groundbreaking architectures that drastically cut data movement, latency, and power consumption. These new architectures are made possible by major advances in semiconductors as well as advanced packaging and heterogeneous integration, technologies that have become pivotal in semiconductor ecosystems.

This presentation will show how CEA-Leti drives innovation in semiconductor technologies as well as advanced packaging, in particular in quantum, photonics and advanced packaging. It will highlight recent advances in spin and superconducting based quantum technologies, sensor and display areas and how heterogenous systems are build thanks to high density electrical and optical interconnects.

Bio: Dr. Emmanuel Ollier is EU Program Manager at CEA-Leti's Semiconductor Components Division. Previously, he led the Laboratory of 3D Integration and Advanced Packaging Technologies at CEA-Leti. With 17 years of experience in the semiconductor industry (including roles at Thales, Atmel, NXP, EM Microelectronics) he holds 22 patents and has authored 45 papers and international conference presentations.

Dr. Ollier earned a PhD in Material Sciences and an Engineering Degree from the French National School of Physics and Chemistry of Bordeaux. His expertise focuses on the heterogeneous integration of semiconductor and photonic technologies, with applications spanning High-Performance Computing, Edge-AI, RF communications, smart sensors and displays, and power electronics.

Co-packaged Optics and Optical Interposers for AI Infrastructure

Joyce Poon (Plenary)

University of Toronto (Canada)

Abstract: Optical interconnects are being actively developed for AI datacenter and compute networking. I will review the approaches and compare the various architectures to highlight the component and circuit-level challenges and opportunities.

Advanced Photonics for Coherent Optical Communications

Kelvin Prosyk (Plenary)

Ciena (Canada)

Abstract: Moore's Law has driven advances in computing for decades. Less widely known, Keck's Law describes the exponential growth of communications capacity spanning nearly 200 years, beginning with the oscillating needle telegraph of the mid-19th century. By the late 1990s, capacity growth in optical networks appeared to be slowing despite advances in dense wavelength-division multiplexing. The introduction of coherent optical communications in the 2000s reignited this growth trajectory. This presentation reviews the principles of coherent transmission and the key photonic technologies that enable continued increases in network capacity and spectral efficiency.

Bio: Dr. Kelvin Prosyk is Director of Photonic Integrated Circuits at Ciena in Ottawa, Canada. He previously served as R&D Director at Teraxion and was a founding employee of Cogo Optronics. He received his Ph.D. in Engineering Physics from McMaster University in 1998 and is an inventor on more than 30 patents and author of 14 papers and conference presentations. His work focuses on the development and large-scale manufacturing of advanced photonic devices for optical communications.

Invited Presentations

Printable Organic Photovoltaics for Lightweight Flexible Power: Materials, Interfaces, and Scalable Manufacturing

Salima Alem (Invited)

National Research Council Canada (Canada)

Abstract: Solution processable organic photovoltaics continue to advance as a promising platform for lightweight, flexible energy harvesting. This talk will present recent progress in the field, including developments from the National Research Council of Canada. It will highlight advances in donor-acceptor materials for solution processing, morphology control, and charge-selective interfaces that improve cell efficiency and stability. Results from roll-to-roll compatible coating of active and interfacial layers will be discussed, along with challenges in drying dynamics, defect control, and reproducible large-area cell fabrication.

Beyond Linear Limits: Nonlinear Architectures for High-Performance Inertial Sensors

Behraad Bahreyni (Invited)

Simon Fraser University (Canada)

Abstract: Accelerometers are critical components in a wide range of applications, from navigation and structural health monitoring to consumer electronics and space exploration. As demand for more precise, reliable, and energy-efficient motion sensing grows, accelerometer design is entering a new era of complexity and innovation. This talk surveys the evolving landscape of high-performance accelerometers, focusing on the device architectures and interface-level decisions that define their operational boundaries.

We begin by outlining the performance requirements of accelerometers, including noise, sensitivity, bandwidth, dynamic range, and cross-axis sensitivity. A comparison of key interfacing mechanisms, capacitive, optical, and resonance, is then presented, highlighting their impact on sensitivity enhancement and system-level integration. The talk explores both linear and nonlinear approaches to performance improvement, including curved-beam and buckled-beam springs, and their responses. Novel concepts, such as capacitive pseudo-differential architectures and boundary-condition modification strategies, are examined to improve performance within a given manufacturing process.

We conclude with a forward-looking discussion on design challenges and opportunities, outlining potential directions in sensor interface integration, adaptive nonlinearity, and hybrid architectures that are being developed for the next generation of high-performance accelerometers.

Bio: Dr Behraad Bahreyni, SMIEEE, PEng, is a professor and the Director of the Intelligent Sensing Laboratory at Simon Fraser University, BC, Canada. He received his BSc from Sharif University of Technology, Iran, and MSc and PhD degrees in electrical engineering from the University of Manitoba, Canada, in 1999, 2001, and 2006, respectively. He was a post-doctoral researcher with the NanoScience Centre at Cambridge University, UK, where he researched interface circuit design for microresonators. He joined SFU in 2008 after a one-year tenure in the industry as a senior MEMS design engineer. In 2016, he was with NXP Semiconductors, the Netherlands, developing advanced signal processing methods for sensing. His research activities focus on the design and fabrication of micro- and nano-sensors for applications in consumer electronics, mining, automotive, and space exploration. Dr Bahreyni has supervised the work of more than 60 postgraduate researchers and contributed to more than 180 technical publications.

Freestanding Semiconductor Membranes for Optoelectronics

Abderraouf Boucherif (Invited)

Université de Sherbrooke (Canada)

Abstract: Freestanding semiconductor membranes (FSMs) have recently emerged as a highly promising platform for next-generation optoelectronic and photovoltaic technologies. In this contribution, I will review recent advances in FSM technologies, with emphasis on their potential for lightweight, flexible, and stackable device architectures, as well as their capacity to enable the heterogeneous integration of high-performance III–V materials with silicon-based platforms. Various approaches for membrane fabrication, epitaxial lift-off, and integration will be discussed, highlighting their respective advantages, limitations, and prospects for scalability.

In this context, I will present recent progress achieved by our team through the development of the Porous Germanium Efficient Epitaxial LayEr Release (PEELER) process. Using a nanoengineered porous germanium layer, a freestanding monocrystalline Ge nanomembrane with sub-nanometer surface roughness (≤1 nm) and high crystalline quality has been realized at the wafer scale. This membrane platform is fully compatible with subsequent III–V epitaxy, enabling high-performance GaAs solar cell. A key advantage of this approach is the demonstrated ability to recondition and reuse the parent Ge wafer over multiple growth and release cycles, substantially reducing material consumption and enabling a more sustainable semiconductor manufacturing pathway. As a proof of concept, a photovoltaic device was fabricated on a released Ge membrane, confirming device-grade performance and demonstrating the practical viability of this platform.

Another approach that will be reviewed and discussed is Anchor Point Nucleation (APN), a graphene-enabled epitaxial strategy developed to overcome fundamental limitations of remote epitaxy. By introducing controlled defects into the graphene layer—such as dangling bonds and nanoholes—preferential nucleation sites are generated, enabling the growth of high-quality single-crystalline semiconductor layers. Unlike conventional remote epitaxy, APN enables the epitaxial growth of both polar and non-polar materials on graphene-coated substrates. Structural analyses have demonstrated the formation of defect-free, stress-free monocrystalline layers aligned with the underlying substrate, establishing APN as a versatile route toward universal 3D/2D heterointegration.

Overall, this work will provide a comprehensive perspective on emerging strategies for FSM fabrication and heteroepitaxy, positioning PEELER and APN as complementary and promising routes toward scalable, sustainable, and high-performance semiconductor platforms for advanced optoelectronic applications.

Photon-to-Digital Converter for Photon Counting Applications: Fabrication, Performances and Perspectives

Serge Charlebois (Invited)

Université de Sherbrooke (Canada)

Abstract: Photon counting applications are rapidly expanding in fields requiring precise timing under very low light conditions. We report on the design, fabrication, and characterization of a Photon to Digital Converter (PDC), a detector on a 3D integrated array of Single Photon Avalanche Diodes (SPADs) individually read out by embedded CMOS electronics. The detector exhibits low dark count rates, high detection efficiency, and a single photon timing resolution below 200 ps. Current performances will be presented, along with perspectives for improved sensitivity in the UV, infrared, and short wave infrared domains for next generation devices.

Ultrafast Light-Induced Phase Transitions in Polar Semiconductors Seen by THz Spectroscopy

David Cooke (Invited)

McGill University (Canada)

Abstract: Ultrabroadband time-resolved THz spectroscopy reveals light-induced phase changes and carrier localization in two polar materials. In CeO_2, UV photoexcitation creates mobile hole polarons ($\mu \approx 100$ cm²/Vs) alongside self-localized Ce 4f electron polarons, with phonon oscillator strength and frequency shifts serving as direct spectroscopic fingerprints of $Ce^{4+} \rightarrow Ce^{3+}$ conversion via Born effective charge reduction. In SnSe, fluence-dependent THz conductivity reveals a non-thermal Pnma→Immm phase nucleation above 3 mJ/cm², evidenced by carrier localization, phonon narrowing, and a new 3 THz mode confirmed by constrained DFT calculations.

Bio: David G. Cooke is a professor of Physics at McGill University and an experimental condensed matter physicist. He received his Ph. D. in Physics in 2006 from the University of Alberta in the Hegmann group and was a H. C. Ørsteds postdoc in the Jepsen group at the Technical University of Denmark (DTU) from 2007-2008. He became associate professor at DTU in 2010 and in 2011 moved to Montreal to join McGill. He has published more than 80 journal articles and conference proceedings, given > 50 invited talks and has been cited > 7500 times. Cooke has served as associate editor of Optics Express and IEEE Transactions in THz Science, and was the general chair of 2023 IRMMW-THz. In 2018 he was awarded a Fessenden Professorship. Cooke's lab studies ultrafast phenomena in novel energy harvesting materials. He is a world expert on time-resolved THz spectroscopy and his lab is working to develop new methods to probe quantum dynamics at the atomic scale with femtosecond resolution.

Infineon GaN Technology & Reliability

Kai Ha (Invited)

Infineon (Canada)

Abstract: Gallium Nitride (GaN) power semiconductors are transforming modern power electronics by enabling higher efficiency, increased power density, and faster switching performance compared with conventional silicon-based technologies. As GaN devices continue to expand into applications such as AI data centers, high-efficient power supplies for GPU, electric mobility, and industrial power conversion, long-term reliability has become a critical factor for widespread adoption.

Unlike traditional silicon power devices, GaN devices operate under unique electrical and thermal stress conditions, introducing new reliability challenges that require dedicated qualification methodologies and a deeper understanding of device and package degradation mechanisms. Ensuring robust reliability is essential not only for product qualification but also for customer confidence and successful deployment in demanding field applications.

This presentation provides an overview of Infineon's CoolGaN technology and discusses the key reliability considerations for GaN power devices. Topics include technology reliability, switching reliability, product qualification strategies, package reliability, and reliability validation across diverse market applications. The presentation will also highlight how comprehensive reliability engineering enables the commercialization of GaN technology and supports its adoption in next-generation power electronics.

Beyond discussing qualification results, this presentation aims to illustrate how reliability engineering bridges innovative GaN technology with real-world deployment, enabling the next generation of efficient and sustainable power electronics.

Bio: Kai Ha is a Senior Manager in GaN Device Development at Infineon Canada, where he leads the reliability team for new process assessment and product reliability studies. With over 10 years of experience in the silicon and GaN industries, Kai specializes in product qualification, reliability engineering, and lifetime modeling. At this conference, he will present insights on Infineon's CoolGaN technology, covering qualification strategies, device & package reliability.

Advancing 2D TMD Quality Through Atomic-Scale Defect Characterization and Control

Madisen Holbrook (Invited)

Université de Montréal (Canada)

Abstract: Two-dimensional transition-metal dichalcogenides have emerged as promising semiconductors for next-generation electronic and optoelectronic technologies. However, their atomically thin nature makes their properties highly sensitive to defects, which can dominate device performance. Despite extensive research, the nature of these defects remains uncertain. In this talk, I will present our approach to identifying and controlling defects in high-quality TMDs using scanning tunneling microscopy, and show how establishing the atomic-scale origin of defects enables improved materials optimization and control of electronic and optical behavior.

Ultra-Thin Silicon Ribbons by Melt Spinning for Sustainable Semiconductor Manufacturing

Ghassan Jabbour (Invited)

University of Ottawa (Canada)

Abstract: The future of semiconductor manufacturing will necessitate not only the development of smaller and more powerful devices but also the implementation of cleaner, faster, and more resource-efficient methods for processing foundational materials. Silicon continues to serve as the predominant material for electronics, photovoltaics, Micro-Electro-Mechanical Systems (MEMS), and sensors. However, the production of ultrathin silicon typically relies on processes such as wafer slicing, thinning, polishing, bonding, or etching, which consume significant amounts of materials, energy, and time. This presentation introduces an innovative direct meltspinning technique that transforms molten silicon into freestanding ultrathin polycrystalline ribbons through a single, rapid solidification process.

Utilizing induction heating, a specially designed graphite crucible, argon atmosphere processing, and a rotating copper wheel, silicon ribbons approximately 1 cm x 5 cm in size and about 20 µm in thickness were produced without the need for a carrier substrate or sacrificial release layer. The research demonstrates how variables such as wheel speed, melt spreading, wetting behavior, and quench rate influence whether silicon forms continuous ribbons, fragmented layers, or fibrous structures. Comprehensive characterization confirms that the material comprises polycrystalline diamond-cubic silicon with micron-scale grains, twin boundaries, limited surface oxidation, measurable semiconducting transport properties, and compatibility with subsequent micro/nano fabrication procedures.

This methodology presents a promising materials-processing pathway toward lowwaste, lightweight silicon platforms suitable for photovoltaics, MEMS, sensors, ultrathin membranes, and advanced semiconductor manufacturing. More broadly, it redefines silicon processing from a subtractive wafer-thinning paradigm to a directforming strategy, promoting sustainable semiconductor substrate development.

Bio: Ghassan E. Jabbour is a Full Professor in the School of Electrical Engineering and Computer Science at the University of Ottawa, where he holds a 2nd term Tier 1 Canada Research Chair in Advanced Materials and Devices. He is Director of the CFI-funded Center for Hybrid Interfaces and Intelligent Thin Films (HIIT) and leads the NSERC CREATE program QuantM-MALL.

Professor Jabbour is the inventor of ultrathin printed organic semiconductor devices, and reactive printing for the in-situ self-assembly of nano- and quantum materials, a field he pioneered through printing-based approaches to functional materials and devices. His research has advanced flexible and rugged electronics, photonics, smart textiles, and low-cost semiconductor and optoelectronic manufacturing. His work has appeared on the covers of leading journals, including six covers of

Advanced Materials, and has received two Best Poster Awards from the U.S. National Academy of Engineering. He was also the only academic invited to address U.S. congressional staff on Capitol Hill on low-cost fabrication of light-emitting devices.

His distinctions include Fellowships of SPIE and the European Optical Society, and the title of Distinguished Professor of the Academy of Finland. An internationally recognized leader who has driven innovation through massive research funding, strategic industry partnerships, and academic mentorship. Over the course of his career, he has led research centers and initiatives that secured more than $780 million in funding and built over 112 industrial collaborations. He has delivered more than 670 plenary, keynote, and invited talks worldwide. Committed to developing the next generation of talent, he has supervised over 300 students and highly qualified personnel, placing graduates into career-defining roles at global semiconductor market leaders including Intel, ASML, and Samsung.

Perovskite Heterostructures: From Crystal Engineering to Device Applications

Ghada Koleilat (Invited)

Dalhousie University (Canada)

Abstract: Metal halide perovskites have emerged as a versatile class of solution-processable semiconductors with exceptional optoelectronic properties and broad application potential. A major challenge remains the precise control of crystal growth, dimensionality, and interfacial chemistry to tailor their structural and electronic properties. This presentation will highlight our group's research on engineering perovskite heterostructures through solution processing, with an emphasis on controlling crystallization pathways to direct semiconductor architecture. I will discuss how solution shearing, solvent engineering, additive engineering, and post-deposition chemical treatments are used to tailor film formation, engineer vertically aligned low-dimensional heterostructures within three-dimensional perovskite matrices, and improve charge transport and environmental stability. The presentation will further demonstrate how advanced structural characterization, including synchrotron grazing-incidence wide-angle X-ray scattering, provides insight into processing-structure-property relationships that guide materials design. These principles are broadly applicable to the development of next-generation semiconductor materials for photovoltaic and optoelectronic devices.

Bio: Dr. Ghada Koleilat is an Associate Professor in the Department of Process Engineering and Applied Science at Dalhousie University and holds the Canada Research Chair in Advanced Semiconductor Materials and Architectures. Her research focuses on the design and solution processing of semiconductor materials, with an emphasis on crystallization engineering, semiconductor heterostructures, and advanced characterization. Her group develops solutionprocessed materials for next-generation energy and optoelectronic devices by establishing fundamental processing-structure-property relationships.

Semiconductor nanowires: Energy, photonic and quantum applications

Ray LaPierre (Invited)

McMaster University (Canada)

Abstract: Semiconductor nanowires represent the next generation of photonic, electronic and optoelectronic devices such as quantum emitters, photodetectors, photovoltaics, betavoltaics and thermoelectrics. Nanowires are one-dimensional semiconductor crystals, standing vertically on a substrate. The self-assisted vapor-liquid-solid method is now a well-established technique for the growth of group III-V compound semiconductor nanowires on silicon substrates. In this method, an array of holes in a SiO_2 film on silicon is used for metal droplet formation, which seeds the growth of vertically oriented nanowires within a periodic array. The free lateral surfaces of nanowires allow elastic relaxation of lattice misfit strain without the generation of dislocations, permitting unique heterostructures and the direct integration of III-V materials with silicon. By modulating the diameter of the nanowires along their length and controlling crystal phase boundaries, it is possible to control phonon scattering for more efficient thermoelectric devices, create distributed Bragg mirrors, and enable crystal phase quantum dots.

Bio: Ray LaPierre is a Professor in the Engineering Physics Department at McMaster University. He obtained a B.Sc. degree in Physics with Honors at Dalhousie University, and an M.Eng. degree and Ph.D. degree in the Engineering Physics Department at McMaster University. His graduate work involved development of molecular beam epitaxy of compound semiconductor alloys for laser diodes in telecom applications. He worked at JDS Uniphase from 1997-2004 where he developed dielectric coatings for wavelength division multiplexing devices. In 2004, he rejoined McMaster University and is currently a full Professor in the Engineering Physics Department. His research interests are focused on group III-V compound semiconductor epitaxy, nanowires, and applications in optoelectronics. He has over 160 publications, 73 invited presentations, and 206 conference presentations related to semiconductor nanowire growth, characterization, and device fabrication. He is a Board Member of the journals Nano Express and Nanotechnology, a Fellow of the Canadian Academy of Engineering, and a member of Professional Engineers Ontario.

Photonics at Peak Performance: High Figure-of-Merit Integrated Photonics for Next-Generation Computing

Di Liang (Invited)
University of Michigan (United States of America)

The Phase Change Material (PCM) Technology and Its Applications to Microwave and Millimeter-Wave Reconfigurable Devices

Raafat Mansour (Invited)

University of Waterloo (Canada)

Abstract: Microwave and Millimeter-wave switches are key components in communication systems. They are used for signal routing and for realizing a wide range of reconfigurable microwave and millimeter-wave devices. The Phase Change Materials (PCM) technology has been widely used in optical storage media and non-volatile memory device applications. Over the past recent years, there have been interests in exploiting the PCM materials such as germanium telluride (GeTe) and metal insulator transition materials such as vanadium oxides (VO_2) for RF applications. The principle of operation of PCM devices is based on the ability of the material to transform from a high-resistivity state (amorphous phase) to a low-resistivity state (crystalline phase) and vice versa with the application of short duration pulses. Several orders of magnitude in resistivity change can be achieved by PCM technology allowing the realization of highly miniature microwave and millimeter-wave switches. In addition to miniaturization, GeTe based switches offer latching functionality and ease of monolithic integration with other RF circuits.

This talk will address recent developments in PCM switches and their applications to the realization of switch matrices, phase shifters, variable attenuators, reconfigurable filters and reflective intelligent surfaces (RISs). It will also address how the PCM technology enables the development of reconfigurable acoustic filters that are widely used in mobile applications. In addition, the talk will outline the performance of PCM switches at cryogenic temperatures and their potential for time-multiplexers in quantum computing applications.

Bio: Raafat Mansour is a Professor of Electrical and Computer Engineering at the University of Waterloo and currently holds a University Research Chair. He held Tier 1- Canada Research Chair (CRC) in Micro-Nano Integrated RF Systems for two terms (2010-2024) and NSERC Industrial Research Chair (IRC) from 2001-2010. Prior to joining the University of Waterloo in January 2000, Dr. Mansour was with COM DEV Cambridge, Ontario, over the period 1986-1999, where he held various technical and management positions in COM DEV's Corporate R&D Department. Professor Mansour holds 47 US and Canadian patents and more than 450 refereed IEEE publications to his credit. He is a co-author of a 23-chapter Book published by Wiley and has contributed 7 chapters to five other books. Professor Mansour founded the Centre for Integrated RF Engineering (CIRFE) at the University of Waterloo https://uwaterloo.ca/centre-integrated-rf-engineering/. It houses a clean room and a state-of-the-art RF test and characterization laboratory. Professor Mansour is a Fellow of the IEEE, a Fellow of the Canadian Academy of Engineering (CAE), a Fellow of the Engineering Institute of Canada (EIC). He was the recipient of the 2014

Professional Engineers Ontario (PEO) Engineering Medal for Research and Development and the 2019 IEEE Canada A.G.L. McNaughton Gold Medal Award.

The Infinite Possibilities of the Infinitely Small: From MEMS Devices to Integrated Microsystems

Frédéric Nabki (Invited)

École de technologie supérieure (Canada)

Abstract: Microelectromechanical systems (MEMS) extend microelectronics by enabling miniature devices to sense and actuate in the physical world. The transition from individual MEMS components to integrated microsystems is examined through selected research examples that illustrate the field's breadth and potential. Emphasis is placed on how the co-design of materials, fabrication processes, devices, electronics, and system architectures can enable compact, energy-efficient, and high-performance solutions for emerging applications, while addressing key challenges in heterogeneous integration and system-level design.

Bio: Frederic Nabki is a Professor in the Department of Electrical Engineering at École de technologie supérieure (ÉTS). He received the B.Eng. (Hons.) and Ph.D. degrees in electrical engineering from McGill University in 2003 and 2010. His research spans MEMS, analog/RF and mixed-signal integrated circuits, sensor interfaces, heterogeneous microsystem integration, and ultra-wideband transceivers. He jointly manages the Microtechnology and Microsystems Laboratory at ÉTS, is a member of the LACIME laboratory, and has co-authored more than 200 scientific publications, two book chapters, and numerous patents. His distinctions include the Governor General of Canada's Academic Bronze Medal, the ÉTS Board of Directors Research Award, and the IEEE Canada J. J. Archambault Merit Award.

Enhancing Emission Properties of Nanowire Quantum Dots through Hybrid Integration

David Northeast (Invited)
National Research Council Canada (Canada)

Integrated Photonics with Opto Mechanical Phase Tuning for Optical Satellite Communication Payloads

Jayshri Sabarinathan (Invited)

Western University (Canada)

Abstract: Optical satellite communication systems require photonic technologies that reduce size, weight, power, and complexity while maintaining high performance. This talk reviews our work on integrated photonic devices, including opto-mechanical phase tuners and optical phased arrays for low-power optical control and reconfigurability. Recent results in radiation testing and qualification of photonic integrated circuits for space applications will be discussed. These developments are extended to spaceborne implementations through the Avocet Photonics Module, a CubeSat payload for in-orbit PIC qualification concluding with future opportunities toward space-qualified integrated photonics for classical and quantum optical communications.

Bio: Dr. Jayshri Sabarinathan is an Associate Professor in Electrical and Computer Engineering at Western University and a faculty member with the Institute for Earth and Space Exploration. She leads the PICSEL (Photonic Integrated Circuits for Space Exploration Lab) research group, developing optical imaging and communications payloads for space and airborne platforms. Her primary expertise is in novel nano-photonic sensors and miniature remote sensing optical instrumentation. She served as PI on the CSA-funded CubeSat mission Ukpik-1 (launched in 2023) and is currently PI for Western Skylark (launching in 2027). She leads a CSA Phase 0 study for a multispectral lunar rover camera and is co-founder of LightSail, a Western spin-off advancing photonic solutions for satellite communications.

Buried Heterostructure Lasers and SOAs for Advanced PIC

Omid Salehzadeh Einabad (Invited)

Canadian Photonics Fabrication Centre (Canada)

Abstract: We are reporting a novel in-situ MOCVD-based technique on the fabrication of buried heterostructure lasers and SOAs. In this technique, the mesa etch is immediately followed by the overgrowth of the blocking layers under H2 Ambient, eliminating the airborne contaminants, significantly improving the device reliability.

GaN on Silicon by Molecular Beam Epitaxy: Challenges and Opportunities

Fabrice Semond (Invited)

Centre national de la recherche scientifique (France).

Abstract: We present key results for high-frequency and high-voltage power electronics applications from III-Nitride heterostructures grown on Silicon by Molecular Beam Epitaxy. We also highlight the specific potential for photonic applications. III-N epitaxial growth on 200 mm silicon substrates is demonstrated. More recently, we explore emerging directions within this material platform, such as the epitaxial integration of III-N with superconducting materials like niobium nitride (NbN), enabling the epitaxial growth of hybrid heterostructures for quantum devices. We also discuss recent advances in polarity engineering for tailoring device functionalities.

Bio: Fabrice Semond is a Senior Research Director at the French National Centre for Scientific Research (CNRS) and a member of the Centre for Research on Hetero-Epitaxy and its Applications (CRHEA) in Sophia Antipolis, France. His research focuses on the molecular beam epitaxy (MBE) of wide-bandgap semiconductors, particularly III-nitride materials, and their integration on silicon for advanced electronic, photonic, and quantum devices. He has made major contributions to the development of GaN-based heterostructures, including HEMTs, quantum nanostructures, and more recently hybrid semiconductor/superconductor heterostructures based on epitaxial niobium nitride (NbN). He has coordinated numerous research projects, supervised many graduate students and postdoctoral researchers, and has authored more than 250 scientific publications and several patents in the field of semiconductor epitaxy.

CMOS and InGaAs/InP SPADs for Visible-SWIR Photon Counting

Alberto Tosi (Invited)

Politecnico di Milano (Italy)

Abstract: Single-Photon Avalanche Diode (SPAD) detectors constitute a fundamental enabling technology for photon-counting applications across a broad spectral range, spanning from the visible to the shortwave infrared (SWIR). Owing to their capability to detect and time-stamp individual photons with picosecond-scale temporal resolution, SPADs underpin a variety of advanced applications, including quantum communication systems, quantum LiDAR, non-line-of-sight imaging, computational and unconventional imaging modalities, as well as near-infrared spectroscopy. This work presents the design, fabrication, and experimental characterization of InGaAs/InP SPAD devices and CMOS-based SPAD arrays. The analysis addresses both the intrinsic performance of the photodetector and the associated front-end electronics required for optimal operation. Particular emphasis is placed on timing jitter, photon detection efficiency, and maximum count rate, highlighting the key advantages and current limitations of SPAD-based detection systems.

Bio: Alberto Tosi received the Master's degree in Electronics Engineering and the Ph.D. degree in Information Technology Engineering from the Politecnico di Milano, Milan, Italy, in 2001 and 2005, respectively. He has been Full Professor of Electronics with the Politecnico di Milano, Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB), since 2024. In 2004, he was a student with the IBM T. J. Watson Research Center, Yorktown Heights, NY, working on optical testing of CMOS circuits. He designs, develops and exploits silicon, InGaAs/InP and Ge-on-Si Single-Photon Avalanche Diodes (SPADs). He works on arrays of SPADs for 2D and 3D applications, and on timecorrelated single-photon counting electronics. He develops single-photon counting modules and time-to-digital converters for high-resolution high-throughput applications. He is co-founder of the start-up company PIONIRS s.r.l. (www.pionirs.com).

High-sensitivity avalanche photodiode detectors for the SWIR application

Xin Yi (Invited)

Heriot-Watt University (United Kingdom)

Abstract: Avalanche photodiodes (APDs) are highly sensitive semiconductor devices designed to detect light by converting incident photons into electrical signals with internal gain. Unlike standard photodiodes, APDs operate at high reverse bias, enabling impact ionisation, in which charge carriers (electrons and holes) gain sufficient energy to create additional carriers. This multiplication mechanism significantly enhances the device's sensitivity, making APDs suitable for low-light detection applications.

APDs can be broadly classified into two main operating modes: linear mode and Geiger mode, distinguished by their biasing conditions and signal response characteristics. In linear mode, the APD is biased just below its breakdown voltage, allowing controlled avalanche multiplication (M). However, the excess noise (F), due to the statistical nature of the multiplication process, degrades the single-to-noise ratio and limits the ultimate sensitivity of the detector. In recent years, antimony-containing avalanche materials lattice-matched to InP, GaSb, and InAs have been systematically studied, leading to a new generation of APDs operating at wavelengths beyond 1.2 µm and at room temperature. Alternative methods for reducing excess noise, such as valence-band engineering using bismuth, will also be discussed.

In contrast, Geiger-mode APDs, also called single-photon avalanche diodes (SPADs), are biased above the breakdown voltage, where a single photon can trigger a self-sustaining avalanche. This results in a large, uniform current output, effectively enabling single-photon detection. Silicon-based SPADs have achieved widespread success due to their high performance and low cost, however, the bandgap of silicon limits their use in the SWIR region. The first demonstration of planar design in germanium-on-silicon geometry in 2019 enabled a significant step-change in performance. Later, a commercial team demonstrated for the first time that silicon-based SWIR SPADs can operate at room temperature. Very recently, several Ge-on-Si SPAD arrays compatible with CMOS fabrication process have also been demonstrated. Ge-on-Si SPADs may challenge the leadership of InGaAs/InP technology, which is currently widely used in SWIR applications such as quantum communications and sensing. We will discuss recent developments in InGaAs/AlGaAsSb SPADs for room-temperature LiDAR.

Bio: Dr Xin Yi is an EPSRC Early Career Research Fellow and an Assistant Professor at Heriot-Watt University, Edinburgh, UK. He earned his PhD in 2020 from the University of Sheffield, where he developed antimony-containing avalanche photodiodes. He has authored >30 journal and conference papers, including in *Nature Photonics*, *Nature Communications*, and *Optica*. His research focuses on understanding impact ionisation and avalanche breakdown in different semiconductor materials and device structures, as well as on the development of SWIR avalanche photodiodes and single-photon avalanche diodes.

Surface-emitting Epitaxial Nanowire Photonic Crystal Ultraviolet Lasers

Songrui Zhao (Invited)

McGill University (Canada).

Abstract: Surface-emitting (SE) semiconductor lasers offer a number of advantages such as potentially excellent beam quality, high beam output power, and easy to scale up and integrate to fiber optics. Expanding the operational wavelength to the ultraviolet (UV) range will enable new applications in photon sensing, optical communication, amongst others. Nonetheless, the electrically injected SE UV lasers had remained unachievable. In this talk, I will discuss our development of electrically pumped SE UV lasers using epitaxial nanowire photonic crystals.

Bio: Songrui Zhao is an Associate Professor in the Department of Electrical and Computer Engineering and Associate Member in the Department of Physics at McGill University. His research interests include molecular beam epitaxy of III-nitride nanostructures and their applications to light emitting, light detection, and photocatalysis. He is the recipient of a number of awards, including the International Conference on MBE Young Investigator Award in 2018 (conferred every two years with one awardee), McGill Peter Silvester Research Award in 2019, the North American MBE Young Investigator Award in 2022 (conferred every year with one awardee), and IDW24 Best Paper Award in 2024.

Contributed Presentations

Multi-junction Edge-Emitting Laser Optimization via Genetic Algorithms

Jose E. Ruiz (1,2), C. Rodriguez (3), T. M. Diallo (3), M. S. Rouifed (3), M. J. Gour (1,2), G. Hamon (1,2)

(1) Institut Interdisciplinaire d′Innovation Technologique (3IT), Université de Sherbrooke (Canada); (2) Laboratoire Nanotechnologies Nanosystèmes (LN2)-IRL3463, CNRS, Université de Sherbrooke (Canada), INSA Lyon, École Centrale de Lyon, Université Grenoble Alpes (France); (3) Laser Components Canada, Inc. (Canada)

Abstract: Genetic Algorithms (GAs) are applied to optimize multi-junction edge-emitting lasers with 15 design variables, including layer thickness, doping, and alloy composition. Coupled with Harold, a photonic device simulator by Photon Design, the GA efficiently explores the design space without exhaustive computation. The optimized structure reduces operating voltage from 8.5 V to 6.3 V while slightly increasing output power (37.2 W to 37.7 W), demonstrating improved electrical efficiency and highlight AI as a powerful tool for semiconductor laser design.

Design of Novel Aperiodic Semiconductor Distributed Feedback Laser Gratings Using Neural Networks

D. Paige Wilson (1), M. Mohsin (2), M. Rahim (2), Y. Grinberg (3), K. Hinzer (1)

(1) SUNLAB, Nexus for Quantum Technologies Institute, University of Ottawa (Canada); (2) Quantum and Nanotechnologies Research Centre, National Research Council of Canada (Canada); (3) Digital Technologies Research Centre, National Research Council of Canada (Canada)

Abstract: As the demand for higher data speeds and improved connectivity across Canada increases so does the need for high efficiency, single mode, low noise lasers. We use inverse design and implement a fully connected neural network to generate aperiodic grating structures compatible with a desired spectral response from a laser. The neural network is trained to take three inputs: a desired peak wavelength, the peak spectral intensity, and the side mode suppression ratio. It returns 21 design parameters: the base periodicity of the grating, and the coupling coefficient and the length of each of the 10 segments.

Intervalence Band Absorption in Semiconductor Optical Amplifiers

Gavin P. Forcade, R. Millett, K. Prosyk, I. Woods

Ciena Canada Corp. (Canada)

Abstract: The rapid growth of optical networks necessitates efficient multi-quantum well semiconductor optical amplifiers. However, their power conversion efficiency can be limited by intervalence band absorption (IVBA). Because IVBA scales with hole concentration, it becomes a critical performance barrier at the high operating gains required by modern systems. Using a calibrated model based on band structure calculations, this study reveals how compressive strain modifies valence band structures, suppressing IVBA. Experimental validation confirms the theoretical insights, offering a framework to design high-efficiency semiconductor optical amplifiers.

Crack-free Thick Epitaxial AlN Grown on Si (111)

Melissa J. Radford (1,2), M. F. Vafadar (1), P. Daoust (3), D. Lister (2), O. Moutanabbir (3), K. L. Kavanagh (2), S. Zhao (1)

(1) Department of Electrical and Computer Engineering, McGill University (Canada); (2) Department of Physics, Simon Fraser University (Canada); (3) Department of Engineering Physics, Polytechnique Montréal (Canada)

Abstract: It is challenging to grow defect-free, thick planar aluminum nitride (AlN) on any substrate. To reduce defects and cracking, gallium nitride nanowires have been used as a buffer layer resulting in up to 2 µm thick AlN layers without cracks. In this work, AlN grown on such a template was investigated using transmission electron microscopy and X-ray diffraction reciprocal space maps and showed no evidence of cracks. However, threading dislocations and related non-uniformity in local lattice constants remain to be improved.

Direct Bandgap GeSn/Ge Quantum Well on Silicon

Nicolas Rotaru, P. Daoust, S. Keolling, P. Del Vecchio, E. Rahier, M. Atalla, S. Singh and O. Moutanabbir

École Polytechnique Montréal (Canada)

Abstract: Heavy holes confined in germanium-tin (GeSn) quantum wells (QWs) offer a direct-bandgap platform that preserves key advantages of Ge QWs. Their p-like symmetry reduces hyperfine interactions, enabling longer coherence times than electrons, while their larger effective mass lowers sensitivity to fabrication-induced size variations. Strong spin–orbit coupling supports qubit control with alternating electric fields via EDSR. We grow a $Ge_{0.83}Sn_{0.17}$/Ge QW on a relaxed GeSn buffer by CVD and characterize it using HRXRD, APT, and TEM. Temperature-dependent PL and k·p theory are used to analyze the sample.

Cubic GaN by Selective Area Growth: A Polarity Constraint and a Strain-Gated Nucleation Model

David Lister, M. Radford, C. Kim, K. A. Kavanagh, S. Watkins

Simon Fraser University (Canada)

Abstract: Cubic gallium nitride (c-GaN) is a metastable phase without spontaneous polarization, of interest for efficient LEDs. We grow c-GaN by merging hexagonal-GaN crystals at 70.5° during OMVPE on selective-area pyramidal templates. We report two contributions. First, a new symmetry constraint: c-GaN nucleates only when growth between facets is asymmetric, a consequence of facet polarity. Second, an emerging strain-mediated nucleation model that reconciles a contradiction between simple thermodynamic prediction and observed nucleation kinetics.

Spin Qubit Measurement Using Multimode RF Reflectometry

Olivier Romain, J. Rivard, A. Morel, D. Leclerc, and E. Dupont-Ferrier

Physics department and Institut quantique, Université de Sherbrooke (Canada); Institut Transdisciplinaire d'Information Quantique (Canada)

Abstract: Radio-frequency (RF) reflectometry is a fast and scalable readout technique for a wide range of qubit platforms. It relies on LC resonant circuits, whose performance critically depends on precise impedance matching constraints. We introduce spiral superconducting inductors supporting multiple resonant modes. Unlike conventional single-mode resonators, this approach leverages higher-order resonances to overcome impedance matching constraints, enabling fast, high-fidelity spin-qubit readout. This architecture is compatible with co-integration alongside nanoscale semiconductor devices, supporting scalable quantum architectures.

Strain-Induced Quantum Emission in Monolayer WSe_2 Deposited onto InP Nanowires

Jasleen Kaur Jagde (1), P. Singh (1, 2), M. Jain (2, 3), E. Yeung (2, 4), D. B. Northeast (4), S. Moisa (2), S. J. Mohammed (2), J. Lapointe (2), U. Rajnis (1), A. Kienast (1), P. J. Poole (2), D. Dalacu (2, 4), K. C. Hall (1)

(1) Department of Physics and Atmospheric Science, Dalhousie University (Canada); (2) National Research Council Canada (Canada); (3) Centre for Nanophotonics, Department of Physics, Engineering Physics, and Astronomy, Queen's University (Canada); (4) University of Ottawa, (Canada)

Abstract: Solid-state strained monolayers of transition metal dichalcogenides offer a promising route towards the creation of on-demand single photon sources. This work investigates quantum emission from a hybrid structure consisting of a monolayer of WSe_2 deposited onto horizontally aligned InP nanowire waveguides. Multiple bright and narrow emission peaks are observed along with $g^{(2)}(0)$ as low as 0.049 ± 0.022, indicative of high purity single photon generation. Strain fields conform to the nanowire facets, enabling flexible placement of quantum emitters and optimal top-surface coupling beyond conventional waveguides.

Effects of deposition parameters and capping on the superconductivity and crystallographic structure of ultra-thin NbN films fabricated using magnetron sputtering at a low temperature

Paramita Bhattacharyya (1), E.Z. Vavaroutsos (1, 2), M. Chesaux (1), D. Deligiannis (1)

(1) Intlvac (Canada); (2) University of Waterloo (Canada)

Abstract: Superconducting ultra-thin NbN films have been of significant interest for fabricating nano-devices in quantum electronics, like superconducting SIS tunnel junctions and SNSPDs. In this work, we demonstrate how TC changes with thickness of NbN films from 100 to 5 nm. We also highlight the effect of N2 flow and sputtering power on the crystallographic structure and TC of 5 nm NbN films. A TC of 8 K and a residual resistivity ratio of 0.882 have been obtained for 5 nm NbN films. All the thin film samples have been capped with a 10 nm AlN layer to prevent oxidation.

Gate-Tunable Supercurrent and High Interface Transparency in Ex-Situ Nb/InAs Heterostructures

Ahmed Elbaroudy, F. Sfigakis, E. A. Bergeron, F. Thompson, Y. Shi, and J. Baugh,

University of Waterloo (Canada).

Abstract: Hybrid superconductor-semiconductor platforms for Majorana-based topological quantum computation typically rely on in-situ epitaxial Al, which is limited by its low critical temperature and field. We present a high-performance ex-situ alternative: Nb sputtered onto high-mobility InAs/AlGaSb surface quantum wells, with sulfur passivation preserving a pristine interface. The resulting gated SNS Josephson junctions exhibit exceptionally high interface transparencies (78–99%) on par with epitaxial Al, and a gate-tunable supercurrent persisting up to 4 K, validating ex-situ Nb as a robust route to topological quantum devices.

RF GaN HEMT Compact Modelling with High-Temperature Effects for Extreme Environment Applications

Ella Lewis (1), R. Fang (1), D. Xu (1), J. Alant (1), R. Griffin (2), L. Wei (1)

(1) University of Waterloo (Canada); (2) National Research Council (Canada)

Abstract: Gallium Nitride HEMTs are essential for extreme environments, yet existing compact models lack accuracy at high temperatures. This work extends the industry-standard MVSG model to 500°C by analytically capturing carrier mobility degradation, threshold voltage shifts, and thermally activated gate leakage. A systematic parameter extraction flow is developed and validated against experimental data from 22°C to 500°C. Results show good agreement with measured output and transfer characteristics, providing a robust framework for high-temperature circuit design and accurate prediction of the device behaviour.

Die-Level 3D Integration Platform for Rapid Prototyping of Custom Photon-to-Digital Converters

Artur Turala (1), F. Vachon (1), S. Parent (2), C.M. Pepin (1), N. Roy (1), T. Rossignol (1), K. Deslandes (1), S. Martel (2), J.-F. Pratte (1), S.A. Charlebois (1)

(1) Interdisciplinary Institute for Technological Innovation (3IT), Université de Sherbrooke (Canada); (2) Teledyne Digital Imaging, Teledyne DALSA Semiconductor (Canada)

Abstract: We introduce a die-level 3D integration process for SPAD-based photon-to-digital converters (PDC) with CMOS readout and advanced signal processing, enabling prototyping without full CMOS wafer runs. Complementary to wafer-level integration, this approach significantly reduces cost and development time, especially for advanced CMOS nodes, while increasing design flexibility. Based on die-level bonding and an epoxy molding process inspired by FOWLP, the platform enables fast iteration of custom PDC architectures and integration with photonic systems, accelerating next-generation photon sensing applications.

Development of a monolithically integrated silicon single-photon avalanche diode for the e-SWIR domain

Jérémy Bélec, M. Atalla, G. Daligou, O. Moutanabbir

Polytechnique Montréal (Canada)

Presented by Anthony Nomezine.

Abstract: The 2 µm atmospheric window is attracting interest due to higher eye-safe power, reduced solar noise, and improved LiDAR performance. This motivates GeSn/Si SPAD designs for e-SWIR detection. TCAD simulations (Sentaurus), solving Poisson and drift–diffusion equations, model triggered avalanche behavior. Material parameters rely on k·p theory, interpolated permittivity, and Ge mobility, with experimentally informed defect profiles and recombination lifetime bounds. Three designs shift peak electric field away from interfaces to reduce dark counts, enabling improved LiDAR and QKD applications.

Revealing Buried Waveguide Defects in Stacked Photonic Chips via Through-Silicon Imaging

Elahe Parham (1), H.S. Becotte (1), and J. Lapointe (1,2)

(1) Jay Photonics (Canada); (2) Université Laval (Canada)

Abstract: Integrated photonic chips rely on buried waveguides that are difficult to inspect because silicon is opaque in the visible range. In this work, we use Jay Photonics high-resolution infrared (IR) transmission microscope to image stacked silicon chips non-destructively. Two 700 µm silicon substrates with embedded circuits were imaged non-destructively, revealing defects such as breaks and irregularities at both 10X and 40X magnifications. Notably, no aberration correction is applied, demonstrating the system's ability to maintain resolution through thick silicon and enabling efficient defect detection.

Emission Wavelength Control of InGaN Quantum Discs by Molecular Beam Epitaxy

Mohammad Fazel Vafadar (1), M. Radford (1), K. L. Kavanagh (2), S. Zhao (1)

(1) Department of Electrical and Computer Engineering, McGill University (Canada); (2) Department of Physics, Simon Fraser University (Canada).

Abstract: In this study, we investigate light emission properties of InGaN quantum discs (QDCs) embedded in GaN nanowire arrays grown by molecular beam epitaxy on patterned substrates. By systematically varying geometrical parameters, we identify nanowire gap size as the key factor governing emission wavelength, rather than nanowire diameter or array period. A constant gap means a negligible wavelength shift, whereas a reduced gap induces a pronounced redshift. A detailed phenomenological model is proposed to explain the gap-dependent behavior, providing a practical guideline for wavelength engineering.

Pitch-dependent Bragg Tuning in Corrugated Nanowires

Clarissa White, J. Huo, R. R. LaPierre

McMaster University (Canada)

Abstract: Sub-wavelength variations in the diameter of semiconductor nanowires (NWs) produce an effective refractive index contrast for Bragg reflection. Therefore, distributed Bragg reflectors (DBRs) composed of NWs with side wall corrugations offer a viable alternative to conventional heterostructure-based DBRs. Finite-element simulations are used to investigate the impact of various NW array parameters, including corrugation depth, period, and array pitch, on reflectance spectra and supported optical modes. In particular, pitch-dependent refractive index tuning through interwire near-field coupling significantly influences Bragg mode selection.

Energy-Efficient and Variability-Resilient Spiking Neural Networks using Graphene Memristors

Kannan Udaya Mohanan (1), I. Kymissis (2), C. Kim (1)

(1) School of Electrical Engineering and Computer Science, University of Ottawa (Canada); (2) Department of Electrical Engineering, Columbia University (United States of America)

Abstract: Physical implementations of Spiking Neural Networks (SNNs) often suffer from reduced energy and area efficiency. Here, we present an energy-efficient solution using eco-friendly nanoporous graphene (NPG) memristors to create a dual-mode circuit functioning as a leaky integrate-and-fire neuron and a dynamic spike encoder. A two-layer SNN based on NPG memristors achieves 97.37% classification accuracy on the MNIST dataset. Furthermore, the system demonstrates robust resilience to device-to-device threshold voltage variability, retaining 87.05% accuracy by leveraging inherent firing stochasticity as a natural regularization mechanism.

Coherent Excitation of Nanowire Quantum Dots using Notch- Filtered Adiabatic Rapid Passage

Kim A. Owen (1,2), G. Wilbur (3), K. C. Hall (3), P. J. Poole (1), A. Gamouras (1, 2), D. B. Northeast (1), R. L. Williams (1), D. Dalacu (1, 2)

(1) National Research Council Canada (Canada); (2) Department of Physics, University of Ottawa (Canada); (3) Department of Physics & Atmospheric Science, Dalhousie University (Canada)

Abstract: Nanowire quantum dots are highly-efficient single photon sources. However, quantum information requires single photons with precisely controlled emission properties. Most excitation mechanisms compromise either the source efficiency or emission quality to maximize the other, but Notch-Filtered Adiabatic Rapid Passage (NARP) is able to optimize efficiency, timing, and purity simultaneously. In this talk, we demonstrate the first s-shell excitation using NARP on nanowire quantum dots and significant improvements in the single photon purity and timing jitter with respect to above-band excitation.

Bio Sourced Adhesives for Microelectronic Packaging

F. A. Banville (1, 2), C. Marsan-Loyer (3), J. Labrecque (4), S. Berger (1), C. Druillole (1), B. Busseniers (5), K. Pilger (5), V. Oberson (5), D. Danovitch (1, 2), D. Gendron (4), Serge Ecoffey (1, 2)

(1) Institut Interdisciplinaire d'Innovation Technologique (3IT), Université de Sherbrooke (Canada); (2) Laboratoire Nanotechnologies Nanosystèmes (LN2) – IRL 3463, CNRS, Université de Sherbrooke, Sherbrooke (Canada); (3) Centre de Collaboration MiQro Innovation (Canada); (4) Kemitek, Cégep de Thetford (Canada); (5) IBM Bromont (Canada)

Abstract: This work reports the development of bio sourced epoxy resins derived from forest biomass for die attach adhesives in microelectronics applications. Formulations without fillers and with conductive or insulating particles were processed using automated industrial dispensing and assembly tools. The bio sourced epoxies showed performance comparable to commercial materials, with glass transition temperatures up to 140 °C, adhesion strengths greater than 5000 psi, and processing windows exceeding 24 hours. Reliability testing and characterization indicate that these materials are viable alternatives to petroleum based die attach adhesives.

209 nm Emitting AlGaN Nanowire Ultraviolet Light-Emitting Diodes by Molecular Beam Epitaxy

Mohammad Fazel Vafadar (1), Q. Zhang (1), H. Yuan (2), G. A. Botton (2), S. Zhao (1)

(1) McGill University (Canada); (2) McMaster University (Canada)

Abstract: In this work, we demonstrate that by growing AlGaN nanowires with molecular beam epitaxy in a Ga highly desorbing regime, light-emitting diodes (LEDs) with emission at 209 nm are obtained. Detailed light emission characteristics and transmission electron microscopy analyses reveal that the emission originates from AlN formation. The correlation between Ga desorption and electroluminescence (EL) is further investigated by using a unique approach with two different Al sources. The underlying mechanism is discussed. This work could advance the development of technically important ultrashort-wavelength semiconductor ultraviolet LEDs.

Electrochemical Etching of Porous SiC for Optical Applications

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Abstract: Silicon carbide (SiC) has recently attracted attention with potential applications in optoelectronics and sensors because of the high conductivity and wide band gap. Due to the remarkable bond strength and chemical inertness, conventional wet etching processes are unavailable, whereas electrochemical etching is one of the known methods and has been utilized to generate porous structures and nanorods. In this research, novel porous structures have been fabricated by with specific optical properties and potential applications.

Fast and Non-Destructive Characterization of Porous Germanium Using Infrared Ellipsometry

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Abstract: Fast and non-destructive characterization of porous germanium (PGe) is essential for estimating thickness and porosity and enabling early detection of structural non-uniformities that can adversely affect subsequent processing steps. Here, infrared ellipsometry is used to evaluate the PGe thickness and porosity at the wafer scale, showing good agreement with complementary characterization techniques (SEM for thickness and XRR for porosity). While the employed optical model provides reliable estimates, more advanced optical models are proposed to improve accuracy and better capture the structural complexity of porous networks.

Porous-Ge Reconstruction for Nanomembrane Porous-Lift-Off

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Abstract: Single-crystal germanium nanomembranes (NM) are gaining interest for lightweight and flexible optoelectronic devices. Direct growth of Ge NM was done on porous Ge template. The formation of a separation layer containing pillars within the template allows the detachment of the Ge NM from its parent substrate. The effect of initial parameters (porosity, thickness) and thermal annealing on pillar morphology (size and density) is investigated. In this work, we report on a comprehensive investigation of the porous transformation enabling pillar creation with different morphology, allowing Ge NM adhesion strength tuning and reliable lift-off.

Source Configuration Dependent Molecular Beam Epitaxy of AlN Nanowires for Deep Ultraviolet Photonic Devices

Milad Fathabadi, M. F. Vafadar, S. Zhao

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Abstract: Aluminum nitride (AlN) nanowires are promising for deep ultraviolet photonic and electronic devices due to their wide bandgap, thermal conductivity, and strain relaxation capability. However, controlling their morphology and uniformity is needed for device development. Here, self-organized AlN nanowires are grown on n-Si(111) by PA-MBE under N-rich conditions to study the effects of Al source configuration and substrate rotation. The results show that these growth parameters strongly affect nanowire morphology and uniformity, providing guidance for AlN-based device applications.

Two-step oxidative solid phase epitaxy of Ge ion-implanted Si(100) and Si(111)

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Abstract: Recently, sub-10-nm-thick SiGe layers produced by selective oxidation of a Ge ion-implanted Si were demonstrated as novel buffer layers for GaAs heteroepitaxy on Si. This paper investigates the properties of SiGe pile-up layers formed by oxidative solid-phase epitaxy. Ge ion-implanted Si (100)–4° and (111) samples were oxidized at various temperatures. The resulting Ge concentration, thickness, and surface roughness of the SiGe layer are strongly dependent on the oxidation temperature. A Two-step oxidation process is introduced, which achieves a high Ge concentration while reducing the surface roughness of the pile-up layer.

Warpage reduction of strained GaAs lasers by microfabrication

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Abstract: Residual stress in epitaxial structures can cause significant warpage of the wafers, directly impacting the yield of device fabrication. This work proposes a method to reduce warpage in stressed wafers without modifying the epitaxial structure. This method involves compensating for residual stress through front- and backside dielectric deposition, as well as etching stressed regions to allow for local relaxation. Finite element modeling was conducted to evaluate the relevance of the proposed designs. Experimental verifications were then performed.

Fast Formation of Wafer Scale Uniform Porous Germanium For Detachable NanoMembranes

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Abstract: This work presents a comprehensive study on the formation of porous Germanium layer using Fast Bipolar Electrochemical Etching, achieving high etch rates near 50 nm/min, while preserving structural uniformity at 4-inch wafers scale. This method overcomes the low etch rates and limited industrial scalability of conventional bipolar electrochemical etching, enabling wafer-scale production. The resulting porous Ge layers are compatible with epitaxial growth and lift-off processes, opening new opportunities for scalable device-oriented applications and optoelectronic integration technologies.

Growing Indium Phosphide on Germanium: A Pathway to Lower Cost Photonics

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Abstract: We report recent progress toward high-quality InP heteroepitaxy on Ge for low-cost photonic devices. Direct InP growth on Ge leads to strain relaxation and 3D Volmer–Weber island formation due to lattice and polarity mismatch. To overcome this challenge, a lattice-matched InGaP interfacial layer was first optimized on GaAs, then transferred to Ge and compositionally graded toward InP-rich compositions to promote smoother 2D growth. This engineered structure will subsequently be combined with nanovoid-based defect mitigation to trap threading dislocations and improve crystalline quality.

High-throughput growth and characterization of MOCVD thin films – a new Canadian quantum materials innovation facility

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Abstract: Two-dimensional quantum matter (2DQM) is promising for a wide range of desirable applications. Their practical deployment beyond research laboratory, however, hinges on the capabilities of fabricating high-quality reproducible materials and devices on a wafer scale. Here we show that our new 2DQM Facility (https://2dqm.uottawa.ca/) at the University of Ottawa, featuring a state-of-the-art AIXTRON metal-organic chemical vapor deposition (MOCVD) system, is well suited for the growth and rational integration of graphene, boron nitride and transition metal dichalcogenides, directly supplying Canadian academic, government and industry researchers.

Predicting vibrational stability of 2D inorganic semiconductors via transfer learning

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Abstract: Studying dynamical (vibrational) stability is essential for 2D inorganic semiconductor applications. Imaginary phonon modes signal instability, invalidating property predictions. E_hull only identifies thermodynamic stability. DFT calculations are time-consuming and computationally expensive. While ML enables efficient screening, scarce 2D data limits generalizability. Using transfer learning from a physics-informed bulk model, for a dataset of 300 2D materials, our model achieved (ROC-AUC: 0.85), excelling at E_hull < 0.1 eV/atom where prior models fail.

Reactive AgNP/MXene Coatings for Breathable X-Band EMI-Shielding Textiles in Electronic-System Protection

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Abstract: The rapid growth of high-frequency electronics, including 5G and semiconductor devices, demands efficient EMI shielding materials. This work presents breathable X-band shielding textiles using reactive AgNP/MXene coatings on a copper-cotton knitted fabric. By tuning nanoparticle size and designing alternating AgNP/MXene bilayers, shielding performance in the 8.2-12.4 GHz range is optimized while preserving flexibility, breathability, and durability for wearable and compact electronic applications.

Effect of porosification cell geometry on porous Germanium synthesis: From horizontal to vertical configurations

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Abstract: This study focuses on the development of a vertical electrochemical porosification cell for germanium, a key material enabling nanomembrane fabrication and substrate reuse in semiconductor manufacturing. The goal is to achieve full-wafer porosification without edge masking using a vertical configuration, a key requirement for industrial-scale processing. The study compares conventional horizontal and vertical cells under identical conditions. Particular attention is given to non-uniformities observed in vertical setups, attributed to hydrogen evolution and its effect on current distribution.

Feigenbaum Route to Chaos in Cycled ReRAM Devices

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Abstract: ReRAM TiN/$Hf_{0.5}Zr_{0.5}O_2$/Pt devices show period-doubling bifurcations during endurance cycling, indicating deterministic chaos. This work investigates the negative feedback mechanism behind these instabilities, attributed to the superposition of counter-eightwise filamentary switching and eightwise oxygen-ion exchange at the Pt/dielectric interface. Electrical measurements show a local maximum in RESET response, supporting this mechanism. A probabilistic drift-diffusion and Butler-Volmer model identifies control parameters governing chaotic switching, with implications for ReRAM reliability, security, and neuromorphic applications.

Evolution of vacancy-type defect concentration in low-T epitaxial Si films revealed by variable-energy, Doppler-broadened positron annihilation spectroscopy (VE-DBPAS)

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Abstract: Fifty (50) nm layers of Si were deposited by Molecular Beam Epitaxy (MBE) on Si substrates (with 50nm Si buffer layer) at 5E-11, 1E-08 and 5E-08 mbar. Deposition temperatures ranged from 200°C to 600°C. PAS results indicate a significant drop in the PAS ‘S’ (sharpness) parameter – an indicator of vacancy-type defects inside the sample – with increasing deposition temperature. Significantly, the onset of the S parameter reduction occurs at lower temperatures when deposition occurred at lower pressure.

Design of Experiments Based Optimization of an InGaAlAs/AlGaAs Semiconductor Laser Structure

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Abstract: This work applies Design of Experiments (DOE) to the structural optimization of a 905 nm InGaAlAs/AlGaAs semiconductor laser, simulated using HAROLD (Photon Design). A fractional factorial screening identified waveguide and barrier aluminum contents, quantum well thickness, and doping as the key parameters governing optical power, threshold current, forward voltage, and emission wavelength. A central composite design (CCD) is currently underway to build a response surface model enabling structured identification of optimal combinations and quantification of parameter interactions.

Epitaxial growth of isotopically purified ^{28}Si layer on Silicon-On-Insulator

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Abstract: The absence of nuclear spins and lattice disorder in ^{28}Si reduces decoherence and phase noise, enabling higher photon indistinguishability and more stable quantum interference. Combined with the SOI platform, this approach provides a pathway toward scalable, high-fidelity quantum photonic circuits. Here, we report an epitaxial growth of isotopically purified ^{28}Si on SOI substrate via MBE. HRTEM shows highly crystalline in the entire epitaxial layers. APT shows ultra-high purity of ^{28}Si about 99.998%. About 20 ppm of ^{29}Si in the ^{28}Si layer and a single digit ^{30}Si. Low temperature PL shows features related to several phonon-assisted emissions.

Engineering Surface Reconstruction and Plasma-Induced States in Top-Down Mg-Doped GaN for Photoelectrochemical Activity

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Abstract: Top-down fabrication of Mg-doped GaN nanostructures is scalable but introduces plasma-induced surface states that affect charge transport and interfacial reactions. This work investigates the effects of ICP etching, KOH treatment, and annealing on photoelectrochemical behavior. KPFM shows CPD drops from ~1.6 V to 0.6 V after etching and recovers to ~1.4 V after treatment. XPS indicates surface reconstruction and fewer defects, while TRPL shows reduced trap-assisted recombination. These results highlight the critical role of surface state engineering in GaN-based photoelectrochemical activity.

Selective area growth of GeSn toward monolithic integration of mid-infrared devices

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Abstract: Selective area growth (SAG) of GeSn is a key enabler for the integration of group-IV mid-infrared photonic devices on silicon platforms, offering localized deposition compatible with CMOS processing. However, controlling Sn incorporation while maintaining crystalline quality and selectivity remains challenging due to strain-driven relaxation and surface diffusion effects. In patterned structures, dielectric interfaces further influence Sn incorporation and strain behavior. Herein, this work establishes the experimental framework enabling controlled GeSn growth with high selectivity and reliable Sn incorporation.

Two-dimensional materials in surface acoustic wave devices

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Abstract: Atomically thin with tunable properties, two-dimensional (2D) materials hold immense technological potential. Scalable synthesis remains a barrier to progress, but metal organic chemical vapour deposition has recently emerged as a solution for graphene and transition metal dichalcogenides. With suitable substrates and growth parameters, a non-destructive film transfer method is required to move 2D materials onto application-specific substrates. The placement of 2D materials onto substrates compatible with surface acoustic wave transducers opens a promising, yet relatively unexplored, technological space for next-generation electronics.

Reconfigurable Si Transistor Memory Cells for Neuromorphic Computing

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Abstract: Spiking neural networks (SNN) use the same amplitude pulses with information included in the time domain, which can reduce power consumption significantly to implement artificial neural networks (ANN). To implement SNN, a neuron cell with hysteretic firing and restoring characteristics is needed. In this paper, reconfigurable neuromorphic circuits using 4-terminal Si transistor memory cells are implemented and measurement results are presented. The implemented dual-NMOS configuration shows good neuron characteristics with stable repeatability. Analysis based on a simple behavioral SPICE model is also provided.

Static and Small-Signal Characterization of Micro-LEDs Based on InGaN/GaN Multiple Quantum Wells

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Abstract: Micro-LEDs based on InGaN/GaN MQW structures exhibit non-ideal carrier transport as device dimensions shrink, due to surface recombination, sidewall damage, and resistive transport effects. This work shows current-voltage analysis, impedance spectroscopy, and electrostatic simulation to investigate these mechanisms. Nyquist analysis reveals bias-dependent relaxation processes associated with recombination and charge storage in the MQW region, while simulations give insight into internal electric field and potential distributions. These results improve understanding of carrier transport and support physics-based modeling of micro-LED devices.

Lightweight High-Efficiency III–V/Ge Triple-Junction Solar Cells via Ge Subcell Thinning for Space Photovoltaics

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Abstract: This work investigates Ge bottom subcell thinning in InGaP/InGaAs/Ge lattice matched triple-junction solar cells for space applications. TCAD-Silvaco simulations under AM0 show that reducing Ge thickness from ~175 µm to 10–20 µm maintains performance comparable to 3JSCs in the literature. The Ge subcell remains non-limiting in current generation, and therefore, it does not constrain the overall device current. This approach enables significant mass reduction while preserving efficiency, improving the power-to-mass ratio for next-generation space photovoltaics.

Solar-Integrated Cold-Climate Energy Systems for Net-Zero Campuses: Performance Evaluation of a 10.3 MWp Rooftop Photovoltaic System for Decarbonization Applications

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Abstract: Rising energy demand and emissions in cold regions require efficient renewable solutions. This study evaluates a solar-integrated rooftop photovoltaic system for campus-scale application under cold-climate conditions. Using PVsyst modeling, key metrics including final yield, reference yield, and performance ratio were analyzed. The 10.3 MWp system generates 14,446 MWh annually with a performance ratio of 0.90, indicating reliable operation. Optimal tilt angles of 30°–40° improve energy capture, highlighting strong potential for net-zero energy and decarbonization.

Bandgap Engineering of Tantalum Nitride Thin Films by Ion-Assisted Magnetron Sputtering for Advanced Electronic and Radiation Detection Applications

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Abstract: Tantalum nitride thin films have been of interest for microelectronics, protective coatings, functional layers in radiation detection and other technologies due to their wide range of electrical and optical properties. In this work, we studied the effects of N2 flow on the structural, optical and electrical properties of TaN thin films, fabricated using plasma assisted reactive magnetron sputtering. N2 variation caused an effective bandgap variation from 0-1.6 eV along a change in resistivity from ~10^{-2} to ~10^{3} Ω·cm. Structural analysis showed disordered Ta-N phase with cubic ordering being suppressed at higher N2 concentrations.

Modeling Direct Optical Crosstalk propagation in Single-Photon Avalanche Diode Arrays

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Abstract: Optical crosstalk (OCT) in SPAD arrays arises when secondary photons emitted during avalanche events travel through the array and trigger false detections in neighboring SPADs. We present a model that describes the propagation of direct OCT photons, considering both propagation through the various media and transmission across isolation trenches. We evaluate the probability of crosstalk events as a function of wavelength and spatial separation between SPADs. We compare the model to measured OCT in a digital SPAD array. This work provides a framework for understanding and minimizing optical crosstalk events through optimised SPAD array design.

Toward Ultra-Thin and Stable Solid-State Nanopores

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Abstract: 10–20 nm thick SiN nanopores are unstable in biosensing environments (diameter expansion up to many nm/day). Film thickness dictates signal strength, favoring lower thicknesses for higher sensitivity. HfO_2 offers superior chemical stability and Atomic Layer Deposition compatibility. This work uses controlled breakdown (CBD) to fabricate 5 nm thick HfO_2 nanopores (2–20 nm diameter). A 10 day aging study shows <0.5 nm/day expansion. DNA experiments validate pore performance. CBD enables ultra-thin HfO_2 nanopores with tunable diameters and long-term stability for biosensing applications.

Validating an Intermediate Band Photovoltaic Device Model

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Abstract: Intermediate band (IB) photovoltaics promise increased efficiency over conventional solar cells. An IB material is a modified semiconductor with mid-gap energy levels enabling both one- and two-photon excitation. Photovoltaic devices cannot be designed effectively without accurately simulating their performance, and since IB materials do not occur in nature, few device models are made able to treat them. Here we use the semiconductor device model Simudo to reproduce the J(V) characteristic of a literature IB photovoltaic. We indicate how its device performance can be improved even without improving the IB material.

Realization, Simulation and Fabrication of a Microwave Sensor for Detecting Low Ethanol Concentrations in Canadian Fuels

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Abstract: This work presents the design and simulation of a microwave resonator sensor for detecting low ethanol concentrations in Canadian fuels. The proposed SRR-based structure analyzes dielectric properties and S11 response variations to differentiate Type A (E1–E10) and Type B (E11–E15) fuels for 87, 89, and 91 AKI gasoline grades. Simulation results demonstrate measurable resonant frequency shifts associated with ethanol concentration, providing a compact, rapid, and non-destructive approach for real-time fuel characterization.

Defect-mediated electroluminescence & photoluminescence in surface-modified SiC JFETs

Maia Hormoz, T. Zhang, Z. Ji, A. Kitai

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Abstract: Defect-mediated luminescence in commercially fabricated 4H-SiC JFET devices was modified through sequential electrochemical etching, electrochemical oxidation, and electron beam irradiation treatments. Electroluminescence and confocal photoluminescence characterization showed that electrochemical etching enhanced electroluminescence intensity, while oxidation and irradiation introduced broadband visible photoluminescence associated with oxygen related interface defects and irradiation-induced dangling bond states. The results demonstrate controllable visible optical emission directly within operational SiC JFET architectures.

Development and Integration of InGaAs Geiger-Mode APD Arrays for Quantum Imaging and Communication

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Abstract: We present the development of hybrid integrated InGaAs / InP Geiger-mode avalanche photodiode (APD) arrays with a CMOS readout, for quantum imaging and quantum communication applications. Scalable arrays of single-photon avalanche diodes were implemented in InGaAs technology in a top-tier chip, which was then hybridized to a bottom-tier chip fabricated in 110 nm technology. The InGaAs APD arrays employ a planar architecture which is fabricated using a selective area growth process with a single Zn diffusion to mitigate the edge breakdown effect. Measurement results are reported for individually contacted test pixels and as hybridized arrays.

Wafer-scale bilayer graphene field effect transistors : conductivity preservation under gate activated functionalization

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Abstract: Covalent grafting enables stable sensing sites on graphene but can make monolayers insulating. Here, wafer-scale bilayer graphene made by sequential CVD transfers preserves a conductive layer while the top layer is functionalized. Gate-activated carboxyphenyl diazonium grafting is controlled by electrolyte gating in a microfluidic cell and tracked by operando Hall measurements, separating carrier density and mobility changes. Hall and impedance capacitance probe delocalized vs total DOS, and pH-dependent carrier density follows a simple site-binding model, supporting bilayer graphene as a tunable sensor platform.

Electrical Response of CdZnTe Radiation Detectors Under X-Ray Irradiation

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Abstract: As a room-temperature semiconductor radiation detector material, CdZnTe has emerged as a promising candidate due to its attractive properties, including a high atomic number, a wide band gap, and high resistivity, which collectively result in high absorption and lower dark current. In the present study, we have demonstrated the fabrication of CdZnTe-based radiation detectors and investigated their electrical response to X-ray irradiation at varying energies and power levels. The fabricated device exhibits a stable and nearly linear response over a broad range of X-ray energies commonly used in medical diagnostic imaging.

Ultrathin III-V Solar Cells with Photonic Rear Side Reflectors

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Abstract: To drive down costs and improve the resource efficiency of III-V solar cells, a reduction of absorber thickness while simultaneously maintaining high efficiencies is desirable. We present an ultrathin GaAs single-junction solar cell with an active cell thickness of less than 300 nm and a nanostructured rear side that improves absorption through multi-resonant light trapping. Rigorous coupled wave analysis (RCWA) is used to identify optimized nanostructure designs. Compared to a planar device, reflection measurements of the first realized nanostructured design show an increased photocurrent of +2.04 mA/cm², a total gain of more than 10 %.

Designing Nanotextured Betavoltaic Cells to Improve Power Density

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Abstract: Betavoltaic cells convert beta radiation into electricity, enabling battery designs that can operate for decades in harsh environments without maintenance. We validate a 3D planar GaAs betavoltaic cell under a 10 mCi/cm² 63Ni source using OpenGate/Geant4, showing good agreement with reference model. Preliminary nanotextured designs increase energy deposition, indicating a promising route toward higher-performance compact betavoltaic devices.

Strain Relaxation and Surface Evolution in Epitaxial SrTiO3 Thin Films on Vicinal MgO

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Abstract: Epitaxial SrTiO3 thin films were deposited on vicinal MgO substrates by RF magnetron sputtering to investigate strain accommodation and Mg diffusion. AFM shows that the films replicate the substrate step-terrace morphology and develop a thickness-dependent network of topographic depressions associated with strain relaxation. XRD reveals lattice distortion, while XPS depth profiling detects Mg diffusion throughout the films. Raman spectroscopy further indicates that strain and Mg incorporation modify the lattice vibrational response, providing insight into strain engineering in oxide heterostructures.

Neural Network Enhanced Hybrid MVSG Compact Model for GaN HEMTs

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Abstract: Accurate, scalable, and computationally efficient compact models are essential for GaN HEMT circuit design. This work proposes a hybrid MVSG compact model enhanced by two feed-forward neural networks (FNNs) for I-V and C-V characteristics. The physics-based MVSG model is first fitted to a rough proximity of the measured data. Then the FNNs are trained to learn the residual between the I-V or C-V of the measured data and the standard MVSG model. The proposed approach improves modeling accuracy while preserving the physical interpretability and scalability.

Quantifying the Interfacial Fracture Energy of Self-Assembled Monolayer Interfaces in Perovskite Solar Cells

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Abstract:.Self-assembled monolayers (SAMs) are widely used as hole-selective contacts in high-efficiency perovskite solar cells, yet the mechanical properties of the buried SAM/perovskite interface remain largely unexplored. Double cantilever beam testing was used to quantify the interfacial fracture energy of 2PACz, MeO-2PACz, and MeO-4PACz interfaces. Comparable fracture energies of 4.8, 4.5, and 4.4 J m^{-2} were measured, indicating similar interfacial adhesion among the investigated SAM chemistries and demonstrating DCB testing as an effective method for buried-interface characterization.

Effect of Adhesion Layers in CdZnTe-Based Direct Conversion Radiation Detectors on Photoelectric Properties

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Abstract: CdZnTe is a promising material for direct-conversion X-ray detectors due to its high resistivity, wide bandgap, and high atomic number. This work investigates the effect of Ti and Cr adhesion layers on the mechanical and photoelectric performance of Au-contacted CdZnTe detectors. Surface leakage current, dark current, X-ray photocurrent, and wire bond reliability were evaluated. Ti/Au electrodes achieved a high wire bond success rate while maintaining low dark current, high X-ray photocurrent, and good stability under high reverse bias. These results suggest that Ti adhesion layers improves both contact robustness and detector reliability.

Interface Modulated Magnetism in Tetradymite Based Topological Materials

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Abstract: We investigate interface-modulated magnetism in tetradymite-based topological materials, focusing on $MnBi_2Te_4$ and related heterostructures. By combining crystal growth, van der Waals device fabrication, and advanced magnetic and electronic characterization, we explore how intrinsic magnetic order, symmetry breaking, and proximity effects generate emergent quantum phenomena. These include the quantum anomalous Hall effect, layer Hall effect, and enhanced interfacial magnetism, providing pathways toward low-power spintronic and quantum devices.

Strain-Mediated Phonon Coupling for Coherent Control of Hole Spin Qubits in Nonpiezoelectric Group-IV Heterostructures

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Abstract: Group-IV semiconductor spin qubits offer long coherence times and CMOS compatibility, yet their coupling mechanisms remain limited to short-range interactions. Harnessing strain-mediated phonons provides a path to scalable, coherent connectivity in nonpiezoelectric germanium-on-silicon (cs-GoS) heterostructures. Using the Luttinger–Kohn–Bir–Pikus model and Multiphysics simulations, we quantify how strain and displacement modulate hole confinement and spin-dependent energy levels in gate-defined double quantum dots. Our results show that biaxial strain, exemplified by surface acoustic wave excitation, dominates displacement effects by over an order of magnitude. Acoustic velocity contrast in the cs-GoS stack concentrates strain within the Ge quantum well, producing phonon modes up to 17 GHz and strong, coherent spin–strain coupling. This establishes strain as the primary communication channel for spin qubits in nonpiezoelectric materials. These findings open pathways toward phonon-based quantum control, interconnects, and elevated-temperature operation above 1 K in scalable quantum architectures.

Optimizing AlGaAs Growth on Nonstandard Crystal Orientations for Quantum Optical Metasurfaces

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Abstract: Quantum optical metasurfaces motivate the extension of GaAs/AlGaAs growth to nonstandard crystal orientations such as GaAs (110) and GaAs (111)B. This work shows that for GaAs (110), morphology is governed primarily by the arsenic overpressure during AlGaAs growth. Using in situ RHEED and diffuse laser scattering together with ex situ black box scattering and Nomarski microscopy, the practical minimum V/III ratio for smooth Al0.55Ga0.45As at 500 °C is found to lie between 5 and 10, establishing a useful growth window for GaAs (110) device structures.

Lateral Grading in Be δ-doped InAlAs Charge Layer in SPADs

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Abstract: InGaAs/InAlAs single-photon avalanche photodiodes (SPADs) reach optimal operation for a very narrow range of doping the charge layer–InAlAs:Be. Multiple substrates and fabrication runs are needed to experimentally identify the ideal doping concentration which proves to be expensive and time-consuming. In this work Molecular Beam Epitaxy is used to achieve lateral dopant concentration grading along the Be cell's azimuth while producing uniform layer thickness across the wafer. The broad doping range enables identification of the optimal doping concentration from a single growth, saving cost and effort for device growth and fabrication.

A model of crystal phase and diameter oscillations in ultrathin Te-doped gallium phosphide nanowires

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Abstract: Semiconductor nanowires (NWs) can be grown epitaxially via the vapour-liquid-solid mechanism. While bulk GaP crystallizes exclusively in the zincblende phase, GaP NWs can also support the wurtzite phase. It is common to observe transitions between the two stable phases during growth. Recently, Te-doped GaP NWs exhibited quasi-periodic crystal phase transitions coinciding with local diameter oscillations. A simple material transport model is developed to describe these effects. It is found that crystal phase dependent segregation of Te dopants can explain the observed crystal phase transitions and corresponding NW diameter oscillations.

RPCVD Growth of Detachable Ge p-n Nanomembranes on Mesoporous Ge Virtual Substrates

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Abstract: We report the first implementation of the PEELER concept using reduced-pressure chemical vapor deposition (RPCVD) for the growth of detachable, in-situ-doped Ge p–n nanomembranes on mesoporous Ge (MPGe) virtual substrates. Using a two-step epitaxial process, we achieved a ~500 nm-thick single-crystal Ge layers with a smooth surface (~1.2 nm RMS), an engineered release interface, and a growth rate about twice that of MBE-grown Ge on MPGe. Successful lift-off with preserved crystalline integrity demonstrates the potential of RPCVD as a scalable, sustainable, and industry-compatible route for Ge nanomembrane fabrication.

Ultrasmooth Surface of GaAs/AlGaAs Nanoheterostructures by Self-Assembly assisted Digital Photocorrosion

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Abstract: Nanoscale surface topography with σRMS <1 nm is critical for high performance III-V semiconductor devices. Here, we investigate in situ L-cysteine passivation of GaAs during a hybrid digital photocorrosion process alternating etching in 18% NH4OH and 1M NaOH for GaAs and AlGaAs, respectively. Applied to 31 pairs of GaAs (6 nm)/AlGaAs (20 nm), we demonstrate that along with revealing 31 PL maxima associated with the photocorrosion front crossing GaAs/AlGaAs interfaces, the ultrasmooth surface of GaAs/AlGaAs nanoheterostructures is obtained, making it possible processing of III-V devices with sub-nano depth resolution.

Mid-infrared GeSn Nanolaser

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Abstract: The mid-infrared range is critical for sensing and communication, yet current technologies remain bulky and costly. GeSn, a CMOS-compatible group-IV alloy, offers a path toward compact photonic devices through epitaxial nanowire growth. This work demonstrates nanolaser operation with single-mode lasing at 2.3 μm using 10 at.% Sn. Increased Sn incorporation further reduces the bandgap, extending emission beyond 6 μm in the mid-infrared range.

Semiconductor Photonic Crystal Waveguides for Enhanced Nonlinear Terahertz Detection

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Abstract: Time-resolved detection of terahertz (THz) fields relies on a second-order nonlinear interaction with a synchronized near-infrared pulse, yet its sensitivity is limited by phase mismatch, weak spatial overlap, and THz divergence. A waveguiding geometry mitigates these constraints by tightly confining THz fields and enabling tailored phase matching. We demonstrate a laser-written THz photonic crystal waveguide in 110-oriented GaP. Numerical and experimental data confirm that the nonlinear coherence length is dictated by waveguide geometry. The resulting device achieves a tenfold improvement in nonlinear THz detection efficiency over bulk GaP.

Mimicking Hydrogen in Energy Harvesting Materials

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Abstract: Perovskites are a diverse family of materials based on octahedral oxygen or halide cages. These widely tunable compounds have recently been found to exhibit optoelectronic properties of relevance for energy harvesting and sensing. Muon Spin Relaxation investigations in double perovskite Cs_2AgBiX_6 (X=Br, Cl) are discussed, where implanted muons form an analog of interstitial defect hydrogen and shed light on the role of electron density and charge dynamics in determining their performance.

Digital Photonics: Optical Logic Gates using Silicon Photonic Micro Rings

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Abstract: Digital photonics enables computation directly within silicon photonics platforms, overcoming energy and bandwidth limits of electronic data movement. We present optical logic gates using silicon photonics microring devices, enabling cascadable logic without external electronics. The architecture reduces electrical interconnect length to the µm scale and supports projected sub-pJ/bit operation. These primitives scale to photonic integrated circuit switch architectures with radix above 4,096 for next-generation data center systems

Kerfless Transfer of Germanium Nanomembranes for III–V Solar Cell Fabrication via Stressor-Induced Detachment

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Abstract: Porous lift-off technology enables reduction of germanium consumption by producing monocrystalline nanomembranes (NMs) used as templates for active layers. However, controlled detachment and handling of NMs remain challenging. We introduce the Stressor-layer-induced Porous-layer Detachment (SPeD) method, a fracture-based approach enabling wafer-scale release of Ge nanomembranes. Compatibility with device fabrication is demonstrated through single-junction GaAs solar cells fabricated on transferred Ge nanomembranes.

Optimizing SiC Betavoltaic Cells under ^{3}H Irradiation to Maximize Power Output

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Abstract: Betavoltaic (BV) technology converts energy from beta radiation using a semiconductor device. This work focuses on the numerical design and optimization of SiC betavoltaic cells by varying the semiconductor layer thickness and doping concentration to maximize output power. The simulation framework comprises three sequential steps: CASINO, a custom Python script (RICC), and Synopsys Sentaurus. Using this approach, a validated numerical model for SiC betavoltaic cells was developed, achieving a maximum power density of 1.89×10^{-7} $W \cdot cm^{-2}$ through particle swarm optimization.

Sc-III-Nitride Nanowires with High Reducing Power for Semiconductor Photocatalysis

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Abstract: Sc-III-nitrides have been widely studied for ferroelectric devices, while their potential for semiconductor photocatalysis remains largely unexplored. Here, we introduce MBE-grown ScGaN nanowires as a high-reducing-power photocatalyst platform, enabled by Sc-induced upward band-edge shifts. Structural and compositional analyses confirm the successful formation of ScGaN nanowires. Compared with GaN, ScGaN shows about 5 times higher production rate, highlighting Sc-III-nitrides for solar fuel applications.

On the Strategies for Enhancement of Light Extraction Efficiency for InGaN MQW Micro and Nano-LEDs

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Abstract: III-nitride μ-LEDs are promising for AR/VR due to their tunable direct bandgap, stability, and mature fabrication. However, device scaling increases sidewall defects and non-radiative recombination, reducing EQE. While prior work focused on IQE, smaller pixels also enhance light extraction efficiency (LEE). Here, we study InGaN/GaN MQW blue and green μ-LEDs (10–60 μm) with ~20° tapered sidewalls. Smaller pixels show 15–20% higher efficiency, attributed to improved LEE, supported by modified ABC modeling and FDTD simulations. Nanoscale designs are further optimized for maximum LEE.

Quantum-dot-based Extended Short-Wavelength Infrared Detectors Enhanced by Plasmonic Nanostructure Arrays

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Abstract: In0.47Ga0.53As photodetectors on InP work efficiently up to 1.7 μm, but extending detection is challenging due to lattice mismatch defects in higher indium alloys. This study uses plasmonic nanostructures to enhance weakly absorbing InAs quantum dots (QD), achieving resonant detection near 1.85 μm. Finite-difference time-domain modeling guided the design. Fabricated devices with 555 nm pitch reached 15% QE at 1.85 μm, a 30× improvement. However, spectral measurements show better results for a 545 nm pitch, albeit lower in magnitude. Plasmonic arrays have the potential to enable efficient, low-noise infrared detection beyond the InGaAs limit.

2D layered semiconductor exciton dissociation by chiral molecules

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Abstract: We leverage the chiral exciton to dissociate and protect the exciton in 2D materials characterized by the temperature dependent photoluminescence.

Observation of tunneling barrier tuning under high magnetic fields for hopping mediated transport of 2H-$MoTe_2$

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Abstract: We investigate low temperature magnetotransport in few layer $MoTe_2$ field effect transistors fabricated on p doped Si/SiO_2 (285 nm). Devices exhibit giant positive magnetoresistance up to ~1200% in the hopping regime, with the effect strengthening as the gate voltage approaches threshold, indicating hopping mediated transport. By fitting the Fowler–Nordheim tunneling model to high resolution I–V_{sd} data, we extract an effective tunneling barrier that increases with magnetic field in a gate dependent manner, directly linking wavefunction localization, gate control, and hopping magnetoresistance in $MoTe_2$.

Magnetotransport in MoS2-organic superlattice heterostructures

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Abstract: 2D materials represent a unique playground for emerging quantum phenomena such as exotic band structures, electron correlation and topological insulators. Transition metal dichalcogenides attract significant attention due to their widely tunable electronic properties. Furthermore, the atomically-thin nature of these materials makes them extremely sensitive to the environment, allowing for additional degrees of freedom in designing the properties. In this work we demonstrate large unsaturated magnetoresistance in MoS2 crystals and manipulate the magnetotransport through the synthesis of molecular super lattices on the atomically-thin layer.

InGaN-based Nano-LED Arrays Monolithically Integrated with BEOL-Compatible amorphous-IGZO TFTs

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Abstract: A fully monolithic three-dimensional (3D) integration of InGaN nano-LED arrays with amorphous indium gallium zinc oxide (a-IGZO) thin-film transistors (TFTs) is demonstrated using a low-temperature back-end-of-line (BEOL)-compatible process. The approach eliminates the need for conventional mass-transfer techniques and enables scalable fabrication of ultrahigh-density, all-inorganic active-matrix near-eye microdisplays for AR/VR applications. The integrated platform exhibits effective electrical switching and optical modulation, highlighting its strong potential for next-generation immersive display technologies.

Novel ultrafast photophysics of semiconductor quantum dots in photovoltaics

Jianbo Gao

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Abstract: For the very first time, we directly collected the ultrafast short-lived hot carrier as a photocurrent in-situ solar cell devices, and understand hot carrier ultrafast dynamics.

Mechanical Characterization of Beam Springs in Monolithically Integrated MEMS Photonic Actuator Platforms

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Abstract: Electrostatic MEMS actuators for silicon photonic systems require optimized suspension stiffness for efficient actuation. This work numerically investigates the influence of beam spring geometry on the stiffness of a monolithically integrated MEMS photonic actuator using finite-element simulations in COMSOL Multiphysics. The effects of beam spring length, width, and platform thickness are evaluated. The results identify beam width as the dominant stiffness parameter and provide practical design guidelines for beam-supported MEMS photonic actuators.

Toward Accurate Parameterization: Decoupling Contact and Channel Properties in Thin-Film Transistors

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Abstract: In staggered thin-film transistors (TFTs), contact resistance and channel transport are closely linked because carriers must move vertically through the semiconductor before entering lateral conduction. This work combines transmission-line method analysis, photoemission spectroscopy, and drift-diffusion simulation to separate these contributions. The results show that contact resistance cannot be explained only by the charge-injection barrier, since out-of-plane transport also strongly affects the transfer characteristics. This provides a practical route to more accurate TFT parameter extraction.

Scalable Aerosol Jet-Printed Silver Electrodes for Flexible Organic Electronic Devices

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Abstract: Aerosol-Jet printing provides a scalable method for creating maskless patterned electrodes for flexible electronics [1]. However, achieving high resolution and low resistance on plastic substrates remains challenging. Here, we present top-gate bottom-contact (TGBC) organic transistors fabricated on polyimide (500HN Kapton, DuPont) substrates using aerosol-jet-printed silver nanoparticle electrodes.

Influence of Boron Nitride Nanotubes on rr-P3HT-based Organic Thin Film Transistors

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Abstract: The air stability of regioregular poly(3-hexylthiophene) (rr-P3HT) is a limiting factor in organic thin-film transistors (OTFTs) printing. A variety of dielectric materials have been blended with the conjugated P3HT polymer (e.g., PMMA, PS) and encapsulation layers (photoresist or paraffin) have been investigated to address this issue. BNNTs possess high chemical stability, strong oxidation resistance and the ability to form π-π interactions with P3HT. This work demonstrates air stable OTFTs fabricated using blended inorganic BNNTs nanomaterials into the rr-P3HT semiconductor layer.

Narrow Bandgap Conjugated Polymer Donors for Bulk Heterojunction Organic Near-Infrared Photodetectors

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Abstract: Near infrared (NIR) photodetection is critical for various applications including imaging in the biological window, environmental sensing, and health monitoring. Narrow band gaps of NIR-absorbing organic semiconductors increases the probability of leakage charge injection and thermal charge generation in the active layer, resulting in poor detectivity. We synthesized several donor-acceptor type alternating conjugated polymers using thiadiazoloquinoxaline (TQ) as electron-withdrawing unit for NIR photodetection. The best candidate exhibited a detectivity of 2.0 x 1010 Jones at 1200 nm under −1V bias, attributed to its low dark current.

Enabling Nanoscale Focusing of XUV Radiation with Dielectric Nanostructures for Imaging and Fabrication

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Abstract: We introduce an active XUV optical element that simultaneously generates and focuses isolated XUV light to the nanoscale. By illuminating an MgO nanostructured surface with an 800 nm femtosecond laser in transmission, we achieve coherent XUV generation and tight focusing (NA ≈ 0.35). However, IR contamination hampers applications. We suppress it by using p-polarized light at Brewster's angle and optimizing MgO nanofabrication. Also, we developed a numerical model revealing that our linear zone plate design performs exceptionally well even in the nonlinear regime.

Hybride-Epsilon-Near-Zero metasurfaces based on transparent conductive oxides

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Abstract: Hybrid-epsilon-near-zero (Hybrid-ENZ) metasurfaces, combine conventional metasurfaces with the enhanced light matter interactions of ENZ materials. Most of the development to date has focused on optimizing the nanoresonator design for a given ENZ film. In contrast, here we present out work that focuses on optimizing the ENZ film properties together with the nanoresonator to achieve optimal design experience. We demonstrate tuning of the ENZ wavelength across the full NIR spectral range, metasurfaces on ENZ films with both graded and uniform permittivity distributions, as well as ENZ metasurfaces operating at wavelengths below 1000nm.

Enhancing THz Third-Harmonic Generation by Stacking Graphene Layers

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Abstract: Terahertz (THz) third-harmonic generation in graphene is limited by the atomic thickness of a single layer. We investigate decoupled multilayer graphene and measure the THz third-harmonic generation for samples containing up to 15 layers. The third-harmonic field increases with layer number and reaches a maximum for 6-layer graphene, with a 5.5-fold enhancement over single-layer graphene. This optimum reflects the trade-off between cumulative nonlinear generation and linear absorption, highlighting multilayer graphene as a promising platform for compact THz frequency conversion.

Plasma etching of GaAs with high aspect ratios for the fabrication of Bragg gratings

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Abstract: Bragg gratings (BGs) are key photonic components enabling wavelength-selective reflection for sensing, telecom and integrated photonics. Fabricated in high-index materials like GaAs, they require high-aspect-ratio plasma etching to enhance index modulation and reflectivity. However, deep etching can induce roughness and sidewall tilt, causing optical losses. This work presents an optimized process using SiO_2 and Cr hard masks. It includes e-beam lithography, sequential plasma etching of Cr, SiO_2, then GaAs. Results show ~100 nm trenches, low roughness and vertical sidewalls.

Development and characterization of tellurium oxide thin films grown by ECR-PECVD

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Abstract: This work investigates the growth of tellurium oxide (TeO_2) thin films using ECR-PECVD for integrated photonic applications. A Design of Experiments examines the effects of precursors and Ar flow rates on film thickness, composition, and optical properties. Characterization techniques, including RBS, spectroscopic ellipsometry, and positron annihilation spectroscopy, will be used to evaluate composition, optical properties, and atomic-scale defects. The approach aims to improve stoichiometric control and reduce optical losses compared to conventional methods.

Dispersion Engineered Subwavelength Components for the AlGaAs-on-Insulator Platform

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Abstract: III-V semiconductors possess direct energy bandgaps and strong optical nonlinearities, enabling diverse photonic devices. Aluminum gallium arsenide (AlGaAs) is especially attractive due to its negligible two-photon absorption compared to silicon at 1550 nm, making it ideal for all-optical signal processing. Despite great success in silicon photonics, subwavelength engineering in III-V platforms remains underexplored. Here, we achieve dispersion engineering via subwavelength structures in the AlGaAs-on-insulator platform to realize compact photonic components, demonstrating a potential path to monolithically integrated photonic circuits.

From Electrons to Light: Bonding Materials for Next-Generation Photonic Chips

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Abstract: The III–V-on-insulator platform integrates a III–V semiconductor layer onto a silica (SiO_2) cladding, creating a high refractive index contrast that enables strong optical confinement in the core. This improves device compactness and enhances nonlinear performance. Developing the III–V-on-insulator platform begins with wafer bonding a III–V wafer to a silicon wafer with a SiO_2 top layer. After bonding, the III–V substrate and etch-stop layer are removed, exposing the guiding layer and leaving a thin III–V on SiO_2 for device fabrication.

Quantum Dot Lasers for Terabit Optical Networks Applications

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Abstract: This paper presents progress in quantum dot lasers for terabit optical applications. This study focused on improving data transmission capacity, spectral and energy efficiency through advanced laser designs. To assess system performance, experiment evaluation and simulation were conducted where results indicated the enhanced modulation bandwidth, reduced noise, improved thermal stability, and lower power consumption compared to conventional laser technologies. Keywords—Quantum dots, quantum dashes, quantum wells lasers, terabit optical networks, photonic integration, spectral efficiency.

Silicon-Integrated GeSn extended-SWIR Avalanche Diodes for Remote Sensing

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Abstract: Photodetectors have hit the physical limit in terms of sensitivity with a detection of light down to a single-photon. Single-photon detection has revolutionized secure communication by implementing Quantum key distribution (QKD). Single-photon LIDAR is required to efficiently recreate complex landscapes while using the least amount of illumination. However, Ge-on-silicon SPADs are scalable and demonstrated promising performance at temperatures reached with thermoelectric cooling.

Scaleable SOI-Based Metasurfaces for Mid-Infrared Polarization

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Abstract: This research proposes a scalable silicon-on-insulator platform for phase control at 4.4 μm. Arrays of birefringent elliptical nanopillars were designed to manipulate polarization and phase, integrating the functionality of traditional half-wave plate optical elements.

Evaluating $Li_2K_4TiGe_4O_{12}$ and $Cd_4InO(BO_3)_3$ as Candidate Materials for THz Applications

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Abstract: In this work, we investigate two newly developed semiconductors, $Li_2K_4TiGe_4O_{12}$ and $Cd_4InO(BO_3)_3$, with large second-order nonlinearities. Using THz time-domain spectroscopy, we measure their refractive indices and absorption. THz generation by optical rectification is compared with that of a GaP crystal. Both crystals transmit THz radiation: $Li_2K_4TiGe_4O_{12}$ has $n\approx3$ and absorption $<47.5\ cm^{-1}$ (0.4–2 THz), while $Cd_4InO(BO_3)_3$ shows $n\approx1.8$ at low frequencies, rising to ~2 near 2.1 THz, with absorption of $40–308.7\ cm^{-1}$ (0.4–4.5 THz). $Cd_4InO(BO_3)_3$ generates broadband THz emission, whereas $Li_2K_4TiGe_4O_{12}$ produces narrowband radiation at 1.29 THz.

Mechanism of electron-beam-induced fluorescence and radiolysis damage in quartz: influence of carbon coatings

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Abstract: SiO_2 surface layers on common semiconductors including silicon and silicon carbide are readily grown by native oxidation and the resulting semiconductor-oxide interfaces are well understood. For photonics applications, both Si and SiC , due to their indirect gap character, lack highly efficient radiative recombination pathways. In this study, we report on fluorescence based on activated silicon suboxide surface layers that may be activated by radiolysis via electron beam irradiation on pristine quartz during an extended electron beam exposure. XPS, Raman and confocal photoluminescence analysis were used to characterize the surfaces.

Adaptive Ground Station Optical Link for UAV Energy Delivery and High-Throughput Data

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Abstract: A free-space optical (FSO) link between a ground station and a UAV is demonstrated for communication and power beaming. Closed-loop tracking ensures stable alignment, with a retroreflector returning the communication beam for assessment and photonic power converter measuring delivered power. The link supports real-time networking, demonstrated by hosting a multiplayer Minecraft server on the UAV. Measurements are used to validate a turbulence- and weather-aware FSO simulation model.

Probing the Propagation Length of Phonon-Polaritons using Raman Spectroscopy

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Abstract: In van der Waals crystals, the propagation of high-k hyperbolic phonon polaritons (HPhPs) enables functionalities that are impossible with conventional photonics including hyperlensing, compact nanophotonic circuits and ultrathin polarization controllers. For such applications, a trade-off between confinement and loss must be considered for practical device implementation. In this work, position-dependent Raman measurements on ε-GaSe flake reveal variations in the intensity of HPhPs modes. These observations suggest that spatial scanning across the flakes could be used to estimate the propagation length of HPhPs.

Calibration and Characterization of a Two-Junction InGaAsP/InP Photonic Power Converter at 1470 nm

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Abstract: We present the calibration and characterization of a two-junction InGaAsP/InP photonic power converter operating at 1470 nm. Two independent optical power calibration methods were implemented and compared to validate the measurement setup and ensure accurate efficiency determination. Current–voltage (IV) measurements were performed under varying irradiance levels, yielding a peak conversion efficiency of 43.8% at 8.2 W cm^{-2}. The agreement between calibration methods and the consistency of the measured efficiency trends demonstrates the reliability of the experimental workflow.

Deep Learning Surrogate for Simulation of Photonic Power Converters with Luminescent Coupling

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Abstract: Photonic power converters (PPCs) convert laser radiation into electrical power. In multi-junction PPCs, luminescent coupling (LC) enables efficiencies near 70%. However, accurate LC modelling requires computationally prohibitive simulations. We train a neural network (NN) surrogate on simulations of III-V semiconductor PPCs with LC to predict current-voltage (JV) characteristics from absorber layer thicknesses. Simulated JV curves are parametrized, compressing them to multiple parameters that the NN predicts, enabling curve reconstruction.

Geometry-Driven Design Guidelines for Electrostatic Control and Interdot Coupling in Silicon MOS Quantum Dot Devices

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Abstract: Silicon MOS spin qubits are promising for scalable quantum computing. Using QTCAD, we investigated how key design parameters influence single and double quantum dot devices, evaluating lever arm, charging energy, tunnel coupling, exchange energy, and g-factor tunability. Thinner oxide enhances lever arm and g* tunability, while reduced plunger gate length introduces a lever arm and g* tunability trade-off. Shorter tunnel gate length increases tunnel coupling and exchange energy while expanding their voltage tunability range. These results provide geometry-driven design guidelines for exchange-based qubit control.

Statistical Characterization of Trap-State Dynamics in Epitaxial GaN Quantum Defects

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Abstract: Gallium nitride (GaN) is emerging as a practical platform for room-temperature quantum emitter, but its single-photon emitters can blink sometimes as defects switch between bright and dark states. This work probes that instability by statistically characterizing photoblinking and trap-state dynamics in epitaxial GaN emitters. By linking emission jumps to local charge or metastable configurations, we aim to reveal the mechanisms that limit optical stability and guide the engineering of reliable, deterministic GaN quantum emitters for future quantum sensing and photonic technologies.

Impact of Control Pulse Distortions on Spin Qubit Performance in Silicon Quantum Dot Systems

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Abstract: A compact model-based co-simulation framework is developed to quantify the effect of control pulse distortions in silicon quantum dot spin qubits. Voltage-dependent spin parameters are extracted from device simulations, modeled using compact analytical expressions, and embedded in a SPICE-compatible qubit model. Realistic DAC-generated pulses are applied to evaluate amplitude and bias variations in control signals. The model matches quantum simulator (QuDiPy) results with <5% relative error, enabling efficient evaluation of control non-idealities and guiding high-fidelity qubit control and circuit–quantum co-design.

New Photoluminescence Peaks in Carbon-Implanted Germanium: Evidence for Excitons Bound to Isoelectronic Centers

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Abstract: Carbon-implanted bulk Ge was studied by low-temperature photoluminescence after rapid thermal annealing. High-dose samples show new peaks at 0.726, 0.737, 0.738, and 0.739 eV, which appear only at low excitation power and saturate quickly. Their thermal and power dependence is consistent with bound excitons at carbon-related isoelectronic centers. The 0.726 eV feature disappears after annealing at 500°C, suggesting a fragile defect complex.

Dipolar Ising coupling between electron and hole spin qubits in ambipolar SiMOS quantum dots

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Abstract: We present a theory of dipolar ZZ coupling between neighboring electron and hole spin qubits in ambipolar SiMOS double quantum dots. Near the symmetry point, spin-dependent charge displacement generates an electric dipole-dipole interaction whose strength is set by device geometry and electrostatic screening extracted from Schrodinger-Poisson simulations. We optimize the tunnel coupling against quasi-static 1/f^{alpha} noise and gate time, identifying conditions for sub-100-ns control-Z (CZ) gates with infidelity below 10^{-2}. The coupling also predicts a hole-conditioned ESR splitting as a clear experimental signature.

A Quantum Dot-Based Sensing Platform for Detection of Metal Ions in Water

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Abstract: Monitoring metal ions in water is critical for health and environmental safety. This work presents a multi-ion detection platform employing sensor arrays of cross-reactive, multi-material quantum dots (QDs). Monodisperse solutions of $CuInS_2$ QDs synthesized in-house exhibit photoluminescence quenching in the presence of Fe^{3+} analytes, with a strong dependence on ion concentration. Integrating these with complementary semiconductor QDs of MoS_2, C, and Si in the proposed platform will generate distinct fluorescence-quenching patterns upon multi-ion exposure and enable ion identification and quantification through data-informed analysis.

Strategic Specialty Optical Fiber Core Co-Doping for High-Power Transmission: Suppressing SBS via Ultra-Low Brillouin Gain and Broadband Near-Zero Flat Dispersion

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Abstract: Stimulated Brillouin scattering (SBS) limits power scaling in narrow-linewidth fiber lasers and optical frequency comb systems. We propose a co-doped optical fiber featuring an Al_2O_3-GeO_2 core and an F-doped acoustic trench that suppresses acousto-optic overlap while preserving single-mode guidance. The result is an estimated Brillouin gain coefficient of 2.37×10^{-12} m/W, which enables a simulated SBS threshold of ~0.32 W, corresponding to a 18.8-fold improvement over standard SMF-28 fiber. The design also maintains ultra-flat near-zero dispersion, supporting efficient high-power frequency comb generation.

Quantum Dash Layer Stack Optimization for Improved Efficiency in InGaAsP/InP Quantum Dash Lasers

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Abstract: Quantum dash (QDash) lasers employ elongated self-assembled nanostructures that provide quasi-one-dimensional carrier confinement. As a result, QDash lasers have emerged as promising candidates for high-speed optical communication, frequency-comb generation, and next-generation photonic integrated circuits. This work identifies QDash layer stack as a critical design parameter for QDash laser performance and presents a device model simulated in CrossLight PICS3D, that optimizes QDash layer stack in the device structural design for improved efficiency in InGaAsP/InP QDash lasers. Device performance parameters measured on the fabricated device, based on the simulated device model, show improved efficiency.

Engineering Silver Telluride Colloidal Quantum Dots for Near Infrared Photodetection

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Abstract: Near-infrared (NIR) materials are important for photodetection, telecommunications, photovoltaics, and bioimaging. Colloidal quantum dots (CQDs) are attractive because quantum confinement allows their properties to be tuned through particle size and composition, while enabling solution processing. Silver chalcogenide CQDs provide a lead- and mercury-free alternative, and Ag_2Te is especially promising because its low bandgap enables NIR-II absorption and emission. Here, we investigate Ag_2Te CQDs, including preliminary ZnTe shell growth, for telecom-wavelength and low-light photodetection.

Latest Advances with ALD using Canadian Made Hollow Cathode Gas Plasma Sources

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Abstract: Meaglow has been manufacturing its hollow cathode gas plasma sources in Canada now for 17 years. Many of our plasma sources have been highly customised, and development is continuous. Recently we developed a mini plasma source for the NASA Goddard Space Flight Center. This unit was built for the ALD deposition of X-ray telescope reflective layers in space flight experiments, the entire ALD experiment had to fit in two 8” x 8” x 8” rack spaces. Land based testing for ALD deposition of AlF_3 in our own lab was carried out. A description of these experiments and some ellipsometry results will be provided.

Novel Organic Electrolyte-Gated Field Effect Transistors with Polycaprolactone

Shiva Ashoori and Ravi Prakash

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Abstract: It is predicted that 35.6 million cardiovascular deaths will occur by 2050[1]. One of the methods to diagnose a patient having cardiac disease is to measure Cardiac Troponin I (cTnI). cTnI is a highly sensitive biomarker released into the bloodstream when heart muscle damage has occurred[2]. We have previously reported an organic electrolyte-gated field-effect transistor (OEGFET) biosensor that can monitor protein analyte levels in serum and saliva [3]. This work presents early outcomes demonstrating a novel polycaprolactone (PCL)-based antibody-immobilized OEGFET device.

Batch fabrication of ultra-sharp atomic force microscope probes with stair-shaped handles for high-precision imaging

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Abstract: Atomic force microscope systems rely on silicon probes for nanoscale characterization, yet fabricating high-aspect-ratio and ultra-sharp tips with compatible handle geometries remains challenging. Here, a scalable batch fabrication strategy is presented for silicon AFM probes integrating ultra-sharp tips, rectangular cantilevers, and stair-shaped handles. The process uses low-cost ultraviolet lithography, dry etching, and oxidation sharpening to achieve ~5 nm tip radius and 7.5° half-cone angle. The stair-shaped handle enables unobstructed laser detection and compatibility with commercial systems.

Inkjet-Patterned Organic Semiconductor Photodetectors for Amplifier-Free Wearable Pulse Sensing

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Abstract: We successfully developed a fully inkjet-patterned flexible OPD based on TIPS-pentacene/PS for wearable pulse sensing. Device performance was optimized by tuning channel length, illumination intensity, and applied bias. A 200 μm channel provided the best balance between photocarrier generation, dark-current suppression, and charge transport. Under 532 nm illumination at 1.1 $\mu W \cdot cm^{-2}$, responsivity and detectivity increased to 0.54 $A \cdot W^{-1}$ and 4.2×10^{11} Jones, respectively. The device retained photodetection under bending and captured real-time photoplethysmography signals from a fingertip without current-amplifying electronics.

Multimodal Characterization and Localized Stress Mapping of Ion Beam Trimmed Nitride Thin Films on 200 mm Wafers

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Abstract: Aluminum nitride (AlN) and silicon nitride (SiN) thin films are critical for MEMS and photonic devices, yet achieving uniform thickness, controlled stress, and low roughness on 200 mm wafers remains challenging. We investigate ion beam trimming (IBT) as a post-deposition technique on 400 nm AlN and SiN thin films deposited on Si and Si/SiO_2 substrates. Using XPS, XRD, nanoindentation, and PCM structures, we evaluate chemical, structural, and mechanical changes. IBT reduces thickness variation and roughness while enhancing stress distribution uniformity, enabling improved control for large-scale device fabrication.

Charge transport in water-dispersed organic core-shell nanoparticles films

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Abstract: Organic PM6:Y6 nanoparticles prepared by emulsion show temperature-dependent morphology and charge transport. AFM and FET characterizations reveal enhanced mobility and ambipolar behavior upon thermal annealing, highlighting morphology-transport correlation in eco-friendly semiconducting films.

Process-Level Carbon Footprint as a Lever for Eco-Design in MEMS Manufacturing

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(1) C2MI (Canada); (2) Sluicebox AI (United States of America)

Presented by Irina Stateikina

Abstract: This work presents a bottom-up, gate-to-gate life-cycle assessment of the carbon process footprint of a MEMS oscillator. Reference metrics are derived per device and per wafer, accounting for wafer lot size. This first analysis highlights the value of full process-level data access, enabling informed eco-design choices and opening new pathways to reduce environmental burdens across semiconductor manufacturing.

Development of a hybrid additive manufacturing process for high-density interconnects on organic substrates

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Abstract: 3D printing of die-to-die interconnects offers a low-cost and mass-customizable alternative to conventional cleanroom-based fabrication processes. This work presents a hybrid additive manufacturing approach to high-resolution printing by combining electrohydrodynamic jetting of Ag seed structures, rapid intense pulsed light curing, and selective electroless Cu plating. High-density Ag-Cu stacked interconnects were fabricated on organic substrates showing a 500% improvement in conductivity with 800 nm Cu deposited on 1-2 µm wide Ag lines, thus enabling a scalable pathway to high-throughput fabrication of advanced interconnect architectures.

Compliant Porous-Silicon Substrate for High-Frequency $LiNbO_3$ RF Filter Integration

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Abstract: This work addresses the limitations of conventional RF components for 6G by integrating $LiNbO_3$ thin films on silicon. A porous silicon buffer layer is introduced to reduce thermal stress and prevent cracking during high-temperature deposition. The $LiNbO_3$ layers, obtained by DLI-MOCVD on a $LaNiO_3$/Pt/$LaNiO_3$ structure, exhibit high crystalline quality, a unique (012) orientation, and are crack-free. Structural and electrical characterization confirms excellent performance, highlighting the potential of porous silicon for integrating high-frequency devices.

Defects in Diamond: Unlocking Novel Nonlinear Photonics

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Abstract: Diamond's unique material properties–wide bandgap, large refractive index and exceptional thermal conductivity–facilitate fabrication of nanophotonic devices capable of supporting large optical intensities, thereby enhancing light-matter interactions. Defects in diamond have been extensively studied; however, how these defects affect the optical properties of the host crystal is less well-understood. In this work, we observe several novel second-order nonlinear interactions mediated by defects in diamond nanophotonic cavities; we demonstrate deterministic switching of the second-order susceptibility, photorefraction and saturable absorption.

Development of a Thermal Resistance Analysis Testboard for Packaged pGaN HEMTs via the Transient Thermal Method

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Abstract: This research proposed and verified a method for Rth measurement in packaged GaN HEMT devices using transient thermal testing. By utilizing the developed test platform and board, the package thermal resistance can be efficiently extracted. This approach provides valuable and practical insights for thermal management and the optimization of high-performance packaging in pGaN HEMT.

Strain Relaxation and Spontaneous Nanopatterning in SiGe Layers Grown by Oxidative Solid Phase Epitaxy for III-V Heteroepitaxy

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Abstract: This work explores the oxidative solid phase epitaxy (SPE) of Ge+ implanted Si(111) for creating ultra-thin strain-relieving buffer layers for subsequent III-V heteroepitaxy. The microstructure, composition and strain in SiGe/Si(111) samples are examined by transmission and scanning electron microscopy. A hexagonally-packed network of dislocations at the SiGe interface results in a nanopatterning in Ge concentration. The nanopatterning is visible in scanning electron microscopy, presenting a non-destructive method for determining the local strain state—needed for subsequent III-V epitaxy.

Influence of Temperature and Additives on Syntheses of Indium Phosphide Core Quantum Dots

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University of Waterloo (Canada)

Abstract: Indium phosphide (InP) quantum dots (QDs) are promising alternatives to toxic cadmium- or lead-based QDs for display applications. However, InP core QDs are prone to surface oxidation and defects, due to the highly covalent bonding nature in InP, leading to low photoluminescence quantum yield. This work investigates the influence of reaction temperature and fluoride-based additives on the photophysical properties of InP core QDs. An elevated reaction temperature is found to promote improved size uniformity. The ZnF2 additive passivates phosphorus dangling bonds, whereas the NH4PF6 additive passivates both indium and phosphorus dangling bonds.

Nuclear Spin-Free Isotopically Purified Group IV Heterostructures for Qubit Processing

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Abstract: Nuclear spin-free group IV based heterostructures such as Ge/SiGe and Si/SiGe quantum wells (QW), are considered promising material platforms to implement spin-based qubits for quantum processing. In this talk, we present our groups latest advances in the commercially sustainable overgrowth of isotopically purified group IV quantum well heterostructures. We demonstrate the pseudomorphic epitaxial growth of heterostructures with isotopic purities above 99.99% for both ^{70}Ge and ^{28}Si, as determined in X-ray diffraction, transmission electron microscopy and atom probe tomography.