Workshop in Quantum Materials & Devices

Indian Institute of Science Bangalore
Waterloo Institute for Nanotechnology

Indian Institute for Science, Bangalore

Indian Institute of Science (IISc), established in 1909, is a public deemed research university for higher education and research. The Institute consistently ranks among the top Indian universities in global rankings and has been recognized as an Institute of Eminence (IoE) by the Government of India in July 2018.

With a mission to lay a solid foundation for the field of quantum technologies, and to establish a framework to promote collaborations between physicists, material scientists, computer scientists and engineers, IISc launched its Quantum Technologies Initiative (IQTI) in September 2019. It would leverage the Institute's research expertise in the area of quantum technologies, and at the same time, form a visionary research and development platform through national and international collaborations. This initiative is envisaged not to be just purely academic science; it would actively engage with industry and strategic partners to create technology with economic benefits and social impact.

Waterloo Institute for Nanotechnology

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

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

Workshop Agenda

Day 1 Schedule – February 17, 2021

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TIME	SCHEDULE
8h00 EST/18h30 IST	Welcoming remarks
8h00-8h05 EST/ 18h30-18h35 IST	**Navakanta Bhat:** Dean of Interdisciplinary Sciences, Indian Institute of Science **Apoorva Patel:** Professor, Indian Institute of Science
8h05-8h10 EST/ 18h35-18h40 IST	**Sushanta Mitra:** Executive Director, Waterloo Institute for Nanotechnology (WIN), University of Waterloo
	Technical Session 1: Quantum Technology **Session Chair: Lisa Pokrajac, Waterloo Institute for Nanotechnology**
8h10-8h30 EST/ 18h40-19h00 IST	Presenter IISc 1: **Vibhor Singh** Department of Physics Title: Superconducting hybrid optomechanical devices
8h30-8h50 EST/ 19h00-19h20 IST	Presenter UWaterloo/WIN 1: **Na Young Kim** Department of Electrical & Computer Engineering Title: Solid state quantum simulators: block exciton-polaritons
8h50-9h10 EST/ 19h20-19h40 IST	Presenter IISc 2: **Varun Raghunathan** Department of Electrical Communication Engineering Title: Emerging Nonlinear photonic devices for Quantum applications
9h10-9h30 EST/ 19h40-20h00 IST	Presenter UWaterloo/WIN 2: **Youngki Yoon** Department of Electrical & Computer Engineering Title: Multi-level simulations: From materials to devices and circuits
9h30-9h50 EST/ 20h00-20h20 IST	Presenter IISc 3: **Jaydeep K Basu** Department of Physics Title: Quantum Photonics with Plasmonic Cavity Coupled Quantum Dots: Single Photon to Collective & Long-Range Emission
9h50-10h10 EST/ 20h20-20h40 IST	Presenter UWaterloo/WIN 3: **Zbig Wasilewski** Department of Electrical & Computer Engineering Title: Elucidating the nature of interfaces in III-V materials heterostructures
	End of Technical Session 1

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UNIVERSITY OF WATERLOO

WATERLOO INSTITUTE FOR nanotechnology

Workshop Agenda
Day 2 Schedule – February 18, 2021

CLICK HERE TO JOIN THE SESSION

*presentations will be recorded for posting online for general viewing with speakers' consent

TIME	SCHEDULE
	Technical Session 2: Quantum materials and Engineering **Session Chair: Akshay Naik, Indian Institute of Science**
8h00-8h20 EST/ **18h30-18h50 IST**	IISc Presenter IISc 4: **Abhishek Singh** Title: Data-driven Materials Science
8h20-8h40 EST/ **18h50-19h10 IST**	Presenter UWaterloo/WIN 4: **Adam Wei Tsen** Department of Chemsitry Title: Giant c-axis nonlinear anomalous Hall effect in T_d-$MoTe_2$
8h40-9h00 EST/ **19h10-19h30 IST**	IISc Presenter IISc 5: **Kausik Majumdar** Title: Tuning electronic functionalities using complex van der Waals heterojunctions
9h00-9h20 EST/ **19h30-19h50 IST**	Presenter UWaterloo/WIN 5: **Kevin Musselman** Department of Mechanical & Mechatronics Engineering Title: Spatial ALD thin-films and laser-processed 2D nanoparticles for quantum-enabled Devices
9h20-9h40 EST/ **19h50-20h10 IST**	IISc Presenter IISc 6: **Mayank Shrivastava** Title: Electrothermal transport induced material reconfiguration and performance degradation of CVD-grown monolayer MoS2 transistors
9h40-10h00 EST/ **20h10-20h30 IST**	Presenter UWaterloo/WIN 6: **Guoxing Miao** Department of Electrical & Computer Engineering Title: Layered quantum materials
	End of Technical Session 2
10h00-10h05 EST/ **20h30-20h35 IST**	Closing Remarks **Arindam Ghosh:** Professor, Indian Institute of Science **Sushanta Mitra:** Executive Director, Waterloo Institute for Nanotechnology (WIN), University of Waterloo
	End of workshop

Abstracts

Technical Session 1: Theme – Quantum Technology

Presenter IISc 1: Vibhor Singh
8h10-8h30 EST/18h40-19h00 IST

Contact Details:
Vibhor Singh, Assistant Professor
Department of Physics
Indian Institute of Science
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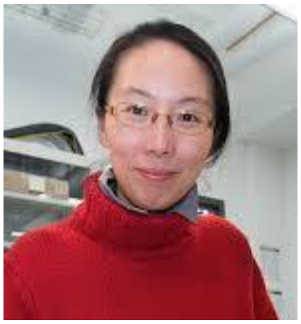
Title: Superconducting hybrid optomechanical devices

Abstract: Control over the quantum states of a massive oscillator is important for several technological applications and to test the fundamental limits of quantum mechanics. Recently, hybrid electromechanical systems using superconducting qubits, based on electric-charge mediated coupling, have been quite successful in this regard. In this talk, I will present our efforts in this direction. I shall introduce a hybrid device, consisting of a superconducting transmon qubit and a mechanical resonator coupled using the magnetic flux. Due to the large coupling between qubit and mechanical resonator is manifested in the observation of the Landau–Zener–Stückelberg effect. In addition, some results from the relaxation of a transmon qubit from unconfined states will be presented.

Biography: Vibhor Singh is an Assistant Professor in the Department of Physics, IISc. The focus of his research is on superconducting devices based emerging quantum technology. Research in his lab spans a variety of activities such as cavity-opto-mechanics in microwave domain, superconducting materials for quantum devices, circuit-QED systems, superconducting qubit-based hybrid optomechanical systems.



Presenter UWaterloo/WIN 1: **Na Young Kim**
8h30-8h50 EST/ 19h00-19h20 IST

Contact Details:
Na Young Kim, Associate Professor
Department of Electrical & Computer Engineering
University of Waterloo
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Title: Solid state quantum simulators: block exciton-polaritons

Abstract: We aim to build solid-state quantum systems and especially we have been working on exciton-polariton quantum simulators, with which we like to construct a designated Hamiltonian solver. Microcavity excition-polaritons are hybrid quantum quasi-particles as an admixture of cavity photons and quantumwell excitons. In order to search for novel phases resulting from the interplay of geometry, spin and interaction, we engineered two-dimensional (2D) honeycomb lattices where Bloch exciton-polaritons form artificial bandstructures and their properties are explained with the two-flavor Hamiltonians.

Biography: Dr. Na Young Kim is Associate Professor in Electrical and Computer Engineering and Institute for Quantum Computing at the University of Waterloo. Dr. Kim studies quantum electronics, quantum optics, cavity quantum electrodynamics, condensed matter physics, and quantum information science and technology. Her primary contributions in quantum electronics and quantum optics were published in top-tier science and engineering journals, including the direct observation of strongly correlated Tomonaga-Luttinger liquid properties from the first shot noise measurement with ballistic single-walled carbon nanotubes in Physical Review Letters, and the first observation of degenerate high-orbital condensates in artificial lattices in Nature and Nature Physics. She is a recipient of AKPA Outstanding Young Research Award in 2012, and she has delivered more than 70 invited talks at international venues.

Presenter IISc 2: Varun Raghunathan
8h50-9h10 EST/ 19h20-19h40 IST

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Department of Electrical and Communication Engineering
Indian Institute of Science
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Title: Emerging onlinear photonic devices for Quantum applications

Abstract: Traditional bulk nonlinear crystal based spontaneous parametric down-conversion (SPDC) light sources used in quantum applications are being replaced by integrated waveguide and resonant cavity devices with high efficiency, small footprint, and the capability of large-scale integration. There is interest in further miniaturization by exploring the use of sub-wavelength dielectric resonant metasurface platforms and two-dimensional layered materials for realizing nonlinear photonic devices. Such light sources can find potential application in free-space quantum communication, spatial mode encoding etc. In this talk, we will discuss some of our recent efforts towards understanding nonlinear optical properties of emerging two-dimensional materials and realizing resonant enhancement of harmonic generation in silicon nanostructure arrays coupled to such high nonlinearity 2D materials. The utility of these devices as quantum light sources with unique polarization properties will also be discussed.

Biography: Varun Raghunathan is an Assistant Professor in the Department of Electrical Communication Engineering. His research interest lies in experimental photonics with a major focus on non-linear optics, integrated optic, flat land photonic components, and optical microscopy. His research group works on the design, fabrication and experimental characterization of micro-/ nano-fabricated photonic devices.

Presenter UWaterloo/WIN 2: Youngki Yoon
9h10-9h30 EST/ 19h40-20h00 IST

Contact Details:
Professor Youngki Yoon, Associate Professor
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Title: Multi-level simulations: From materials to devices and circuits

Abstract: In this talk, I will introduce a multi-level simulation approach to investigate novel nanomaterials and their electronic devices, which will be further extended to circuit analysis and optimization through compact modeling. In particular, the unique material property of two-dimensional (2D) $PtSe_2$ will be discussed and I will demonstrate its direct impact on device performance. I will also explain how a virtual source model could be modified considering the unique nature of 2D materials. If time permits, I will also show our recent result of negative capacitance devices.

Biography:
Dr. Youngki Yoon is currently an Associate Professor in the Department of Electrical and Computer Engineering at the University of Waterloo, Waterloo, Ontario, Canada. His research focuses on modeling and simulation of emerging and exploratory devices. He received Early Researcher Award from the Ministry of Research, Innovation and Science of Ontario, and Waterloo Institute for Nanotechnology (WIN) Research Leader Award, both in 2018. Dr. Yoon was the Director of Nanotechnology Engineering Program of the University of Waterloo in 2018-2020. Dr. Yoon served on the Institute of Electrical and Electronics Engineers (IEEE) Electron Devices Society (EDS) Technical Committee in Nanotechnology in 2017-2020, and he was also a guest editor of IEEE Transactions on Electron Devices for a special issue on '2D Materials for Electronic, Optoelectronic and Sensor Devices' in 2017-2018.

Presenter IISc 3: Jaydeep K Basu
9h30-9h50 EST/ 20h00-20h20 IST

Contact Details:
Jaydeep K Basu, Professor
Department of Physics
Indian Institute of Science
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Title: Quantum Photonics with Plasmonic Cavity Coupled Quantum Dots: Single Photon to Collective & Long-Range Emission

Ravindra K Yadav & Jaydeep K Basu

Abstract: We will discuss our recent results on coupling of colloidal quantum dot (QD), all the way from single to compact assemblies, to plasmonic nanocavity arrays. With single isolated QDs we were able to distinguish quantum coupling to localised surface plasmon and surface lattice resonances modes in plasmonic nanocavity arrays while also suggesting existence of indirect excitation of remote QDs mediated by the lattice modes. Further increase of QD density allows exploration the weak-to-strong coupling transition in in these hybrid devices at room temperature. Using generalized retarded Fano–Anderson and effective medium models it was observed that while individual QD are found to interact locally with the lattice yielding Purcell-enhanced emission, at high QD densities, polariton states emerge as two-peak structures in the photoluminescence, with a third polariton peak, due to collective QD emission, appearing at still higher QD concentrations. Finally, we also demonstrate ultralong-range optical energy propagation in these hybrid quantum photonic devices due to excitons in SQDs strongly coupled to surface lattice resonances (SLRs) in the nanoparticle array. We provide direct evidence for the detection of an exciton-SLR (ESLR) strongly coupled mode at least 600 µm away from the region of excitation. We also observe existence of additional energy propagation the range of which goes well beyond that of the ESLR mode and is dependent on the magnitude of strong coupling, g. Cavity quantum electrodynamics (cQED) calculations correctly capture the nature of the experimentally observed PL spectra for consistent values of g, while coupled dipole (CD) calculations show a QD number dependent electric field decay profile away from excitation region which is consistent with the experimental spatial PL profile. Our results indicate that this highly flexible quantum photonics platform for the manipulation of collective spontaneous emission using lattice plasmons, could find applications in optoelectronics and ultrafast optical switches. In addition, it suggests an exciting new direction wherein SLRs or high-quality plasmonic modes can be used to mediate long-range interactions between QDs or other quantum emitters, having various possible applications in sensing and quantum information science.

Biography: Jaydeep K Basu is a Professor in the Department of Physics, IISc. His research interests include soft condensed matter physics, physics of biological systems, nanophotonics, quantum plasmonics, topological photonics. His group has developed considerable expertise in fabrication of single photon emitting quantum emitters as well as their arrays which can be readily coupled to optical and metamaterial templates. His group's work in the area of light-matter interactions at the nanoscale is well recognized

Presenter UWaterloo/WIN 3: Zbigniew Wasilewski
9h50-10h10 EST/ 20h20-20h40 IST

Contact Details:
Zbigniew Wasilewski, Professor
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University of Waterloo
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Title: Elucidating the nature of interfaces in III-V materials heterostructures

Abstract: Most of the semiconductor or semiconductor-superconductor-based quantum devices rely on layered structures, combining epitaxially grown materials with different properties such as bandgaps, band alignment, or conductivity types. Considerable progress has been achieved by modeling such systems using properties of the bulk constituent materials. However, as some of the layers' thickness approaches sub-nanometer dimensions, the nature of the interfaces between adjacent layers becomes very important. Good examples here are quantum cascade lasers (QCLs), with many having well over a thousand interfaces. Moreover, some interfaces, notably in InAs/AlSb QCLs, are very complex, and their exact structure depends sensitively on growth conditions and details of employed growth procedures. In this case, both group III and V atoms change across the interface. The III-V bonds at the interface – Al-As and In-Sb – have very different lengths from the constituent materials bonds, causing significant interfacial strain perturbing electronic states in both InAs wells and AlSb barriers. Much remains to be done in understanding how such interfaces influence the device properties. Simultaneously, the atomic scale of the problems creates challenges in characterizing such interfaces and correlating their structure with the growth conditions. In this presentation, I will discuss some examples of our current work to elucidate the structure of such interfaces and relate it to the optimization of molecular beam epitaxial growth of QCLs in mid-IR and THz spectral regions.

Biography: Zbig Wasilewski is a Professor in the Electrical and Computer Engineering Department at the University of Waterloo. He is internationally renowned for his contributions to the field of Molecular Beam Epitaxy, quantum-dot and quantum-well photonic devices, as well as quantum structures based on high mobility 2D electron gases.

Dr. Wasilewski earned his doctoral degree from the Institute of Physics of the Polish Academy of Sciences in 1986, based on his magneto-optical studies of semiconductors under high hydrostatic pressures. In 1988, after a post-doctoral appointment at the Imperial College, London, he joined the National Research Council of Canada, focusing on molecular beam epitaxial growth and characterization of quantum structures based on III– V semiconductor compounds. In July 2012, Dr. Wasilewski joined the University of Waterloo as a full Professor and the University of Waterloo Endowed Chair in Nanotechnology, where he established the Quantum-Nano Centre MBE Facility (QNC-MBE).

Abstracts
Technical Session 2: Theme – Quantum Materials and Engineering

Presenter IISc 4: Abhishek Singh
8h00-8h20 EST/ 18h30-18h50 IST

Contact Details:
Abhishek Singh, Associate Professor
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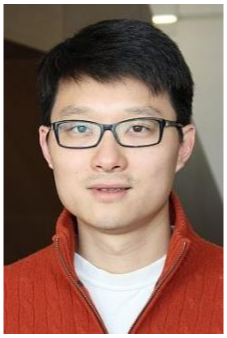
Title: Data-driven Materials Science

Abstract: Data driven machine learning methods in materials science are emerging as one of the promising tools for expanding the discovery domain of materials to unravel useful knowledge. In this talk, the power of these methods will be illustrated by covering three major aspects, namely, development of prediction models, establishment of hidden connections and scope of new algorithmic developments. For the first aspect, we have developed accurate prediction models for various computationally expensive physical properties such as band gap, band edges and lattice thermal conductivity. The prediction model for band gap and band edges are developed on 2D family of materials -MXene, which are very promising for a wide range of electronic to energy applications, which rely on accurate estimation of band gap and band edges. These models are developed with GW level accuracy, and hence can accelerate the screening of desired materials by estimating the band gaps and band edges in a matter of minutes. For the lattice thermal conductivity prediction model, an exhaustive database of bulk materials is prepared. By employing the high-throughput approach, several ultra-low and ultra-high lattice thermal conductivity compounds are predicted. The property map is generated from the high-throughput approach and four simple features directly related to the physics of lattice thermal conductivity are proposed. The performance of the model is far superior than the physics-based Slack model, highlighting the simplicity and power of the proposed machine learning models. For the second aspect, we have connected the otherwise independent electronic and thermal transport properties. The role of bonding attributes in establishing this relationship is unraveled by machine learning. An accurate machine learning model for thermal transport properties is proposed, where electronic transport and bonding characteristics are employed as descriptors. In the third aspect, we have proposed a new algorithm to develop highly transferable prediction models. The approach is named as guided patchwork kriging, which is applied for prediction of

lattice thermal conductivity. We will also discuss the scope these materials in accelerated search for Quantum Materials.

Biography: Abhishek Singh is an Associate Professor at the Material Research Centre, IISc. His research interests include quantum ab-initio theory for real materials, machine learning and material database generation, hydrogen generation and storage, mechanical, structural, electronic, and magnetic properties of nanostructures, theory of defects, impurities, doping and diffusion in bulk and reduced dimensional systems, thermal and electrical transport and quasiparticle and optical excitations. His group has found several ultra-low and ultra-high lattice thermal conductivity materials and developed a ML model to predict thermal conductivity of a large class of materials using physics driven four parameters.



Presenter UWaterloo/WIN 4: Adam Wei Tsen
8h20-8h40 EST/ 18h50-19h10 IST

Contact Details:
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University of Waterloo
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Title: Giant c-axis nonlinear anomalous Hall effect in Td-MoTe2

Abstract: While the anomalous Hall effect can manifest even without an external magnetic field, time reversal symmetry is nonetheless still broken by the internal magnetization of the sample. Recently, it has been shown that certain materials without an inversion center allow for a nonlinear type of anomalous Hall effect whilst retaining time reversal symmetry. Here, the application of a harmonic longitudinal current or voltage generates a second harmonic component in the transverse direction. I will discuss our observation of an extremely large c-axis nonlinear anomalous Hall effect in the non-centrosymmetric Td phase of MoTe2 without intrinsic magnetic order, whose strength obeys a general scaling with sample conductivity. Application of higher bias yields a Hall ratio of 2.47 and anomalous Hall conductivity of order 108 S/m. The former is the largest outside the quantum Hall regimes, while the latter is the largest yet observed in any material.

Biography: Adam Wei Tsen joined the University of Waterloo in 2016, working in structural, optical and electronic properties of low-dimensional quantum materials, nanoscale electronic devices, and novel microscopy techniques for materials characterization. Before joining UW, Professor Tsen held a postdoctoral position at the Department of Physics at Columbia University with Abhay Pasupathy and Philip Kim, where he studied atomically thin quantum materials for nanoscale electronic devices. He earned his BSc in Electrical Engineering & Computer Science, and in Engineering Physics at the University of California Berkeley, and completed his doctorate in Applied Physics at Cornell University in the Jiwoong Park research group.

Presenter IISc 5: Kausik Majumdar
8h40-9h00 EST/ 19h10-19h30 IST

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Title: Tuning electronic functionalities using complex van der Waals heterojunctions

Abstract: Complex van der Waals (vdW) heterojunctions are attractive because of their atomically sharp interface, gate tunability, and strong electro-optical activity. Their robustness against lattice mismatch between the successive layers allows possible integration with dissimilar materials and of varying dimensionality. In this talk, our recent results on stacking heterogeneous materials to obtain new electronic and optoelectronic functionalities will be discussed. As a specific example, the demonstration of a robust van der Waals Esaki diode with large peak-to-valley current ratio, and its versatility as a voltage-controlled oscillator and as a one-bit memory will be discussed. As another example, the demonstration of strong quantum-confined Stark effect (QCSE) will be discussed in monolayer and bilayer semiconducting systems, and the impact of layer dependent reflection symmetry breaking will be emphasized in tuning the nature of QCSE.

Biography: Kausik Majumdar is an Associate Professor at the Department of Electrical Communication Engineering. His research group uses a combination of theoretical and experimental techniques to investigate the electrical and optoelectronic properties of low dimensional materials and their nanostructures. They also explore the possibilities of applying these properties to develop novel devices, encompassing the entire spectrum of device design and simulation, device fabrication using state of the art semiconductor fabrication techniques, and device characterization using various electrical, optical and spectroscopic techniques.

Presenter UWaterloo/WIN 5: Kevin Musselman
9h00-9h20 EST/ 19h30-19h50 IST

Contact Details:
Kevin Musselman, Assistant Professor
Department of Mechanical & Mechatronics Engineering
University of Waterloo
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Title: Spatial ALD thin-films and laser-processed 2D nanoparticles for quantum-enabled Devices

Abstract: Professor Musselman's Functional Nanomaterials Group focuses on the development of spatial atomic layer deposition (SALD) thin film technology, laser-processing of two-dimensional nanoparticles, and the application of these materials in a variety of devices including solar cells, quantum-tunneling metal-insulator-metal diodes, gas sensors, chemical sensors, cancer theranostic agents, and memristive devices. In this talk, Prof. Musselman will introduce the SALD technology for fabricating nanoscale metal oxide thin films and the laser-processing technique for simultaneously fabricating and functionalizing 2D nanoparticles, such a graphene, MoS_2, and WS_2. He will provide examples of the use of these materials as insulating layers in MIM diodes and as stability-enhancing additives to the hole transport layer of a perovskite solar cell.

Biography: Dr. Musselman received his PhD from the University of Cambridge (Department of Materials Science) in 2011 and was a Junior Research Fellow in the Department of Physics at Cambridge before joining the University of Waterloo in 2015. His research focuses on the development of functional nanomaterials for a variety of applications, with a particular emphasis on sustainability and health. Materials of interest include nanostructured metal oxides, nanoparticles of 2D materials, and metal halide perovskites, among others. Current topics of focus include: developing scalable manufacturing processes for nanomaterials, including new spatial atomic layer deposition techniques, improving the stability of next-generation devices, such as perovskite photovoltaics, developing 2D materials for chemical sensing of toxic heavy metal pollutants, developing 2D materials for cancer imaging and therapy, and integrating combinatorial approaches and machine learning into the development of nanomaterials.

IISc Presenter IISc 6: Mayank Shrivastava
9h20-9h40 EST/ 19h50-20h10 IST

Contact Details:
Mayank Shrivastava, Associate Professor
Department of Electronic Systems Engineering
Indian Institute of Science
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Title: Electrothermal transport induced material reconfiguration and performance degradation of CVD-grown monolayer MoS2 transistors

Abstract: Device and material reliability of 2-dimensional materials, especially CVD-grown MoS2, has remained unaddressed since 2011 when the first TMDC transistor was reported. For its potential application in next generation electronics, it is imperative to update our understanding of mechanisms through which MoS2 transistors' performance degrades under long-term electrical stress. We report, for CVD-grown monolayer MoS2, results on temporal degradation of material and device performance under electrical stress. Both low and high field regimes of operation are explored at different temperatures, gate bias and stress cycles. During low field operation, current is found to saturate after hundreds of seconds of operation with the current decay time constant being a function of temperature and stress cycle. High field operation, especially at low temperature, leads to impact ionization assisted material and device degradation. It is found that high field operation at low temperature results in amorphization of the channel and is verified by device and kelvin probe force microscopy (KPFM) analyses. In general, a prolonged room temperature operation of CVD-grown MoS2 transistors lead to degraded gate control, higher OFF state current and negative shift in threshold voltage (VT). This is further verified, through micro-Raman and photoluminescence spectroscopy, which suggest that a steady state DC electrical stress leads to the formation of localized low resistance regions in the channel and a subsequent loss of transistor characteristics. Our findings unveil unique mechanism by which CVD MoS2 undergoes material degradation under electrical stress and subsequent breakdown of transistor behavior. Such an understanding of material and device reliability helps in determining the safe operating regime from device as well as circuit perspective.

Biography: Mayank Shrivastava is an Associate Professor in the Department of Electronic Systems Engineering, IISc. His group works on the science and technology of electron devices, having focus on power semiconductor devices as well as nanoscale / beyond Si CMOS for SoC applications. Given a strong focus on the semiconductor technology for the future electronics, the group also work on a multitude of science threads like (i) physics of semiconductor device reliability, (ii) electro-thermal / electron – phonon interaction in beyond Si materials / devices, (iii) thermometry and thermal / phonon transport in these materials / devices.

Presenter UWaterloo/WIN 6: Guo-Xing Miao
9h40-10h00 EST/ 20h10-20h30 IST

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Title: Layered quantum materials

Abstract: Layered materials are useful toolset to engineer novel devices towards both quantum and classical information processing. We show our efforts on topological insulators and Weyl semimetals, where the protected Dirac band structures serve as the platform to potentially host exotic composite particles for further manipulations. Specifically, in a vertical topological insulator Josephson junction, edge currents show Andreev bound states centered at zero energy signaturing presence of unconventional fermions. On the other hand, planar Hall effects in Weyl semimetals reveal mixed type of the Weyl fermions. Separately, we also show that ion infusion in layered cathode materials can add spintronic modulations into battery-like devices.

Biography: Guo-Xing Miao received his PhD from Brown University in 2006, and then went on to roles as a postdoctoral associate and research scientist at the Francis Bitter Magnet Laboratory at MIT. He later joined University of Waterloo and is currently Associate Professor in the Electrical and Computer Engineering Department and the Institute for Quantum Computing (IQC). Professor Miao's research interests focus on a particular aspect of the electrons – their spin degrees of freedom, and use precise electron spin manipulation for information processing. His work places a strong emphasis on nano electronic and ionic devices established on newly emerging spin platforms, such as topologically nontrivial and low dimensional materials, where information can be processed coherently on the quantum level, rather than digitally on the classical level.