Online event via ZOOM

WIN-ICN2 Joint Online Workshop

18 February 2025

15:00 CET / 9:00 EST
to
18:00 CET / NOON

ICN2
Institut Català de Nanociència i Nanotecnologia

University of Waterloo | Waterloo Institute for nanotechnology

Waterloo Institute for Nanotechnology

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

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

Institut Català de Nanociència i Nanotecnologia

The Catalan Institute of Nanoscience and Nanotechnology (ICN2), is a leading international research institute devoted to generating knowledge, materials and devices in ICT, health, energy and the environment. ICN2 has a strong interdisciplinary approach, bringing together experts in physics, chemistry, and engineering to explore the unique properties of nanoscale materials and devices.

Located at the Autonomous University of Barcelona (UAB) campus close to Barcelona (Catalonia, Spain), ICN2 is part of a unique ecosystem of academic and industrial partners, providing world-class facilities for researchers and fostering collaborations to advance cutting-edge nanoscience and nanotechnology research and its real-world applications.

Time (EST)	Title	Speaker
9:00 - 9:05 am	**Welcome**	**Jose A. Garrido**, *Vicedirector* (ICN2) **Sushanta Mitra**, *Executive Director* (WIN)
HEALTH		
9:05 - 9:12 am	Aptamer-based biosensors for antibiotics	**Juewen Liu**
9:12 - 9:19 am	DNA-based sensors for bioanalytical applications	**Marianna Rosetti**
9:19 - 9:26 am	NanoBiomaterials for 3D Bioprinting	**Shirley Tang**
9:26 - 9:33 am	Bidimensional materials-based medical implants with ultimate sensing capabilities	**Elena del Corro**
9:33 - 9:40 am	Multiplexed surface-enhanced Raman spectroscopy of live biological models	**Jung-Ho Yu**
9:40 - 9:47 am	Graphene-based thin-film neuroelectronic devices	**Eduard Masvidal**
9:47 - 9:54 am	Enhanced neuronal differentiation on nanopatterned biomaterials for potential cell therapy	**Evelyn Yim**

CLIMATE, ENERGY AND MOBILITY		
Time (EST)	**Title**	**Speaker**
9:54 - 10:01 am	Noise-driven resonant sensors	**Eihab Abdel-Rahman**
10:01 - 10:08 am	Dual-Energy tomosynthesis of the chest using a triple layer X-ray Detector	**Karim Karim**
10:08 - 10:15 am	How Nanohybrid materials can lead to better energy storage	**Pedro Gomez**
10:15 - 10:22 am	Solar to hydrogen generation: Photoelectrochemical devices	**Vivek Maheshwari**
10:22 - 10:29 am	Machine Learning strategies to accelerate the discovery of novel materials for CO_2 capture & utilization	**Luis Ricardez-Sandoval**
10:29 - 10:36 am	Recent advances in energy harvesting and vibrations laboratory	**Armaghan Salehian**
10:36 - 10:43 am	Nanomaterials at the atomic scale	**Jordi Arbiol**
10:43 - 10:50 am	The phase change material (PCM) technology and its application in the development of advanced RF devices	**Raafat Mansour**
10:50 - 10:57 am	Examining different clean energy carriers' roles in decarbonization	**XiaoYu Wu**
10:57 - 11:04 am	Magnetic/optic-based materials for biomedical applications, energy and environmental remediation	**M. Jose Esplandiu**
11:04 - 11:11 am	Single atom alloy electrocatalysis and microenvironment for CO_2	**Yimin Wu**

FOOD, BIOECONOMY, NATURAL RESOURCES, AGRICULTURE AND ENVIRONMENT		
Time (EST)	**Title**	**Speaker**
11:11 - 11:18 am	Inorganic nanoparticle tools for energy, environment and medicine	**Víctor F. Puntes**
11:18 - 11:25 am	Nanofibre and nanopaper for sensors and flexible functional materials	**Leonardo Simon**
11:25 - 11:32 am	Sustainable approaches for the development of advanced materials and their application in Health and Environment	**Salvio Suárez**
11:32 - 11:39 am	Surface science, bionanomaterials and antimicrobial nanoengineering	**Boxin Zhao**
11:39 - 11:46 am	DFT and Hybrid QM/MM large scale simulations	**Pablo Ordejón**
11:46 - 11:53 am	Liquid-Liquid Encapsulation: Novel technique to create value-added sustainable products	**Sushanta Mitra**
11:53 - noon	**Joint Seed Funding announcement and Closure**	**Jose A. Garrido** *Vicedirector* (ICN2) **Sushanta Mitra** *Executive Director* (WIN)

Speakers and Abstracts

Waterloo Institute for Nanotechnology

Juewen Liu

Department of Chemistry

Title: **Aptamer-based biosensors for antibiotics**

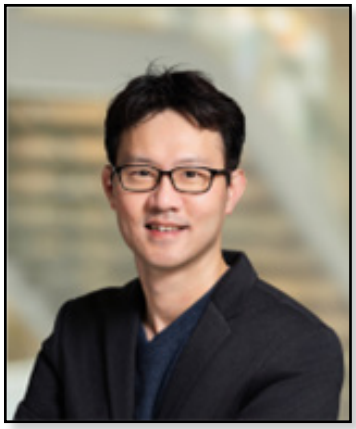
Abstract: In this talk, I will discuss the selection of new DNA aptamers for a few important antibiotics including oxytetracycline, chloramphenicol, kanamycin and sulfonamide. These aptamers all have a simple hairpin structure and most have nanomolar affinities. Some can detect a class of antibiotics. They have been developed to biosensors with a fluorescence readout. We expect them to be useful for designing biosensors for food and environmental analysis.

Shirley Tang

Department of Chemistry

Title: **NanoBiomaterials for 3D Bioprinting**

Abstract: 3D bioprinting is an additive manufacturing process which allows precise positioning of biomaterials and living cells to create 3D architectures that imitate natural tissues and organs. Even though 3D bioprinting technologies are advancing at a rapid pace, major challenges remain, including the limited selection of ink formulations. Here, I report a series of recent studies on hybrid ink systems incorporating nanomaterials (NMs) and polymers for high-resolution and high-speed printing via microextrusion and digital light processing (DLP). Our results show that NM-polymer hybrid inks can be designed to possess suitable rheological, mechanical, biological, and chemical characteristics to achieve printability and cell/tissue compatibility simultaneously. Highlighted in this talk are the printing of 3D heterogeneous tissue mimetics, stem cell transporters, and microfluidic cell culture devices. Our studies offer promising new strategies for the fabrication of in-vitro disease models and test platforms, as well as transplantable scaffolds, that can find important applications in biomedical research, drug discovery, and stem cell therapy.



Jung-Ho Yu

Department of Chemistry

Title: **Multiplexed surface-enhanced Raman spectroscopy of live biological models**

Abstract: I will propose surface-enhanced Raman spectroscopic platform for the measurement of multiple biological components across diverse live biological environments, including single-cell analysis, in vivo studies, and point-of-care diagnostics settings.

Evelyn Yim

Department of Chemical Engineering

Title: **Enhanced neuronal differentiation on nanopatterned biomaterials for potential cell therapy**

Abstract: Stem cells respond to both physical and biochemical changes in their stem cell niche. Studies have shown that physical forces from the substrate topography play a role in stem cell proliferation and cell fate determination. Our research group is interested in studying the interactions of adult and pluripotent stem cells with nanotopography, the mechanism of the topography-induced cell behavior and how to apply this knowledge to direct stem cell differentiation. We demonstrated that the application of anisotropic topography enhanced neuronal differentiation. Our study of temporal presentation of topography during human pluripotent stem cell neuronal differentiation showed that the topography contact during the differentiation period is necessary and significant for topography-induced differentiation.

Eihab Abdel-Rahman

Department of Systems Design Engineering

Title: **Noise-driven resonant sensors**

Abstract: We will discuss new paradigm to design and operate nano sensors that allow us to realize cheaper and more sensitive sensors. It turns thermal noise into a drive signal, reduce the noise floor, and increase the measurement range. The talk will briefly present the underlying theory and proof-of-concept noise-driven pressure and temperature sensors. We will also sketch the outlines of extending this concept into noise-aware sensors that combine the traditional external drive with statistically stationary noise processes.

Karim Karim

Department of Electrical and Computer Engineering

Title: **Dual-energy tomosynthesis of the chest using a triple layer X-ray detector**

Abstract: Portable tomosynthesis with material separation may provide material separation with depth localization at the point-of-care, improving patient outcomes and reducing referrals to computed tomography (CT). In this preliminary study we investigate composing dual-energy subtraction algorithms with tomosynthesis reconstruction on phantom data acquired with the Reveal 35C triple-layer detector. Sixty-one projections over a 30-degree angle were acquired by linearly translating the X-ray source. Data were reconstructed into a grid of 0.14 mm × 0.14 mm × 0.5 mm voxels using a least squares objective function. Material separation was achieved using traditional logarithmic subtraction and a proprietary algorithm. The results demonstrate that subtraction and reconstruction algorithms can be readily composed to enable depth localization and material separation. Additionally, the order of reconstruction and subtraction appears unimportant when using traditional logarithmic subtraction. Future work including dose/noise analysis, geometry tolerance and calibration, and more algorithm comparisons will be used to purse bringing material separation and tomosynthesis to the patient bedside.

Vivek Maheshwari

Department of Chemistry

Title: **Solar to hydrogen generation: Photoelectrochemical devices**

Abstract: Combining photovoltaics with water splitting electrochemical devices leads to green hydrogen generation. The challenge in developing such effective systems lies in optimizing the photovoltaic device and the water splitting electrochemistry and engineering their interfacing for high efficiency. We briefly discuss the use of perovskite solar cells with designed water splitting catalyst to develop such systems and their future.

Luis Ricardez-Sandoval

Department of Chemical Engineering

Title: **Machine Learning strategies to accelerate the discovery of novel materials for CO_2 capture & utilization**

Abstract: This talk will cover our recent efforts to accelerate the screening of novel catalyst materials that can be used to transform CO_2 into valuable chemicals and fuels. In particular, we will discuss our computational chemistry calculations for bi-metallic doped CeO_2 catalyst in the reverse water gas shift reaction and a new machine learning framework that makes use of human feedback to accelerate the training of reinforcement learning strategies in the discovery of new catalyst materials.

Armaghan Salehian

Department of Mechanical and Mechatronics Engineering

Title: **Recent advances in energy harvesting and vibrations laboratory**

Abstract: Professor Salehian, an Associate Professor at UWaterloo MME department, will be giving a talk on the applications of vibrations and acoustics in the field of green energy and clean technologies. She will present some of the state-of-the-art research using piezoelectric MEMS screen printing technologies to power sensors and the applications of metamaterials fabricated using the additive manufacturing technologies for environmental noise cancellation.

Raafat Mansour

Department of Electrical and Computer Engineering

Title: **The phase change material (PCM) technology and its application in the development of advanced RF devices**

Abstract: The Chalcogenide Phase Change Material (PCM) technology has been widely used in optical and non-volatile memory device applications. Over the past few years, there has been interest in exploiting the PCM technology, especially germanium telluride (GeTe) and its alloys for RF applications. The principle of operation of PCM-based devices stems from the ability of the material to transform from a high-resistivity state (amorphous phase) to a low-resistivity state (crystalline phase) and vice versa. This is achieved through the application of short duration pulses, generating heat to switch between the two states. A PCM GeTe-based RF switch can exhibit more than five orders of resistance change between the two states. PCM-based RF switches are expected to bridge the gap between semiconductor switches and MEMS switches. They combine the low insertion loss performance of MEMS technology with the small size and reliability performance of semiconductor technology. In addition to miniaturization, GeTe based switches offer latching capability and ease of monolithic integration with other RF circuits. The talk addresses the use of PCM technology in the development of RF devices with unprecedented performance.

XiaoYu Wu

Department of Mechanical and Mechatronics Engineering

Title: **Examining different clean energy carriers' roles in decarbonization**

Abstract: Various clean energy carriers, such as hydrogen and ammonia, play essential roles in decarbonizing the economy. In this talk, I will highlight some studies in my research group on the topic and focus their roles of energy storage and sectoral integration.

Yimin Wu

Department of Mechanical and Mechatronics Engineering

Title: **Single atom alloy electrocatalysis and microenviorment for CO_2**

Abstract: Achieving large-scale electrochemical CO_2 reduction to multicarbon products with high selectivity using membrane electrode assembly (MEA) electrolyzers is promising for carbon neutrality. However, the unsatisfactory multicarbon products selectivity and unclear reaction mechanisms in an MEA have hindered its further development. I will talk about the single atom alloy strategy for high selectrivity towards multicarbon products. I will also discuss a strategy that manipulates the interfacial microenvironment of Cu nanoparticles in an MEA to suppress hydrogen evolution reaction and enhance C_2H_4 conversion. The in situ multimodal characterization reveals the mechanism in the reaction.

Leonardo Simon

Department of Chemical Engineering

Title: **Nanofibre and nanopaper for sensors and flexible functional materials**

Abstract: Films prepared with renewable nanofibres can provide a sustainable alternative as substrate for flexible electronics. Sensors, energy devices (photovoltaics, batteries, capacitors) or functional materials can benefit from films that have low environmental impact while maintaining desirable properties to enable advance manufacturing. Nanopaper can be a sustainable substrate for printed and flexible electronics. Our research group is exploring aspects related to production of nanopaper and films with properties suitable for functionalization, barrier and applications in flexible electronics. This talk will present our research to produce nanofibres using industrial hemp and its application in plastic films and nanopaper. Our research group is conducting fundamental research to explore the mechanism of nanofibre and nanopaper formation, while exploring the possibility to functionalize the nanofibre or nanopaper. We are also interested in creating technology and in removing barriers to enable venture creation by working with startups and industrial partners to advance the technology readiness level beyond lab-scale.

Boxin Zhao

Department of Chemical Engineering

Title: **Surface science, bionanomaterials and antimicrobial nanoengineering**

Abstract: Surface science and functional bionanomaterials are crucial to many chemical and material engineering processes, driving advanced manufacturing and innovations to address global water, energy, health and environmental challenges. In this talk, I will present an overview of our laboratory's recent studies in surface science and polymer nanotechnology, including wetting, adhesion, smart polymers, and gels. I will also discuss antimicrobial nanoengineering as a novel strategy for engineered infection control on high-touch surfaces, and explore future collaborative endeavors.

Sushanta Mitra

Department of Mechanical and Mechatronics Engineering

Title: **Liquid-Liquid Encapsulation: Novel technique to create value-added sustainable products**

Abstract: Encapsulation of liquid-phase analytes is crucial in industries such as pharmaceuticals, nutraceuticals, cosmetics, and food processing, as it protects sensitive compounds, facilitates controlled release, and enhances stability. We have developed a novel liquid-liquid encapsulation technique that enables controlled wrapping of liquid-phase analytes with thin shell layers of compatible shell-forming liquids. In the talk, we will demonstrate various industry relevant applications. We are looking for collaboration to further exploit this technology for various applications relevant to food, agriculture, environment and drug delivery systems.

Catalan Institute of Nanoscience and Nanotechnology

Marianna Rosetti

Nanobioelectronics and Biosensors group

Title: **DNA-based sensors for bioanalytical applications**

Abstract: DNA-based sensors have emerged as powerful tools in bioanalytical applications, leveraging the inherent programmability and specificity of nucleic acids. These sensors capitalize on DNA's unique properties, such as sequence recognition and self-assembly, to detect a wide array of targets, including nucleic acids, proteins, small molecules, and antibodies. Beyond aptamers, DNA can be engineered as a versatile scaffold by conjugating various recognition elements (e.g., peptides, proteins, small molecules, and antibodies) to DNA strands. This approach enables specific, high-affinity interactions with targets, further broadening the scope of applications. The integration of CRISPR-based technologies and nanomaterials enhances both the sensitivity and performance of these sensors. In this presentation, I will show examples of DNA-based sensors, ranging from simple hybridization probes to advanced scaffolded DNA architectures, highlighting their adaptability across diverse detection platforms.

Elena del Corro

Advanced Materials and Devices group

Title: **Bidimensional materials based medical implants with ultimate sensing capabilities**

Abstract: Graphene possesses unique mechanical and electronic properties that make it a crucial material in the biomedical field. Along with these unique properties, graphene is nowadays capable of integrating with other 2D and thin film materials into flexible electronic technologies. All this makes graphene-based electronic devices a promising candidate for biomedical recording and sensing purposes in the development of a new generation of brain computer interfaces. The progress of this ultimate application is closely related to technological improvements in the materials used to interface with tissue. In this work we present nanomaterials engineering efforts, from the 2D material synthesis to its integration in the final device, with special emphasis on the achievement and preservation of the material highest quality and properties. We present large-scale growth and characterization achievements of graphene and MoS_2, micro-fabrication innovations for these materials and advanced interfacial characterization of based devices.

Eduard Masvidal

Advanced Materials and Devices group

Title: **Graphene-based thin-film neuroelectronic devices**

Abstract: Microfabricated bioelectronic devices based on nanomaterials have a huge potential for advancing neuroscience research by providing high-resolution mapping capabilities and high-precision neuromodulation. In this talk, the current state-of-the-art in neuroelectronic interfaces and particularly those based on graphene will be reviewed. Also, applications and opportunities for neuroscience both at basic and translational level of this technologies will be detailed, such as cortical-wide brain mapping and deep brain or nerve implants.

Pedro Gómez

Novel Energy-Oriented Materials group

Title: **How Nanohybrid materials can lead to better energy storage**

Abstract: The use of nanoclusters dispersed in conducting, capacitive carbons, leads to a novel type of electrodes with the intrinsic advantages of supercapacitor electrodes but with added capacity and energy densities.

Jordi Arbiol

Advanced Electron Nanoscopy group

Title: **Nanomaterials at the atomic scale**

Abstract: The increasing interest in Materials Science, Nanoscience and Nanotechnology has created a serious global need for the development of nanoscopy tools in order to be able to observe and chemically / physically analyze the synthesized nanostructures at atomic scale. We explore by means of electron microscopy and related spectroscopies the structure-properties relationships in nanomaterials for physical applications (photonics / plasmonics/ phononics / electronics / quantum) adding AI-based methodologies for advanced automated data analysis (deep and machine learning). In parallel, we work on the understanding of the behavior of nanomaterials for energy and environmental applications down to the atomic scale and create in-situ and correlative methodologies combining electron microscopy, synchrotron and AI.

M. Jose Esplandiu

Magnetic Nanosctructures group

Title: **Magnetic/optic-based materials for biomedical applications, energy and environmental remediation**

Abstract: Our group is devoted to three research lines: (i) control of magnetism through interactions or external stimuli; (ii) biomedical applications of multifunctional magnetic and/or optic based materials and (iii) environmental and energy related studies, ranging from water decontamination to efficient H_2 generation, high value chemicals for biofuel production and Li-batteries. We are also particularly interested in novel methods to elucidate the structural and magnetic properties of nanostructured materials, based on transmission electron microscopy and synchrotron or neutron experiments.

Víctor F. Puntes

Inorganic Nanoparticles group

Title: **Inorganic nanoparticle tools for energy, environment and medicine**

Abstract: Our interdisciplinary research group focuses on the design and engineering of inorganic nanoparticles to advance applications in energy, environment, and medicine. We specialize in the wet-chemical synthesis of nanocrystals (metals, semiconductors, oxides) and complex heterostructures, investigating their optical, catalytic, magnetic, and thermal properties. By developing tailored surface modifications and functionalization strategies, we enable targeted interactions for biomedical and environmental applications. Additionally, we study nanoscale transformations, optimizing materials for sustainability and performance. Committed to Safe and Sustainable by Design (SSbD) principles, we integrate safety and environmental responsibility into innovation, aligning with European Commission recommendations to ensure responsible technological progress.

Salvio Suárez

Nanostuctured Functional Materials group

Title: **Sustainable approaches for the development of advanced materials and their application in Health and Environment**

Abstract: The Nanostructured Functional Materials Group at ICN2 is at the forefront of developing cutting-edge nanotechnological approaches to integrate molecular materials into practical devices. These innovations aim to tackle challenges of the coming centuries with a focus on fostering healthier societies. In this presentation, we will showcase the groundbreaking technologies our group has developed in the fields of health and environment. Our research group has pioneered various advanced bio-inspired materials, including nanoparticles, coatings, and bioadhesive membranes, designed for applications in biomedicine, including tissue regeneration, age-related diseases, and the fight against antimicrobial resistance. Moreover, we will highlight our endeavours in environmental sustainability. Our team has developed materials tailored for water and air remediation, effectively capturing a wide array of contaminants such as pathogens, metal oxides, and organic molecules. Finally, the latest advances in the design and application of chromogenic materials for smart buildings and energy saving applications will be showed.

Pablo Ordejón

Theory and Simulation group

Title: **DFT and Hybrid QM/MM large scale simulations**

Abstract: The Teory and Simulation group of ICN2 is specialized in developing methods and software for very large scale atomistic simulations. We focus on first-principles approaches like Density Functional Theory, also trying to reach larger system sizes and simulation times liking DFT with classical potentials (the so-called hybrid QM/MM approach). I will give an overview of our computational capabilities, and examples of physical and chemical problems in which the group is interessted.

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ICN2 Institut Català de Nanociència i Nanotecnologia

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