6th Annual Nano Ontario Conference

November 5 and 6, 2015

Hosted by the University of Ottawa
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The University of Ottawa is proud to host the 6th annual Nano Ontario Conference and to welcome attendees for the first time to Eastern Ontario. Indeed, the nation’s capital is a rapidly growing hub of nanoscience and nanotechnology research and development. At the heart of it all are dozens of University of Ottawa researchers who are working in fields that range from engineering to physics, chemistry, law and ethics to unlock the secrets of the infinitesimally small for the benefit of the world at large.

The theme of this year’s conference is “Integrating Nanotechnology”. The program features a distinguished slate of speakers who bring a rich international perspective on the latest advances in nano research. In addition, a special panel composed of industry and government representatives will shed light on building successful university-industry collaborations. Finally, there will be plenty of opportunities to network and exchange ideas during a poster session and reception.

We look forward to welcoming you on campus.

Sylvain Charbonneau
Associate Vice-President, Research

It may seem ironic that one of the most promising keys to scientific innovation cannot even be seen. But in the minute lies the potential for massive progress in all aspects of everyday life, be it how we run our mobile devices or how we treat cancer and other diseases. As such, the pioneering group of researchers gathered at the Nano Ontario Conference are part of an emerging revolution.

The University of Ottawa is delighted to be a part of this wave of innovation as host of this year’s conference. Nanoscience and nanotechnology are among the University’s research strengths and are featured in its Strategic Areas of Development in Research. Some of our scientists have forged important international research collaborations and partnerships with industry in areas such as photonics and catalysis. It’s all part of an ongoing global effort to understand and harness the power of the nano world.

May you be inspired by this conference.

Mona Nemer
Professor and Vice-President, Research
The 6th annual Nano Ontario Conference, a focal point of our organization’s activities during the year, will be held on November 5 and 6, 2015, at the University of Ottawa. The organizing committee, chaired by Sylvain Charbonneau, associate vice-president of research at the University of Ottawa, has assembled an attractive program with four eminent keynote speakers on topics of current interest in the field and has invited Ontario researchers and a panel of industry experts and innovators to make presentations. The committee has also organized a poster session. The program is designed to encourage collaboration, facilitate networking and stimulate discussion on the latest developments in nanotechnology both in Ontario and around the globe.

In 2015, Nano Ontario broke new ground, hosting a very successful industry-university showcase event, Nanofacilities for Emerging Technologies, to highlight the state-of-the-art tools and infrastructure at Ontario universities and accessible to the industrial community in the province. More than 100 participants, including 60 from industry, attended this inaugural event.

Nano Ontario is a not-for-profit organization representing the interests of members of the academic, industrial, government and financial communities in the safe development of nanotechnology in Ontario. Our members work together to raise the profile of the field, increase R&D, build investment and drive economic returns from nanotechnology in Ontario and across Canada.

Also in 2015, Nano Ontario and Nanopolis in the Suzhou Industrial Park in China signed an MOU to create a new nanotechnology innovation centre (NIC) in Suzhou that will provide space and services to help foster the growth of new Canadian nanotechnology companies in China.

This NIC initiative is based on a science and technology agreement between the Government of Ontario and the government of Jiangsu Province in China.

Elected Nano Ontario officers for 2015:

Arthur J. Carty, Chair, Board of Directors
Peter Mascher, Vice-Chair
Alain Francq, Treasurer
Kuyler Neable, Secretary

To learn more about the vision and objectives of Nano Ontario, or to join Nano Ontario as a voting member, visit: www.nanoontario.ca.

Arthur Carty
Chair, Board of Directors
Day 1 - November 5, 2015

1:00 p.m.                                      Registration (Desmarais, room 12102)

1:30 p.m. - 1:35 p.m.                          Opening remarks by Sylvain Charbonneau (Associate Vice-President, Research, University of Ottawa)

1:40 p.m. - 1:45 p.m.                          Message by Arthur Carty (Chair, Board of Directors, Nano Ontario)

1:45 p.m. - 1:50 p.m.                          Message by Marie D’Iorio (Executive Director, National Institute for Nanotechnology)

1:50 p.m. - 2:35 p.m.                          Keynote 1 - David Gracias (John Hopkins University)

2:35 p.m. - 3:35 p.m.                          Invited speakers

Jean-François Masson (Université de Montréal)
Robert Boyd (University of Ottawa)
Warren Chan (University of Toronto)

3:35 p.m. - 4:35 p.m.                          Industry expert panel

Mike Phaneuf (President and CTO, Fibics Incorporated)
Marie D’Iorio (Executive Director, National Institute for Nanotechnology)
Dan Gale (Vice-President and CTO, CMC Microsystems)
Adrien Côté (Senior Scientist, Xerox Research Centre of Canada)

4:40 p.m. - 6:30 p.m.                          Poster session and networking reception (Alex Trebek Alumni Hall)
Day 2 - November 6, 2015

8 a.m. - 9 a.m.  Registration (Desmarais, room 12102)

9 a.m. - 9:45 a.m.  Keynote 2 – Ulrich Wiesner (Cornell University)

9:45 a.m. - 10:25 a.m.  Invited speakers
  Neil Branda (Simon Fraser University)
  Vincent Tabard-Cossa (University of Ottawa)

10:25 a.m. - 10:40 a.m.  Coffee break

10:40 a.m. - 11:40 a.m.  Keynote 3 – Jean-Michel Nunzi (Queen’s University)

11:40 a.m. - 12 p.m.  Invited speaker
  Glenn Hibbard (University of Toronto)

12 p.m. - 1 p.m.  Lunch

1 p.m. - 2 p.m.  Invited speakers
  Robin Williams (National Research Council Canada)
  Tito Scaiano (University of Ottawa)
  François Lagugné-Labarthet (Western University)

2 p.m. - 2:20 p.m.  Coffee break

2:20 p.m. - 3 p.m.  Keynote 4 – Federico Rosei (INRS)

3 p.m. - 3:50 p.m.  Poster award presentation

3:50 p.m. - 4 p.m.  Closing remarks by Sylvain Charbonneau (Associate Vice-President, Research, University of Ottawa)
Three-dimensional nanostructured materials and devices: From metamaterials to dust-sized surgical tools

Nanotechnology offers the possibility to sculpt materials and devices with extreme precision and at very small size scales. These structures can enable novel properties and functionality that are inaccessible at larger-length scales. However, significant challenges need to be addressed to fully enable the vision of nanotechnology. For example, true 3D nanofabrication and assembly, heterogeneous integration of materials and energy harvesting for actuation are all very challenging at small-length scales.

In this talk, by way of three examples, Gracias will discuss strategies that address these challenges to realizing micro- and nano-patterned 3D materials and devices. Examples will include the self-folding and self-assembly of truly three-dimensional metamaterials for optical and electronic applications, 3D printing of bionic organs and the in vivo operation of environmentally responsive untethered biopsy devices.

Bio

David Gracias is a professor and Russell Croft Faculty Scholar at John Hopkins University with a primary appointment in chemical and biomolecular engineering. He completed his education at the Indian Institute of Technology, UC Berkeley (PhD, 1999) and Harvard University (post-doc). Gracias has published over 100 journal articles and holds 26 issued U.S. patents in the areas of micro- and nano-systems, surface science as well as self-folding and self-assembly.
Despite significant promise of nanomaterials in medicine, few colloidal materials make the transition into clinical applications. Silica nanoparticles have seen increasing focus in recent years due to facile and versatile synthetic approaches to a plethora of particle architectures and properties. This includes multifunctionality due to the integration of different material classes into the same colloid, mesoporosity to increase the available particle surface area and various surface functionalities to tailor colloidal interactions or multivalency effects with targeted environments. After highlighting recent advances in the synthesis and characterization of various silica nanoparticles, Wiesner will introduce a class of multifunctional fluorescent silica-based core-shell nanoparticles referred to as “Cornell dots” or simply “C dots.” These particles can be tuned to sizes below 10 nm, which is below the threshold for renal clearance, leading to favourable biodistributions and pharmacokinetics when injected into living organisms. A smaller than 10-nm-sized PEGylated label for nanomedicine such as this is the first dual-modality (optical/PET) hybrid nanoparticle of its class and properties receiving investigational new drug (IND) approval by the Food and Drug Administration (FDA) for in-human clinical trials in the US. Results on clinical trials with human melanoma patients will be reported, making it possible to assess particle pharmacokinetics and safety. Wiesner will describe work towards employing these probes in sentinel lymph node mapping involving a specific camera system that surgeons can use for visualization of nodes during surgery. Finally, Wiesner will highlight future developments for the use of such colloidal nanomaterials in diagnostic and therapeutic applications in oncology.

Bio

Professor Wiesner studied chemistry in Mainz, Germany, and Irvine, California. He earned his PhD in 1991 with work at the Max Planck Institute for Polymer Research in Mainz and was a postdoctoral fellow at the ESPCI in Paris until 1993. He joined the Cornell Material Science and Engineering faculty in 1999 after being awarded his habilitation higher doctorate. In 2005, he became a full professor. Wiesner works at the interface of polymer science and solid-state chemistry/physics with the goal of generating novel hierarchical and multifunctional hybrid materials. He is the co-founder of Hybrid Silica Technologies Inc. and a recipient of multiple awards, including the Carl Duisberg Memorial Award from the German Chemical Society.
Jean-Michel Nunzi  
Queen's University  
Professor, Department of Physics, Engineering Physics and Astronomy, Department of Chemistry

**Self-organized nano-photonics and nonlinear photovoltaics**

Several approaches are currently being explored to build devices exploiting size effects in nanosciences. Self-assembly emerges as a master technique to enable applications in the real world. Nonlinear phenomena related to light-matter interactions open the door to new paradigms related to the self-organization of nanophotonic structures and ultra-high efficiency photovoltaic devices.

Practically, when illuminated under resonant excitation conditions, photoactive molecules move like molecular motors into a glassy matrix. The movement results in a macroscopic mass transport. This property was discovered in 1995 by research teams in Canada and the U.S. The researchers named the resulting deformations surface relief gratings. Over the years, a microscopic picture of the origin of the phenomenon has been developed. Later on, the researchers discovered that the same materials self-organized into robust photonic structures; meanwhile, they were excited under a uniform light beam. The process could be attributed to the nonlinear optical interaction in which the movement of the molecules under light happens from regions of high excitation rate to regions of lower excitation rate, in a totally reversible manner. The process stops when the excitation rate is minimized. This allows the collective fabrication of nanostructures that maximize light matter interaction. That is exactly what is desired in order to harvest solar energy.

On a similar scale, Nunzi's team is studying a photovoltaic technology that is not limited to the Shockley-Queisser efficiency limit and is amenable to low-cost and large-area production requirements. The physics does not rely on the photoelectric effect, which is at the origin of the efficiency limits of the photovoltaic conversion in semiconductor devices; it is based on optical rectification of sunlight. Antennas efficiently convert waves into a potential difference, which must be rectified to DC or low frequency current to be useable for energy production. This particular type of visible-light antenna, named a rectenna, was theoretically designed 40 years ago. EM-wave to DC conversion can, in principle, be done at solar frequencies with much higher conversion efficiency than present-day photovoltaic technologies, but that rectification should be achieved at optical frequencies where diodes do not exist. Self-assembly enables the design of large-area devices in which light rectification is achieved by metallic nano-antennas covalently coupled to molecular diodes. The nonlinear optical effects happening at the top of the antennas are the keys Nunzi's team explores in order to design ultra-high efficiency and low-cost next-generation photovoltaic devices.

**Bio**

Jean-Michel Nunzi was named a professor in the Department of Chemistry at Queen's University in 2006. He has held the Canada Research Chair in Chiral Photonics since 2013. Previously, he was a professor at University of Angers (France) and a research scientist at CEA-Leti (France). His research interests are the optical and electronic properties of organic materials and devices—photo-physics, nonlinear optics, self-organization under light, charge generation and transport, solar cells, plastic lasers and nanomaterials. He also studies the fabrication of chiral structures using light-matter interactions.
Multifunctional materials for electronics and photonics

The bottom-up approach is considered a potential alternative for low-cost manufacturing of nanostructured materials. This approach is based on the concept of self-assembly of nanostructures on a substrate and is emerging as an alternative paradigm for traditional top-down fabrication used in the semiconductor industry. Rosei’s team demonstrate various strategies to control nanostructure assembly (both organic and inorganic) at the nanoscale. The team studies, in particular, multifunctional materials—materials that exhibit more than one functionality—and structure/property relationships in such systems, including for example, control of size and luminescence properties of semiconductor nanostructures, synthesized by reactive laser ablation. The team has also developed new experimental tools. Rosei will present a comparison with simulations to gain atomic scale insight into the surface processes that govern nucleation, growth and assembly. His team has also devised new strategies for synthesizing multifunctional nanoscale materials to be used for electronics and photovoltaics.

Bio

Federico Rosei has held the Canada Research Chair in Nanostructured Organic and Inorganic Materials since 2003. He is a professor and director of the INRS Énergie Matériaux Télécommunications Research Centre at Université du Québec in Varennes (Canada). Since January 2014, he has held the UNESCO Chair in Materials and Technologies for Energy Conversion, Saving and Storage. He received his MSc and PhD degrees from the Sapienza University in Rome in 1996 and 2001, respectively. He has published over 200 articles in prestigious international journals (including Science, Nature Photonics, Proceedings of the National Academy of Sciences, Advanced Materials, Angewandte Chemie International Edition, Journal of the American Chemical Society, Advanced Functional Materials, Nano Letters, ACS Nano, Biomaterials, Small, Physical Review Letters, Nanoscale, ChemComm, Applied Physics Letters and Physical Review B). He has also been invited to speak at over 210 international conferences and has given over 170 seminars and colloquia and 20 public lectures in 42 countries. He has an h-index of 41, with his publications being cited over 5,900 times.
**Robert W. Boyd**  
Canada Excellence Research Chair, Department of Physics and School of Electrical Engineering and Computer Science and Max Planck Centre for Extreme and Quantum Photonics, University of Ottawa

**New results in nanophotonics**

In this talk, Robert Boyd will present an overview of his team’s results, while at the same time attempting to convey some feeling for the intrigue and promise of nanophotonics. He will give examples of three recent results.

Free-space propagation: The team has recently performed a measurement that shows that a laser beam with a specially prepared transverse polarization structure can take the form of a Möbius strip when tightly focused. This work illustrates that optical fields can possess complex sub-wavelength structures and holds promise for metrology at subwavelength distance scales.

Guided-wave propagation: This work includes the development of photonic crystal (PhC) slow-light waveguides and spectrometers. The team has developed techniques for the post-process tuning of PC waveguides.

Structured surfaces: The team has fabricated a structured plasmonic metasurface that can diffract an incident plane wave into a wave possessing orbital angular momentum (OAM) of light. This work illustrates that thin structures only tens of nm thick can be designed in such a way as to perform tasks traditionally performed by complex bulk-optics systems.

**Neil Branda**  
Professor, Canada Research Chair in Materials Science, joint affiliations with 4D Labs and Department of Chemistry, Simon Fraser University

**Using light to control the chemistry of nanomaterials**

The use of light to trigger organic reactions in materials or organisms has offered ways to spatially and temporally control chemical and biochemical functions. This technology is limited by the delivery of the light, which must be achieved without causing damage to the surrounding systems. This limitation implies that ultraviolet and high-energy visible light cannot be used and ways must be found to deliver lower energy light in the near infrared.

Branda will discuss several examples of how nanoparticles decorated with photoresponsive molecules can be used to control chemical reactions. The general theme of the presentation, molecular switching, is a field that aims to use small molecules to turn “on” and “off” processes relevant to chemical and biochemical processes. Despite numerous examples of successful molecular photoswitches (those that reversibly change their shape and properties in response to light) being reported, several issues limiting their use in biological applications still exist. Many of these limitations can potentially be overcome by decorating the molecular switches onto photoresponsive nanoparticles. The examples presented in the presentation will include: 1) how lanthanide-doped upconverting nanoparticles can
harness near-infrared light and convert it into the ultraviolet and visible light required to trigger the photoreactions of organic compounds; 2) how polymer-encapsulated nanoparticles can provide the local hydrophobic environment to allow effective photoreactions; 3) how gold nanoparticles can be used to generate the heat needed to break down anchored organic compounds and release singlet oxygen.

Warren Chan
Associate Professor (cross appointed), Institute of Biomaterials and Biomedical Engineering and Department of Chemistry, University of Toronto

Quantum dot smartphone device for diagnosing infected patients

Integrating mobile-cellular devices with multiplex molecular diagnostics can potentially provide the most powerful platform for tracking, managing and preventing the transmission of infectious diseases. With over 6.8 billion subscriptions globally, handheld mobile-cellular devices can be programmed to spatially map, temporally track and transmit information on infections over wide geographical spaces and boundaries. In this presentation, Chan will discuss the engineering of a simple and low-cost nanotechnology/smartphone device that can diagnose infections in patients in less than one hour. This device is based on plastic barcodes generated by encasing the nanoparticle quantum dots inside a plastic container. Each individual barcode is designed to identify and diagnose a disease target. The device can analyze 20 µL of sample (blood or other fluids) and can potentially detect thousands of genetic biomarkers and diseases simultaneously with a zeptomole analytical sensitivity. This low sensitivity enabled Chan's team to detect 9 out of 10 patients infected with a pathogen (e.g., HIV, Hepatitis B and C). This device advances the capacity for global surveillance of infectious diseases at or near the point-of-care and has the potential to accelerate the knowledge exchange and transfer of emerging or exigent disease threats with healthcare and military organizations in real time in both the developed and developing worlds.

Glenn Hibbard
Associate Professor and Canada Research Chair in Cellular Hybrid Materials, Department of Materials Science & Engineering, University of Toronto

Designing lightweight structural nanomaterials

There are several strategies that one can follow in designing new types of structural nanomaterials. This talk will focus on the design strategies involved in the fabrication of nanocrystalline microtruss materials, which are structurally optimized polymeric templates that have been additively manufactured and then reinforced by nanocrystalline electrodeposition. There are three distinct internal-length scales controlling the performance of these materials. From smallest to largest there is, first, the length scale of the crystal building blocks making up the nanocrystalline metal. The electrodeposition of nanocrystals typically occurs far from equilibrium conditions, and the non-equilibrium structure is manifested in the ultra-small grain size. The second length scale is the cross-sectional structure of the internal truss members. Because the electrodeposited material is optimally positioned away from the neutral bending axis of the starting preform microtruss struts, even very small amounts of nanocrystalline material can have a large effect on the overall performance because of the large second moment of area. Third is the strut connectivity within the cellular architecture of the starting preform. This level of structure
determines whether externally applied loads are resolved axially or transversely to the constituent struts and hence whether the microtruss is stretching or bending dominated. It is the ability to control all three of these scales independently that make nanocrystalline microtruss structures so attractive. However, fabricating useful structures requires optimal design at all three length scales.

François Lagugné-Labarthet
Associate Professor, Department of Chemistry, Western University

**Pushing the limits of spectroscopy with plasmonics**

The optical properties of nanoscale metallic structures are highly tunable by altering the material properties or the shape and arrangements of the individual structures. In the past decade, the rise of plasmonics has highlighted the possibility to enable all-optical logic operations using the interaction with light and metal. In this presentation, Lagugné-Labarthet will focus on the use of plasmonics to yield large local electromagnetic field enhancement that can be used for high spatial resolution spectroscopy. The coupling between a sharp metal tip of an atomic force microscope and a tightly focused light beam allows one to obtain optical spatial resolution better than 10 nm, which can be used to probe a single DNA chain, small polymer domains or monolayers at surfaces. Tip-enhanced Raman spectroscopy is ideal for providing chemical mapping of surfaces and interfaces with a spatial resolution increased by a 20- to 50-fold factor compared with standard measurements. Vibrational spectroscopy (SERS and SEIRA) can further benefit from such structures increasing by several orders of magnitude the signal-to-noise ratio of the measurements of a few molecules located in the vicinity of the metal hotspots. Lagugné-Labarthet will elaborate on the critical parameters to be tuned for optimized enhancements. Last, he will explore how nonlinear optical phenomena such as SHG can be enhanced through the excitation of a plasmon mode of metal structures with no inversion centre. Such non-centrosymmetric structures are active for second-order nonlinear processes and show particular polarization dependence for high anisotropic structures fabricated by electron beam lithography.

Jean-François Masson
Associate Professor, Département de chimie, Université de Montréal

**Plasmonic nanopipettes: A new tool for monitoring cell secretion events?**

The fabrication and properties of plasmonic nanopipettes will be demonstrated for monitoring the extracellular media near cells. Monitoring cell secretion events remains a challenge to overcome in chemical analysis. Under stimulus, the molecules secreted by cells are related to the biological processes inside cells. Thus, monitoring the secretion of these markers may provide important biological information. Cells may also secrete important chemical messengers to regulate interactions with neighbouring cells that are currently challenging to detect. In one of the few examples of chemical detection of secreted molecules, electrochemical nanosensors provided unprecedented information of secretion event of electroactive molecules from cells. However, one must provide chemical information for molecules inactive in electrochemistry. Plasmonics provides an interesting alternative to electrochemical nanosensors. Plasmonic nanopipettes were developed based on the decoration of patch clamp nanocapillaries with Au nanoparticles. Au nanoparticle deposition (Au NP) using electrostatic interactions creates disordered arrays of agglomerated particles, suited for surface-enhanced Raman scattering (SERS) measurements. SERS benefits from the high enhancement factor
of the hot spots created between Au NP. Molecules diffusing in the hot spot experienced high electric fields and, thus, high Raman response. The plasmonic nanopipette is thus competent for dynamic SERS measurements in the liquid environment near cells. The capability of precisely positioning the nanopipette near cells led to the dynamic measurement of the content of extracellular matrix in real time. This new nanosensor should facilitate the measurement of cell secretion events in the near future.

Tito Scaiano
Professor and Canada Research Chair in Applied Photochemistry, Department of Chemistry, University of Ottawa

**Single molecule spectroscopy as a tool to optimize catalytic processes at the laboratory scale**

Colloidal or heterogeneous nanocatalysts improve the range and diversity of Cu(I)-catalyzed click reactions and facilitate catalyst separation and reuse. Catalysis by metal nanoparticles raises the question as to whether heterogeneous catalysts may cause homogeneous catalysis through metal ion leaching, since the catalytic process could be mediated by the particle or by metal ions released from it. The question is critical because unwanted homogeneous processes could offset the benefits of heterogeneous catalysis. Here Scaiano’s team combines standard bench-scale techniques with single-molecule spectroscopy to monitor single catalytic events in real time and demonstrates that click catalysis occurs directly at the surface of copper nanoparticles. This general approach could be implemented in other systems.

Single molecule fluorescence microscopy reveals that the commercial catalyst “copper-in-charcoal”—a high performance click catalyst—has remarkably few catalytic sites, with 90% of the charcoal particles being inactive, and that for the catalytic ones, the active sites represent a minute fraction (~0.003%) of the surface. The intermittent nature of the catalytic events enables sub-diffraction resolution and mapping of the catalytic sites.

Scaiano and his team emphasize the emerging idea in which mole scale reactions can be optimized through an intimate understanding of the catalytic process at the single-molecule—single catalytic nanoparticle level leading to improvements of the catalytic process in a much larger scale.

Vincent Tabard-Cossa
Professor, Department of Physics, University of Ottawa

**Nanomanufacturing nanopore-based technologies**

In the last decade, due to the promise of low-cost rapid DNA sequencing, nanopores (i.e., holes of nanometer dimensions in a thin insulating membrane) have emerged as a unique class of single-molecule detectors, directly translating properties of biomolecules into an electrical signal.

In this talk, Professor Tabard-Cossa will review the principle of nanopore-based single-molecule sensing, which is expected to revolutionize genomic research and clinical diagnostics. He will discuss the nanofabrication challenges that remain in the field and present the new opportunities offered by an original, low-cost nanofabrication method his team has developed for reliably making nanopores with atomic precision, a method named nanopore fabrication by controlled breakdown (CBD).
Robin Williams
Senior Research Officer, Institute for Microstructural Sciences, National Research Council Canada

**Nanophotonics with single semiconductor quantum dots**

Single semiconductor quantum dots offer an attractive, scalable route to localized sources of non-classical light, to spatially tailored refractive index profiles for slow-light engineering and to small footprint devices for optical switching. In this talk, Williams will describe his team’s use of directed self-assembly techniques for the spatial control of individual quantum dot nucleation site and how these dots can then be embedded within semiconductor nanowires or photonic crystal waveguides and cavities as a means to control light-matter interaction and out-coupling to external collection optics.

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**Industry expert panel**

**Panel session: Integrating technology**

This session explores best practices in forging, maintaining and growing successful university-government-industry partnerships. The following questions will guide the discussion:

- What are the best approaches for establishing solid working relationships with both government and academia?
- What are some of the most successful technologies that have come out of academic/government/industry partnerships? What are the most important ingredients or best practices for maintaining university-government-industry research relationships?
- What are the most significant challenges in maintaining multi-stakeholder research relationships and what can we do to overcome them?
- How can we ensure high-quality HQP training in nanotechnology for the next generations?
- What are the major ethical and regulatory issues surrounding university-industry research partnerships and how can we resolve them?
- Is the Canadian model for forging and maintaining university-government-industry relationships a good one? Are there better models out there and, if so, can they be adapted to the Canadian environment?

**Moderator:**

Sylvain Charbonneau, Associate Vice-President, Research, University of Ottawa

**Members:**

- **Mike Phaneuf**, President and CTO, Fibics Incorporated
- **Marie D’Iorio**, Executive Director, National Institute for Nanotechnology (NINT)
- **Dan Gale**, Vice-President and CTO, CMC Microsystems
- **Adrien Côté**, Senior Scientist, Xerox Research Centre of Canada
Jennifer I.L. Chen
Assistant Professor, Department of Chemistry, York University

“Unconventional plasmonic sensors for optical detection in complex media: From plasmon hybridization in actuable dimers to target-controlled permeability change in polyelectrolyte-aptamer/AgNP composite films”

Author: Jennifer I.L. Chen

Label-free sensing is desirable for a range of chemical and biological analysis. Portable, economical and easy-to-use sensing devices are valuable for point-of-care medicine and field analysis. On the other hand, bioanalytical tools that provide high sensitivity and multiplexing capability are highly sought-after for the detection of biomarkers. Here I present recent developments in our group on unconventional sensing modalities. We explore the localized surface plasmon resonance (LSPR) of closely-linked nanoparticle dimers for the detection of miRNA-210 – an indicator of hypoxia-related diseases such as pre-eclampsia. Detection is based on the actuation of discrete gold nanoparticle dimers as monitored by single-nanostructure darkfield scattering spectroscopy. The analytical signal is an unconventional spectral blue shift in the hybridized plasmon mode when the micro-RNA geometrically extends the dimer upon binding. Second, we present a dip-stick sensing platform based on the morphological changes of plasmonic nanoparticles. Detection is achieved by using a stimulus-responsive polyelectrolyte-aptamer thin film to control the rate of diffusion of etchants that alter the shape and size of the nanoparticles. The specificity, versatility and detection range of the sensors are examined and their potential for detection in complex media is addressed.

Spyridon Ntais
Research Associate, Laboratory of Electrochemical Engineering, Department of Chemical and Biological Engineering, Centre for Catalysis Research and Innovation, University of Ottawa

“X-Ray photoelectron studies of nanostructured catalysts and electrocatalysts for environmentally important applications”

Authors: Spyridon Ntais and Elena Baranova

Recent progress in nanotechnology and surface science techniques opened up new opportunities in understanding and rational design of nano-structured catalytic materials with desired properties. Several parameters control the catalytic and electrocatalytic activity of nanoparticles (NPs); among them are particle size, shape, size distribution, surface and bulk composition, structure, metal-support interaction, etc.

X-ray photoelectron spectroscopy (XPS) is a powerful tool for investigating the chemical composition and electronic structure of surfaces and interfaces. This work focuses on the use of XPS for analysis of nanosized catalytic and electrocatalytic systems and the correlation of the surface properties and catalytic performance.

The main advantage of XPS is that it provides important information concerning the surface composition, however the spectral features can vary depending on parameters such as size, dispersion, metal-support interaction, etc., which, if not taken under consideration, might lead to misinterpretations.
In this work, XPS studies of Pt NPs of various average sizes (1.6 – 7 nm) supported on carbon and on Yttria-Stabilized–Zirconia (YSZ) will be discussed. The Pt4f XPS peaks show shifts due to the size and the nature of the support while their catalytic performance for ethylene and CO oxidation shows size dependence. The effect of the metal support interaction (MSI) in the Pt/YSZ systems that results in charge transfer through the triple phase boundary (tpb) on the experimental data will be presented.

Finally, an example of how XPS can be used for the study of Pd-Ru-based electrocatalysts for ethanol electrooxidation will be presented.

Md Anisur Rahman
PhD Candidate, WATLab and Department of Chemistry, University of Waterloo

“Defect-rich TiO2-nanocrystal decorated 1D TiO2 nanowires for super-efficient photoelectrochemical water splitting driven by visible light”

Authors: Md Anisur Rahman and Kam Tong Leung

Engineering the defects in wide bandgap transparent conductive oxide semiconductors is crucial in governing the physical and chemical properties of these oxides. Compared to defect-free oxides, defect-rich oxides are more attractive for photovoltaics, photocatalysis, and fuel cell applications because of their narrower bandgaps, which enable absorption of visible light, and relatively high electrical conductivity. Enormous efforts have been made to narrow the band gap and to extend the working spectrum to the visible light region, and these efforts include doping, defect creation by hydrogen treatment, and plasmonic nanoparticle sensitization. Unfortunately, all of these efforts provide two to three orders less photoactivity when ultraviolet light (<430 nm) is filtered out from the AM 1.5 G spectrum. Despite recent achievements, a simple method of fabricating oxide semiconductors for efficient visible-light-driven photoactivity remains elusive.

Compared to other types of defects (such as those introduced by doping, hydrogen treatment), oxygen vacancy defects are desirable for wide band gap semiconductors because the oxygen vacancies act as electron donors and could therefore significantly enhance light absorption and electrical conductivity. The dependence of photoelectrochemical activity on the surface morphology of and the amount of oxygen vacancy defects in the 1D nanostructures are also not well understood. For TiO2 nanowires reported to date, oxygen vacancies are mainly generated by post-treatment of as-synthesized nanowires. This comes with a disadvantage that oxygen vacancies are found to form just within a few tens of nanometres at the outer surface of these nanowires, and the photocurrent density is significantly reduced by two to three orders of magnitude when ultraviolet light (<430 nm) is filtered out from AM 1.5G light. Here, we demonstrate the controlled growth of TiO2 nanocrystal decorated 1D TiO2 nanostructures with incorporation of oxygen vacancy defects on a Si substrate by a one-step, catalyst-assisted pulsed laser deposition (PLD) method. By manipulating the thickness of the SiO2 buffer layer, together with optimized growth temperature and growth environment, we are also able to synthesize TiO2 nanobelts, corrugated nanowires, and straight nanowires. Photoelectrochemical water splitting measurement under simulated sunlight shows that the decorated nanowires provide one of the highest photocurrent densities of TiO2 nanomaterials reported to date. More importantly, the decorated nanowires exhibit the highest photoactivity in the visible region (>430 nm), which represents 87% of the overall photocurrent. The higher activity in the visible region can be attributed to more conductive TiO2 nanostructures (i.e., with a larger amount of oxygen vacancy defects), and the enhanced charge transfer from the nanocrystallites to the core of the decorated nanowire. The strategy of intentionally making defect-rich TiO2 nanowires that are highly photoactive in the visible region in a one-step method opens up new opportunities in a variety of solar energy-driven applications.
**Plasmonic modulators and photodetectors operating at telecommunications wavelengths**
Presenter: Mohammad Alavirad
Authors: Mohammad Alavirad\(^1\),\(^5\), Anthony Olivieri\(^2\), Chengkun Chen\(^2\), Sa’ad Hassan\(^3\), Ewa Lisicka-Skrzek\(^2\), Langis Roy\(^1\), R.N. Tait\(^1\) and Pierre Berini\(^2\),\(^4\),\(^5\)
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**Super-resolution cellulose imaging**
Presenter: Mouhanad Babi
Author: Mouhanad Babi
McMaster University

**Compressing a simulated lipid bilayer vesicle with an AFM tip**
Presenter: Benjamin Barlow
Authors: Benjamin Barlow\(^1\), Béla Joós\(^1\), Martine Bertrand\(^2\)
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**Linear optical absorption of SWCNTs at fluences in the photoluminescence saturation regime**
Presenter: Meghan Beattie
Authors: Meghan Beattie\(^1\), Mitchell Anderson\(^2\), James Fraser\(^3\)
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**Nanotube array and quantum dot hybrid PV material**
Presenter: Ashok Bhowmick
Authors: V.I. Lakshmanan, Tyler Sennema, Adam Tetreault, R. Sridhar and Ashok Bhowmick
Process Research Ortech

**Enhancement of nonlinear optics by plasmonic metasurfaces**
Presenter: Antonino Cala’ Lesina
Authors: Antonino Cala’ Lesina\(^1\),\(^2\), Lora Ramunno\(^1\),\(^2\), Pierre Berini\(^1\),\(^2\),\(^3\)
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**Bridging the understanding of fracture mechanisms of graphene oxide**
Presenter: Changhong Cao
Authors: Changhong Cao\(^1\), Matthew Daly\(^2\), Brandon Chen\(^1\), Jane Y. Howe\(^2\),\(^3\), Chandra Veer Singh\(^2\), Yu Sun\(^1\) and Tobin Filleter\(^1\)
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**Applications of nanopore fabrication by controlled breakdown**
Presenter: Martin Charrron
Authors: Martin Charrron and Vincent Tabard-Cossa
Department of Physics, University of Ottawa
Unconventional plasmonic sensors for optical detection in complex media: From plasmon hybridization in actutable dimers to target-controlled permeability change in polyelectrolyte-aptamer/AgNP composite films
Presenter: Jennifer I.L. Chen
Author: Jennifer I.L. Chen
Department of Chemistry, York University

Cellulose nanocrystals as latex polymer property modifiers
Presenter: Zahra Dastjerdi
Authors: Zahra Dastjerdi¹, Stephanie Kedzior², Emily D. Cranston², Marc A. Dubé¹
¹Department of Chemical and Biological Engineering, Centre for Catalysis Research and Innovation, University of Ottawa, ²Department of Chemical Engineering, McMaster University

A nanopore-based device with a central cavity for the selective transport and modification of biomolecules
Presenter: Hendrick de Haan
Authors: Hendrick de Haan and Martin Magill
University of Ontario Institute of Technology

A microfabricated impedance sensor with nanogap electrodes: Surface modification and evaluation using high performance liquid chromatography
Presenter: Al-Amin Dhirani
Authors: Yoshinori Suganuma, Frederic Menard, Mark Lautens and Al-Amin Dhirani
Department of Chemistry, University of Toronto

Generation of superposed vortex beams using angular gratings
Presenter: Marie-Claude Dicaire
Authors: Marie-Claude Dicaire and Robert Boyd
Quantum Photonics, University of Ottawa

Nanowire alignment through substrate stretching
Presenter: Jianjin Dong
Authors: Jianjin Dong¹,³, Nasser Mohieddin Abukhdeir²,³, Irene A. Goldthorpe¹,³
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Atomic scale quantum circuits in silicon
Presenter: Amintor Dusko
Authors: Amintor Dusko¹,³, Isil Ozfidan¹,², Marek Korkusinski⁵, Alain Delgado¹, Belita Koiller³, Andre Saraiva³ and Pawel Hawrylak¹
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AlGaAs microring resonator for all optical signal processing
Presenter: Prova Gomes
Authors: Prova Gomes, Kashif Awan, Lilian Sirbu and Ksenia Dolgaleva
Fabrication of copper oxide nanoparticles in liquid media by laser ablation
Presenter and author: Homeira Faramarzi
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Engineering Novel Poly (9-vinylbenzyl carbazole) (pVBK) based polymers by nitroxide mediated polymerization for orthogonal processable hole transport layers
Presenter: Christian Imperiale
Authors: Christian Imperiale, Owen Melville and Benoît Lessard
Department of Chemical and Biological Engineering, University of Ottawa

Cu2O nanoparticle formation by radiolytic oxidation of copper
Presenter: Arielle Jean
Authors: A.M. Jean, J.M. Joseph, J.C. Wren
Department of Chemistry, Western University

Evaluating industrial and commercial applications of nanocoatings and nanofilms
Presenter: Edward Jerjian
Author: Edward Jerjian
GreenLife Nano

Immobilized AuNPs fabricated on –OH functionalized polystyrene using organo metallic chemical vapor deposition (OMCVD)
Presenter: Sivayini Kandeepan
Authors: Sivayini Kandeepan and Silvia Mittler
Department of Physics and Astronomy, University of Western Ontario

Electrically conductive textiles enabled by silver nanowires
Presenter: Nupur Maheshwari
Authors: Nupur Maheshwari1,2 and Irene A.Goldthorpe1,2
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Optical and electrical contribution to short circuit current density of post-treated hybrid solar cells
Presenter: Donald McGillivray
Authors: D. McGillivray, J. Thomas and Kam Tong Leung
WATLab, University of Waterloo

Size isn’t everything: Impact of nanoparticles on portable power applications
Presenter: Medhi Mostajeran
Authors: Medhi Mostajeran and R. Tom Baker
Centre for Catalysis Research and Innovation (CCRI), Department of Chemistry and Biomolecular Sciences, University of Ottawa
High-yield microwave-assisted preparation of graphene/polymer composite for Li-ion batteries
Presenter: Olga Naboka
Authors: Olga Naboka and Yaser Abu-Lebdeh
Energy, Mining and Environment Portfolio, National Research Council Canada

SERS-based point-of-care biosensing system for food-borne pathogen detection
Presenter: Suresh Neethirajan
Authors: Nawfal Adam Mungroo, Gustavo Oliveira and Suresh Neethirajan
BioNano Laboratory, Biological and Biomedical Engineering, University of Guelph

Molecular communication via diffusion
Presenter: Adam Noel
Authors: Adam Noel1, Karen C, Cheung2 and Robert Schober3
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X-Ray photoelectron studies of nanostructured catalysts and electrocatalysts for environmentally important applications
Presenter: Spyridon Ntais
Authors: Spyridon Ntais and Elena Baranova
Laboratory of Electrochemical Engineering, Department of Chemical and Biological Engineering, Centre for Catalysis Research and Innovation, University of Ottawa

Novel thiophene-based push-pull chromophore: Synthesis and self-assembled monolayers
Presenter: Lionel Patrone
Authors: Volodymyr Malytskyi, Jean-Jacques Simon, Jean-Manuel Raimundo and Lionel Patrone
Aix-Marseille Université, France

Defect-rich TiO2-nanocrystal decorated 1D TiO2 nanowires for super-efficient photoelectrochemical water splitting driven by visible light
Presenter: Md Anisur Rahman,
Authors: Md Anisur Rahman and Kam Tong Leung
WATLab and Department of Chemistry, University of Waterloo

Effect of thermal treatment on the conductivity of single-walled carbon nanotube-polymer composite films
Presenter: Sokunthereath (Kevin) Saem
Authors: Sokunthereath (Kevin) Saem and Jose Moran-Mirabal
Department of Chemistry, McMaster University

Building a better metasurface: High accuracy fabrication of plasmonic nanostructures
Presenter: Sebastian Schulz
Authors: S. A. Schulz, J. Upham, F. Bouchard, I. De Leon, E. Karimi and R. W. Boyd
Department of Physics and Max Planck Centre for Extreme and Quantum Photonics, University of Ottawa
Tuning slow light in silicon photonic crystals by post-processing
Presenter: Sebastian Schulz
Authors: K. Awan1, S. A. Schulz2, D. X. Liu2,3, K. Dolgaleva1,2, J. Upham2 and R. W. Boyd2
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Radiation-induced synthesis of iron oxide nanoparticles: Effect of scavengers on the growth kinetics
Presenter: Connor Sparks
Authors: C. J. Sparks, T.I. Sutherland, J.M. Joseph and J.C. Wren
Department of Chemistry, University of Western Ontario

High-speed bipolar resistive switching in amorphous TiOx-based memristors
Presenter: Saurabh Srivastava
Authors: Saurabh Srivastava, Joseph P. Thomas, Nina F. Heinig and Kam Tong Leung
Department of Chemistry, University of Waterloo

Evaluation of a mussel-derived polymer as a natural bioactive coating for titanium
Presenter: Alexander Steeves
Authors: Alexander Steeves1, Aman Atwal1,3, Fabio Variola1,2,3.
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Mechanical behavior of core-shell Si nanowire anodes for Li-ion batteries
Presenter: Shiming Su
Authors: Shiming Su1, Ijya Srivastava2, Hao Sun2, Jian Liu3, Andrew Lushington3, Jane Y. Howe2,4, Xueliang Sun3, Chandra Veer Singh2, Yu Sun1, Tobin Filleter1
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Effects of linear index mismatch on nonlinear optical microscopy
Presenter: Jarno van der Kolk
Authors: Jarno van der Kolk and Lora Ramunno
Department of Physics, University of Ottawa

Redox active graphene oxide nanosheets: Dual-functional biosensor for on-farm monitoring of dairy cow metabolic diseases
Presenter: Murugan Veerapandian
Authors: Murugan Veerapandian, Robert Hunter and Suresh Neethirajan
Bionano Lab, School of Engineering, University of Guelph

Dye-sensitized hexagonal boron nitride nanostructures: Electrochemical immunosensor for rapid detection of avian influenza virus
Presenter: Murugan Veerapandian
Authors: Murugan Veerapandian, Robert Hunter and Suresh Neethirajan
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