9th NAMIS International Summer School

- Nano and Micro Systems -

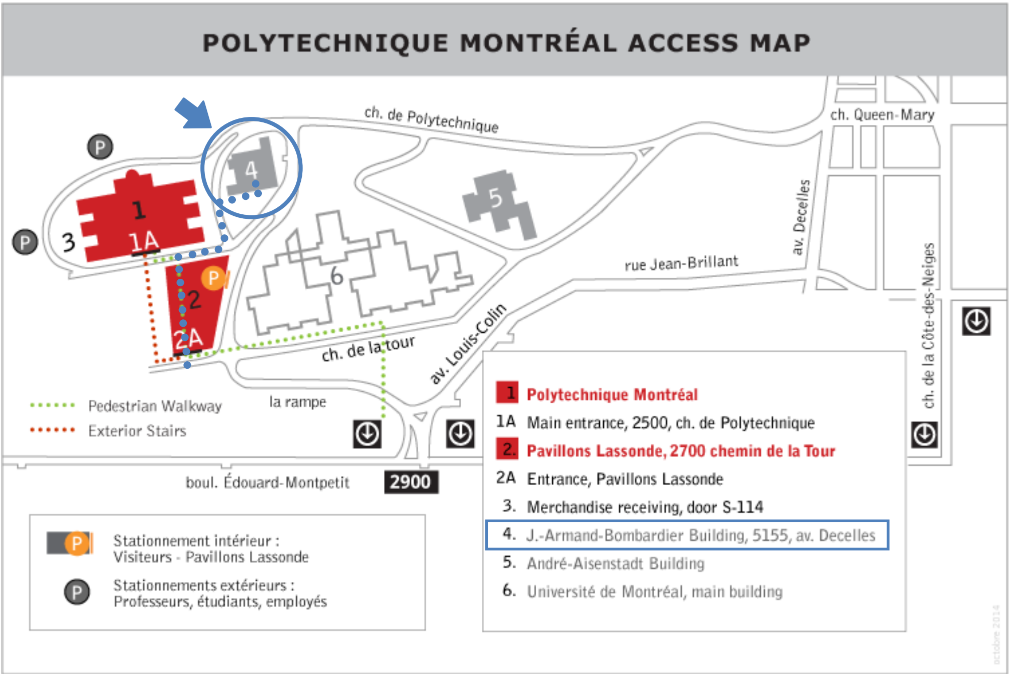
Information Booklet

Polytechnique Montreal
CNRS
CIRMM/IIS-University of Tokyo

<u>School Venue</u>
Polytechnique Montreal
J.-A. Bombardier Building
Room J-1035

Montreal
June 29th – July 3rd 2015

MAPS


POLYTECHNIQUE MONTRÉAL ACCESS MAP
ch. de Polytechnique
ch. Queen-Mary
av. Decelles
rue Jean-Brillant
ch. de la Côte-des-Neiges
av. Louis-Colin
ch. de la tour
la rampe
boul. Édouard-Montpetit
2900
1
1A
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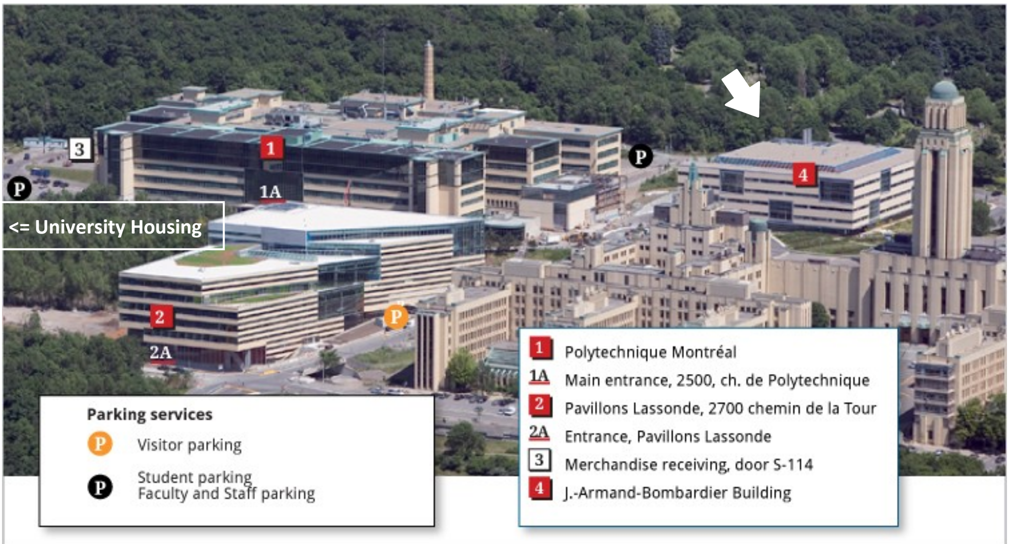
6
Pedestrian Walkway
Exterior Stairs
Stationnement intérieur :
Visiteurs - Pavillons Lassonde
Stationnements extérieurs :
Professeurs, étudiants, employés
1 Polytechnique Montréal
1A Main entrance, 2500, ch. de Polytechnique
2. Pavillons Lassonde, 2700 chemin de la Tour
2A Entrance, Pavillons Lassonde
3. Merchandise receiving, door S-114
4. J.-Armand-Bombardier Building, 5155, av. Decelles
5. André-Aisenstadt Building
6. Université de Montréal, main building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1
1A
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Parking services
Visitor parking
Student parking
Faculty and Staff parking
1 Polytechnique Montréal
1A Main entrance, 2500, ch. de Polytechnique
2 Pavillons Lassonde, 2700 chemin de la Tour
2A Entrance, Pavillons Lassonde
3 Merchandise receiving, door S-114
4 J.-Armand-Bombardier Building

PROGRAM

	Monday, June 29		Tuesday June 30		Wednesday, July 1
08:30	Registraion	08:30	Registration Practical information	08:30	Registration Practical information
		08:45	Practical information	08:45	Practical information
09:00	Welcome NAMIS news Organisation	09:00	**Dr. Marty** Deep reactive Ion Etching	09:00	**Prof. Français** Electrical field-bio cell interaction
09:45	**Prof. Moutanabbir** Nanowires: Growth and Devices	09:45	**Prof. Therriault** 3D printing of microsystems	09:45	**Prof. Gervais** Tumor response using microfluidics
10:30	Coffee Break	10:30	Coffee Break	10:30	Coffee Break
11:00	**Prof. Santato** Towards a "greener" electronics	11:00	**Prof. Charette** Surface plasmon resonance microscopy	11:00	**Prof. Ammar** Integrated biofunctionalization techniques in fluidic MEMS
	Prof. Fréchette Heat Engines for waste heat harvesting		**Prof. Canva** Biochip Plasmonics Imaging Systems and Applications		**Prof. Martel** Swarms of nanorobots
12:30 13:30	Lunch	12:30 13:30	Lunch	12:30 13:30	Lunch
13:45	**Flash Presentations 1** 20 x 2 min	13:45	**Lab visit 1**	13:45	**Prof. Cicoira** Organic Bioelectronics
14:30	**Poster session 1**				**Prof. Morimoto** Tissue engineering based on microfabrication techniques
		15:15	**Break**	15:15	Team competition **Laser Quest** B-512
15:30	**Coffee Break**	15:30	**Lab work 1**		
15:45	**Flash Presentations 2** 20 x 2 min				
16:30	**Poster session 2**				
		17:00	Free time	17:00	Gala Dinner (offered by NAMIS school)
17:30	Welcome Reception (offered by NAMIS school)				

PROGRAM

	Thursday, July 2		Friday, July 3
08:30	Registration Practical information	08:30	Registration Practical information
08:45	Practical information	08:45	Practical information
09:00	**Prof. Francoeur** Coherent optical control in nanostructures	09:00	**Dr. Maindron** OLEDs for microdisplays
09:45	**Prof. Sankey** Optically-Defined Micromechanical Sensors	09:45	**Prof. Izquierdo** Optoelectronic and electrochemical sensors
10:30	Coffee Break	10:30	Coffee Break
11:00	**Prof. Kéna-Cohen** Strong light-matter coupling regime	11:00	**Prof. Drouin** Monolithic 3D integration of nanoelectronic devices
	Prof. Sawan Brain-microsystem Interfaces		**Prof. Blaquière** Towards an Enhanced Programmable Device
12:30 13:30	Lunch	12:30 13:30	Lunch
13:45	**Lab visit 2**	13:45	**Prof. Bosseboeuf** Wafer-level vacuum packaging
			Prof. Juncker Microfluidics for addressing key challenges in medicine
15:15	**Break**	15:15	**Break**
15:30	**Lab work 2**	15:30	Awards ceremony
		16:00	Next NAMIS events Adjourn of the day
17:00	**Jazz festival**	16:30	

LECTURES & SPEAKERS

Lecture 1: **Nanowires: Growth and Devices**

Prof. Oussama MOUTANABBIR , Polytechnique Montréal, Canada
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Abstract:

This lecture focuses on recent advances in understanding the basic properties of semiconductor nanowires (NWs) and their integration in complex device structures. NWs are quasi-one-dimensional nanostructures that have sparked a surge of interest as powerful and versatile nanotechnological building blocks. Particularly, semiconductor NWs have been a rich playground to develop innovative nanoscale devices enabling a vast variety of applications in nanoelectronics, biosensing, quantum computing, and environment-friendly energy conversion such as thermoelectrics and solar energy. These novel technologies exploit size-related effects, the flexibility in fabrication offered by the use of NWs and the concomitant progress in probing nanoscale properties. Besides top-down fabricated NWs, which are currently employed in high-mobility and low-power nanoelectronics, bottom-up synthesized NWs through metal-catalyzed vapor phase epitaxy presents category of NWs that are technologically highly attractive because of the degree of freedom they provide in design and fabrication of nanodevices that extend beyond what is achievable with the planar geometry. A scalable and viable integration of these NWs requires, however, precise control of their physical properties. Herein, I will describe new strategies to address these challenges.

Biography:

Oussama MOUTANABBIR holds Canada Research Chair in Integrative Nanoscale and Hybrid Materials at department of Engineering Physics of Polytechnique de Montréal. He obtained a Ph.D. degree in energy and materials sciences from Institut National de la Recherche Scientifique (INRS-EMT). As a fellow of the Japan Society for the Promotion of Science, he was involved in collaborative research between Keio University and University of California at Berkley. Before taking position in Montreal, he worked for nearly five years as Project Leader at the Max Planck Institute of Microstructure Physics in Germany. Since 2008, he has been visiting scientist at Northwestern University Center of Atom Probe Tomography. He also holds a joint appointment as an Invited Researcher at RIKEN Institute of

Advanced Science in Japan since 2009. His research is in materials physics and engineering encompassing fundamental scientific and industrial activities. His main work focuses on expanding the fundamental understanding of basic physical properties of a variety of semiconductor nanomaterials and quantum systems. Additionally, his group is also actively involved with major semiconductor companies in developing innovative integration processes to enable a variety of cost-effective and high-performance optoelectronic, photovoltaic, and electronic devices. He is co-founder and coordinator of the Global Materials Network (http://www.globalmaterialsnetwork.org/), which is an active platform to unite materials researchers around the world and promote their global collaborations in materials research and education.

Lecture 2: Towards a "greener" electronics: the eumelanin case

Prof. Clara SANTATO, Polytechnique Montréal, Canada
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Abstract:

The ubiquitous natural pigment eumelanin is widely studied for its photoprotective, thermoregulating, free-radical scavenging, and anti-oxidant functions in the human body. Recently, eumelanin received increased attention for potential applications in organic bioelectronics due to its unique set of physicochemical properties including strong broad-band UV-Vis absorption, metal chelation properties, and potentially mixed electronic-ionic conduction in a hydrated state [1,2]. To further explore the use of eumelanin in organic bioelectronic devices, the properties of eumelanin thin films interfaced with device components such as metal electrodes need to be investigated in presence of water and ionic species. A good understanding of the interaction of eumelanin with different metal electrodes is also essential to study the intrinsic charge transport properties of eumelanin films, which are still largely undiscovered.

We characterized eumelanin films grown on substrates patterned with gold, platinum, and palladium hydride electrodes using hydration-dependent transient electrical current and atomic force microscopy measurements. We discovered an electrochemical interaction among metal-chelating catechol groups of hydrated eumelanin, Cl^- traces in the eumelanin material and Au electrodes, assumed to be electrochemically stable in previously published works on the electrical properties of eumelanin. This interaction leads to the growth of highly conductive Au-eumelanin dendrites between the electrodes, ultimately leading to sudden resistive changes of the sample. This phenomenon suggests new possibilities for biocompatible memory devices and has to be taken into account when integrating eumelanin-like materials in electronic devices [3].

Electrical characterization of eumelanin films interfaced with ion-blocking Pt and proton-transparent PdH_x electrodes complemented by impedance spectroscopy measurements give new insights into the charge transport properties of eumelanin films. Our results indicate the presence of protonic

currents in eumelanin thin films, increasing with sample hydration, and cannot exclude the presence of electronic currents. These results support recently published data obtained by spectroscopic measurements on eumelanin pellets [2] and underline the attractiveness of eumelanin films for applications at the interface of electronics and biology.

[1] M. D'Ischia et al., Angew. Chem. Int. Edit. 48, 3914 (2009).
[2] A. B. Mostert et al., Proc. Natl. Acad. Sci. 109, 8943 (2012).
[3] J. Wünsche et al., Adv. Funct. Mater. 23, 5569 (2013).

Biography:

Clara SANTATO (Ph.D. in Chemistry, University of Geneva) is an Associate Professor at the Department of Engineering Physics of Polytechnique Montreal. Prior to her appointment, she worked as permanent research scientist for the National Research Council of Italy. She has been visiting scientist at the National Renewable Energy Laboratory and at Purdue University. Her research background is in Organic Electronics (design, fabrication, and optoelectronic characterization of Organic Light-Emitting Field-Effect Transistors) and Materials Science (nanostructured materials for applications in photoelectrochemical solar energy conversion).

Lecture 3: **MEMS-based Heat Engines for waste heat harvesting,**

Prof. Luc FRÉCHETTE, Sherbrooke University, Canada
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Abstract:

Microelectromechanical system (MEMS) technologies enable the fabrication of heat engines at the microscale for distributed power generation and waste heat recovery. Power-plants-on-a-chip, such as micro steam turbines and other novel concepts to convert heat into electricity at small scale have therefore been developed over the past decade. This presentation will first describe micro heat engines, including micro-turbomachinery-based engines that implement traditional thermodynamic cycles (Rankine, Brayton) as well as membrane-based engines for the Stirling cycle, and novel heat engine approaches enabled by microscale phenomena. Challenges in microfabrication, design and integration will be discussed, as well as the applications and potential performance levels.

Biography:

Luc G. FRÉCHETTE is professor of mechanical engineering at the Université de Sherbrooke. He received his Ph.D. at the Massachusetts Institute of Technology (MIT) in 2000 for the design and fabrication of MEMS-based energy conversion microsystems. After 4 years on the faculty at Columbia University, Dr. Fréchette moved his research activities to the Université de Sherbrooke (Canada) to hold the Canada Research Chair in Microfluidics and Power MEMS (2004-2014). He specializes is the development of microelectromechanical systems (MEMS) with an emphasis on thermal and fluidic devices for micro power generation and thermal management. His research activities include micro heat engines, micro fuel cells, vibration energy harvesting, microfluidics, as well as MEMS sensors and actuators for cooling and harsh environments. Dr. Fréchette contributed over 150 journal and conference publications in these fields and is a member of ASME and IEEE.

Lecture 4: **Deep reactive Ion Etching (DRIE) of ultra high aspect ratio micro and nanostructures**

Dr. Frédéric MARTY, ESIEE Paris/Esycom Lab/Université Paris Est, France
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Abstract:

The ability of pattern transfer into silicon with vertical sidewalls and high accuracy is a crucial requirement in silicon-based microdevices, mainly –but not limited to– MEMS.To do so, deep reactive ion etching plasma reactors which use an inductively coupled plasma source are commonly used. Bosch or Cryogenic processes combined to the use of SiO2, photoresist or metals as etch masks make it possible to achieve very high aspect ratio microstructures (HARMS) on silicon. Aspect ratio is indeed a key factor of merit as it directly affects the performance of most MEMS devices. We succeeded in achieving aspect ratio greater than 100:1. Furthermore, other etching indicators are also of high interest: verticality, wall roughness, Aspect Ratio Dependent Etching (ARDE), notching on SOI substrates are examples of key etch characteristics to deal with.

We are currently investigating DRIE process capabilities at the nano-scale. In particular transfer of nano-patterns into silicon is possible using modified Bosch process to lower wall roughness(scalloping) and minimize critical dimensions loss (under-etch).

Black silicon obtained by mixing SF6+O2 gases at cryogenic temperatures (-110°C) is also studied as a promising material. Control of the nano-textured

surface morphology enables enhancement and tuning of physical properties, such as hydrophobic and hydrophilic behaviour and optical absorption. Hence, numerous applications were developed based on surface engineering.

Biography:

Frédéric MARTY is a project manager in the field of MEMS. He received his diploma in microelectronics from ESTE (ESIEE, Paris, France) in 1989 and his M.Sc. degree in electronics from ISEN, Lille, France in 2007. He worked at various companies involved in MEMS R&D and manufacturing, particularly in the field of pressure measurement and acceleration for aerospace and automotive applications. In 1998, he joined ESIEE Paris, where he is engaged in microsystems developments from design to fabrication in clean-room conditions. Among his skills in clean-room processes, he has 15 years of experience in Deep Reactive Ion Etching (DRIE).
His current research interests include development of MEMS dedicated to Smart Cities and Sustainable Environment.

Lecture 5: **3D printing of microsystems**

Prof. Daniel THERRIAULT, Polytechnique Montréal, Canada
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Abstract:

This lecture will introduce students to different three-dimensional (3D) printing technologies and their utilization to manufacture a wide variety microsystems. First, different 3D printing methods will be reviewed such as fused deposition modeling, stereolithography and selective laser melting. Then, recent advances from Pr. Therriault's research group such as the 3D freeform printing by UV exposure and solvent-cast will be detailed. The third part of this lecture will be an overview of ongoing projects on printed microsystems and their applications ranging from microfluidic devices, piezoelectric sensors, high-toughness microstructured fibers, biomimetic fish scales and conductive grids for electromagnetic shielding.

Biography:

Daniel THERRIAULT holds a Canada Research Chair in Fabrication of microsystems and advanced materials. He obtained his BSc and MSc degrees in mechanical and aerospace engineering respectively, from Polytechnique Montréal and his PhD in aerospace engineering from the

University of Illinois at Urbana-Champaign. His main research interests are the fabrication of micro/nano systems and advanced materials such as microfluidic devices, fuel cells, micro heat pipes and nanocomposites. His patented microfabrication method based on the direct-write assembly of 3D microvascular networks was published in Nature Materials and Advanced Materials. His work on 3D freeform printing were cover articles in Small and Nanotechnology. He received the prestigious "Excellence in Teaching" award from Polytechnique Montréal in 2012.

Lecture 6: **Surface plasmon resonance microscopy**

Prof. Paul CHARETTE, Sherbrooke University, Canada
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Abstract:

Plasmonics are one of the most important methods used in biosensing. Though plasmonics were first proposed for use in biosensing over 30 years ago, intensive research and technological developments continue to this day both in academia and industry over a wide range of applications. This talk will give an overview of the basic physics and technology underlying plasmonics, followed by recent advances in plasmonics-based high-resolution imaging of biological cells. The talk will also give examples of how plasmonics can be combined with other methods for multimode sensing.

Biography:

Paul CHARETTE is a Professor in the department of electrical and computer engineering at the Université de Sherbrooke (UdeS). He obtained his Ph.D. in biomedical engineering from McGill University in 1986 followed by postdoctoral fellowships at the University of Auckland (New Zealand) and the Massachusetts Institute of Technology (USA). He joined the UdeS in 2012 after a career in industrial R&D. His research interests are in biosensing and labs-on-a-chip using a variety of technologies such as fluorescence, surface plasmon resonance, microcalorimetry, and surface acoustic waves.

Lecture 7: **Biochip Plasmonics Imaging Systems and Applications – From milli to micro and nano structuration**

Michael CANVA, CNRS researcher, LN2 laboratory, Sherbrooke University, Canada
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Abstract:

Plasmonic imaging systems have become increasingly popular as surface biomolecular interaction characterization tools due to their unique ability to spatially localize the light:matter interaction in the vicinity of a metal:dielectric interface and to be very sensitive to any optical index change occurring in its vicinity. Classically, these surface plasmon resonance based systems make use of propagating surface plasmon mode localized on a flat interface. Many applications have been demonstrated and many commercial instruments are now available on the market. However to increase performance and overcome some of the intrinsic limitations due to the use of such propagative modes, other plasmon modes based on localized nanoparticles or even better on new hybrid modes based on the coupling between these two extremes cases, can be taken advantage from. Nanoplasmonic based bimodal SPRI/SERS, Surface Plasmon Resonance Imaging / Surface Raman Enhanced Scattering, sensing instrumental system can be envisioned to respectively quantify and identify biomolecular targets at trace concentration.

Biography:

Michael CANVA is a CNRS Researcher. He is currently director of the LN2, Laboratoire Nanotechnologies Nanosytèmes. The LN2 is an international research institute (Unité Mixte Internationale - UMI) founded by CNRS, Université de Sherbrooke (UdeS) as well as several other French partners, INSA Lyon, ECL, CPE, Université Joseph Fourier (UJF) and RENATECH, the French micro and nanofabrication network for innovation. LN2 is localized at the UdeS in Sherbrooke, Québec, Canada, where Michael Canva is also associated professor. He had obtained his Ph.D. in physics from the Université d'Orsay Paris Sud in 1992. For most of his carrier he worked at the Laboratoire Charles Fabry (LCF) of the Institut d'Optique Graduate School (IOGS), a CNRS laboratory in France. He however also spent many years as visiting researcher in the USA, at CREOL in Florida with George Stegeman (1996-1998) and at Duke University in North Carolina with Tuan Vo-Dinh (2009-2010). His research interests are in the relationships between hybrid material compositions and structures and the impact on their properties and applications, as well as how they can be tuned to optimize given requirements. Current focus is on biosensing using plasmonics and nanostructures, i.e. nanobioplasmonic systems.

Lecture 8: **Study of Electric Field interaction with biological species within microfluidic devices**

Prof. Olivier FRANÇAIS, SATIE Laboratory/ENS de Cachan, France
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Abstract:

With size reduction within microfluidic devices, the electric field can be used in order to interact with biological species. It is a « tool » that permits to detect, sort, treat and analyze species at a single cell level. This lecture will be focused on the use of microtechnologies to study cell behaviour under electric field. It will make on overview of the physics associated in relation with "dielectric properties" of biological species. Applications concerning cell trapping, sorting and analyzing will be presented.

Keywords: Biochips; Microfluidics, Dielectrophoresis, Bioimpedance, Electropermea-bilisation

Biography:

Olivier FRANÇAIS graduated in "Electrical Engineering" before he got his Ph.D. degree in 1998 at ENS Cachan (France) on electrostatic microactuators applied to micropumps. From 1998 to 2004, he developed a research on microtechnologies and microfluidics at ESIEE (Marne la Vallée, France). He joined in 2004 the CNAM (Paris, France) and worked on bio-chemical resonant sensors and microfluidics. In 2009, he had been recruited at ENS Cachan where he focused his research towards bio-microsystems with an "applied physics" point of view. He is specialist on interaction between electric fields and biological species within a microfluidic chip, particularly in dielectrophoresis, bioimpedance (EIS) and electroporation.

Lecture 9: **Microfluidic tools for live microtumor assays**

Prof. Thomas GERVAIS, Polytechnique Montréal, Canada
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Abstract:

How to find the right treatment for a patient suffering from advanced cancer? In the past decade, there has been a growing awareness among clinicians that tumours are highly patient--specific and likely to have different sensitivities to different types of anti--cancer drugs. Given that the therapeutic effects of most drugs can only be felt after several weeks, identifying non--responders early in a treatment should greatly reduce side--effects and save costs associated with no clinical benefit. To seek solutions to the treatment response problem in cancer, we tap into microfluidics unparalleled potential for the low cost, rapid, and integrated culture of cells and tissues on chip. In this presentation, we will introduce new microfluidic platforms under development in our laboratory to maintain alive and probe various kinds of 3D tumor samples, from spheroids to ex vivo human tumors.

Biography:

Thomas GERVAIS is assistant professor of engineering physics and biomedical engineering at Polytechnique Montreal. He is also associate researcher at the University of Montreal's hospital research center. He holds a bachelor degree in engineering physics from Polytechnique Montreal and a Ph.D. in bioengineering from MIT. His research interests center on microfluidics systems applied to the assessment of tumor response to treatments. He is also an avid popularizer of science, having reported on science and technology on various TV Shows on Quebec's Public Television Networks and in the Canadian written press.

Lecture 10: **Integrated bio-functionalization techniques in fluidic MEMS: how to play with magnetic nanoparticles for immune assays**

Prof. Mehdi AMMAR, IEF/CNRS-Université Paris-Sud, France
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Abstract:

The lecture will present an approach of innovative BIOMEMS dedicated to an ultra-sensitive and controlled protein detection. The concept is based on fully-integrated immune-complex assays [antibody – biomarker – antibody – fluorescent dye and/or magnetic nanoparticles] inside microfluidic systems. The first part of the lecture will be focused on the presentation of high efficient

techniques of functionalization (silanization) of silicon microchannel with carboxylic or amine functions, while forming a monolayer which can accept protein and recognize specific biomarkers of neurodegenerative diseases or for bacteria detection. To attain a very high performance of dynamic silanization, the internal surface of the microchannel is systematically characterized by XPS, AFM and FTIR to optimize several parameters of the silanization method (temperature, solvent, flow rate…). The second part of the lecture is relied on the bio-functionalization of magnetic nanoparticles by controlling their movement within integrated microcoils in fluidic microsystems. The trapping of immune-functionalized nanoparticles offers several advantages such as (i) the control of multi-level immune-complex construction (ii) the possibility, as captured element, to concentrate the biomarkers of interest from a complex biological sample, (iii) by applying a magnetic field, the nanoparticles will be concentrated in the detection area and the kinetic of the immunologic recognition will increase (iv) their detection by the electromagnetic signal collected by the microcoils could be considered as an original alternative to the fluorescence technique. The presented biosensing concepts are applied to the sensitive detection of Alzheimer disease biomarkers (Amyloid peptides, Tau protein, ERK1/2) or cardiac pathologies (BNP, Troponin I biomarkers) or recently for bacteria detection.

Keywords: Dynamic bio-Functionalization, magnetic nanobeads, MEMS/microfluidic assembling, surface characterization, magnetic trapping, immuno-assay.

Biography:

Mehdi AMMAR, he is a researcher at the “Institut d’Electronique Fondamentale” (IEF University Paris Sud/CNRS). He received his M.S. degrees in Nanostructures and Nanotechnologies from University Paris Sud and his Ph.D in Physics, in the field of nanostructured magnetic materials, in 2007 from ENS Cachan. His research interests cover micro/nanotechnologies, surface bio-functionalization and characterization techniques, in particular for the development of specific physical and chemical micro-sensors. For a few years, his activity focused on developing controlled coating techniques of nanostructured materials in particular magnetic nanoparticles (sol-gel techniques). Since 2009, he has developed activities in the topic of dynamic bio-functionalization techniques in fluidic microchips using magnetic nanoparticles for bioanalysis applications (in particular Alzheimer biomarkers detection). Current focus is the field of bacteriological detection for biodefense applications.

Lecture 11: **Fighting cancer using swarms of nanorobots**
Prof. Sylvain MARTEL, Polytechnique Montréal, Canada
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Abstract:

The implementation of medical artificial nanorobots is still far beyond present technological feasibility. But nature has already provided natural nanorobots that have the capability of these envisioned nanorobots of the future. As such, our approach was then to learn how to exploit their capabilities to accomplish specific tasks. More specifically, it will be shown how tens of millions of MC-1 bacteria can be harnessed simultaneously to mimic swarms of such futuristic artificial nanorobots with an equivalent capability level when operating in a computer-controlled artificial environment enabling the exploitation of their magneto-aerotactic migration behavior. Our experimental results conducted in animal models suggest that exploiting the actuation-navigation-sensory capability of these natural nanorobots can lead to more effective targeting and to the first method of non-systemic transports of drug molecules to deeply located tumor regions such as the hypoxic zones to achieve maximum therapeutic outcomes. Besides showing how such a technology can also be used as a powerful diagnostic tool, the talk will continue with some novel complementary methods of navigation and transport of therapeutic agents in the vascular network using clinical MRI scanners being adapted to act as drug delivery platforms, and how the integration of nanoscale components in such robotic navigable agents allowing the exploitation of physical phenomena occurring at the nanoscale can be used to embed functionalities and capabilities such as locally opening the blood-brain barrier. The talk will conclude with some thoughts about future prospects including but not limited to the exploitation of swarm behaviors to increase targeting efficacy further, and genetically modified agents suited for particular tasks and physiological environments.

Biography:

Sylvain MARTEL, Fellow of the Canadian Academy of Engineering as well as IEEE Fellow, is Chair of the IEEE Technical Committee on Micro- Nanorobotics and Automation, and Director of the NanoRobotics Laboratory at Polytechnique Montréal, Campus of the University of Montréal, Canada. He received many awards mostly in interdisciplinary research and he is a recipient of a Tier 1 Canada Research Chair in Medical Nanorobotics. He developed several biomedical technologies including platforms for remote surgeries and cardiac mapping systems when at McGill University, and new types of brain implants for decoding neuronal activities in the motor cortex when at MIT. Among other achievements, Dr. Martel's research group is also credited for the first demonstration of the controlled navigation of an untethered object in the blood vessel of a living animal. Presently, Prof. Martel is leading an interdisciplinary team involved in the development of navigable therapeutic agents and interventional platforms for cancer therapy. This research is based on a new paradigm in drug delivery pioneered by Prof. Martel and being known as direct targeting where therapeutics are navigated in the vascular network towards solid tumors using the most direct physiological routes. Such approach leading to a significant increase of the therapeutic index has been featured in several media around the world such as The Globe and Mail, MIT Technology Review, New Scientist, The Economist, BBC, Newsweek, etc.

Lecture 12: Organic bioelectronics

Prof. Fabio CICOIRA, Polytechnique de Montréal, Canada
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Abstract:

Organic electronics, based on semiconducting and conducting polymers, have been extensively investigated in the past two decades and currently have found wide commercial applications in lighting panels, smartphone screens, and TV screens using OLEDs (organic light emitting diodes) technology. Many other applications are foreseen to reach the commercial maturity in future in areas such as OFETs (organic field effect transistors), sensor devices, and organic photovoltaics. This success was due to many unique and desired properties of organic semiconductors in comparison to their inorganic counterparts such as mechanical flexibility, tunability of electrical and optical properties via chemical synthesis, ease of processing, and low temperature fabrication.

Organic electronic devices, apart from consumer applications, are paving the path for key applications at the interface of electronics and biology, such as in polymer electrodes for recording and stimulating neural activity in neurological diseases, the subject of this proposal. In such applications, organic polymers are very attractive candidates due to their distinct property of mixed conduction: the ability to transport both electron/holes and ionic species [1-2]. The ionic conduction is of special importance since most biological signals consist of ionic currents. Conducting polymers like polyanilines, polypyrroles, and polythiophens are ideal choices for bioelectronic applications. Besides supporting mixed ionic/electronic conduction, these materials are chemically stable over a broad pH range, offer a direct (oxide-free) interface to electrolytes, can incorporate and release ionic species of biological interest, and are biocompatible. Additionally, conducting polymers offer the possibility to tune their surface properties (e.g., wettability or chemical reactivity) by changing their oxidation state, thus promoting or hindering the adhesion of biomolecules. This feature can be particularly useful for enhancing the biocompatibility of implantable electrodes. Finally, the ability of organic conducting polymers to release chemicals in a

controlled fashion is opening new avenues for applications in drug delivery systems, making them indispensable tools in nano-biotechnology [3-4].

My lecture will give an overview of the activity of my research group on processing and characterization of conducting polymer films and devices for flexible bioelectronics [5-7]. I will particularly focus on micro-patterning of conducting polymer films for flexible and stretchable devices and on grafting of biological species on conducting polymer surfaces.

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2. G. Tarabella, F. M. Mohammadi, N. Coppedé, F. Barbero, S. Iannotta, C. Santato and F. Cicoira. New opportunities for organic electronics and bioelectronics: ions in action, Chem. Sci. 4, 1395, 2013.
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5. O. Berezhetska, B. Liberelle, G. De Crescenzo, F. Cicoira , A Simple Approach for Protein Covalent Grafting on Conducting Polymer Films, J. Mater. Chem. B (in press).
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7. H. Tang, P. Kumar, S. Zhang, Z. Yi, G. De Crescenzo, C. Santato, F. Soavi, F. Cicoira , Conducting polymer transistors making use of activated carbon gate electrodes, ACS Appl. Mater. Interfaces 7, 969−973, 2015.

Biography:

Fabio CICOIRA is a professor of Chemical Engineering at École Polytechnique de Montreal. He is known for his studies of organic field-effect transistors, growth of organic semiconductors and organic electrochemical transistors. His activities focus in organic bioelectronics and carbon based electrodes in organic electronic devices. Prof. Cicoira received his MSc in Chemistry from the Università di Bologna (Italy), after a research internship at the European Laboratory for Particle Physics (CERN), and his PhD in Materials Science and Engineering from the Swiss Federal Institute of Technology Lausanne (Switzerland). He worked as a researcher at the National Research Council of Italy (2002-2005 and 2007-2011) and as postdoctoral fellow at INRS-EMT (2005-2007). He was a visiting scientist at Cornell University from 2007 to 2009. From 2007 to 2010 he was recipient of the prestigious Marie Curie International Outgoing Fellowship of the European Union. He has published 56 articles in international peer-reviewed scientific journals and several book chapters. His works have been cited more than 1300 times and his H-index is 22.

Lecture 13: **Tissue Engineering Based on Microfabrication Techniques**
Prof. Yuya MORIMOTO, Institute of Industrial Science, the University of Tokyo, Japan
y-morimo@iis.u-tokyo.ac.jp

Abstract:

The demand for reconstruction of functional living tissues and organs *in vitro* has increased in various fields, especially in regenerative medicine and animal-alternative pharmacokinetic studies. As the recent advances in iPS cells have made diverse species and types of cells available, developments of novel tissue engineering techniques has become the major challenge to achieve the above mentioned applications. In this regard, the engineered tissues should mimic *in vivo* tissues, i.e. be composed of 3D hierarchical structures with various types of cells and proteins in order to offer suitable environments to elicit functions and properties of cells. As one of the tissue engineering methods, the bottom-up approach, which uses multiple microsized cellular constructs as cellular building blocks, has recently attracted attentions for the reconstruction of spatially-organized 3D tissues with high-cell-density. Among various fabrication methods, microfluidic techniques are well suited for the formation of microsized cellular constructs

This presentation will show an overview of the microfluidic techniques for the fabrication of the cellular constructs. We then show recent developments in 3D macroscopic tissues as assembly of the cellular constructs using microfluidic and microfabrication techniques. Finally, we introduce applications of the cellular constructs in the field of clinical treatment.

Biography:

Yuya MORIMOTO is assistant professor at Institute of Industrial Science, the University of Tokyo. He received his bachelor's and master's degree from the University of Tokyo. Thereafter, he was a mechanical engineer in Fujifilm Corporation, where he developed medical endoscopes. He then returned to academic, and he received a Ph. D. from the University of Tokyo. His research interests are in the field of tissue engineering where he constructs macroscopic 3D tissues *in vitro* using microfluidic and microfabrication techniques.

Lecture 14: **Coherent optical control in nanostructures,**

Prof. Sébastien FRANCOEUR, Polytechnique Montréal, Canada
sebastien.francoeur@polymtl.ca

Abstract:

Quantum information processing potentially offers unprecedented resources for solving strategic computational problems ranging from the factorisation of large prime numbers to the simulation of complex quantum systems. Amongst the various platforms currently explored, optically controlled nanostructures offer a number of advantages: their large dipole moment lead to ultrafast gating, they offer relatively long coherence times allowing for a large number of operations, and they benefit from an outstanding device fabrication and processing technology.

In this presentation, I will describe the physical concepts involved in the initialization, control and single-shot read out of a single qubit defined by an electron spin trapped in a semiconductor nanostructure.

Biography:

Sébastien FRANCOEUR received a Ph.D. from the University of Colorado at Boulder for research work done at the Basic Science division of the National Renewable Energy Laboratory in Golden, Colorado. Associate professor in the department of Engineering Physics at Polytechnique Montréal, he specializes in the optical spectroscopy of novel materials and nanostructures, and the coherent control of quantum states. Recently, he was the first to propose using isoelectronic centers as building blocks for an optically controlled semiconductor-based quantum computer and his team has recently demonstrated the several powerful advantages associated to this approach.

Lecture 15: **Optically-Defined Micromechanical Sensors,**

Prof. Jack SANKEY, McGill University, Canada
jack.sankey@mcgill.ca

Abstract:

Our goal is to develop a coherent interface between micro-electromechanical systems (MEMS), photons, quantum defects, and (most recently) spin-transfer-driven nanoscale magnetic circuits. MEMS are currently used in a variety of technologies ranging from accelerometers in vehicles to three-dimensional mapping of atomic nuclei in solids (~5 nm resolution). More recently, they have been proposed as a versatile platform for quantum information science. The majority of these applications are fundamentally limited by the mechanical

quality factor attainable using modern elastic materials. In order to overcome this limitation, our group is currently exploring a variety of experiments related to optically-levitated MEMS. Because the physics of photons is fundamentally different from that of atoms in elastic solids, such devices are predicted to circumvent the dissipative limitations of the best existing materials and achieve an unprecedented level of coherence — whereas the best existing MEMS might ring for seconds when struck, optically-supported MEMS are predicted to ring coherently for weeks. Such systems would be sensitive to sub-zeptonewton forces, and should be capable of coherently shuttling quantum information between wide array of competing qubit technologies and telecom-wavelength photons.

Biography:

Jack SANKEY joined the McGill Physics Department as an assistant professor in 2012. He received his Ph.D. in 2007 from the Cornell University Physics Department (Dan Ralph Group) for his work on spin transfer in individual nanomagnets, and subsequently switched to the field of optomechanics for his postdoc in the Yale Physics Department (Jack Harris Group). At McGill he continues to pursue optomechanics. Specifically, he is interested in engineering new types of micromechanical force sensors controlled by laser light, potentially operating in the limit where quantum mechanics plays a central role. He currently holds the Tier II Canada Research Chair in Experimental Optomechanics, and was awarded a 2013 Alfred P. Sloan Fellowship for promising early-career researchers. .

Lecture 16: **Optics in the strong light-matter coupling regime,**

Prof. Stéphane KÉNA-COHEN, Polytechnique Montréal, Canada
stephane.kena-cohen@polymtl.ca

Abstract:

All of the optical processes that we are familiar with: absorption, emission and scattering of light treat the interaction of light perturbatively. In other words, if a semiconductor emits a photon, the photon has almost no chance of being re-absorbed by the same electron-hole pair. The physics of light matter-interaction become drastically different when the interaction is made strong enough. One must then treat light and matter on equal footing and new quasiparticles emerge called polaritons. We will discuss some of the peculiar properties of polaritons, and their application to realizing ultralow threshold lasers, nonlinear optical switching and quantum information. We will then focus on recent experiments

using organic semiconductors to reach the strong light-matter coupling regime at room temperature. We will show the exciting phenomenology which results in physics analogous to those which take place at a few nanokelvin in atom Bose-Einstein condensates.

Biography:

Stéphane KÉNA-COHEN is an Assistant Professor at Polytechnique Montréal since January 2014. He completed his Ph.D. at Princeton University under the supervision of Stephen Forrest in 2010, where his work focussed on the realization of hybrid organic-inorganic devices and on light-matter interaction in organic microcavities. There, he demonstrated the first organic polariton laser. After his studies, he moved to Imperial College London for a post-doctoral appointment in nanophotonics with Stefan Maier and Donal Bradley where he developped plasmonic amplifiers using organic gain media. He was awarded an Imperial College Junior Research Fellowship in 2012 to perform independent research and in this position focussed on quantum plasmonics and on new platforms for polariton condensates. He also holds two patents related to the field of organic electronics.

Lecture 17: **Brain-microsystem Interfaces for the Recovery of Neural Functions,**

Prof. Mohamed SAWAN, Polytechnique Montréal, Canada
mohamad.sawan@polymtl.ca

Abstract:

Implantable Brain-Microsystem-Brain Interfaces (BMBIs) for diagnostic and recovery of neural vital functions are promising alternative to study neural activities underlying cognitive functions and pathologies. This lecture covers the architecture of typical BMBI intended for wireless neurorecording and neurostimulation. Massively parallel multichannel spike recording through large arrays of microelectrodes will be introduced. Attention will be paid to low-power mixed-signal circuit design optimization. Advanced signal processing implementation such as adaptive thresholding, spike detection, data compression, and transmission will be described. Also, the talk includes Lab-on-chip technologies intended to build biosensors, and wireless data links and harvesting power to implants. Tests and validation of devices: electrical, mechanical, package, heat, reliability will be summarized. Case studies will be covered and include research activities dedicated to vision recovery through

implant used to apply direct electrical microstimulation, to present the environment as phosphenes in the visual field of the blind. And we will summarize latest activities on locating epileptic seizures using multimodal fNIRS/EEG processing, and will show the onset detecting seizure and techniques to stop it, using bioelectronic implant.

Biography:

Mohamad SAWAM received the Ph.D. degree in electrical engineering from Université de Sherbrooke, Sherbrooke, QC, Canada, in 1990. He joined Polytechnique Montréal in 1991, where he is currently a Professor of Microelectronics and Biomedical Engineering, and he is Advisory Professor in Shanghai Jiao Tong University, China. Dr. Sawan is co-Founder and Associate Editor of the IEEE Transactions on Biomedical Circuits and Systems, Associate Editor of the IEEE Transactions on Biomedical Engineering, and the International Journal of Circuit Theory and Applications. He is founder of the International IEEE-NEWCAS Conference and of the Polystim Neurotechnologies Laboratory, and Co-Founder of the International IEEE-BioCAS Conference, and the International IEEE-ICECS. He was Deputy Editor-in Chief of the IEEE Transactions on Circuits and Systems-II: Express Briefs (2010-2013). His scientific interests are the design and test of analog and mixed-signal circuits and systems, signal processing, modeling, integration, and assembly. He holds the Canada Research Chair in Smart Medical Devices, and he is leading the Microsystems Strategic Alliance of Quebec (ReSMiQ). Dr. Sawan published more than 700 peer reviewed papers, two books, 10 book chapters, and 12 patents. He received several awards, among them the Barbara Turnbull 2003 Award for spinal cord research, the American University of Science and Technology Medal of Merit, and the ACFAS - Bombardier and Jacques-Rousseau Awards. Dr. Sawan is Fellow of the Canadian Academy of Engineering, Fellow of the Engineering Institutes of Canada, and Fellow of the IEEE. He is also “Officer” of the National Order of Quebec.

Lecture 18: **OLED for microdisplays,**
Prof. Tony MAINDRON, CEA, France
tony.maindron@cea.fr

Abstract:

Organic Light-Emitting Diodes (OLED) technology today offers new opportunities for viewing, competing LCD displays, as well as for lighting, in addition to LEDs. Since recent years some Asian smartphones have been incorporating AMOLED (Active-Matrix OLED) displays. In 2014, such displays have been released for large TV screens. Some mirrorless compact cameras also integrate tiny OLED displays, with a < 1'' diagonal, in their Electronic Viewfinder. These displays are called microdisplays. The main asset of the OLED microdisplays compared to the LCD ones lie in their low power consumption, their very high resolution, their infinite contrast and their highly saturated colors. Besides, the OLED is a surface emitter which could be deposited onto a non planar surface in order to achieve flexible displays or lighting panels. Applications for OLED lighting panels are focusing today mainly onto niche market like for lighting designers. Thin-film encapsulation (PECVD, ALD technologies) of OLED devices is of main concern today in order to protect the fragile devices against the oxidizing gases (O2, H2O) of the atmosphere. In this lecture we will review the basics of OLED technology, its use in general displays but with a particular attention onto microdisplay technology (which is developed in France by the Company MicroOLED, a spin-off from CEA-LETI in 2008, now 30 employees) and in lighting applications. The issues related to the thin-film encapsulation will be addressed too.

Biography:

Tony MAINDRON received his doctoral degree (PhD) in Materials Science in 2002 from the Institut National de la Recherche Scientifique, Energie, Matériaux et Télécommunications, a governmental Research institution located in Montréal, Québec, Canada. His research aimed at developing OLED architectures based on the use of new organic semiconductors that emit in the blue and the use of new electron transporting molecules. Following this he completed a postdoctoral fellowship in the same laboratory to develop hybrid OLED. He then worked one year in the Canadian company Nova-Plasma Inc. (Montréal, QC, CANADA) where he was a research engineer responsible for characterizing the defects in thin barrier films developed by the company. Back in France in 2004, he worked one year at the CEA centre in Saclay. He then joined Thomson R & D France in Rennes where he was an engineer for the development of new generation of displays incorporating the OLED technology. Since the former OLED business of Thomson R & D was transferred to CEA-LETI at the end of 2006, he joined the CEA-LETI Display Technology Laboratory where he has been developing innovative thin film encapsulation for OLED-on-CMOS for microdisplay applications. He published over 28 publications, papers, books and articles and holds 18 patents.

Lecture 19: **Integration of optoelectronic and electrochemical sensors on a microfluidic platform for water pollution detection,**

Prof. Ricardo IZQUIERDO, Université du Québec à Montréal, Canada
izquierdo.ricardo@uqam.ca

Abstract:

A portable system to monitor water quality in both developed and developing countries is highly required. Currently, there is no commercial test available to satisfy this demand, as only accredited laboratories can perform such evaluations. Miniaturization of analytical instrumentation is one of the dominant trends within the chemical and biological sciences. Miniaturization of diagnostic devices not only affords portability and significant cost reductions but also performance gains in terms of speed, analytical efficiency, automation and reproducibility.

To address this issue, a phytoplankton (alga and cyanobacteria) based detection system implemented in a micro-fluidic platform was developed. As change of the environment of algae induced by toxic compound can affect their metabolism, this makes phytoplankton ideal natural biosensors. Their response can be measured in real time by various detection mechanisms *i.e.,* optical, chemical or electrical

In general, photosynthesis process of algae is inhibited in presence of toxic compound, in our case, Diuron. Electrochemical detection is based on the measurement of oxygen produced by algae under such conditions. It was carried out using transparent silver nanowires electrode. The size distribution of the Ag nanowires is ~ 80 nm in length and the transparency of the electrode is 80%. Fluorescence detection is based on the activity of photosystem II in the presence and absence of Diuron. The concentration of Diuron can be detected by electrochemical detection between 50 and 1000 nM. and 0.50 to 1000 nM using fluoresecense detection. The two detection systems can be integrated into a single chamber in a way which enables for more reliable and sensitive detection of water pollutant.

Biography:

Ricardo IZQUIERDO joined the Computer Science Department at Université du Québec à Montréal (UQAM) in 2005, after seven years in the industry as Director of R&D

at Technologies Novimage and OLA Display Corporation, where he contributed to the emergence of a cluster of research activities in the field of organic electronics in the Montreal area. Since his arrival at UQAM he participated in the creation of two institutional research centers, one in nanomaterials and energy (NanoQAM), where he was adjunct director from its creation in 2007 until 2010 and the research center in Co-design and fabrication of microsystems (CoFaMic), which he has been directing from its creation in 2010 until now.

Lecture 20: **Monolithic 3D integration of nanoelectronic devices,**
Prof. Dominique DROUIN, Sherbrooke University, Canada
Dominique.Drouin@usherbrooke.ca

Abstract:

We propose to integrate low-power nanoelectronic devices above CMOS circuits using a 3D monolithic approach to benefits from both technologies. While nanoelectronic devices will be used to integrate low-power logic, memory and/or new functionalities such as sensors, CMOS devices will be used for high-performance logic and memory but also for I/O signals restoration. We have developed the nanodamascene process that can produce tunnel junctions with extraordinary small capacitance while maintaining an accurate control on junction area. We will present how this process can be used to integrate metallic SET and tunnel FET above CMOS but also proposed new fabrications approach for low power passive RRAM.

Biography:

Dominique DROUIN is a chair holder of NSERC/IBM Industrial Research Chair CRSNG/IBM in Smarter Microelectronics Packaging for Performance Scaling and professor at the electrical and computer engineering department of the Universite de Sherbrooke since 1999. He received his electrical engineering degree in 1994 and his PhD in mechanical engineering in 1998. He is co-inventor of a new approach for the fabrication of nanoelectronics devices featuring performances never reached before that has been acknowledged by the industry as a technology breakthrough. He also cumulates six years of industrial experience as Vice-President of operations within a start-up company (Quantiscript), where he was appointed to the development on new microfabrication processes.

Lecture 21: **Towards an enhanced programmable device,**

Prof. Yves BLAQUIÈRE, Université du Québec à Montréal, Canada
blaquiere.yves@uqam.ca

Abstract:

3D and 2.5D multi-stacking technologies significantly reduce the size/weight and increase the functionalities of electronic systems. They allow the creation of heterogeneous microsystems that integrate processor, memories, sensors, antennas, MEMS with very large number of electrical connections between them, mainly due to the venue of through silicon (or glass) vias (TSVs) technologies. Silicon or glass interposers with multiple metal layers are used as passive interconnect structure between Si dices, where TSVs are aligned to silicon dice terminals (micro-balls). These passive structures are customized to each dice and therefore increase the integration cost. The talk presents a new research project that intends to reduce risks and uncertainties of multidimensional stacking technologies by the use of an intelligent active interposer populated with a sea of configurable tiny pads that can be electrically connected to any others or any TSVs. This enhanced programmable device embeds several configurable structures, such as interconnect network, analog and digital signaling, configurable power supplies, multiple sensors and instruments to ease test and diagnosis of these multidimensional stacking devices. Preliminary results achieved for a prototyping platform for electronic systems are also presented, such as the completion of a silicon wafer post-processing with the successful fabrication of research world-first 4,864 TSVs; an on-wafer distributed voltage regulators; a spatially configurable very high speed differential Input/Output; an configurable analog and digital signaling and conventional busses.

Biography:

Yves BLAQUIÈRE received the B.Ing., M.Sc.A and Ph.D. in electrical engineering from Ecole Polytechnique de Montreal, Canada in 1984, 1986 and 1992 respectively is professor with Université du Québec à Montréal (UQAM) since 1987 (www.micro.uqam.ca). His main research interests are in the field of Microelectronic Engineering, specifically in integrated circuit design and test, reconfigurable systems (FPGA), ASIC/VLSI/WSI microsystems design, system conception methods, CAD tools for microelectronic, system architectures and fault tolerance. Professor Blaquière is Director of microelectronic engineering programs and Engineering director at UQAM.

Lecture 22: **Wafer-level vacuum packaging**
Alain BOSSEBOEUF, CNRS researcher, IEF/CNRS-Université Paris-Sud
alain.bosseboeuf@u-psud.fr

Abstract:

Vacuum packaging is required by various micro/nano devices such as resonant MEMS devices, thermal sensors, switches, scanners,etc.. The current trend is the replacement of standard vacuum packages by wafer-level packages which allows a reduction of size and cost owing to the use of collective fabrication processes. The development of a successful vacuum wafer-level packaging process relies on the mastering of several issues such as the choice of suitable materials and thermal cycle, the achievement of hermetic wafer bonding and connections feedthroughs, the maintenance of vacuum by the use of getter films or high temperature annealing steps, and the management of mechanical stress. In the lecture we will discuss all these issues and illustrate solutions investigated by various labs and in our institute.

Biography:

Alain BOSSEBOEUF obtained a telecommunications engineer diploma from ENSTBr in 1980 and a master degree in Solid State Physics from University Paris VI in 1981. He received in 1989 the state doctorate degree in Physics from University Paris-Sud (Orsay). Since 1983 he works as a CNRS full-time researcher in the Institut d'Electronique Fondamentale (IEF), a joint institute of CNRS and University Paris-Sud located in Orsay Campus(France). After more than 10 years of research activity on thin film deposition and characterization, he started to work in the field of microsensors, MEMS and related instrumentation at the beginning of nineties. Since 2006, he is coordinating the international research network NAMIS (Nano and Microsystems) involving 12 partners from 9 countries. He leaded various research teams and for almost ten years the research department "Microsystems and nanobiotechnologies" of IEF. Now he is fully involved in experimental research work and current interests include resonant sensors, MOEMS, getter and metal oxides films, vacuum Wafer Level Packaging (WLP), 3D integration processes, and the development of characterization tools for films, MEMS and WLP.

Lecture 23: Microfluidic technologies for addressing key challenges in medicine, and for the fun of it,

Prof. David JUNCKER, McGill University, Canada
david.juncker@mcgill.ca

Abstract:

Despite tremendous progress, the diagnosis of disease often only occurs late in the process, upon the apparition of symptoms. Here I will summarize some of the challenges in early disease diagnosis, and link them to our efforts in creating, developing, and applying microfluidic technologies. First I will briefly discuss our work on multiplex protein analysis using antibody colocalization microarrays. Next, our work on capillary microfluidics and the development of "capillaric" circuits that – akin to electronic circuits – can be assembled using libraries of capillaric elements and execute complex fluidic operations autonomously. Next, I will present our latest efforts in developing novel microfluidic concepts introducing microfluidics on elastic strings. Using these strings digital microfluidic operations are conducted by transferring, mixing, and copying of droplets, simply by mechanically manipulating the elastic strings.

Biography:

David JUNCKER stayed as a visiting scientist at the National Metrology Institute of Japan in Tsukuba from 1997-98. He conducted his PhD research at the IBM Zurich Research Laboratory from 1999-2002. He then pursued his studies as a Post-doc first at IBM Zurich until 2004, and then one year at the Swiss Federal Institute of Technology in Zurich (ETH). David started as an assistant professor in the Biomedical Engineering Department of McGill University in 2005 and in 2011 he was promoted to associate professor with tenure.
David's current interests are in the miniaturization and integration in biology and medicine, which includes the engineering and utilization of novel micro and nanotechnologies for manipulating, stimulating and studying oligonucleotides, proteins, cells, and tissues. The emerging field of nanobiotechnology, in a broad sense, is the most exciting to David, and is also key to tackle some of the major challenges in biology and medicine, for example identifying novel biomarkers for early disease diagnosis and developing low-cost point-of-care diagnostics.

POSTERS

Session 1

1. Droplet transport with ARCs
Hal Holmes

3. Thin-film edge electrode lithography enabling low-cost collective transfer of nanopatterns
Kunhan Chen

5. Design and fabrication of a Thermoelectric Nanowire Characterization Platform(TNCP) for structual and thermoelectric investigation of single nanowires
Seyedh Hoda Moosavi

7. Design and fabrication of microoptical components for miniaturized optical imagers
José Vincent Carrion

9. Implantable real-time microsystem for continuous monitoring of various bio-particles
Abbas Hammoud

11. Hybrid diaphragm development for a MEMS based Stirling engine
Ravinder Chutani

13. Development of a Miniaturized Passive Air Sampler to Characterize the Exposure of Emerging Contaminants in Birds
Ali Rezeai

15. Towards a Lb-on-Chip hand-held device for nucleic acid detection
Hendrik Hubbe

17. Zero power sensor network – a fully passive wireless sensing platform
Colm Mac Caffrey

19. Vertical silicon nanowire arrays for gas sensing applications for gas sensing applications
Brieux Durand

21. Energy harvesting using vertical bi-stable cantilever with tip mass based on stochastic resonance
Michitaka Kawano

POSTERS

Session 1

23. 3D printing piezoelectric energy harvesters
Bodkhe Sampada

25. Fabrication and characterization of functionalized nanostructures for lead detection
Brice Le Borgne

27. Study on Cu(In,Ga)Se2 solar cells by means of photothermal mode AFM
Risa Komatsu

29. Electronics packaging and interconnection technologies at VTT
Arttu Huttunen

31. Oxygen gradient formation in a microfluidic cell culture device
Satomi Matsumoto

33. The effect of metallic nanograins on the sensibility of WO3 gas sensors
Mehdi Othman

35. Capillarity guided patterning of micro-liquids
Dohyun Park

37. In vitro micro-vasculature model on chip: macroscpic and microscopic investigation
Yasuhirao Yukawa

39. Nanostructured WO_3 optical properties using electrolyte-gating
Francis Quenneville

POSTERS

Session 2

2. Deformability as a new physical biomarker
Amin Amirouche

4. MEMS liquid cell fabricated with graphene-for nao-scale real-time observarion in liquid
Ryohei Matsui

6. A sub-ppm ammonia gas sensor for liver disease using ultrathin (Pt-InN) resistive gas sensor
Sujeet Rai

8. Development of calibration method using caged ATP for deep-sea in situ microbial ATP analyzer
Kohei Hanatani

10. Piezoelectrically actuated resonators on ring-shaped suspension for application in MEMS phase-sensitive gyroscope
Sergey Gorelick

12. Multiscale nanopatterned porous membrane via hot embossing technique for in vitro skin culture platform
Jihoon Ko

14. Improvement of microvalve for glaucoma drainage device
Ruo Chi Hsu

16. Miniaturized gas chromatography for light compounds analysis
Imameddine Azzouz

18. MEMS resonator and photonic crystal integration for enhanced cellular mass sensing
Ethan Keeler

20. Towards atomic microscopy with chemical contrast
Kohei Kaminishi

22. Microfluidics for Energy Harvesting – Use of superhydrophobic surfaces
Florent Fouché

POSTERS

Session 2

24. 128-channel deep brain recording probe with heterogeneously integrated analog CMOS readout for focal epilepsy localization
Frederick Pothof

26. CMOS-MEMS resonators and sensors
Anurag Zope

28. 3D printing of conductive nanocomposites for liquid sensor applications
Kambiz Chizari

30. Flexible parylene-based neural probe with optimized silk coatin structure for improved insertion in the brain
Aziliz Lecomte

32. Microelectronic roll-up blind for switchaable mirror
Kentaro Mori

34. A 3D multilayer electrostatic energy harvester for medical implants applications
Sarah Risquez

36. A novel process to fabricate suspended carbon nanostructures for hydrogen sensing
Arun Shivaram

38. Fabrication and electrochemical of Ir microelectrode arrays for trace metal detection water
Marianna Fighera

40. $NaGdF_4$:Er^{3+}, Yb^{3+}/WO_3 nanocomposite films for NIR solar light harvesting
Frederic Venne

LAB WORKS

Lab work A (L-5904)

Inverter design with Cadence

Objectives:

- Using the CMOSP18 technology, the objective is to design the layout of an inverter consisting of two transistors (PMOS and NMOS),
- Get familiar with the various fabrication steps of CMOS transistors along with circuit optimization techniques,
- Introducing both DRC and LVS techniques,
- Performing both AC and DC analysis to verify functionality of the inverter.

Lab work B

Microfluidic device for synthesis and culture of cellular spheroids

Cellular spheroid, 3D cellular aggregates roughly spherical in shape, show great promise as more realistic replacement to test drug response in vitro. Numerous groups around the world use microfluidic to synthesize spheroids in a massively parallel fashion with minimal reagent consumption and user manipulation. In this workshop, you will learn the basics of spheroid synthesis on chip. You will assemble simple PDMS devices, prepare them with non-adhesive coating and subsequently load cells inside to form spheroids. A few days after the formation, spheroids will be formed and we will email results to the various teams.

LAB WORKS

Lab work C (J-3312)

Dye sensitized solar cells: fabrication and characterization

Objectives:

- Relevance and working principles of dye sensitized solar cells,
- Fabrication of nanostructured mesoporous titanium dioxide films and photosensitization of the films,
- Characterization of solar cell (PV) performance.

Lab work D (J-5133)

Introduction to 3D printing

Objectives:

- Learn the basics of 3D printing and how to use a commercial printer (SLA and FDM technologies),
- Tailor the different printing parameters (printing temperature, level substrate, etc.),
- Manipulate CAD files and use a slicer software (e.g., Makerware, Preform),
- 3D print a complex structure made of at least two different polymers.

CONTACT INFORMATION

IF YOU HAVE ANY QUESTION, YOU CAN CONTACT

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CIRMM

Core-to-Core Program

JSPS

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RESMIQ

Regroupement Stratégique en Microsystèmes du Québec

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PRIMA

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