IEEE NMDC 2015

PROGRAM

10th IEEE Nanotechnology Materials and Devices Conference

Anchorage, Alaska

September 13-16, 2015

IEEE

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Contents

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See ieee.org/nanotech.

Conference Schedule

Time	Sunday, September 13
4:00 PM-6:00 PM	Registration — Promenade, 2nd Floor
6:00 PM-8:00 PM	Welcome Reception — Chart Room, 15th Floor

Time	Aleutian Room	Dillingham Room	Katmai Room
Monday, September 14			
7:00 AM-8:30 AM	BREAKFAST		
8:30 AM-9:00 AM	*Welcome*		
9:00 AM-10:00 AM	*Opening Plenary*		
10:00 AM-10:30 AM	BREAK		
10:30 AM-12:00 PM		*Session M1*	*Session M2*
12:00 PM-1:00 PM	**LUNCH**		
1:00 PM-3:00 PM		*Session M3*	*Session M4*
3:00 PM-3:20 PM	BREAK		
3:20 PM-5:30 PM		*Session M5*	*Session M6*
Tuesday, September 15			
7:00 AM-8:30 AM	BREAKFAST		
8:30 AM-10:00 AM	*Tuesday Plenary*		
10:00 AM-10:30 AM	BREAK		
10:30 AM-12:00 PM		*Session T1*	*Session T2*
12:00 PM-1:00 PM	**LUNCH**		
1:00 PM-3:00 PM		*Session T3*	*Session T4*
3:00 PM-3:20 PM	BREAK		
3:20 PM-5:30 PM		*Session T5*	*Session T6*
6:30 PM-8:30 PM	**DINNER**		
Wednesday, September 16			
7:00 AM-8:00 AM	BREAKFAST		
8:00 AM-9:00 AM	*Wednesday Plenary*		
9:00 AM-9:30 AM	*Closing & Awards*		
9:30 AM-10:00 AM	BREAK		
10:00 AM-12:40 PM		*Session W1*	*Session W2*

IEEE NMDC 2015 General Chair's Letter

On behalf of the Conference Program Committee, it is a pleasure to welcome the authors, reviewers, session chairs, and participants to this 10th IEEE Nanotechnology Materials and Devices Conference in Anchorage, Alaska, USA. The Program Committee has gone to great lengths to plan a noteworthy event and to ensure that the presentations and content of the proceedings meet a high technical standard.

The proceedings of the conference features original technical papers by experts on leading-edge topics cover the entire spectrum of the field of nanotechnology.

The main purpose of this conference is to foster interaction and networking among the researchers, academicians, and the industry. As such, we strongly encourage all authors and participants, whether this is your first time at NMDC or you have attended in the past, to make the most of this important event and to take the time to connect and communicate with fellow attendees. NMDC serves as an outstanding forum to share new and futuristic ideas, which in turn have the potential to become extraordinary technological innovations for the benefit of humanity.

The NMDC 2015 is truly an International one with participants from countries around the world and more than 85 papers. It also provides IEEE the opportunity to hold best papers awards ceremony before a large audience. At this ceremony, IEEE recognizes the achievements and contributions of its members. We strongly encourage you to attend the ceremony to increase your awareness of the great work being done in the field and to help us congratulate the winners.

In closing, we wish you an agreeable and memorable time here at the NMDC 2015.

Dr. Saif alZahir, General Chair, NMDC 2015
Professor of Electrical Engineering and Computer Science, UNBC, Canada

Dr. Kenrick J Mock, General Co-chair
Professor of Electrical Engineering and Computer Science, University of Alaska Anchorage, USA

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Plenary Speakers Program

Toshio Fukuda, Nagoya University/Meijo University, Beijing Institute of Technology
"Bio Cell Analysis and Assembly by Micro and Nano Robotic Technology"

Philip R. LeDuc, Carnegie Mellon University, USA
"Planes, Trains, Automobiles…and Cells?"

John A. Rogers, UIUC, USA
"Semiconductor Nanomaterials for Transient Electronics"

Prof. Toshio Fukuda
Nagoya University/Meijo University, Beijing Institute of Technology

"Bio Cell Analysis and Assembly by Micro and Nano Robotic Technology"

Micro-nano robotic technology nowadays has a solid discipline, as synergetic integration of the micro and nano sensor, actuator, control, computer and material, and wide spread applications to industry and consumer in our daily life. Micro-nano fabrication, materials, assembly with evaluation leads downsizing of the products and give more economical material and energy efficiency, and more functions from the viewpoints of Green and Life innovations.

This micro-nano robotic technology can also show to give a new dimension of theory and applications in the life science, such as medical engineering, bio-engineering, bio-robotics and other areas. In particular, more active observation with micro-nano robotic manipulation has been more popular, leading new discovery and finding in bio cell analysis as well as improving the quality of life. Then it is challenging to investigate how we can construct a 3 D bio cell assembly by the synthesis approach based on the knowledge and findings of the bio cell analysis. There will be several methods to achieve this challenge. In this paper, we show some of the unique assembly methods by the DEP, hydro gel fibers and so on.

Prof. Philip R. LeDuc
Mechanical Engineering, Biological Sciences, Biomedical Engineering, Computational Biology, Carnergie Mellon University, USA

"Planes, Trains, Automobiles… and Cells?"

Two areas that have always interested me are the mechanics of machines and the wonders of nature. My interest in mechanics, first beginning as a youth taking apart machines like lawn mowers, has intersected with my fascination with nature at the cellular and molecular levels. Here I will present how my lab has been merging mechanical engineering with biology. My lab approaches this intersection by envisioning cells and molecules as ""systems"" that can be investigated with some of the same fundamental approaches used on machines such as planes, trains, and automobiles looking for unifying principles. The biological systems range from mammalian cells to microorganisms to developmental biology systems (e.g. neurons, magnetic bacteria, energy generating bacteria, Xenopus laevis, stem cells) and we apply principles from mechanical engineering fields (e.g. solid mechanics, control theory, fluidics, heat transfer, design) to understand how these principles may apply across diverse nature-based systems. In addition, I will present in this talk our approaches of using solid mechanics in areas such as cell mechanotransduction. We pursue these goals through developing and utilizing unique custom-built systems as well as nanotechnology, microtechnology, and computational biology. These intersections are especially fascinating to me as biological systems have evolved for distinct reasons (the ""initial and boundary conditions"" are different). In addition, as an engineer, I truly am interested in building new systems from the knowledge that we obtain in a similar thought process as we use information to build new machines. Thus, I will also present how our lab thinks about nature-inspired design principles at the molecular and cellular levels to work toward generating novel approaches for contributing to technology development and medical applications. My goal for this talk is to present some of our work and thoughts about how one mechanical engineer approaches these nature-based systems at the cellular and molecular levels.

Prof. John A. Rogers

UIUC, USA

"Semiconductor Nanomaterials for Transient Electronics"

A remarkable feature of the modern integrated circuit is its ability to operate in a stable fashion, with almost perfect reliability. Recently developed classes of electronic nanomaterials create an opportunity to engineer the opposite outcome, in the form of devices that dissolve completely in water, with harmless end products. The enabled applications range from 'green' consumer electronics to bio-resorbable medical implants - none of which would be possible with technologies that exist today. This talk summarizes recent work on this physically 'transient' type of electronics, from basic advances in materials chemistry, to fundamental studies of dissolution reactions, to engineering development of complete sets of device components, sensors and integrated systems. Biodegradable nerve stimulators, intracranial monitors and pacemakers provide some recent demonstrations of devices that address unmet clinical needs.

John A. Rogers (SM'08–F'09) became a Senior Member (SM) in 2008, and a Fellow (F) in 1987. He obtained BA and BS degrees in chemistry and in physics from the University of Texas, Austin, in 1989. From MIT, he received SM degrees in physics and in chemistry in 1992 and the PhD degree in physical chemistry in 1995. From 1995 to 1997, Rogers was a Junior Fellow in the Harvard University Society of Fellows.

He joined Bell Laboratories as a Member of Technical Staff in the Condensed Matter Physics Research Department in 1997, and served as Director of this department from the end of 2000 to 2002. He is currently Swanlund Chair Professor at University of Illinois at Urbana/Champaign, with a primary appointment in the Department of Materials Science and Engineering, and joint appointments in several other departments, including Bioengineering. He is Director of the Seitz Materials Research Laboratory. He has published more than 500 papers and is inventor on over 80 patents, more than 50 of which are licensed or in active use to various startups and large companies.

Prof. Rogers is a Fellow of the IEEE, APS, MRS and the AAAS, and he is a member of the National Academy of Sciences, the National Academy of Engineering, the National Academy of Inventors and the American Academy of Arts and Sciences. His research has been recognized with many awards, including a MacArthur Fellowship in 2009, the Lemelson-MIT Prize in 2011, the MRS Mid-Career Researcher Award and the Robert Henry Thurston Award (American Society of Mechanical Engineers) in 2013, the 2013 Smithsonian Award for Ingenuity in the Physical Sciences and the 2015 ETH Zurich Chemical Engineering Medal.

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M. P. Anantram, University of Washington, USA
"A Modeling Study of Mechanisms for NDR in graphene-BN-graphene Heterostructures"

Heterostructures made out of 2D materials are being actively investigated for a variety of device applications. In this work, we discuss recent results on modeling electrical transport through graphene - Boron Nitride (BN) - graphene heterostructures. The main result is that there are two potential mechanisms for negative differential resistance (NDR). We also show how the increase in BN layers changes the device conductance. Non-idealities in the sizes of the layers can alter the device characteristics from a perfectly aligned device. We have initiated this study by varying the size of the layers forming the heterostructure, and report that the peak position and peak to valley ratio of the NDR peak are altered. Finally, we discuss the role of electron-phonon scattering in altering the NDR peak. The calculations of electron transport are carried out using the pi-orbital tight binding Hamiltonian, and electron-phonon scattering is included in the Born approximation using the Green's function approach.

S. Bandyopadhyay, Virginia Commonwealth University, USA
"Straintronics: Strain-switched multiferroic nanomagnets for extremely low energy logic/memory"

Straintronics is an extraordinarily energy-efficient novel hardware paradigm for digital computing and signal processing. The central idea is to build the basic binary switch with a nanoscale multiferroic consisting of a magnetostrictive layer elastically coupled to a piezoelectric layer. A tiny voltage of a few mV generates sufficient strain in the piezoelectric layer to switch the magnetization of the magnetostrictive nanomagnet for a memory or logic operation, while dissipating few aJ of energy. Low density processors employing straintronics and operating at slow clock speeds of ~100 MHz are estimated to dissipate such low power that they can run by harvesting energy from the ambient and never even need a battery. We have designed straintronic logic gates and memory cells, and extracted their performance figures with Landau-Lifshitz-Gilbert simulations to predict unprecedented energy efficiency. Rudimentary non-volatile logic and memory functions have been demonstrated experimentally and validate the low energy expectations.

Stephan Breitkreutz-von Gamm, TUM, Munich, Germany
"Towards Nanomagnetic Logic systems: A programmable Arithmetic Logic Unit for Systolic Array-based Computing"

In this paper, we show that 3D-integrated perpendicular Nanomagnetic Logic (pNML) is highly suitable for the demands of systolic array-based computing. A runtime-programmable arithmetic logic unit (ALU) built from pNML devices and applicable for pipelined and massively parallel information processing in systolic architectures is presented. Systolic architectures and signal routing concepts for integrated pNML circuits are discussed. Modeling of 3D-integrated pNML devices is presented. Simulation results prove the functionality of the ALU and pave the way for next-generation 3D-integrated magnetic computing.

Saptarshi Das, Argonne National Laboratory, USA
"A holistic understanding of 2D materials: Synthesis, Devices and Applications"

Two dimensional materials, by the virtue of their unique properties and excellent electrostatic integrity, provide immense opportunities not only to explore fundamental physics but also to solve critical technological problems across all scientific and engineering disciplines. In my talk, I will take a holistic approach that will combine material, device as well as circuit aspects of these 2D materials. I will start with an innovative technique of synthesizing 2D monolayers using electrochemistry. This technique is distinctly different from bottom up chemical vapor deposition (CVD) techniques and provides rapid top-down fabrication of wafer scale 2D layers. Then, I will discuss the use of Graphene as a metal, hexagonal-BN as an insulator and Phosphorene, MoS2, WSe2 and many others transition metal dichalcogenides (TMDs) as semiconductors. In this context, I will demonstrate how "Contact Engineering" can be implemented to connect the three dimensional world to these 2D materials to enhance their performance. Next, I will talk about various "Scaling Aspects" of 2D materials. Finally I will discuss the "Integration and Application" of 2D materials for flexible and transparent electronics as well as low power device/circuit design. I will conclude the talk with my "Future Research" objectives with 2D materials and beyond.

Shadi Dayeh, UCSD, USA
"Nanoscale Electronic Materials for Neurophysiological Interfaces"

The development of nanotechnologies that can provide high spatiotemporal resolution in monitoring electrophysiological activity can enable new frontiers of scientific discovery in bio-nanoelectronic interfaces and can pave the way for rehabilitation technologies for neurodegenerative diseases. This paper focuses on the development of electronic materials for high-fidelity neuronal interfaces at multiple length scales to record from cortical surfaces down to subcellular levels. We established a robust and scalable fabrication process for ultra-high density intracellular neuronal probes on insulating and flexible substrates. Arrays at an electrode density of 10 million/cm2 enabled multiple intracellular and extracellular single-unit recordings with high signal-to-noise ratio and resolved subthreshold potential activity, which carries the basis for neural network activity and have significant implications for understanding their large scale network behavior.

Pierre-Emmanuel Gaillardon, EPFL, Switzerland
"Towards Functionality-Enhanced Devices: Controlling the Modes of Operations in Three-Independent-Gate Transistors"

In this paper, we review the different modes of operations achievable with Three-Independent-Gate Field-Effect Transistors (TIGFETs). We report fabricated Schottky-barrier FET transistors featuring three independent gate-all-around electrodes. The two gate electrodes in proximity with the source and drain Schottky contacts are used to dynamically modulate the barrier heights and tune the operation of the transistor, while the third gate electrode, acting on the center region of the channel, serves as standard gate. Different channel geometries have been employed such as FinFETs or vertically-stacked silicon nanowires. The additional gate terminals bring additional functionalities to the device with (i) a dynamic reconfiguration of the polarity (n- or p-type); (ii) a dynamic control of the threshold voltage (VT) that does not lead to any detriment of the on-state current; and (iii) a dynamic control of the Subthreshold Slope (SS) with an average SS of 6 mv/dec over 5 decades of current swings. Devices with an enhanced set of functionalities are expected to extend the envelope of computation performance with high regularity and compactness, beyond the limits of scaling.

Christopher L. Hinkle, University of Texas at Dallas, USA
"van der Waals Epitaxy for New 2D Materials Based Low-power Logic and Memory"

Heterostructures coupling transition metal dichalcogenides (TMDs) and insulating hexagonal boron nitride (h-BN) were grown by molecular beam epitaxy (MBE) demonstrating the unique opportunities for fabricating all 2D heterostructures with appropriate band alignments for novel nanoelectronic devices. Structural and chemical characterization as well as experimentally determined band alignment of the TMDs and h-BN was conducted via reflection high energy electron diffraction (RHEED), X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning tunneling microscopy/spectroscopy (STM), X-ray photoelectron spectroscopy (XPS), and Raman.

Seungpyo Hong, University of Illinois at Chicago, USA
"Biomimetic Nanotechnology for Enhanced Detection of Circulating Tumor Cells"

Although circulating tumor cells (CTCs) have shown great potential for use as a clinical indicator for cancer progress and metastasis, the development of reliable CTC detection methods from peripheral blood specimens remains a challenge due to their extreme rarity and heterogeneity. We have developed a novel multifunctional surface, UiChip(TM), to capture the rare tumor cells through a biomimetic combination of: 1) efficient recruitment of flowing cells to the surface by E-selectin-mediated cell rolling; 2) strong surface binding of tumor cells by poly(amidoamine) dendrimer-mediated multivalent binding effect; and 3) multiple antibodies against surface markers of tumor cells. In this study, we aimed to test UiChip(TM) in terms of its capture efficiency of tumor cells after epithelial-mesenchymal transition (EMT), as post-EMT cells are known to have high metastasis potential compared to pre-EMT cells. We performed various experiments under static and dynamic conditions using human blood samples spiked with breast and prostate cancer cell before and after treatment with transforming growth factor beta1 (TGFbeta1) that induces EMT. UiChipTM achieved highly sensitive capture of both pre- and post-EMT cells under flow (up to 95%). Additionally, in our clinical pilot study, UiChipTM captured CTCs at high purity (up to 75%) and sensitivity from human blood samples collected from head and neck cancer patients. These results support the great potential of our capture system for clinically significant detection and identification of CTCs with heterogeneous metastatic propensities.

Malgorzata Chrzanowska-Jeske, Portland State University, USA
"Delay and yield of CNFET-based circuits in the presence of variations"

Carbon Nanotubes (CNTs) exhibit excellent electronic properties such as near-ballistic transport, high carrier mobility (103~104cm2/Vs), for electrons and holes, high thermal conductivity, and compatibility with CMOS fabrication process including easy integration of high-k dielectric. Therefore, they are good candidate for future integrated circuits as channel material in FETs, wires and for heat removal. Despite the superior electric properties fabrication challenges and imperfections have to be overcome before carbon nanotube FETs (CNFETs) could be become building blocks in integrated circuit technology. Extending Logical Effort technique to CNFET-based circuits would be trivial if not for significant CNT variation that causes variations in CNFET capacitances, ION, and consequently in delay, power dissipation and yield. Logical effort therefore is redefined to capture statistical changes in gate behavior.Based on delay evaluation we discuss prediction of functional yield and propose design approaches for yield optimization.

Young Soo Kang, Sogang University, Korea
"Length Control of Packed Single Crystalline TiO2 Nanorods for Dye-sensitized Solar Cell"

Photovoltaic solar cells have been spotlighted with the growing demands of green and clean energy. Especially, since Oregan and Gratzel reported mesoporous TiO2 electrode dye sensitized solar cells (DSSCs) in 1991,the related works have been widely reported for the enhanced performance. Dyes with high adsorption coefficient and electrolyte with more stability need to be considered for improving DSSCs performance. Moreover, the study has been focused on the functions of the fast electron transport and high electron collecting ability. Nanocrystalline TiO2 electrode with 12 µm-thick film on a fluorine doped tin oxide (FTO) coated glass is the most general photoelectrochemical architecture considering its large surface area. However, electrons trapping at the contacts between nanoparticles suppress the electron diffusion of nanoparticulate films.

Research on vertically aligned single crystalline semiconductor nanorod or nanowire electrodes with wide band gap are attracting widespread because those electrodes provide direct electrical pathways for photogenerated electrons. In ZnO-based DSSCs electrodes such as 1-dimensional (1D) crystalline nanorod or nanowire arrays, the instability of ZnO in acidic dye solution and low surface area cause poor photoconversion efficiencies, approximately 2% less compared to those made from TiO2. Very recently, the highest solar to electricity conversion efficiency of 6.15% has been achieved by [10-10] oriented multichannel ZnO nanowire array. Polycrystalline TiO2 nanotube array films made it possible to reduce the recombination rate but the fabrication of TiO2 nanotube array films is very demanding due to a series of steps such as Ti film deposition, an anodization step, and thermal annealing, which reduce the conductivity of the FTO layers. However, TiO2 nanotube electrodes show slightly enhanced electron transport rate in DSSCs. Until now, there are some articles regarding synthesis of vertically oriented single-crystalline TiO2 nanorods or nanowires using a variety of synthesis techniques. However, those electrodes could not produce enhanced performance in their DSSCs because of heir insufficient roughness factor, which results in insufficient short circuit current. Roughness factor related with amount of adsorbed dye on the surface of electrode, it needs to enlarge their roughness factor for better performance. Considering roughness factor, closed packed single crystalline rutile TiO2 with 1D longer length provides larger surface area and increases their roughness factor. Recently, several ways have been carried out for enhancing the efficiency of DSSCs using 1D TiO2 nanorods photoanodes, such as combination with 3D structures or etching to porous nanorod arrays. In this paper, we demonstrated easy hydrothermal methods for the controlled growth of closed packed single crystalline rutile TiO2 nanorod arrays up to 10 µm length on FTO glass. Variations of the morphology, length, and diameter of TiO2 nanorods are monitored to get the highest efficiency of DSSC electrode. Possible mechanism for the formation of TiO2 nanorods was proposed. Finally, light to electricity conversion efficiency of single crystalline TiO2 nanorod electrodes with diverse morphology, length, and diameter has been studied.

Vertically aligned and packed single crystalline rutile TiO2 nanorod arrays with the length up to 10 µm on the surface of fluorine doped tin oxide (FTO) coated glass were prepared by a surfactant-free and low-temperature hydrothermal method. The morphology, length, and diameter of TiO_2 nanorods can be controlled by changing reaction time and concentration of titanium precursor solution. The structures and composition of the prepared structures were characterized by scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and nitrogen adsorption/desorption isotherms. The prepared TiO_2 nanorods have 20-50 nm diameters with 4-10 µm length and the inter-distance between TiO_2 nanorods was approximately 3.8 nm. The closely-packed TiO_2 nanorods stop growing by the hindrance of the reduced space between TiO_2 nanorods. It means the maximum diameter of the nanorods in this experimental condition can reach 50 nm with a constant growth rate. The average length of TiO_2 nanorod was 4 µm after 1 h of reaction and increased to 10 µm long after 8 h of reaction. If the growth time is extended to over 8 h, there is no more increase in the diameter and length of nanorods. It is caused by a competition between growth rate and dissolution rate.

We have investigated that light-to-electricity conversion efficiency of single crystalline TiO_2 nanorods electrode with diverse morphology, length, and diameter in DSSC device. From the J-V characteristics of synthesized samples under AM 1.5 illumination by different reaction time, a photoconversion efficiency of 3.4% is accomplished for 4 µm length TiO_2 nanorod arrays, with an open circuit voltage (Voc) of 0.77 V short circuit current density (Jsc) of 3.8 mA cm-2, and fill factor (FF) of 0.83. Photoconversion efficiencies of 6.0 and 10.0 µm lengths of TiO_2 nanorod arrays are achieved at 7.6% (Voc = 0.97 V, Jsc = 9.3 mAcm-2, FF = 0.84), and 11.6% (Voc = 0.98 V, Jsc = 13.5 mA cm-2, FF = 0.88), respectively.

The increased surface area enhances the solar cell performance by the increased amount of dye absorption, corresponding to decrease of the packing density per unit area of the TiO_2 nanorod electrode. On the other hand, the efficiency of DSSC can be increased by the higher absorption of irradiated photons of the solar light. The solar light is consisted of UV, visible and Infra-red light. Among those different wavelength ranges, visible light is mostly absorbed and the other wavelength of solar light should be wasted because the absorption band gap energy is not matched well with preliminary existing light absorbing dye molecules.

In the present work, we have fabricated the wavelength conversion system to increase the photon absorption ability of solar light. This was carried out by the fabrication of phosphor nanoparticles/metal nanoparticles films which could be able to do wavelength conversion and light energy amplification at the same time. Wavelength conversion is possible by phosphors nanoparticles and amplification of solar light was possible by the surface plasmon effect of metal nanoparticles. Finally, we could be able to increase efficiency of DSSC by more than 20% in the presence of phosphor nanoparticles/metal nanoparticles films. In this presentation, we will talk and discuss on the fabrication process, characterization on the structure and chemical/physical properties and the application to DSSC.

Jean-Pierre Leburton, University of Illinois at Urbana-Champaign, USA
"2D Nanoscale Semiconductors for Genomics"

In recent years, there has been immense interest in finding a low-cost, rapid genome sequencing method. Amongst such methods, the use of solid-state nanopore membranes is a promising new technology that can lead to tremendous advancement in the field of personalized medicine. In this context, the single-atom thickness of monolayer graphene makes it an ideal candidate for DNA sequencing as it can scan molecules passing through a nanopore at high resolution. Additionally, unlike most insulating membranes, graphene is electrically active, which can be exploited to control and electronically sense biomolecules. By using molecular dynamics integrated with self-consistent transport modeling based on non-equilibrium green function formalism, we have shown that a graphene membrane conductor containing a nanopore in a quantum point contact (QPC) geometry is a promising device to sense and potentially sequence a DNA molecule translocating through the nanopore. In this talk, we outline a comprehensive scenario on the use of graphene nanoribbons with a QPC geometry (g-QPC) to detect and characterize the passage of both double and single-stranded DNA molecules in a variety of configurations. In particular, we demonstrate the ability of a g-QPC to detect the helical nature of dsDNA, to detect the conformational transitions of dsDNA subjected to forced extension, and to distinctively count base pairs of a passing ssDNA molecule through the nanopore While the position of the nanopore in the QPC membrane can drastically influence the conductance variation in response to the charge carried by a biomolecule, detection sensitivity can be enhanced by choosing a particular nanopore geometry i.e. its diameter and shape, as well as by modulating the graphene Fermi energy by use of an electrical bias on a gate electrode. Overall, this new approach demonstrates the ability to detect morphological transformations of a double-stranded DNA, as well as the passage of individual base pairs of a single-stranded DNA molecule through the nanopore. This work, in collaboration with A. Girdhar, C. Sathe and K. Schulten, is supported by a grant from Oxford Nanopore Technology, and the Seeding Novel Interdisciplinary Research program at the Beckman Institute.

Lih Y. Lin, University of Washington, USA
“Optical Modulation and Manipulation of Neurons and Cells with High Efficiency through Quantum Dots and Photonic Crystals”

Nanomaterials such as semiconductor quantum dots and nanostructures such as photonic crystals can interact with light in unique ways due to their nm's to sub-μm feature size. This enables versatile applications with high efficiencies. In this paper, we focus on biological applications, specifically, photostimulation and optical manipulation of cells. We report photostimulation and activation of neurons with very low optical intensity (0.0036 mW/mm^2) through colloidal quantum dots. We also demonstrate efficient optical manipulation of cells and nanoparticles on a 2-D photonic crystal platform. Particles as small as 100 nm can be trapped with ~16 μW/μm^2 optical intensity.

Chee-wee Liu, National Taiwan University, Taiwan
"3D Ge nanowire transistors"

High performance junctionless Ge GAAFETs with fin width down to 9 nm are demonstrated with superior performance than recently reported inversion-mode Ge 3D FETs. Junctionless devices also show better mobility than the INV devices due to less dependence on surface roughness scattering. Excellent performance and short channel behavior are suitable for the device scaling down to Lg = 10 nm.

Boon S. Ooi, KAUST, Saudi Arabia
"Recent progress in InAs/InP quantum dash nanostructures and devices"

In this talk, we will give an outline and introduction to the broad inter-band emission devices focusing on the InAs/InP quantum dash material system, device physics and the establishment of the ultrabroad stimulated emission behavior. In addition, the technology for growing these nanostructures, as well as the technologies for engineering the bandgap of the InP-based quantum dash system using epitaxy growth technique and postgrowth intermixing methods will be presented. At device level, we will focus our discussion on our recent progress in achieving ultra-broad lasing emission from quantum dash lasers, and recent achievements in broad gain semiconductor optical amplifiers (SOA), mode locked lasers, comb-lasers, wide band superluminsect diodes fabricated on this material system.

Eric Pop, Stanford University, USA
"Device and Energy Properties of Two-Dimensional (2D) Atomically Thin Materials"

This talk will give an overview of our recent work on two-dimensional (2D) materials and devices. Particular focus will be placed on high-field transport, device self-heating, and fundamental aspects of thermal (phonon) transport in 2D materials including graphene and MoS2.

Two-dimensional (2D) materials like graphene and transition metal dichalcogenides (TMDs) have unique electronic and highly anisotropic thermal properties, making them attractive for applications ranging from nanoscale transistors to heat spreaders and thermoelectrics.

In this presentation we will overview recent progress in our understanding of electrical and thermal transport in 2D materials and devices. We will discuss, for example, the requirements for making "well-behaved" 2D transistors, including selection of substrates, low and high-field transport, 2D contacts, and their temperature dependence. We have uncovered that despite its great intrinsic thermal conductivity, heat dissipation can be a challenge in graphene and other atomically thin 2D transistors, where heat flow is limited by interfaces with adjacent materials and thermal transients are limited by the heat capacity of the surrounding materials.

We will also discuss thermal measurements in 2D devices with dimensions comparable to the electron and phonon mean free paths (~100 nm) which show quasiballistic thermal transport and significant phonon-edge scattering in narrow devices. For instance, we found that the thermal conductivity of grapheme becomes a strong size of the device dimensions (both length and width) for devices with sub-micron features.

Finally, we will describe thermoelectric (e.g. Peltier) effects observed during device operation and how these could be leveraged to enable energy-efficient electronics and energy harvesters. In general, the 2D properties will be discussed both from a fundamental point of view and in the context of device applications.

Gaurav Sahay, OSU/OHSU College of Pharmacy, USA
"Mechanisms of endosomal escape for nanoparticle-mediated cytosolic drug delivery"

Subcellular delivery of nanoparticles remain central to the field of drug/gene delivery. Lipid Nanoparticles (LNPs) are synthetic drug/gene delivery vectors that enter cells through the process of endocytosis. Pleomorphic early endosomes (EE's) sequester nanoparticles, and transport them to the late endosomes/lysosomes for degradation or towards the recycling compartment. It's been proposed that nanocarriers designed with a buffering capacity triggers the proton pump to maintain a decreasing pH inside the endosome resulting in increased osmotic pressure, causing vesicular swelling and subsequent endosomal escape of cargo. Alternatively, it has been suggested that cationic nanoparticles can interact with anionic lipids of the endosome, causing destabilization of the endosomal membrane. Regardless of the release mechanism, imaging studies have revealed that nucleic acids are largely trapped inside the endo/lysosomes which allows the nano-carriers to exert toxic effects due to their vesicular confinement. We employed a combination of small molecule libraries; cellular probes and state-of the-art microscopy to identify novel compounds that relieve compartmentalization of LNP delivered mRNA and improve its cytosolic delivery. We have utilized a library of 2000 FDA approved small molecules to identify compounds that can trigger escape. The disruption of normal endosomal progression by these compounds reveal putative vesicular sites of escape that result in improved cytosolic release, indicative of productive avenues for endosomal escape. Unlocking the mechanisms of intracellular transport will guide in the development of novel nanoparticles that can efficiently delivery mRNA inside cells for therapeutic production of proteins for the treatment of wide variety of diseases.

Dar-Bin Shieh, National Cheng Kung University, Taiwan

"Metallic nanoparticles for cancer cell selective therapeutics"

With the development of nanomedicine, metallic nanomaterials show a prominent potential as a combined therapeutic and diagnostic tool in medical applications, especially in cancer treatment. In conventional therapeutic applications, metallic nanomaterials can not only serve as gene or drug carriers but can also be applied as thermotherapeutic probes under radiation exposure of various frequency domains according to the endogenous physical properties of the nanoparticles. We developed theranostic strategies based on cancer targeting gold nanorods. Using different NIR as excitation wavelength we could achieve multiplex photoacoustic molecular imaging in vivo followed by hyperthermia by switching the power and model of laser irradiation. The in vivo study showed promising efficacy in xeno-graft cancer lesion model. In addition to gold nanomaterials, we found that the iron core-gold shell (Fe@Au) metallic nanoparticles showed a cancer-preferential cytotoxicity in several types of cancers from both *in vitro* and *in vivo* studies. We further confirmed it was caused by the non-oxidized iron elements in Fe@Au nanoparticles. Further, we discerned that Fe@Au caused their cytotoxic effect in oral cancer cell lines and colorectal cancer cell lines through mitochondria-medicated autophagy. There are, however, some literature reports showing that a number of nanomaterials have a cancer preferential cytotoxicity, such as ZnO nanoparticles in leukaemia cells. Thurber A. et al. demonstrated that using Fe doping in ZnO nanoparticles improved their selective cancer killing ability in leukaemia cells. They suggested that pure iron possesses potential as a cancer-selective anti-cancer agent. ZnO nanoparticles kill cancer cells through the generation of reactive oxygen species (ROS) - resulting in cancer cell cytotoxicity. In contrast, Fe@Au nanoparticles were found to trigger autophagy to suppress cancer-cell growth via mitochondria-dependent pathways at a dosage of about its IC_{50} in oral cancer cell lines.

In our serial studies indicates that zero valent iron is the key elements for the observed cancer selective cytotoxicity *in vitro* and *in vivo*. To test the hypothesis, we synthesize serial zero-valent Fe containing nanoparticles to test the cancer selective cytotoxicity in paired oral cancer and healthy cells. The synthesized particles are evaluated and characterized through transmission electron microscopy (TEM) and quantitative X-ray energy dispersive spectrometry (EDX). The cell viability is evaluated by (3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) (MTT) assay. Furthermore the underlining molecular mechanisms are evaluated by flow cytometry and western blot. Our results suggested that zero valent iron containing nanoparticles selectively diminished cancer cell growth through ROS generation and autophage induction, while spare the non-cancerous cells. Furthermore, the serial zero valent iron containing nanoparticles lost their cytotoxicity while being oxidized. The anti-cancer activity is inversely proportional to the Fe/O ratio of the nanomaterials. This finding suggested that the zero-valent iron-containing NPs demonstrated the "self detoxification" ability. In conclusion, we put zero valent iron based nanomaterials forward as new innovative and alternative therapeutic means to treat a variety of malignant tumours selectively.

Alexander Sinitskii, University of Nebraska, USA
"Atomically precise graphene nanoribbons and transition metal chalcogenide nanostructures for electronics applications"

This talk will be focused on the synthesis and characterization of emerging two-dimensional semiconductor materials and heterostructures for electronics applications. In the first part of this talk I will discuss bottom-up synthesis of atomically precise graphene nanoribbons. Because of its extraordinary electronic, mechanical, thermal and optical properties, graphene, a twodimensional carbon allotrope, is often considered as a complement, and in some cases even a replacement for silicon in future electronics. However, the absence of an energy bandgap in graphene prevents its use in logic applications. Theoretical studies predict a bandgap comparable to that in silicon (1.1 eV) in narrow graphene nanoribbons (GNRs) that have atomically precise armchair edges and widths <2 nm. But scalable synthesis of narrow GNRs with atomic precision remains a great challenge. I will compare different top-down and bottom-up approaches that are currently used for the fabrication of GNRs. The top-down approaches, such as nanofabrication, sonochemical method, nanowire lithography, and unzipping of carbon nanotubes, typically yield ribbons with widths > 10 nm and disordered edges. In contrast, the emerging bottom-up techniques allow synthesis of GNRs with much greater precision.

Electronic properties of GNRs can be tuned via their doping with heteroatoms, such as boron or nitrogen. This possibility has been extensively studied theoretically, but only a few experimental attempts to synthesize nitrogen-doped GNRs (NGNRs) by bottom-up approaches have been reported. I will discuss a recently developed solution bottom-up method for gram quantities of narrow GNRs and N-GNRs that are less than 2 nm wide and have atomically precise armchair edges. Preliminary studies indicate that these nanoribbons are electrically conductive and have large electronic bandgaps, which makes them promising for applications in field-effect transistors with high on-off ratios, composites and photovoltaic devices.

With recent advances in exfoliation and synthesis, transition metal chalcogenides (TMCs) have been actively explored for electronic and optoelectronic applications, such as high on-off ratio transistors and photodetectors. In the second part of this talk I will demonstrate that TMCs also have a great promise for memory applications. First will be discussed the electronic and memory properties of field-effect transistors (FETs) based on monolayer or few-layer MoS2 or WS2 on ferroelectric substrates, such as lead zirconium titanate (Pb(Zr,Ti)O3, PZT) or lithium niobate (LiNbO3). These FETs exhibit a large hysteresis of electronic transport with high on-off ratios. They also have a number of advantages and unique features compared to their graphene-based counterparts as well as commercial ferroelectric random-access memories (FeRAMs), such as nondestructive data readout, low operation voltage, wide memory window and the possibility to write and erase them both electrically and optically. This dual optoelectrical operation of these memories can simplify the device architecture and offer additional practical functionalities, such as an instant optical erase of large data arrays that is unavailable for many conventional memories.

The experimental studies so far have been mostly focused on TMCs with MX2 composition

(M = Mo, W; X is a chalcogen), such as MoS2, MoSe2, WS2 and WSe2. However, the TMC family is very rich and contains many other layered materials with interesting properties that have received limited attention from the researchers. I will discuss properties of emerging TMCs with MX3 composition, such as titanium trisulfide (TiS3). TiS3 has an interesting quasi-1D structure and was recently predicted to have an anisotropic electron mobility of up to 10,000 cm2/Vs. Device studies of TiS3 FETs and TiS3-ferroelectric memories will be presented.

Katsuaki Suganuma, Osaka University, Japan
"Nanoparticle or Microparticle sintering for 3D/Power Assembly?"

Power devices have being rapidly developed to fulfill the demands for increasing high power density, for ensuring high operation temperature, and also for improving reliability. There are high expectations for wide band gap (WBG) power semiconductors, such as SiC and GaN devices, because they can be operated in extreme conditions, over 200 ℃, in which temperature range Si power devices cannot work. Bringing out the full potential of WBG power devices requires new approaches covering all relevant technologies extending from structural design, electrical design, and packaging materials.

This paper briefly describes the current status of Ag sinter joining and Ag film stress migration bonding. Ag has great advantages in both the surface reaction in air benefitting joining quality and the excellent electric/thermal properties. Ag sinter joining has already exhibited a great potential in the market as high temperature interconnection technology, while our Ag film stress-migration bonding is expected to provide an alternative route. SMB is also applicable to flip-chip bonding at low temperature. The recent TEM work revealed that these two approaches can be effective due to surface nano-scale sintering mechanism. Similar bonding methods using Cu or other metallic materials instead of Ag would be explored as cost-effective interconnections in future.

Anderson Sunda-Meya, Xavier University of Louisiana, USA
"Synthesis and characterization of MoS2 nanostructures and 2D layers using Pulsed laser depostion system"

Nanostructures, with one or more dimensions in the 100nm size range, exhibit a variety of unique and tunable chemical and physical properties when engineered appropriately. The high degree of variability in size and surface chemistry of nano-scale materials in coatings, crystal structure, shape and composition used in growing layered MoS2 and nanostructures increase both their complexity and the multiple permutations that must be considered in their evaluation. This project will systematically study the growth kinetics of MoS2 structures. A number of parameters such as electronic structures, surface morphology, experimental deposition conditions, will be considered in relation to the size and shape of the nanostructures. These results will be used as a criterion for determining regimes of suitable surface modification.

Wei Wu, USC, USA
"Sub-5 nm Patterning and Applications by Nanoimprint Lithography and Helium Ion Beam Lithography"

Nanoimprint lithography (NIL)1 is a cost-effective nano-patterning technology based on the mechanical deformation of a resist. It is capable of high-resolution, large-area, high-throughput and low-cost patterning. Moreover, it can be used to pattern 3D nanostructures and on non-flat and flexible substrate. The resolution of NIL is limited by the available NIL mold. Helium ion beam lithography (HIBL)2 is a recently developed technology. It works in a way similar to electron-beam lithography (EBL), except replacing the electron beam with a Helium ion beam. Due to the smaller beam spot size and less forward and backward scattering of Helium ions, HIBL has better resolution than EBL. However, HIBL has very low throughput and it can damage certain substrates. The drawbacks of both technologies can be solved by combining them: using HIBL to make high-resolution NIL molds, and then using NIL to pattern real samples with those mold. In this way, we have demonstrated high-resolution patterning down to 4 nm half-pitch3.

We fabricated Graphene nanoribbons with dense lines down to 4 nm half-pitch using Helium ion beam lithography. Our Raman spectra show that the HIBL patterned Graphene nanoribbons (GNRs) have lower line-edge roughness than reported GNRs patterned by EBL. Field effect transistor (FETs) based on those GNRs were also demonstrated. Bandgap of 88 meV was observed for the first time in GNRs with width of 6 nm and NO2 gas sensors were demonstrated using those GNRs4.

Qing Zhang, Nanyang Technological University, Singapore
"CNT based electronic devices"

In this talk, I shall review our research activities of carbon nanotube (CNT) based electronic devices. The talk can be divided into four parts, i.e., functionalized CNTs for sensing applications, CNT based soft electronics, CNT based OLED drivers and CNT based soft Li-ion batteries. It has been found that humidity sensors based on as-grown CNT networks show an interesting response, where the total resistance of the CNT networks decrease and then increase for the humidity increasing from 10% to 85%. The 'minimal humidity' is in between 30% and 45 % for CNT loading larger than 5 µm-2 and it becomes larger for CNT loading less than 5 µm-2. After covalently functionalized with 10 µM 4-BBDT solution, the 'minimal humidity' shifts to a high humidity. We suggest that the overall resistive humidity response of a SWCNT network is determined by CNT resistance and inter-tube junction resistance. CNT resistance in response to humidity is largely dominated through the Poole-Frenkel defects on the CNT sidewalls. In contrast, inter-tube junction resistance is affected by the suppression of inter-tube carrier hopping by water molecules. Appropriate covalent modifications to CNTs can enhance the humidity detection dynamic ranges and sensitivities of the CNT networks. We employ a novel post transfer technique to prepare CNT based soft electronic devices. All CNT devices are initially fabricated on a hard substrate and then they are encapsulated into polyimide (PI) and peeled off from the hard substrate to form flexible devices. The soft transfer medium used here serves as the flexible substrate after a plastic transformation process so that the devices and circuits are capsulated into the flexible plastic, in favor of high flexibility and reliability. As the initial processes are completed on hard substrates, the conventional IC fabrication technology could be utilized and complex structures with submicrometer feature sizes (which are not reproducible on a soft substrate) can be easily achieved. CNT has been regarded as a promising material for backplane driver circuits for future flexible and transparent active matrix organic light emitting diode (AM OLED) displays due to its high field-effect mobility, excellent current carrying capacity, optical transparency and mechanical flexibility. We have successfully demonstrated the first CNT based thin film transistor (TFT) driver circuits for static and dynamic AM OLED display with 6 × 6 pixels. High device yields and performance uniformity are achieved using randomly-grown SWNT networks as the active channel material for the TFTs. High device mobility of ~ 45 cm2V-1s-1 and the high channel current on/off ratio of ~ 105 of the CNT-TFTs fully guarantee the control capability to the OLED pixels. We demonstrate a layer-by-layer assembling technique as a facile and scalable method to prepare a multilayer Si/CNT coaxial nanofiber anode which possesses an areal storage capacity above 1mAh cm-2. In addition, the prepared Si/CNT coaxial nanofiber anodes show an excellent cyclability. The excellent performance of the Si/CNT coaxial nanofiber multilayer anodes is attributed to the unique nanostructure. The CNT network matrix offers mechanical support to accommodate the stress associated with the large volume change of Si coating and the nanoporous multilayer structure provides continuous paths for Li ion and electron transport. In addition, we have developed high capacity 3D current collectors for flexible battery electrodes. We grow vertically aligned CNT array directly on carbon cloths (CC) as a hierarchical 3D current collector and load amorphous Si onto the CNT array with a large areal mass density. Beneficial from the porous structure and hierarchical 3D conductive pathway, the as-synthesized hierarchical 3D CNT-Si array on CC electrode exhibits a high areal capacity up to 3.32 mAh/cm2 at a current density of 0.2 mA/cm2, a superior cycle performance with a capacity retention of 94.4% after 200 cycles at a high current density of 1 mA/cm2, and excellent rate capability.

Haiguang Zhao, INRS-EMT, Canada
"Advanced Nanomaterials for Solar Energy Applications"

In quantum dot (QD) based solar cells the photoconversion efficiency (PCE) is critically related to the ability of exciton generation after photon absorption and electron injection from photoexcited QDs to the wide bandgap semiconductor constituting the photoanode of the solar cell. Near infrared (NIR) QDs have attracted much attention due to their unique size-tunable optical properties. In this talk, we focus on the synthesis of NIR colloidal PbS@CdS core@shell QDs, the investigation the photoelectron transfer rate from QDs to wide bandgap semiconducting mesoporous films using photoluminescence (PL) lifetime spectroscopy and further fabrication of solar cell. We have synthesized high-quality PbS QDs via a simple, solventless, greener approach. In order to improve the stability of bare PbS QDs, a cation exchange approach has been used to produce higher efficient, better stability core/shell QDs with respect to the bare QDs. The as-synthesized various types QDs were loaded into the mesoporous metal oxide thin film by a link-assisted methods. The different electron affinity of the oxides (SiO2, TiO2 and SnO2), the core size and the shell thickness allow to fine tune the electron injection rate by determining the width and height of the energy barrier for tunneling from the core to the oxide. Theoretical modeling using the semi-classical approximation provides an estimate for the escape time of an electron from the QD 1S state, in good agreement with experiments. The results demonstrate the possibility of obtaining fast charge injection in NIR QDs stabilized by an external shell (injection rates in the range of 110~250 ns for TiO2 films and in the range of 100~170 ns for SnO2 films for PbS cores with diameters in the 3~4.2 nm range and shell thickness around 0.3 nm), with the aim of providing viable solutions to the stability issues typical of NIR QDs capped with pure organic ligand shells. In the end, all solution processed depleted bulk heterojunction (DBH) solar cell devices based on NIR PbS@CdS core@shell QDs and films of rutile TiO2 nanorod arrays have been investigated. The device fabrication was achieved through the layer-by-layer spin-coating of PbS@CdS QDs, in ambient atmosphere, onto hydrothermally grown TiO2 nanorod arrays film leading to the general device architecture consisting of fluorine doped tin oxide (FTO)/TiO2/QDs/interfacial layer/Au. It was found that the maximum PCE of the solar cell up to ~2%. The stability and ease of processing in air together with the good performance of the PbS@CdS core@shell QDs, strongly suggest their high potential in solar cell applications.

Rongkun Zheng, University of Sydney, Australia
"3D atomic-scale insight into semiconductor nanowires"

Semiconductor nanowires (NWs) are ideal systems to investigate the fundamental science of reduced dimensionality and size, and are also building blocks for fabricating nanoscale electronic, optoelectronic, photonic devices in the proposed bottom-up paradigm. Controllable growth of semiconductor NWs with desired properties and functionalities is the cornerstone to realise these applications. In the most widely used vapour-liquid-solid (VLS) growth, crystal growth rate in one dimension at a given temperature is greatly enhanced by a metal seed. Despite of many years of study, this growth mechanism remains under lively debate. In this letter, we report that the reactant molecules impinged on the seed nanoparticles are responsible for the axial growth, and that the surface adatoms on NW sidewalls are responsible for radial deposition. There are also diffusion interactions between the core and shell at growth temperature. Our findings represent a significant advance to understand the NW growth mechanism, and are helpful to design and grow sophisticated NWs for practical applications.

NMDC 2015 Technical Program

Sessions

Time	Aleutian Room	Dillingham Room	Katmai Room
Monday, September 14			
08:30 AM-09:00 AM	*Welcome*		
09:00 AM-10:00 AM	*Opening Plenary*		
10:30 AM-12:00 PM		*Session M1*	*Session M2*
12:00PM-1:00PM	**LUNCH**		
01:00 PM-03:00 PM		*Session M3*	*Session M4*
03:20 PM-05:30 PM		*Session M5*	*Session M6*
Tuesday, September 15			
08:30 AM-10:00 AM	*Tuesday Plenary*		
10:30 AM-12:00 PM		*Session T1*	*Session T2*
12:00PM-1:00PM	**LUNCH**		
01:00 PM-03:00 PM		*Session T3*	*Session T4*
03:20 PM-05:30 PM		*Session T5*	*Session T6*
06:30-08:30PM PM	**DINNER**		
Wednesday, September 16			
08:00 AM-09:00 AM	*Wednesday Plenary*		
09:00 AM-09:30 AM	*Closing & Awards*		
10:00 AM-12:40 PM		*Session W1*	*Session W2*

Monday, September 14

8:30 AM – 9:00 AM Welcome

Room: **Aleutian**

Chair: Saif alZahir, NMDC 2015 Chair, UNBC, Canada

9:00 AM – 10:00 AM Opening Plenary Keynote

Room: **Aleutian**

Chair: Parviz Famouri, IEEE NTC VP Conferences, UWV, USA

"Planes, Trains, Automobiles…and Cells?"

Speaker: Philip R. LeDuc, Carnegie Mellon University, USA

10:30 AM – 12:00 PM

Session M1 — Invited Presentations

Room: Dillingham

Chair: Kenrick J Mock, NMDC Co-chair, University of Alaska Anchorage, USA

10:30 am ***Biomimetic Nanotechnology for Enhanced Detection of Circulating Tumor Cells***
Seungpyo Hong, Ja Hye Myung and Sin-jung Park (University of Illinois at Chicago, USA); Andrew Wang (University of North Carolina, USA)

11:00 am ***Advanced Nanomaterials for Solar Energy Applications***
Haiguang Zhao and Federico Rosei (INRS, Quebec University, Canada)

11:30 am ***Recent developments on InAs/InP quantum dash nanostructures and devices***
Boon S. Ooi, Mohammed Zahed Mustafa Khan and Tien Khee Ng (King Abdullah University of Science and Technology, Saudi Arabia)

Monday, September 14

10:30 AM – 12:00 PM

Session M2 — Invited Presentations

Room: Katmai

Chair: Frank Moore, University of Alaska Anchorage, USA

10:30 am ***Towards Functionality-Enhanced Devices: Controlling the Modes of Operations in Three-Independent-Gate Transistors***
Pierre-Emmanuel Gaillardon, Jian Zhang, Michele De Marchi and Giovanni De Micheli (EPFL, Switzerland)

11:00 am ***3D Atomic-Scale Insight Into Semiconductor Nanowires***
Rongkun Zheng (The University of Sydney, Australia)

11:30 am ***Ge Nanowire Transistors***
Chee-Wee Liu, I-Hsieh Wong, Shih-Hsien Huang and Chih-Hsiung Huang (NTU, Taiwan)

1:00 PM – 3:00 PM

Session M3

Room: Dillingham

Chair: Andrew Wang, University of North Carolina, USA

1:00 pm ***Nanoparticle or Microparicle Sintering for 3D/Power Assembly? (Invited)***
Katsuaki Suganuma (Osaka University, Japan)

1:30 pm ***Raman spectroscopy studies of phonons in a nanowire subjected to a magnetic field***
Md. Iftekhar Hossain, Jayasimha Atulasimha and Supriyo Bandyopadhyay (Virginia Commonwealth University, USA)

1:50 pm ***Biodegradable Nanoporous Microspheres by RAFT and Photodegradation***
Ildoo Chung and Taeyoon Kim (Pusan National University, Korea)

2:10 pm ***Nanoscaled Self-Assemblies for Facilitated Energy Conversion***
Hsing-Lin Wang (MSJ567, Chemistry Division, Los Alamos National Laboratory & Los Alamos National Laboratory, USA); Hsinhan Tsai (MSJ567, Chemistry Division, Los Alamos National Laboratory, USA)

2:30 pm ***Dielectric engineering of nanostructured layers preventing electrostatic charging in thin dielectrics***
Kremena Makasheva and Christina Villeneuve-Faure (LAPLACE, University of Toulouse, France); Caroline Bonafos (CEMES-CNRS, France); Christian Laurent (University of Toulouse and CNRS & LAPLACE, France); Alessandro Pugliara (LAPLACE, CEMES-CNRS, University of Toulouse, France); Bernard Despax and Laurent Boudou (LAPLACE, University of Toulouse, France); Gilbert Teyssedre (University of Toulouse & CNRS, LAPLACE & CNRS, Paul Sabatier University, France)

1:00 PM – 3:00 PM

Session M4

Room: Katmai

Chair: Frank D Witmer, University of Alaska Anchorage, USA

1:00 pm ***Advanced Carbon Nanotube Based Devices (Invited)***
Qing Zhang (Nanyang Technological University, Singapore)

1:30 pm ***Photon Induced Negative Capacitance in Metal Oxide Semiconductor Structures***
Anant M. P. Anantram (University of Washington, USA); Anita Fadavi Roudsari, Iman Khodadad and Simarjeet Saini (University of Waterloo, Canada)

1:50 pm ***Exploration of Digital Latch Design using Ballistic Deflection Transistors – Modeling and Simulation***
Poorna Marthi and Jean Francois Millithaler (University of Massachusetts Lowell, USA); Ignacio Iñiguez-de-la-Torre, Javier Mateos and Tomás González (University of Salamanca, Spain); Martin Margala (University of Massachusetts Lowell, USA)

2:10 pm ***Resistive Switching Effect At Boundary Between Film Like Grown ZnO Nanorods***
Eunji Yoo (Sejong University, Korea)

2:30 pm ***Correlation Between Gate Length, Geometry and Electrostatic Driven Performance in Ultra-Scaled Silicon Nanowire Transistors***
Talib Al-Ameri (University of Glasgow & Device Modelling Group, United Kingdom); Y. Wang (Peking University, P.R. China); Vihar Georgiev, F. Adamu-Lema, Xingsheng Wang and A. Asenov (University of Glasgow, United Kingdom)

Monday, September 14

3:20 PM – 5:30 PM

Session M5

Room: Dillingham

Chair: Andrew Wang, University of North Carolina, USA

3:20 pm ***Length Control of Packed Single Crystalline TiO2 Nanorods for Dye-sensitized Solar Cell (Invited)***
YoungSoo Kang (Sogang University & Korea Center for Artificial Photosynthesis, Korea)

3:50 pm ***A Low-cost Superlyophobic Dry Adhesive Film Based on EVA Copolymer***
Lifang Yuan, Lei Wang, Zhiwei Wang, Tianzhun Wu and Yu Zhao (Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, P.R. China)

4:10 pm ***Mesaporous polyurea aerogel for large loading, uniform and slow release of insect repellent oil***
Hao Tang and Chunrong Zhu (Onechip Co. Ltd, P.R. China); Wanli Niu (WindTalk Co. Ltd, P.R. China); Honglei Wang (University of Texas at Dallas, USA); Walter Hu (800 W. Campbell Rd & University of Texas at Dallas, USA)

4:30 pm ***A Wireless Motion Detection System with Silver Nano Ink Printed Accelerometer***
Jae Sung Park and Woo Soo Kim (Simon Fraser University, Canada)

4:50 pm ***Optical and Morphological Properties of Porous Silicon Grown At Low Hydrofluoric Acid Concentration by Electrochemical Anodization***
Mateus Moura (Federal University of Bahia, Brazil); Ademir Costa (Federal Institute of Bahia, Brazil); Leizer Schnitman (Universidade Federal da Bahia, Brazil); Marcio Fontana (Federal University of Bahia, Brazil)

5:10 pm ***3D Printed Inductor Designs Decorated with Silver Nano Ink***
Benny Chou, Jae Sung Park and Woo Soo Kim (Simon Fraser University, Canada)

Monday, September 14

3:20 PM – 5:30 PM

Session M6

Room: Katmai

Chair: Frank D Witmer, University of Alaska Anchorage, USA

3:20 pm ***Synthesis and Characterization of MoS2 Nanostructures Using Pulsed-laser Deposition System (Invited)***
Anderson Sunda-Meya (Xavier University of Louisiana, USA)

3:50 pm ***Heterodimensional Transistor Technology for Attojoule Electronics***
Michael Shur (Rensselaer Polytechnic Institute, USA)

4:10 pm ***Electronic Properties of Metal-Molecular Nanojunctions and Networks***
Po Zhang and Chris Papadopoulos (University of Victoria, Canada)

4:30 pm ***Study on the ESD-Induced Gate-Oxide Breakdown and the Protection Solution in 28nm High-K Metal-Gate CMOS Technology***
Chun-Yu Lin (National Taiwan Normal University, Taiwan); Ming-Dou Ker (National Chiao-Tung University, Taiwan); Pin-Hsin Chang (National Chiao Tung University, Taiwan); Wen-Tai Wang (Global Unichip Corporation, Taiwan)

4:50 pm ***Self-assembled Coffee-ring Colloidal Crystal Arrays with Periodical Structural Colours Utilizing Porous Polydimethylsiloxane Film as a Template***
Xuemin Du (Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS), P.R. China); Tengyue Li and Tianzhun Wu (Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, P.R. China)

5:10 pm ***Nanoimprinted Solar Cells with Large Molecular Weight P3HT Nanogratings with Enhanced Molecular Alignment***
Yi Yang, Kamil Mielczarek and Anvar Zakhidov (University of Texas at Dallas, USA); Walter Hu (800 W. Campbell Rd & University of Texas at Dallas, USA)

Tuesday, September 15

8:30 AM – 10:00 AM Tuesday Plenary Keynote

Room: Aleutian

Chair: Yonhua (Tommy) Tzeng, IEEE NTC VP Publications, National Cheng Kung University (NCKU), Taiwan

"Semiconductor Nanomaterials for Transient Electronics"

Speaker: John A. Rogers, UIUC, USA

10:30 AM – 12:00 PM

Session T1 — Invited Presentations

Room: Dillingham

Chair: Saif alZahir, NMDC 2015 Chair, UNBC, Canada

10:30 am ***Metallic Nanoparticles for Cancer Cell Selective Therapeutics***
Dar-Bin Shieh (National Cheng Kung University & NCKU Hospital, Taiwan)

11:00 am ***Mechanisms of endosomal escape for nanoparticle-mediated cytosolic drug delivery (Invited)***
Gaurav Sahay (Oregon State University, USA)

11:30 am ***Straintronics: Strain-switched multiferroic nanomagnets for extremely low energy logic/memory***
Hasnain Ahmad (Virginia Commonwealth University, USA); Ayan Kumar Biswas (BUET, Bangladesh); Jayasimha Atulasimha and Supriyo Bandyopadhyay (Virginia Commonwealth University, USA)

Tuesday, September 15

10:30 AM – 12:00 PM

Session T2 — Invited Presentations

Room: Katmai

Chair: Yonhua (Tommy) Tzeng, IEEE NTC VP Publications, National Cheng Kung University (NCKU), Taiwan

10:30 am ***Van Der Waals Epitaxy for New 2D Materials-Based Low-power Logic and Memory***
Christopher Hinkle (University of Texas at Dallas, USA)

11:00 am ***Sub-5 nm Patterning and Applications by Nanoimprint Lithography and Helium Ion Beam Lithography***
Yuanrui Li, Ahmed Abbas, Yuhan Yao and Yifei Wang (University of Southern California, USA); Wen-Di Li (University of Hong Kong, Hong Kong); Chongwu Zhou and Wei Wu (University of Southern California, USA)

11:30 am ***A Modeling Study of Mechanisms for NDR in graphene-BN-graphene Heterostructures***
Yunqi Zhao, Zhenni Wan, Xu Xu, Sunil Patil, Ulrich Hetmaniuk and Anant M. P. Anantram (University of Washington, USA)

1:00 PM – 3:00 PM

Session T3

Room: Dillingham

Chair: Osama Abaza, University of Alaska Anchorage, USA

1:00 pm ***Delay and Yield of CNFET-based Circuits in the Presence of Variations (Invited)***
Malgorzata Chrzanowska-Jeske (Portland State University, USA)

1:30 pm ***Enabling Antenna Design with Nano-magnetic Materials Using Machine Learning***
Carmine Gianfagna (Georgia Tech, Italy); Madhavan Swaminathan and Raj Pulugurtha (Georgia Tech, USA); Giulio Antonini (Università degli Studi dell'Aquila, Italy)

1:50 pm ***Enhancing the Electronic Conductivity of Lignin-sourced, Sub-micron Carbon***

Particles
Naveen kumar Palapati (300 W Franklin St, USA); Muslum Demir (Virginia Commonwealth University, USA); Charles Harris (Sandia National Laboratories, USA); Arunkumar Subramanian and Ram Gupta (Virginia Commonwealth University, USA)

2:10 pm ***Thin Graphite Membranes for Laser Photoacoustic Spectroscopy***
Jan Suchánek (J. Heyrovsky Institute of Physical Chemistry of the ASCR, v. v. i. & Faculty of Safety Engineering, VŠB – Technical University of Ostrava, Czech Republic); Michal Dostál (J. Heyrovsky Institute of Physical Chemistry of the ASCR, v. v. i., Czech Republic); Tereza Vlasáková (Faculty of Science, Charles University in Prague, Czech Republic); Pavel Janda, Monika Klusáčková and Pavel Kubát (J. Heyrovsky Institute of Physical Chemistry of the ASCR, v. v. i., Czech Republic); Václav Nevrlý and Petr Bitala (Faculty of Safety Engineering, VSB – Technical University of Ostrava, Czech Republic); Svatopluk Civiš and Zdeněk Zelinger (J. Heyrovsky Institute of Physical Chemistry of the ASCR, v. v. i., Czech Republic)

2:30 pm ***Graphene Based Photoconductivity and Surface Enhanced Raman Scattering***
Yonhua Tzeng, Pinyi Li, Minjui Lo and Chuncheng Chang (National Cheng Kung University, Taiwan)

1:00 PM – 3:00 PM

Session T4

Room: Katmai

Chair: James Randy Moulic, University of Alaska Anchorage, USA

1:00 pm ***Nanoscale Electronic Materials for Neurophysiological Interfaces (Invited)***
Shadi Dayeh (UCSD, USA)

1:30 pm ***HSPICE Macromodel of a PMA Racetrack Memory***
Pilin Junsangsri (Northeastern University, USA); Jie Han (University of Alberta, Canada); Fabrizio Lombardi (Northeastern University, USA)

1:50 pm ***Food Nanotechnology and Nano Food Safety***
Hongwu Bai (Jiangsu Academy of Agricultural Sciences, Canada)

2:10 pm ***Cell Impedance Sensing System Based on Vertically Aligned Carbon Nanofibers***
Syed Islam, Nicole McFarlane and Yongchao Yu (University of Tennessee, USA); Khandaker Abdullah Al Mamun (The University of Tennessee, USA)

2:30 pm ***Nanopatterning in GeTe Phase Change Materials Using Heated Atomic Force Microscope Tips***
Adrian Podpirka, Woo Lee, Todd Brintlinger, Nabil Bassim, Paul Sheehan and Laura Ruppalt (United States Naval Research Laboratory, USA)

Tuesday, September 15

3:20 PM – 5:00 PM

Session T5

Room: Dillingham

Chair: Osama Abaza, University of Alaska Anchorage, USA

3:20 pm ***Theoretical Investigation of the Oxygen Bond Dissociation Energies in Graphene Oxide***
Walid M. I. Hassan (Qatar University, Qatar); Amit Verma and Reza Nekovei (Texas A&M University – Kingsville, USA); R. Jeyakumar (CSIR-National Physical Laboratory, Pusa Campus, India); Mahmoud M Khader (Qatar University, Qatar)

3:40 pm ***Polaron Effect on Ballistic Transport in Armchair Graphene Nanoribbon***
Nazir Hossain, Poorna Marthi, Jean Francois Millithaler and Martin Margala (University of Massachusetts Lowell, USA)

4:00 pm ***Origin of Competing Blue and Green Emission in InGaN/GaN Quantum-Disks in Nanowires Heterostructure***
Aditya Prabaswara, Tien Khee Ng, Dalaver Anjum, Nini Wei and Chao Zhao (King Abdullah University of Science and Technology, Saudi Arabia); Abdulrahman M. Albadri, Ahmed Y. Alyamani and Munir El-Desouki (King Abdulaziz City for Science and Technology, Saudi Arabia); Boon S. Ooi (King Abdullah University of Science and Technology, Saudi Arabia)

4:20 pm ***A Novel Approach for Preparation of CuO Nanostructures on Conductive Substrate***
Fanan Wei (Shenyang Institute of Automation, P.R. China)

4:40 pm ***Antimicrobial Properties of Silver Nanorods: Chemical or Physical Kill?***
Md. Iftekhar Hossain (Virginia Commonwealth University, USA); Jarrod Edwards (US Army Engineer Research and Development Center, USA); James Tyler (Virginia Commonwealth University, USA); John Anderson (US Army Engineer Research and Development Center, USA); Supriyo Bandyopadhyay (Virginia Commonwealth University, USA)

Tuesday, September 15

3:20 PM – 5:30 PM

Session T6

Room: Katmai

Chair: James Randy Moulic, University of Alaska Anchorage, USA

3:20 pm ***Towards Nanomagnetic Logic systems: A Programmable Arithmetic Logic Unit for Systolic Array-based Computing (Invited)***
Stephan Breitkreutz-v. Gamm, Irina Eichwald and Grazvydas Ziemys (Technische Universität München, Germany); György Csaba, Gary Bernstein and Michael Niemier (University of Notre Dame, USA); Wolfgang Porod (University of Notre Dame, Germany); Mariagrazia Graziano (Politecnico di Torino, Italy); Doris Schmitt-Landsiedel and Markus Becherer (Technische Universität München, Germany)

3:50 pm ***Controllable Reversibility of Ultrafast Electron Dynamics in Buckled Dirac Materials***
Hamed Koochaki Kelardeh, Vadym Apalkov and Mark Stockman (Georgia State University, USA)

4:10 pm ***Strain induced and Spin Torque induced Switching of Nanomagnets: Coherent or Incoherent?***
Md Mamun Al-Rashid, Dhritiman Bhattacharya, Supriyo Bandyopadhyay and Jayasimha Atulasimha (Virginia Commonwealth University, USA)

4:30 pm ***Nanorods Self-Assembled From Polyaromatic Compounds: A Molecular Dynamics Study***
Cuiying Jian and Tian Tang (University of Alberta, Canada)

4:50 pm ***Tuning macroscopic body interactions by manipulation of quantum vacuum photon-modes at the nanoscale***
Louis Dellieu and Olivier Deparis (University of Namur, Belgium); Branko Kolaric (UNAMUR, Belgium); Michael Sarrazin (University of Namur, Belgium)

5:10 pm ***Multilevel Resistance in Ti/Pt/AlOx/HfOy/Ti/Pt/Ag Resistive Switching Devices***
Farhana Anwar (University of New Mexico, USA); John Nogan (Center for Integrated Nanotechnologies, USA); Payman Zarkesh-Ha and Marek Osiński (University of New Mexico, USA)

Wednesday, September 16

8:00 AM – 9:00 AM Wednesday Plenary Keynote

Room: Aleutian

Chair: Saif alZahir, NMDC 2015 Chair, UNBC, Canada

"Bio Cell Analysis and Assembly by Micro and Nano Robotic Technology"

Speaker: Toshio Fukuda, Nagoya University/Meijo University, Beijing Institute of Technology

9:00 AM – 9:30 AM Closing & Awards

Room: Aleutian

Chairs:

Kenrick J Mock, NMDC Co-chair, University of Alaska Anchorage, USA

Parviz Famouri, IEEE NTC VP Conferences, UWV, USA

10:00 AM – 12:20 PM

Session W1

Room: Dillingham

Chair: Martin Cenek, University of Alaska Anchorage, USA

10:00 am ***Device and Energy Properties of Two-Dimensional (2D) Atomically Thin Materials (Invited)***
Eric Pop, Stanford University, USA

10:30 am ***Atomically precise graphene nanoribbons and transition metal chalcogenide nanostructures for electronics applications (Invited)***
Alexander Sinitskii, University of Nebraska, USA

11:00 am ***Nanotechnology Laboratory and Nanoelectronics Simulation Courses***
James Morris (Portland State University, USA)

11:20 am ***Yield Estimation for CNFET- Based Circuits with Imperfections***
Rehman Ashraf (Tyfone & Tyfone, USA); Malgorzata Chrzanowska-Jeske (Portland State University, USA)

11:40 am ***Channel limitation of 1-D wire random network for transparent conducting electrodes application***
Jinyoung Hwang (Samsung Advanced Institute of Technology, Korea); Sang Hyun Lee (Sejong University, Korea); Hyosung Lee (Samsung Advanced Institute of Technology, Korea)

12:00 pm ***Characteristics Analysis of InN-In0.25Ga0.75N Quantum Well Laser with In0.4Al0.6N Layers for Short Distance Communication Wavelength***
Md. Mobarak Hossain Polash (Bangladesh University of Engineering and Technology & University of Asia Pacific, Bangladesh); Kamruzzaman Khan (University of Toledo, USA)

10:00 AM – 12:20 PM

Session W2

Room: Katmai

Chair: Frank Moore, University of Alaska Anchorage, USA

10:00 am ***Optical Modulation and Manipulation of Neurons and Cells with High Efficiency through Quantum Dots and Photonic Crystals (Invited)***
Lih Lin, Peifeng Jing, Ethan Keeler and Jingda Wu (University of Washington, USA)

10:30 am ***2D Nanoscale Semiconductors for Genomics (Invited)***
Jean-Pierre Leburton (University of Illinois at Urbana-Champaign, USA)

11:00 am ***Detection of base pair charges during DNA extension with Si nanowire FETs towards DNA sequencing***
Yuchen Liang and Silu Zhang (University of Texas at Dallas, USA); Walter Hu (800 W. Campbell Rd & University of Texas at Dallas, USA)

11:20 am ***A Nanomedicine Approach to Improving Chemoradiation Treatment for Cancer***
Andrew Wang (University of North Carolina, USA)

11:40 am ***Physico-chemical characterization of the interaction of red fluorescent protein – DsRed with silica layers***
Marvine Soumbo (LAPLACE, University of Toulouse, France); Alessandro Pugliara (LAPLACE, CEMES-CNRS, University of Toulouse, France); Marie-Carmen Monje and Christine Roques (LGC, University of Toulouse, France); Bernard Despax (LAPLACE, University of Toulouse, France); Caroline Bonafos (CEMES-CNRS, France); Robert Carles and Adnen Mlayah (CEMES-CNRS, University of Toulouse, France); Kremena Makasheva (LAPLACE, University of Toulouse, France)

12:00 pm ***In-situ Study of O2 Adsorption on Few-layer MoS2 Field Effect Transistor in Ultrahigh Vacuum***
Long Qi, Ying Wang, Braj Bhusan Singh and Yihong Wu (National University of Singapore, Singapore)