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PROGRAM AT A GLANCE

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Keynote	Local time	GMT Time
Prof. Lan Fu	10:00 am (Canberra)	11:00 pm (23rd)
Prof. Seiji Samukawa	09:00 am (Tokyo)	12:00 am (24th)
Prof. Inkyu Park	10:00 am (Korea)	01:00 am (24th)
Prof. Qing Zhang	10:00 am (Singapore)	02:00 am (24th)
Prof. Kin Fong Lei	11:00 am (Taiwan)	03:00 am (24th)
Prof. Subhankar Bedanta	09:30 am (India)	04:00 am (24th)
Prof. S. Narayana Jammalamadaka	10:30 am (India)	05:00 am (24th)
Prof. Osamu Tabata	03:00 pm (Tokyo)	06:00 am (24th)
Prof. Yogendra Mishra	08:00 am (Denmark)	07:00 am (24th)
Dagur Albertsson	09:00 am (Sweden)	08:00 am (24th)
Prof. Arokia Nathan	09:00 am (UK)	09:00 am (24th)
Prof. Ulla Lassi	12:00 pm (Finland)	10:00 am (24th)
Prof. Caue Ribeiro	08:00 am (Brasil)	11:00 am (24th)
Prof. Cecilia de C. C. e Silva	09:00 am (Brasil)	12:00 pm (24th)
Prof. Philiswa Nomngongo	03:00 pm (South Africa)	01:00 pm (24th)
Prof. Giovanni Finocchio	03:00 pm (Italy)	02:00 pm (24th)
Prof. Ghassan Jabbour	10:00 am (Ottawa)	03:00 pm (24th)
Prof. Amina Hussein	09:00 am (Edmonton)	04:00 pm (24th)
Prof. Attila Bonyar	06:00 pm (Hungary)	05:00 pm (24th)
Prof. Reuven Gordon	10:00 am (Vancouver)	06:00 pm (24th)
Prof. Dustin Gilbert	11:00 am (Knoxville)	07:00 pm (24th)
Prof. Oluwaseyi Balogun	02:00 pm (Chicago)	08:00 pm (24th)
Prof. Rachel A. Oliver	09:00 pm (UK)	09:00 pm (24th)
Prof. Nicholas Fang	05:00 pm (Boston)	10:00 pm (24th)

TOPICS

NOVEMBER • 24TH • 2021

PROF. LAN FU

III-V COMPOUND SEMICONDUCTOR NANOWIRES FOR OPTOELECTRONIC APPLICATIONS

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ABSTRACT

III-V compound semiconductor nanowires have drawn much attention as nanoscale building blocks for integrated photonics/optoelectronics due to their nanoscale size, excellent optical properties and strain relaxation feature enabling the monolithic growth on lattice-mismatched substrates. In particular, highly-ordered nanowire arrays grown by selective area epitaxy technique have many advantages such as controllability of nanowire size and position, high uniformity in diameter and length, as well as CMOS process compatibility, facilitating their integration with other optical and electronic components. In this work, I will present the study of a variety of III-V compound semiconductor-based nanowire array structures, including their material properties and device applications as lasers/LEDs, photodetectors and solar cells.

BIOGRAPHY

Lan Fu is currently a Professor and Head of the Department of the Electronic Materials Engineering at the Research School of Physics, the Australian National University. Professor Lan Fu's main research interests include design, fabrication and integration of optoelectronic devices (LEDs, lasers, photodetectors and solar cells) based on low-dimensional III-V compound semiconductor structures including quantum wells, self-assembled quantum dots and nanowires grown by metal-organic chemical vapour deposition (MOCVD). She has published ~200 publications (including 140 journal papers), 3 book chapters, co-edited 5 conference proceedings/journal special issue, and holds 2 US patents. Prof. Lan Fu was the recipient of the IEEE Photonic Society Graduate Student Fellowship (2000), Australian Research Council (ARC) Postdoctoral Fellowship (2002), ARF/QEII Fellowship (2005), Future Fellowship (2012), and Distinguished Lecturer award of IEEE Photonic Society (2021-2022). Professor Fu is a senior member of IEEE, IEEE/Photonics and Electron Devices Societies and was the past chair of the Photonics Society, Electron Devices Society and Nanotechnology Council Chapters of the IEEE ACT section. She is the current Chair of IEEE Nanotechnology Council Chapters & Regional Activities Committee, Associate Editor of IEEE Photonics Journal, and member of Editorial Board of Opto-Electronic Advances. She is also the current member of the Australian Academy of Science National Committee on Materials Science and Engineering, Secretary of the Executive Committee of Australian Materials Research Society (AMRS), and Australian Research Council College of Experts.

PROF. SEIJI SAMUKAWA

ATOMIC LAYER NEUTRAL BEAM PROCESSES FOR NANOFABRICATION AND INTERFACE ENGINEERING

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ABSTRACT

In the fabrication of semiconductor devices, reactive plasmas are widely used in key processes such as microfabrication, surface modification and film deposition, and there are now demands for processing precision at the atomic layer level, and for deposition accuracy that allows the control of structures at the molecular level. However, in ultra-miniature nanoscale devices that will become the mainstream in the future, the use of plasma processes can cause serious problems such as breakdown of insulation films by the accumulation of ions or electrons emitted from the plasma and the formation of surface defects (dangling bond) of over a few tens nm in depth by exposure to ultraviolet (UV) emissions from the plasma. In particular, since nano-scale devices have a larger surface area compared with the bulk material, plasma processes can have a large influence on the electrical and optical properties of devices due to process-induced defects caused by ultraviolet exposure, since future nano-devices will require size control of three-dimensional structures at the atomic layer level, it will be absolutely essential to control surface chemical reactions with high precision and selectivity at the atomic layer level. To achieve charge-free and UV photon irradiation damage-free processes, we have developed a new neutral beam generation system based on my discovery that neutral beams can be efficiently generated from the acceleration of negative ions produced in pulsed plasmas. This paper introduces the neutral beam generation technique and discusses its application to atomic layer etching (ALE), modification (ALM) and deposition (ALD) that have recently been pursued.

BIOGRAPHY

Prof. Seiji Samukawa joined NEC in 1981 after graduating in Instrumentation Engineering from Keio University. Worked on the research and development of ultra-precise plasma etching processes for ULSI devices. Promoted to Principal Researcher in Microelectronics Laboratory, R&D Group NEC Corporation. Obtained a Ph.D. in Instrumentation Engineering from Keio University in 1992. Since July 2000, he has been a full professor at Tohoku University, where he is currently Director of the Innovative Energy Research Center at the Institute of Fluid Science (IFS) Tohoku University. He is also a Principal Investigator (PI) at Advanced Institute of Materials Research (AIMR) Tohoku university, deputy director of Material Solutions Center (MaSC) Tohoku university, and also joint Chair Professor of Taiwan National Chiao Tung University. His significant scientific achievements earned him Ichimura Award (2008) in the New Technology Development Foundation, Prizes for Science and Technology; The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (2009), Plasma Prize in American Vacuum Society (2010) and IEEE NTC Distinguished Lecturers (2019). Additionally, he has been elected as a “Distinguished Professor” of Tohoku University, a “Fellow” of the Japan Society of Applied Physics (JSAP) since 2008, a “Fellow” of American Vacuum Society (AVS) since 2009 and a also “Fellow” of Institute of Electrical and Electronics Engineers (IEEE) since 2018.

PROF. INKYU PARK

SELF-POWERED PHYSICAL AND CHEMICAL SENSORS TOWARDS NEXT GENERATION IOT

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ABSTRACT

In the era of 4th industrial revolution, the importance of internet of things (IoT), which is the network of physical objects, has been rapidly growing. Among many core components for IoT, sensors measure physical parameters and status of objects including pressure, strain, temperature, pH, gas concentration, etc. As more sensors are deployed in numerous objects, especially in remote places, the power supply for the sensor operation is becoming a highly challenging issue. Accordingly, a number of low-power or self-powered sensors are being actively developed. In this talk, I will introduce recent development of self-powered physical and chemical sensors at our research group. In particular, the following research topics will be discussed: (1) wearable self-powered pressure sensor by integration of piezo-transmittance microporous elastomer with organic solar cell, (2) self-powered strain sensor based on the piezo-transmittance of a mechanical metamaterial, (3) self-powered H2 gas sensor based on chemo-mechanically operating palladium-polymer nanograting film, (4) self-powered gas sensor based on a photovoltaic cell and a colorimetric film with hierarchical micro/nanostructures, and (5) self-powered humidity sensor using chitosan-based plasmonic metal-hydrogel-metal filters .

BIOGRAPHY

Prof. Inkyu Park received his B.S., M.S., and Ph.D. from KAIST (1998), UIUC (2003) and UC Berkeley (2007), respectively, all in mechanical engineering. He has been with the department of mechanical engineering at KAIST since 2009 as a faculty and is currently an associate professor. His research interests are nanofabrication, smart sensors, nanomaterial-based sensors and flexible & wearable electronics. He has published more than 70 international journal articles (SCI indexed) and 100 international conference proceeding papers in the area of MEMS/NANO engineering. He is a recipient of IEEE NANO Best Paper Award (2010) and HP Open Innovation Research Award (2009-2012).

PROF. QING ZHANG

ROLES OF DYNAMIC SEMICONDUCTOR JUNCTIONS IN MECHANICAL ENERGY HARVESTING

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ABSTRACT

In this talk, we discuss a new type of electric generators which are fully based on dynamic semiconductor junctions formed with a pair of semiconducting or/and metallic electrodes which possess distinct chemical potentials. The generators have two different working modes: (1) When the two electrodes are brought in contact, electrons could diffuse from the high into the low chemical potential electrode. Once the two electrodes are being separated, the diffused electrons are then discharged to the external circuit and flow back to the high chemical potential electrode, converting the mechanical power to electrical power. (2) In contrast, a direct current is generated in the direction of the built-in electric field in the dynamic p-n junction across the contacted surfaces if one electrode is slid on the other. Electron transport through the semiconductor junctions will be addressed in the talk. In addition, the state-of-the-art development in this type of electric generators will be highlighted.
Acknowledgements: This project is financially supported by MOE AcRF Tier2 (2018-T2-2-005) and A*STAR AME IRG Grant SERC A1983c0027, Singapore

BIOGRAPHY

Qing Zhang is a professor at Centre of Micro-/Nano-electronics, School of Electrical and Electronic Engineering, Nanyang Technological University (NTU), Singapore. His research interests cover nanomaterials and nano/micro-electronic devices, carbon/silicon based thin films, etc. His attention focuses on carbon nanotube and nanostructure-based devices and fundamentals, etc. He and his group members have studied functionalized carbon nanotubes for several types of sensors, logic circuits and Li-ion batteries, etc. He has published more than 260 peer-review scientific papers in the fields of electronic materials, physics and devices for data processing, sensing and energy storage and harvesting

PROF. KIN FONG LEI

TOWARDS A MINIATURIZED, HIGH THROUGHPUT PLATFORM FOR CANCER BIOLOGY RESEARCH

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ABSTRACT

IIn order to achieve high predictive value of cell chemosensitivity test for the clinical efficacy, cancer cells encapsulated and cultured in hydrogel can mimic the natural microenvironment of tumors. Cells suspended in hydrogel were cultured in a standard multi-well microplate. Because of the volume of the cells/hydrogel construct, unequal chemical concentration may be induced within the hydrogel. Also, cellular responses are difficult to be observed and quantified in the hydrogel. In this work, a novel platform for conducting 3D cell culture and analyzing cell viability has been developed for high throughput drug screening. Cells were encapsulated in the hydrogel and cultured in the microwells of a paper substrate. The substrate was then immersed in the culture medium containing drug for 2 days. Cell viability of two human hepatoma cell lines (Huh7 and Hep-G2) was quantitatively investigated by the impedance measurement under the treatment of two drugs (doxorubicin and etoposide). The results represented by IC50 values revealed that Huh7 cells had a higher drug resistance than Hep-G2 cells and doxorubicin had a higher efficacy than etoposide for treating hepatocellular carcinoma. The current work has demonstrated a high throughput, convenient, and quantitative platform for the investigation of chemosensitivity of cancer cells cultured in 3D environment.

BIOGRAPHY

Dr. Kin Fong Lei is a Professor in Biomedical Engineering and Dean for International Affairs at Chang Gung University, Taiwan. He was also appointed to be an Adjunct Professor at Yonsei University, Korea. Prior to joining CGU, he was a Lecturer at The Hong Kong Polytechnic University, Hong Kong (2007-2010). He received B.S. degree from National Tsing-Hua University, Taiwan (1998), and Ph.D. degree from The Chinese University of Hong Kong, Hong Kong (2005), both in mechanical engineering. In 2006, he was a post-doctoral fellow at the University of Western Ontario, Canada. Dr. Lei has made significant original contributions to research in bio-microfluidics, bio-sensing, and molecular diagnostics. He has published over 100 peer-reviewed academic articles and was invited to contribute in 8 book/book chapters. Dr. Lei was elected to be Fellow of Royal Society of Chemistry (RSC) and Institute of Physics (IOP), and Senior Member of Institute of Electrical and Electronics Engineers (IEEE). He serves as a Chair of IEEE-EMBS Technical Committee on Bionanotechnology and BioMEMS (BNM) and Associate Editor at EMBS Conference Editorial Board in 2020 and 2021. He also served as a General Chair in IEEE-NANOMED 2021 and Program Chair in IEEE-NEMS 2022. Dr. Lei is an Associate Editor for IEEE Access and IEEE Transactions on NanoBioscience.

PROF. SUBHANKAR BEDANTA

SPINTRONICS WITH HEAVY METALS, TOPOLOGICAL INSULATORS AND ANTIFERROMAGNETS

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ABSTRACT

The precession of magnetization in a ferromagnet (FM) can transmit pure spin current into an adjacent heavy metal (HM) via spin pumping. This pure spin current gets converted to a charge current due to high spin orbit coupling (SOC) of the HM due to the inverse spin Hall effect (ISHE). I will discuss recent ISHE results on Co2Fe0.4Mn0.6Si/Pt bilayers, where Co2Fe0.4Mn0.6Si is a full Heusler alloy. Damping analysis indicates the presence of significant spin pumping at the interface of Co2Fe0.4Mn0.6Si and Pt. I will also discuss ISHE experiments on some other combinations such as CoFeB/IrO2 and manganite based La0.66Sr0.34MnO3/Pt bilayers. Recently AFM materials having high SOC have been found to be a good replacement of HM in spin current based study. We have performed the ISHE study of CoFeB (10 nm)/ AFM (d nm) where we considered various AFM such as Mn2Au, Mn3Ga, IrMn etc. The systematic angle dependent ISHE measurements have been carried out to disentangle the different spin rectification effects viz. anisotropic magnetoresistance and anomalous Hall effect. Further I will show the ISHE study on topological insulator (TI)/ferromagnetic Bi2Se3/CoFeB films. ISHE experiments have also been performed to demonstrate that TIs are potential candidates to replace HM as they possess high spin-orbit coupling. In the second part of my talk, I will discuss about magnetic skyrmion. Skyrmions in ultrathin films are believed to offer large performance advantages in the development of novel spintronics technologies. Recent studies have shown that skyrmions can be stabilized by interfacial Dzyaloshinskii-Moriya Interaction (iDMI). The controlled nucleation, stabilization, smaller size and efficient motion of skyrmions at room temperature and low magnetic field are the major challenges for R&D purpose. In this context, I will discuss the generation of skyrmions from triangular antidot structure in a ferromagnetic nanotrack using local Oersted field. The dependency of skyrmion size and shape for variable Dzyaloshinskii–Moriya interaction and uniaxial anisotropy will also be discussed. Sometimes the shape of skyrmions is not perfectly circled which is explained by the presence of different local anisotropy energy using micromagnetic simulations. I will discuss the effect of the interlayer exchange interaction on between skyrmion-antiskymion pair. I will also discuss the current induced motion of skyrmions in Pt/CoFeB thin films. The presence of low pinning sites in the Pt/CoFeB thin films helps skyrmions to move with a low threshold current density. Acknowledgement: I like to sincerely thank my group members and collaborators for their hardwork and kind cooperation. I also acknowledge the funding agencies.

BIOGRAPHY

Dr. Subhankar Bedanta is an Associate Professor at the School of Physics at NISER-Bhubaneswar, India. He has obtained his PhD from University Duisburg-Essen, Germany. He has worked as a postdoctoral associate at (i) University Duisburg-Essen, Germany and (ii) Princeton University, USA. He was a guest scientist at Forschungszentrum Juelich, Germany and also worked as a visiting associate professor at Tohoku University, Japan. His research interests are nanomagnetism and spintronics. He focuses on domain imaging, domain wall dynamics in magnetic multilayers, magnetic antidot lattices. His recent work focuses on organic spintronics, antiferromagnetic spintronics, topological insulators, flexible spintronics etc. He has been awarded the “Young Achiever Award 2019” by department of atomic energy, India. He has published about 75 papers and has got about 2500 citations. He is an editor of the Journal of Magnetism and Magnetic Materials (JMMM).

PROF. S. NARAYANA JAMMALAMADAKA

ATOMISTIC SWITCH BASED ON MAGNETOSTRICTIVE NANOCONTACTS – QUANTUM TRANSPORT

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ABSTRACT

Controlling the electrical conductance in a remote way through atomic junctions may play an important role in next generation electronic devices if we can operate them at room temperature. Here we report on the electrical conductance G of magnetic nanocontacts prevailed from wires of the giant magnetostrictive compound Tb0.3Dy0.7Fe1.95 as an active element in a mechanically controlled break junction device. The nanocontacts are switched at room temperature between “open” (G = 0) and “closed” (G > 0) by variation of an applied magnetic field H. Below 70 K, the magnetoconductance G(H) shows a hysteresis which is in agreement with the hysteresis observed in the magnetization loops M(H) due to the pinning of domain walls. G(H) measurements in magnetic field oriented parallel or perpendicularly to the long wire axis show a different behavior due to the strongly anisotropic magnetostrictive strain. Tunneling characteristics are obtained by controlling the gap between the two electrodes mechanically as well as by magnetic field. In both the cases, we encounter that the transport characteristics are distinctly different in the ballistic as well as in the tunneling regime. From the magnetic-field switching of the conductance, we estimate the length change by the field to 0.053 x 10-7 m/T at 10 K. The present results pave the way to utilize the giant magnetostrictive compound Tb0.3Dy0.7Fe1.95 as an active element in devices based on nanoelectromechanical systems (NEMS) operating at room temperature.

BIOGRAPHY

Dr. Suryanarayana Jammalamadaka is an associate professor at Department of Physics, IIT Hyderabad. Prior to his appointment at IIT Hyderabad, Dr. Suryanarayana finished M.Sc from University of Hyderabad and pursued his PhD from Indian Institute of Technology Madras during 2003 - 2007. He was a recipient of Prof. A. L. Laskar award for his contribution, as part of his thesis to the magnetostrictive materials and transducers at IIT Madras. He was a postdoctoral research fellow at Tata Institute of Fundamental Research, Mumbai, National University of Singapore and Katholic University of Leuven, Belgium, where he enriched his broad knowledge in the field of nanomagnetism as well as on the devices based on spin and semiconductors. His current research aims toward the understanding the physics behind various nanoscopic and mesoscopic magnetic materials and realization of their usage in practical devices such as spinelectronics and opto-electronics. He published more than 50 high impact international journals and delivered number of seminars at different reputed institutes in India as well as in abroad. He also received many awards to pursue his research nationally as well as internationally. Two patents have been applied out of the work that he carried out. He was a visiting scientist at Karlsruhe Institute of Technology, Germany through IIT – DAAD Faculty exchange program during May – Jun 2014 and Dec 2018. He is a life member of the Magnetic Society of India, electron microscopy of India and reviewer for many reputed international journals. He also received outstanding reviewer recognition from JMMM (2017) and Physica E (2018).

PROF. OSAMU TABATA

TOP-DOWN MEETS BOTTOM-UP: WAY TO EXPLORE THE PLENTIFUL ROOM AT THE BOTTOM

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ABSTRACT

In 1982 two papers in particular were published. One is recognized as the bible of Silicon micromachining, which is a typical top-down approach to miniaturization, and the other is known as the origin of DNA nanotechnology, which is a typical bottom-up approach to realizing nanoscale objects. Almost 40 years later the former is still the key to MEMS and the latter is the key to molecular machines. Both of these are recognized as powerful technologies and yet there remains a significant gap between them.

In this talk I begin by introducing the historical aspects of these two approaches to exploring the world at micro and nano scales. I then survey the current status of MEMS and DNA nanotechnology before discussing one challenging goal that remains to be addressed.

BIOGRAPHY

Osamu Tabata received his M.S. and Ph.D. degrees from Nagoya Institute of Technology, Japan, in 1981 and 1993, respectively. In 1981, he joined the Toyota Central Research and Development Laboratories, Inc., Japan. In 1996, he joined the Department of Mechanical Engineering, Ritsumeikan University, Japan. In 2003, he moved to the Department of Mechanical Engineering, Kyoto University, Japan. Since April 2005, he has been a Professor at the Department of Micro Engineering, Kyoto University. From October 2019, he moved to Kyoto University of Advanced Science as a founding Dean of New Engineering School launched in 2020. He is currently engaged in research on micro/nano processes, MEMS, DNA nanotechnology. Prof. Tabata was a guest professor at the Department of Microsystem Engineering, University of Freiburg, Germany from September to December 2000, a guest Professor of ETH Zurich, Switzerland from January to March 2001, a visiting senior international scientist of the Chinese Academy of Science in 2010, a guest Professor of Huazong University of Science and Technology, China from July 2011 to July 2014, a senior research fellow at the Freiburg Institute for Advanced Studies (FRIAS) from May 2010 to September 2012, a distinguished visiting researcher of American University in Cairo in 2016 and a visiting Professor of Tsinghua University China from November 2018. He is a senior editor of the IEEE Transactions on Nanotechnology (TNANO), an associate editor of the ASME/IEEE Journal of Micro Electromechanical Systems (JMEMS), and an editorial board member of the Elsevier Journal Sensors and Actuators. He is as a member of Award Committee for EDS. He is also a program committee member of many important International Conferences in his area of expertise. He is a Fellow of Institute of Electrical and Electronics Engineers and Institute of Electrical Engineer Japan.

PROF. YOGENDRA K. MISHRA

TETRAPODS BASED SMART MATERIALS FOR ADVANCED TECHNOLOGIES

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ABSTRACT

Considering the size dependent utilization complexities of nanoscopic dimensions towards real applications, the focus of nanomaterials community is merging to three-dimensional (3D) form of materials which are built out interconnected nanostructures. This talk will briefly introduce the importance of complex shaped nanostructures towards smart 3D nanomaterials structuring. A simple flame based single step approach was developed for synthesizing zinc oxide tetrapods which demonstrated many applications in different technologies. These tetrapods have been used as building blocks to construct highly porous interconnected 3D nanonetworks in form of flexible ceramics which offer further new application avenues. Additionally, these 3D networks have been utilized as sacrificial templates to develop hollow tetrapodal 3D networks from almost any desired material, carbons, nitrides, oxides, polymers, hydrogels, etc. The sacrificial template-based strategy offers new and unique opportunities in the direction of 3D nanomaterials engineering and accordingly advanced technological applications. Some examples of 3D nanomaterials engineering will be demonstrated alongwith their applications. The scopes of 3D nanostructuring based smart materials in sensing, electronics, optoelectronics, energy, and biomedical engineering will be briefly highlighted in the talk.

BIOGRAPHY

Yogendra Kumar Mishra is Professor MSO at Mads Clausen Institute, NanoSYD, University of Southern Denmark (SDU), Denmark. Prior joining to SDU, he worked as group leader at Functional Nanomaterials Chair, Kiel University, Germany. He did Habilitation in Materials Science from Kiel University in 2015 and Ph. D. in Physics in 2008 from Jawaharlal Nehru University (Inter University Accelerator Centre), New Delhi, India. In Kiel, he introduced a new flame-based process for metal oxide tetrapod nanostructuring and their 3D networks which showed many applications in engineering and biomedical fields. Additionally, tetrapods can be used as templates to create hybrid and new 3D materials. At NanoSYD, he is heading 'Smart Materials' group with the focus to develop new materials for green and sustainable technologies.

Publications > 230, Citations> 10500, H-index: 56

DAGUR INGI ALBERTSSON

SPINTRONIC OSCILLATOR BASED APPLICATIONS: MODELLING AND DESIGN

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ABSTRACT

Spintronic oscillators have gained significant interest in recent years. Their characteristics including high operating frequency, nano-scaled size and integration compatibility with CMOS circuits make them an interesting device for applications such as wireless communications, magnetic field sensing and non-boolean/neuromorphic computing. This seminar will focus on spintronic oscillators modeling and CMOS circuit design, as its required for exploring and developing new spintronic oscillators based applications. Specifically, a novel magnetic-field sensing system inspired by time-based analog-to-digital converters will be presented and the possibility of developing Ising Machines based on spintronic oscillators will be discussed

BIOGRAPHY

Dagur Ingi Albertsson received the B.Sc. degree in mechatronics engineering from the University of Reykjavik, Reykjavik, Iceland, in 2016, and the M.Sc. degree in embedded systems from the KTH Royal Institute of Technology, Kista, Sweden, in 2018, where he is currently pursuing the Ph.D. degree, with the research area of circuit design for spin torque and spin hall nano oscillators. He is also the receiver of best paper of the year 2020 in IEEE Transaction on Nanotechnology.

PROF. AROKIA NATHAN

INTEGRATION STRATEGIES TO MEET LOW POWER REQUIREMENTS OF BIOSENSOR INTERFACES

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ABSTRACT

A key design consideration in flexible electronics, particularly for wearables and sensing applications, is low voltage, low power operation. This requirement not only serves to maximize battery lifetime but crucially ensures operational stability of thin film transistor (TFT) circuits and systems. Ultralow voltage/current operation is especially important in sensor interfaces so as to achieve a high resolution of the sensory signal. This presentation will review the TFT design and materials selection strategies for ultralow power operation. We examine the main issues that lead to a high operating voltage of the TFT, and discuss processing conditions for suppressing the interface trap density. Recent advances in low-voltage thin-film transistors show it is possible for the subthreshold slope to approach the thermionic limit, q/kT. Based on these considerations, an all-inkjet-printed ultra-low-power high-gain amplifier, applied to eye movement tracking by detecting human electro-oculogram signals, is presented.

BIOGRAPHY

Arokia Nathan is a leading pioneer in the development and application of thin film transistor technologies to flexible electronics, display and sensor systems. Following his PhD in Electrical Engineering, University of Alberta, Canada in 1988, he joined LSI Logic USA and subsequently the Institute of Quantum Electronics, ETH Zürich, Switzerland, before joining the Electrical and Computer Engineering Department, University of Waterloo, Canada. In 2006, he joined the London Centre for Nanotechnology, University College London as the Sumitomo Chair of Nanotechnology. He moved to Cambridge University in 2011 as the Chair of Photonic Systems and Displays, and he is currently a Bye-Fellow and Tutor at Darwin College. He has over 600 publications including 4 books, and more that 110 patents and four spin-off companies. He is a Fellow of IEEE, a Distinguished Lecturer of the IEEE Electron Devices Society and Sensor Council, a Chartered Engineer (UK), Fellow of the Institution of Engineering and Technology (UK), and winner of the 2020 IEEE EDS JJ Ebers Award.

PROF. ULLA LASSI

SUSTAINABLE LITHIUM-ION BATTERIES

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ABSTRACT

The demand for lithium-ion batteries is growing rapidly due to the increasing popularity of electric vehicles, portable devices, and energy storage from renewable energy sources, particularly household electricity generated by wind power and solar cells. This means increasing battery capacity need, and new Gigafactories are being built in Europe. Further, several investment plans for the manufacture of batteries and battery chemicals have also been published. The growing need for batteries will significantly increase the need for both primary battery minerals and recycled materials. However, these secondary materials alone are not enough to cover even the current need for battery materials. Therefore, we need responsible mining and sustainable battery mineral processing. Discussions on sustainability raise often the role of cobalt in battery metals, its availability and, in particular, the ethical aspects related to cobalt processing chain. Cobalt has been paid too much attention in this regard, as already in existing lithium-ion batteries, the use of cobalt is quite low and will decrease significantly with new NMC chemistries and even completely cobalt-free chemistries. In addition, cobalt can be efficiently recycled from lithium-ion batteries, as can nickel. In addition to battery metals, the focus should also be on current cell manufacturing processes, which typically use toxic solvents and fluorinated binders or electrolyte salts. These compounds pose challenges not only from the viewpoint of battery cells recycling but also from the point of view of ecology and safety. In our own research, we have recently focused on new cell manufacturing methods. At the same time, we have been able to replace e.g. harmful NMP solvent and binders with new material choices without compromising the performance of the battery cell itself. Such a greener cell manufacturing technology would also like to be transferred to the production of more and more battery factories in the short term.

BIOGRAPHY

Doctor of Technology, in 2003. Since 2006, Professor in Applied Chemistry and Process Chemistry, University of Oulu, Faculty of Technology. Currently also the Head of Research Unit of Sustainable Chemistry (51 employers), at the university of Oulu. Her research areas involve inorganic material chemistry in industrial applications, esp. heterogeneous catalysis in biomass conversion and wastewater treatment as well as lithium-ion battery chemicals. She has over 140 peerly-reviewed scientific publications. As a professor, she has supervised 20 PhD theses and more than 100 M.Sc theses. She has been principal investigator of 30 research projects. Professor Lassi is also an active member in several scientific and educational societies and committees. She has several positions of trust.

PROF. CAUE RIBEIRO

A PERSPECTIVE VISION OF NANOTECHNOLOGY APPLICATIONS IN AGRICULTURE

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ABSTRACT

Brazil is widely known for the leadership in agriculture production, which currently represents (including the industrial processing of agricultural products) 1/3 of the Brazilian GDP. That importance comes from the role of technological advance in agriculture in tropical lands, which - despite not easily seen - is widespread in many levels, from seeds to animal production. The economic diversification of modern agriculture requires the development of novel technologies, especially those in the frontier of knowledge - such as Nanotechnology, which can put the agriculture income in a remarkable new level. Therefore, products such as biobased materials, systems for controlled release of fertilizers, sensors and biosensors for food quality assessment, technologies for water and soil decontamination, among others have been studied. Thus, we will summarized the recent achievements and perspectives for novel products, discussing technology gaps and the further research needed.

BIOGRAPHY

Caue Ribeiro received his PhD in Physical Chemistry from the Federal University of Sao Carlos in 2005. After a period in the private sector, he joined the Brazilian Agricultural Research Corporation (Embrapa) as Senior Researcher in 2007. He currently is the coordinator of Agronano Network - a research network for nanotechnologic applications in agriculture, involving about 150 researchers in Brazil and abroad (https://www.embrapa.br/nano). His primary research interests include the development of synthesis routes to produce heterogeneous catalysts for energy production, catalytic activity of nanoparticles and development of nanocomposites for slow/controlled release in agriculture. He has published more than 200 papers, with H index 49 and more than 8,000 citations (Google Scholar).

PROF. CECÍLIA DE C. C. E SILVA

GRAPHENE-BASED TECHNOLOGIES FOR BIOSENSORS: FROM FIELD EFFECT TRANSISTORS TO MICROFIBERS

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ABSTRACT

Graphene based sensors have received widespread attention due to its unique properties such as high electrical conductivity and high surface area. The 2D structure of graphene allows all carbon atoms to be exposed to the surroundings, which makes it a good platform for adsorbing and detecting molecules with increased sensitivity. Graphene is also a biocompatible material, providing a good microenvironment for the immobilization of biocompounds, such as antibodies, enzymes, DNA, and aptamers. Therefore, these properties make graphene an appealing transducer material in biosensors. This presentation will provide an overview of the fundamentals and applications of graphene and its derivatives (graphene oxide (GO) and reduced graphene oxide (rGO)) in biosensors and microfibers. It will explore the development of high sensitivity devices based on graphene field effect transistors (FETs) for the diagnosis of breast cancer and COVID19. Additionally, a simple method based on 3D flow focusing microfluid devices will be demonstrated to produce GO microfibers, with good control of thickness and length. Thermal and microwave treatments are also presented as an efficient tool to obtain rGO microfibers with spectroscopic and electrical properties similar to CVD graphene, that are good candidate in the development of microelectrodes.

BIOGRAPHY

Dr Cecília de Carvalho Castro Silva obtained her PhD at the University of Campinas (Unicamp), Campinas, Brazil (2015). Since January 2016, she has been assistant professor at MackGraphe - Graphene and Nanomaterials Research Center, Mackenzie Presbyterian University, São Paulo, Brazil. She was a visiting professor in the Nanobioelectronics and Biosensors Group at the Catalan Institute of Nanoscience and Nanotechnology (ICN2), Barcelona, Spain (2020-2021). Cecilia was included by Forbes-Brazil in the list "30 Under 30", of the 30 most talented youngsters under 30 years in 2016. Her research interests are dedicated to two-dimensional materials, biosensors, and bioelectronics for health-care applications.

PROF. PHILISWA N. NOMNGONGO

NANOMATERIALS AS A TOOL IN ANALYSIS AND REMOVAL OF POLLUTANTS FROM CONTAMINATED WATER SYSTEMS

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ABSTRACT

The global increase in the quality of life accompanied by demand for emerging pollutants such as pharmaceuticals and personal care products, has introduced a new threat to an already scarce natural resource for humans, which is water. These also drew considerable attention over the last decades due to the number of emerging pollutants that have been detected in aqueous environment compartments. Various studies also indicated that the occurrence of emerging pollutants in environmental water bodies is because of both domestic and industrial activities. Moreover, their fate and impact on the aquatic environment is not well documented or understood as such they are classified as emerging pollutants. In addition, metals are also regarded as major pollutants that are directly or indirectly discharged to the environment. With alarming concern about environmental pollution, increasing research has been focused on the development of methodologies for environmental analysis, monitoring and remediation. The use of nanotechnology has become a topic of interest due to the remarkable advantages of using various nanomaterials in many fields including environmental analytical chemistry. The flexibility and distinct properties of nanomaterials has allowed us to profile the occurrence and distribution of pollutants in our water system as well as the concentration levels of these contaminants. This also offers an improved selectivity, adsorption, and extraction efficiency towards target analytes, which, in turn, improves the sensitivity of the complete analytical method. In environmental analysis, the use of nanomaterials has received considerable attention since they can provide substantial simplification of the analytical procedures.

BIOGRAPHY

Prof Philiswa N. Nomngongo is a full Professor of Environmental Analytical Chemistry at the University of Johannesburg, Faculty of Science (Department of Chemical Sciences). She holds a Department of Science and Innovation/National Research Foundation (DSI/NRF) South African Research Chair (SARChI) in Nanotechnology for Water and NRF Y1 rating. Her scientific career has been dedicated to Environmental Analytical Chemistry aiming in solving different environmental problems in the field of water quality and environmental protection. Her most important contributions have been particularly in the development of sample preparation methodologies using porous nanostructured materials as an adsorbent for monitoring of various pollutants in wastewater and natural water. Her current research includes application of various nanomaterials in fields that are attracting increasing interest, such as wastewater treatment, groundwater remediation, water quality monitoring, development of water quality sensors, treatment, and recovery of precious metals, among others.
Her research achievements have been recognized through prestigious fellowships and awards such as 2014 L'Oreal-UNESCO Sub-Saharan Women in Science Regional fellowship; 2017 South African Women in Science award in the Distinguished Young Woman Research in the Natural and Engineering Sciences category; 2017 Vice-Chancellor's Distinguished Award: Most Promising Young Researcher of the Year; 2020/2021 NSTF-South23 Award winner (Category: Emerging Researcher &Engineering Research Capacity Development. Prof Nomngongo is author/co-author of 110 peer-reviewed publications, 9 book chapters, 2 peer reviewed conference proceedings and has presented 50+ keynote and invited contributions at scientific conferences.

PROF. GIOVANNI FINOCCHIO

SPINTRONIC MICROWAVE AND THZ DETECTORS: STATE-OF-THE ART AND FUTURE!

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ABSTRACT

Microwave detectors based on the spin-torque diode effect are among the key emerging spintronic devices. By utilizing the spin of electrons in addition to their charge, they have the potential to overcome the theoretical performance limits of their semiconductor (Schottky) counterparts. Those devices realized with magnetic tunnel junctions exhibit high-detection sensitivity >200kV/W at room temperature, without any external bias fields, and for low-input power (micro-Watts or lower). In the first part of the talk, I will discuss our recent results in the field of microwave detectors based on spin diodes and possible implementations of THz detectors based on antiferromagnets. Another application of spintronic diodes, when they have a broadband frequency response, is as electromagnetic energy harvesting, which offers an attractive energy source for applications in self-powered portable electronics in the "internet of things" era. Here I will show the development of a bias-field-free spin-torque diodes based on a magnetic tunnel junction having a canted magnetization in the free layer and demonstrate that those devices could be an efficient harvester of broadband ambient RF radiation, capable to efficiently harvest microwave powers of microWatt and below and to power a black phosphorous nanodevice. The frequency response of spin-torque diodes and their current tunability can be also used as building blocks of the hardware realization of neurons and synapses in neuromorphic applications. Finally, I will show how to implement hardware multiplication with spintronic diodes by using the concept of degree of rectification.

BIOGRAPHY

Giovanni Finocchio received the Ph.D. degree in advanced technologies in optoelectronic, photonic and micromagnetic modeling from the University of Messina, Italy, in 2006. Since 2010, he has been an Assistant Professor first and Associate professor now with the Department of Mathematical and Computer Sciences, Physical Sciences and Earth Sciences at the University of Messina. He is director of the laboratory PETASPIN (Petascale computing and Spintronics) between University of Messina and Suzhou Institute of Nanotech and Nanobionics (China). His research interests include spintronics, skyrmions, and computing. In the last 10 years, he served on many technical program committees of international conferences and organized more than 10 international conferences and workshops as Chair, Program Committee Member, or in other positions. He is regularly invited at conferences in Magnetism and Spintronics. He is also president of Petaspin association (www.petaspin.com), chair of the IEEE Magnetics Italy chapter, AdCOM member of the IEEE Magnetics society and chair of the TC-16 on Quantum, neuromorphic and unconventional computing of the IEEE Nanotechnology council

PROF. GHASSAN E. JABBOUR

REACTIVE PRINTING AND R2R COMPATIBLE PROCESSES FOR THE SELF-ASSEMBLY OF NANOPARTICLES AND QUANTUM DOTS: FROM PHOTONIC TO COVID-19 APPLICATIONS

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ABSTRACT

Few topics of our research in reactive additive printing and coating will be discussed in this talk, including the development of self-assembled metallic nanoparticles and functional textile for applications such as personal protective equipment to mitigate the devastating effects of COVID-19 illness by providing a high disinfection rate against the virus (SARS-Cov-2) that causes it. Our work is focused on creating and implementing environmentally responsible processing methodologies that will result in product cost reductions without sacrificing materials or device target specifications. The goal is to realize sustainable development and multiscale manufacturing of functional nanomaterials, devices, and systems, for applications in areas including, but not limited to, power generation, solid-state-lighting, energy conversion and storage, and antimicrobial textile. If time allows a brief discussion on the use of artificial intelligence in the fight against COVID-19 topic will be presented.

BIOGRAPHY

Dr. Jabbour is the Canada Research Chair Tier 1 in Advanced Materials and Devices and professor of Electrical Engineering at uOttawa. Prof. Jabbour spent the last 14 years building research and development centers of excellence from the ground up. He was the Founding Director of the Solar and Photovolatic Engineering Center, Named Professor of Materials Engineering and Professor of Electrical Engineering at KAUST. Dr. Jabbour was one of the founding PIs for the Flexible Display Center (FDC) at Arizona State University (ASU), the Director of Flexible and Organic Electronics Development at FDC, Director of Advanced Photovoltaics Center (ASU), and a Professor of the School of Materials (ASU). Prof. Jabbour has many distinguished honors and awards including: 1) SPIE Fellow (youngest fellow the year of the award), 2) Fellow of European Optical Society, 3) Distinguished Professor of Finland-Academy of Finland, 4) Al-Rawabi Endowed Research Chair Professor (only one at KAUST at the time), 5) Numerous keynote, plenary, seminars, and invited talks (more than 580) at national and international scientific conferences, universities and companies, roadmap meetings and workshops, 6) Invited to attend the dinner for the Millennium Award Ceremony (2010 and 2012) in Helsinki, Finland, 7) An MRS Symposium X speaker, 8) and Best Poster (2 posters) Award at the USA National Academy of Engineering 2006/the Japan-America Frontiers of Engineering Symposium. Moreover, Prof. Jabbour was the only academic invited to speak at the United States of America's 2006 Senate Science and Technology Caucus on Advancing Energy Efficiency. Professor Jabbour has been the Chair/Co-Chair/Committee Member/Session Chair of more than 230 leading conferences. In the last 16 years, Prof. Jabbour raised more than $540 million in competitive research funding as PI, Co-PI, and collaborator. His research and development advances have been highlighted in numerous international journals, magazines and newspapers, including Chemical and Engineering News, Angewandte Chemie, Nature, Nature Photonics, Science, Scientific Reports (Nature), IEEE, Advanced Materials, MIT Technology Review, MRS Bulletin, USA Today, PC Magazine, LA Times, Boston Globe, Wired, Financial Times London, NSF website on "Technological Challenges for Flexible, Light-weight, Low-cost Scalable Electronics and Photonics", and NSF 2005 Year of Physics, to mention a few. Prof. Jabbour is on the Editorial Board of the Light: Science & Applications (Nature Publishing Group), Associate Editor of 3D Printing in Medicine (Nature-Springer) and on the Editorial Board of Energies. Acknowledgement: Dr. Mutalifu Abulikemu, Bita Ebrahimzadeh Asl Tabrizi, Hamed Mohammadimofarah, Dr. Choi Hyung, and Dr. Ned Brooker.

PROF. AMINA HUSSEIN

LASER-PLASMA INTERACTIONS IN THE RELATIVISTIC REGIME

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ABSTRACT

At relativistic intensities, electrons can be driven close to the speed of light, facilitating exploration of a new regime of laser-plasma interactions and high-field science. These intense pulses can drive matter into extreme states of temperature and pressure, mimicking those typically found in astrophysical environments, and leading to the observation of new states of high-energy-density matter. Advancements in intense laser matter interactions have also led to a new generation of pulsed particle and radiation sources, each with ultrashort, femtosecond-scale duration inherited from the laser driver. These sources can be used to study ultrafast dynamic phenomena in dense materials, such as material phase transitions and electron-ion equilibration.
In this talk, I will discuss our recent work performing high-resolution X-ray spectroscopy of K-shell emission from high-intensity ($I \sim 10^{21}$ W/cm^2) laser experiments using the ALEPH laser at Colorado State University. Through measurements of K-shell fluorescence, electron emission and XUV spectroscopy of the plasma emission, we examine the generation and propagation of energetic electrons in thin foil and layered targets to elucidate the physics of high-intensity laser solid interactions. I will also discuss the generation of broadband hard X-ray sources through laser wakefield acceleration, generated by an intense laser pulse traveling through low-density plasma, and how these sources can be used to diagnose high-energy-density matter and phase transitions in dense materials.

BIOGRAPHY

Dr. Amina Hussein is an Assistant Professor in Electrical and Computer Engineering at the University of Alberta in Canada. She leads a research group exploring high-intensity laser-matter interactions, including laser-driven beam and radiation sources, with applications in fundamental physics, industry and medicine. Her research has been supported by the National Sciences and Engineering Research Council (NSERC) of Canada, the Canadian Foundation for Innovation, Alberta Innovates, the US Department of Energy and Compute Canada. Dr. Hussein received her BSc Hons. in Physics from McGill University in 2013, a MS in Nuclear Engineering from Purdue University in 2015 and a PhD in Applied Physics from the University of Michigan, Ann Arbor in 2019, where she was a member of the Gérard Mourou Center for Ultrafast Optical Science. She was a University of California President’s Postdoctoral fellow in Physics at the University of California Irvine from 2019-2020.

PROF. ATTILA BONYAR

DEVELOPMENT OF NANOPLASMONIC NUCLEOTIDE SENSORS

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ABSTRACT

In the past couple of decades, the development of plasmonic nanosensors underwent rapid progress in fabrication, integration, and realized applications. Localized surface plasmon resonance imaging (LSPRi) promises the possibility of high-throughput biomolecule sensing integrated into miniaturized point-of-care devices. Label-free nucleotide (DNA, RNA) sensing is one of the promising application areas, encompassing the fields of genetics, clinical diagnostics, environmental monitoring, or food testing. The presentation will introduce the main types of plasmons and their utilization for sensing, with emphasis on the advantages of localized surface plasmon resonance sensors based on various nanostructures. As a particular example, the development of an epoxy – gold nanoparticles surface-nanocomposite LSPR sensor and its application for label-free DNA sensing will be presented.

BIOGRAPHY

Dr. Attila Bonyár is an associate professor and head of the Nanotechnology laboratory at the Department of Electronics Technology, Faculty of Electronics Engineering and Informatics, Budapest University of Technology and Economics. He has two M.Sc. degrees in electrical engineering (2009) and biomedical engineering (2011), a Ph.D. (2014), and habilitation (2021) in electrical engineering. He co-authored 121 publications, including 50 journal papers. In the past decade, he received best/excellent paper/presentation awards at various (mostly IEEE) conferences 10 times. He was elected to serve in the Hungarian Academy of Sciences (HAS) Electron Devices and Electronics Technology Scientific Committee for two terms (in 2017 and in 2021). He is a co-chair for IEEE EPS/NTC Nanopackaging Technical Committee and actively serves in many other international committees in elected/volunteer positions. He is a Steering Committee member for two regional IEEE conferences (IEEE-SIITME, International Symposium for Design and Technology in Electronics Packaging, since 2014 and IEEE-ISSE, International Spring Seminar on Electronics Technology, since 2017). Since 2019 he is the chair of the IEEE Hungary&Romania EPS&NTC Joint Chapter. He also serves IEEE NTC as a regional chapter coordinator in R8. Besides IEEE, he is a Technical Committee member for the Eurosensors conference series since 2016. His current research activities are focused on the development of optical biosensor technologies utilizing plasmonics, low-dimensional nanomaterials, nanocomposites and nanometrology.

PROF. REUVEN GORDON

NANOPLASMONICS: REACHING OUT TO THE SINGLE MOLECULE

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ABSTRACT

Arthur Ashkin was co-recipient of the Nobel prize in 2018 for his work on optical tweezers; however, those conventional optical tweezers are limited to objects that are >100 nm in size. This talk will review our work on nanoaperture optical tweezers that can trap particles down to the single digit nanometer size, including proteins. I will describe how to measure the low frequency Raman modes of these particles (including proteins and DNA fragments) with high spectral resolution, as well as the THz dynamics of nanoparticles. I will emphasize recent developments in nanofabrication and some exciting biophysical problems we are studying.

BIOGRAPHY

Reuven Gordon is a Professor in the Department of Electrical and Computer Engineering, University of Victoria. He has received a Canadian Advanced Technology Alliance Award (2001), an Accelerate BC Industry Impact Award (2007), an AGAUR Visiting Professor Fellowship (2009), the Canada Research Chair in Nanoplasmonics (2009-2019), the Craigdarroch Silver Medal for Research Excellence (2011), a Fulbright Fellowship (2016), an NSERC Discovery Accelerator (2017), the Faculty of Engineering Teaching Award (2017) and an JSPS Invitational Fellowship (2020). He is a Fellow of the Optical Society of America (OSA), the Society for Photographic Instrumentation Engineers (SPIE), and the Institute for Electrical and Electronic Engineers (IEEE). Dr. Gordon has authored and co-authored over 170 journal papers (including 13 invited contributions). He is co-inventor for five patents and two patent applications. Dr. Gordon is a Professional Engineer of BC. Dr. Gordon has been recognized as an “Outstanding Referee” by the American Physical Society. He has also served as conference chair for several conferences, including SPIE NanoScience + Engineering and NFO16. Dr. Gordon is an Associate Editor for Optics Express and on the Editorial Advisory Board for Advanced Optical Materials.

PROF. DUSTIN GILBERT

THE ROLE OF COMPOSITION AND ORDER IN DETERMINING THE MAGNETIC PROPERTIES OF HIGH-ENTROPY ALLOYS

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ABSTRACT

High-entropy alloys are materials with five-or-more elements randomly occupying a single lattice site. The extreme local environments resulting from the distributions in atomic size, mass, and electronegativity results in novel functional properties, including superconductivity, thermoelectricity, and magnetism. In this talk I will discuss our recent investigations of the magnetic properties in (FeNiMnCr) multicomponent alloys. In as-prepared (BCC) sputtered films, these materials demonstrate an incredible transformation, from a soft magnet (HC<1 mT) to a hard magnet (HC>400 mT) with decreasing temperature. The Curie temperature, even for FeNi-rich samples, were all <400 K. Annealing the samples resulted in large compositional ranges with single structural phases. The Curie temperatures were generally doubled, and saturation magnetization increased by 5×. Notably, the coercivity was much more modest and largely independent of temperature. These results demonstrate potential opportunities in un-relaxed materials which have not been explored in the more-common bulk investigations. (Phys. Rev. Materials 5, 114405 (2021))

BIOGRAPHY

Dustin A. Gilbert is an Assistant Professor in the Materials Science and Engineering Department, at the University of Tennessee. He received his B.S. in Physics from the University of California in Santa Cruz in 2008, then his M.S. and Ph.D. in Physics from the University of California in Davis in 2014. His thesis, titled "Physics on the Nanoscale - a Study of Nanomagnetic Phenomena", investigated the magnetic behavior in a variety of nanoscale systems. In 2014, Prof. Gilbert was awarded a National Research Council Postdoctoral Fellowship to work at the National Institute for Standards and Technology in Gaithersburg, MD, as part of the neutron scattering division. While working at NIST, he pioneered work on magnetic skyrmions and magneto-ionic devices. In 2018, Prof. Gilbert became a tenure-track faculty member at the University of Tennessee, where his group continues to work on magnetic skyrmions through a DOE Career award, using neutrons in novel measurement schemes to investigate these materials. Their research also includes magnetic and thermal properties of high entropy alloys, high-frequency magnetic dynamics and quantum material heterostructures. Prof. Gilbert is currently the co-chair of the IEEE technical committee on nanomagnetism.

PROF. OLUWASEYI BALOGUN

NANOSCALE THERMAL TRANSPORT MEASUREMENTS IN ELECTRONIC THIN FILMS

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ABSTRACT

Future electronic devices will benefit from the remarkable properties of Van der Waals (VdW) materials, particularly as the material thicknesses approach the single atomic layer limit. VdWs materials offer a crossover from indirect to direct electronic bandgaps in MoS2 and other transition metal dichalcogenides (TMDs), layer-dependent magnetic phases in few-layered CrI3, strain and layer-dependent anisotropic thermal conductivity, etc. These remarkable properties are critical building blocks for future nano-electronic, optoelectronic, photonic, and thermoelectric devices. This lecture will cover experimental investigations from my research group on phonon transport measurements in VdW materials. Special attention will be devoted to an overview of heat conduction at the nanoscale and a review of optical techniques for nanoscale thermal characterization. I will also present representative thermal conductivity measurements in graphene interface materials, inorganic-organic films, and substrate and superstrate encased VdW thin films. VdW materials provide a novel platform for fundamental studies of heat flow in nanoscale materials and prospective applications in thermal management and nano-thermoelectric devices.

BIOGRAPHY

Oluwaseyi Balogun is an Associate Professor of Mechanical Engineering and Civil and Environmental Engineering at Northwestern University. He received his B.S. degree from the University of Lagos, Nigeria, and his M.S. and Ph.D. degrees from Boston University, all in Mechanical Engineering. Dr. Balogun's research focuses on nanoscale heat transport measurements and thermal properties of small-scale materials, experimental mechanics of soft biological materials, and optical and elastic wave sensors. His research is relevant to applications that involve nanoscale heat conduction, elastic wave propagation, optical sensing, and nanometrology. He currently serves as the co-director for the Center for Smart Structures and Materials at Northwestern University. He is a member of the IEEE UFFC and IEEE Nanotechnology Societies and a recipient of the 2020 & 2021 IEEE Nanotechnology Council Distinguished Lecturer awards.

PROF. RACHEL OLIVER

THE MATERIALS SCIENCE OF NITRIDE OPTOELECTRONICS

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ABSTRACT

Nitride optoelectronic materials are revolutionizing lighting, with nitride light emitting diodes providing an efficient, sustainable source of light that can be deployed across the globe. Meanwhile, nitride materials also dominate the field of short-wavelength laser diodes and are increasingly being explored for exotic light sources such as single photon emitters. The key material at the heart of nitride optoelectronic devices is gallium nitride, a human-made compound, which has never been observed to occur in nature. Optimizing this new material to make light sources which are efficient, long-lived, and reasonably affordable has been a huge challenge, and despite the undoubted commercial success of these devices many aspects of their operation remain mysterious.This lecture will explain how we can take the quantum structures at the heart off nitride light emitters apart, literally atom by atom, to understand in depth the vital interaction between structure and optical properties. The relevant techniques emerged from traditional metallurgy but are now being used to understand materials for cutting edge optoelectronic devices, illustrating how the basic principles of materials science are vital to the development of the technologies of tomorrow.

BIOGRAPHY

Rachel Oliver received her MEng (2000) and PhD (2003) degrees from the University of Oxford, UK. She then moved to Cambridge as a Research Fellow at Peterhouse College, and later won a prestigious Royal Society University Research Fellowship. In 2011, she took up her permanent academic position at the University of Cambridge and she is currently Professor of Materials Science and Director of the Cambridge Centre for Gallium Nitride. She held a Leverhulme Senior Research Fellowship in 2015-2016 and delivered the Rank Prize Lecture in Photonics in 2018. She was one of the Women in Engineering Society's Top 50 Women in Engineering in 2020 and was elected a Fellow of the Royal Academy of Engineers in 2021. Rachel's research focusses on understanding how the small-scale structure of nitride materials effects the performance and properties of devices. She uses expertise in microscopy and materials growth to develop new nanoscale nitride structures which will provide new functionality to the devices of the future. She was the first to apply atom probe tomography to nitride materials, developed the first InGaN-based single photon source, and most recently has patented novel methods compatible with large scale manufacturing for the porosification of nitride materials. She is a founder and Chief Scientific Officer of Poro Technologies Ltd, a university spinout company exploiting her group's research on porous nitrides, and hence developing novel red microLEDs. Rachel is also a passionate advocate for increased equality, diversity and inclusion in science and engineering and a founder member of The Inclusion Group for Equity in Research in STEMM (TIGERS). She is an Equality and Diversity Champion for the University of Cambridge School of Physical Sciences and has addressed the Parliamentary and Scientific Committee on equity issues.

PROF. NICHOLAS X FANG

PRINTING OPTICAL MATERIALS

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ABSTRACT

Will future of smart lighting and window coatings enable energy-efficient cooling in smart buildings? Can printed color converters lead to next generation micro displays with high brightness, sharp image resolution, and ultra-low power consumption? Recently, exciting new physics of nanoscale optical materials has inspired a series of key explorations to manipulate, store and control the flow of information and energy at unprecedented dimensions. In this talk I will report our recent efforts on controlling light harvesting and conversion process using scalable micro/nanofabrication. These emerging optical materials show promise to a range of important applications, from optical networks and chip-scale photonic sensors to lasers, LEDs, and solar technology. For example, pixelated color converters are envisioned to achieve full-color high-resolution display through down conversion of blue micro-LEDs. Quantum dots (QDs) are promising narrow-band converters of high quantum efficiency and brightness enabling saturated colors. However, challenges still remain to produce high resolution color-selective patterns compatible with the advanced blue micro-LEDs with pitch and pixel size approaching 1 μm. Here we demonstrate our preliminary study on scalable printing of high-resolution pixelated red and green color converters patterned through projection lithography. I will also discuss potential applications such as high-resolution wide-gamut microdisplay for mixed reality and high speed visible light communication. In this talk, I will also introduce versatile 3D shape transformations of nanoscale structures by deliberate engineering of the topography-guided stress of gold nanostructures. By using the topography-guided stress equilibrium, rich 3D shape transformation such as buckling, rotation, and twisting of nanostructures is precisely achieved, which can be predicted by our mechanical modeling. Benefiting from the nanoscale 3D twisting features, giant optical chirality is achieved in an intuitively designed 3D pinwheel-like structure, in strong contrast to the achiral 2D precursor without nano-kirigami. The demonstrated nano-kirigami, as well as the exotic 3D nanostructures, could be adopted in broad nanofabrication platforms and could open up new possibilities for the exploration of functional micro-/nanophotonic and mechanical devices.

BIOGRAPHY

Nicholas X. Fang received his BS and MS in physics from Nanjing University, and his PhD in mechanical engineering from University of California Los Angeles. He is currently Professor of Mechanical Engineering. Prior to MIT, he worked as an assistant professor at the University of Illinois Urbana-Champaign until 2010. Professor Fang's areas of research look at nanophotonics and nanofabrication. His research on nanoarchitectured metamaterials was highlighted among the top 10 Emerging breakthrough technologies of the year 2015. His recognitions also include the OSA Fellow (2021); ASME Chao and Trigger Young Manufacturing Engineer Award (2013); the ICO prize from the International Commission of Optics (2011); the NSF CAREER Award (2009) and MIT Technology Review Magazine's 35 Young Innovators Award (2008).