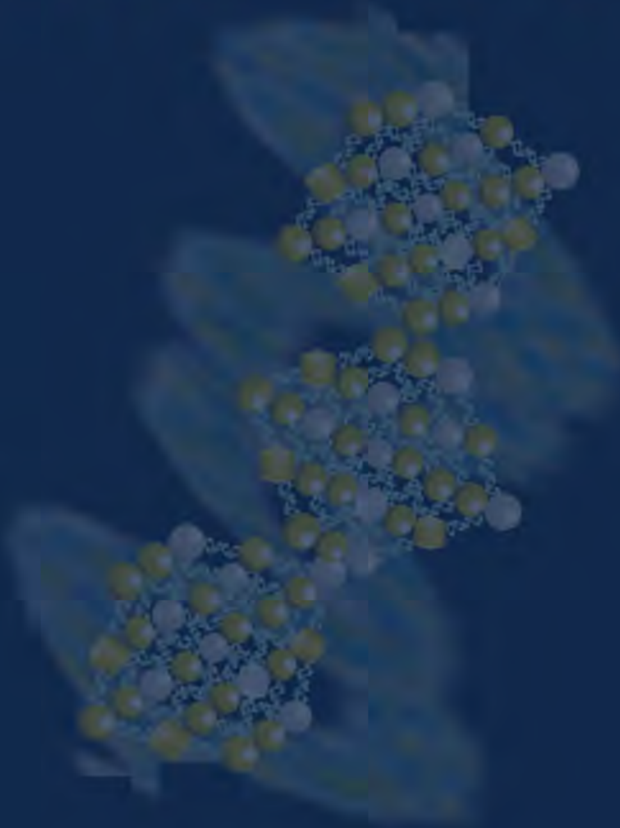
The 2023 23rd IEEE International Conference on Nanotechnology

IEEE-NANO

2023

TECHNICAL PROGRAM



http://2023.ieeenano.org

July 2-5, 2023 | Jeju, Korea

IEEE

IEEE Nanotechnology Council®

IEEE-NANO 2023 TECHNICAL PROGRAM

July 2023

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IEEE-NANO 2023

July 2023

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IEEE-NANO 2023

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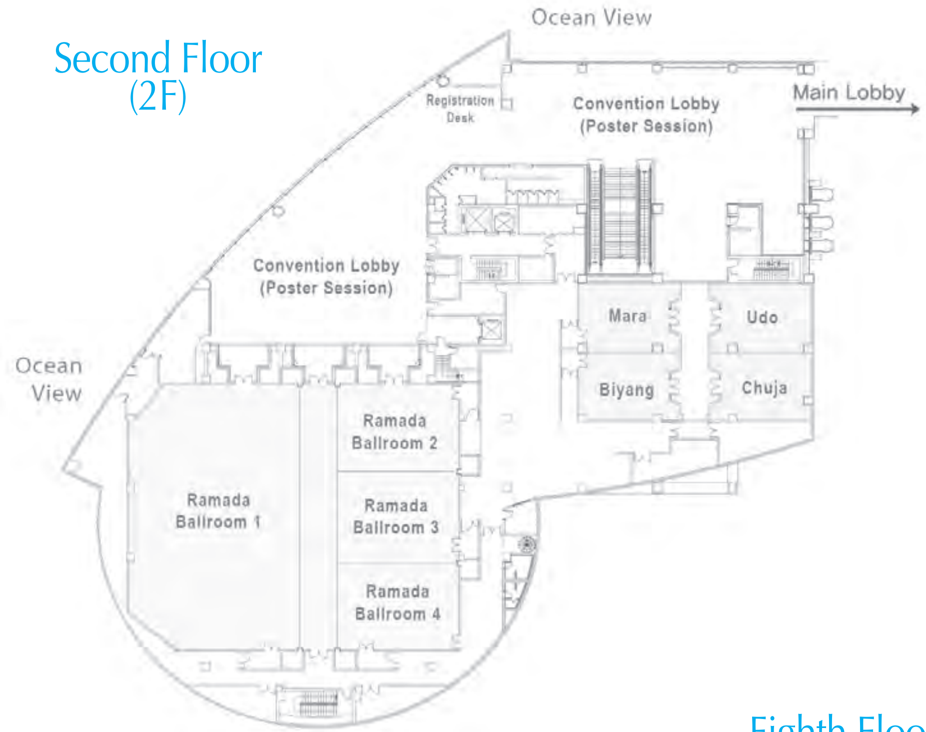
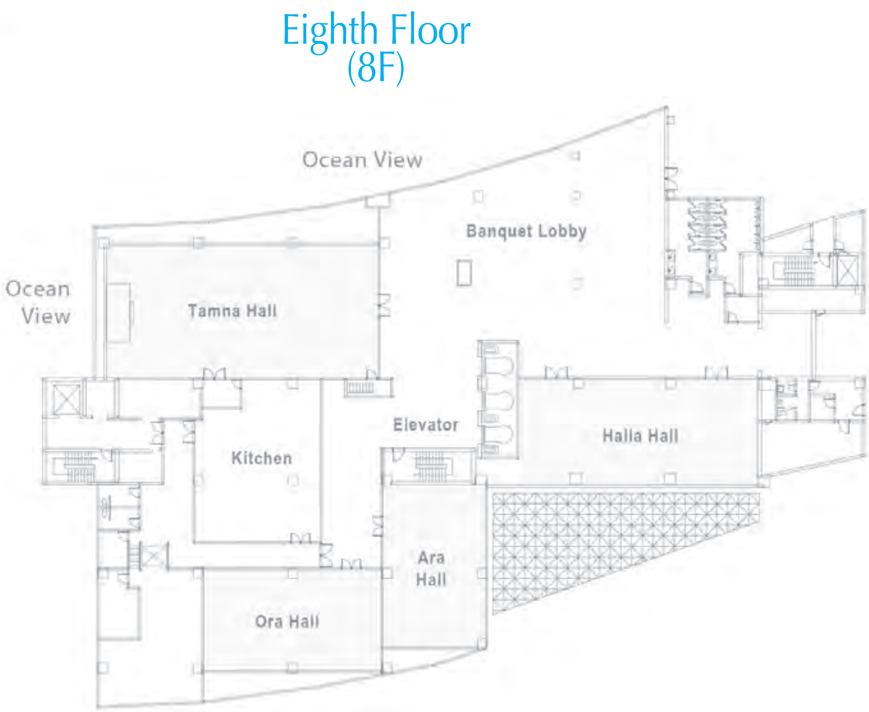
IEEE-NANO 2023

FACILITY MAPS

Ramada Plaza Jeju Ocean Front





Program	Place
Registration Desk	Lobby (2F)
NTC ExCom/ AdCom Meeting	Ara Hall (8F)
Welcome Reception	Ramada Ballroom 1
Plenary Session	Ramada Ballroom 1
Keynote Session	Ramada Ballroom 1 ~ 4 (2F) Tamna/Halla/Ara/Ora Halls (8F)
Special Invited Session	Ramada Ballroom 1 ~ 4 (2F) Tamna/Halla/Ara/Ora Halls (8F)
Oral Session	Ramada Ballroom 1 ~ 4 (2F) Biyang/Udo/Mara (2F) Tamna/Halla/Ara/Ora Halls (8F)
Poster Session	Lobby (2F)
Banquet	Ramada Ballroom

On behalf of
the IEEE Nanotechnology Council
& the conference organizing
committee

WELCOME

we are delighted to welcome you to the 23rd International Conference on Nanotechnology (IEEE-NANO 2023) in July 2-5, 2023. Originally launched in 2001, IEEE-NANO is the flagship conference series of the IEEE Nanotechnology Council, focusing on the promotion of advanced research in the fields of nanoscience and nanotechnology. It has brought together world-class engineers and scientists from all over the word and every sector of academy and industry, enabling the exchange of the latest advances in basic and applied research in nanoscience and nanotechnology. Recent IEEE-NANO conferences were held in Palma de Mallorca (Spain, 2022), Montreal (Virtual; Canada, 2021), Virtual (2020), Macau (China, 2019), Cork (Island, 2018), Pittsburgh (USA, 2017), Sendai (Japan, 2016), Rome (Italy, 2015), etc.

IIEEE-NANO 2023 is destined to be one of the best yet, thanks to the talents and dedication of many volunteers, the invaluable assistance from our stellar professional staffs, and strong support from sponsors. IEEE-NANO is sponsored by the IEEE Nanotechnology Council, the University of Arkansas, University of Waterloo, and Pohang University of Science & Technology. Special gratitude and appreciation is extended to the Conference Organizing Committee, particularly Program Chairs, Invited Session Chairs, and Technical Program Committee. Without their outstanding work, we would not have such an excellent and challenging technical program, which broadly reaches the field of nanoscience and provides a highly innovative and informative venue for essential and advanced scientific and engineering research as well as translational research. Seventeen state-of-the-art plenary and keynote presentations by leading experts, 34 special invited sessions with over +160 invited presentations, 44 technical sessions, and 2 poster sessions during our 4-day event ensure an interactive and inspiring exchange between participants, making IEEE-NANO 2023 the right place for new bridges in science and knowledge.

We are happy to host IEEE-NANO 2023 at Jeju Island, Korea, recognized by UNESCO as a World Natural Heritage Site. Known as an "Island Paradise" in Korea, Jeju offers a near endless supply of scenic beauty and exciting activities to explore, the better to extend thought provoking and profitable discussions from the formal conference. We wish you a superb conference experience and a memorable stay in Jeju, Korea!

Welcome to IEEE-NANO 2023!

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Plenary

Xiang ZHANG

Univ. of Hong Kong,
Hong Kong, China

"Photonics at Sub-wave Length Scale"

Yu SUN

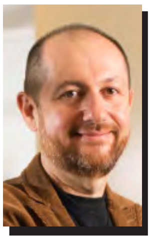
Univ. of Toronto,
Canada

"Intracellular Manipulation & Measurement: Science & Applications"

Ian UNDERWOOD

Univ. of Edinburgh, UK

"CMOS-compatible Microscale & Nanoband Edge Electrodes for Electrochemical Sensing Applications"



Oleg GANG

Columbia Univ., USA

"Designed Nanoscale Materials through DNA-Programmable Assembly"

Xiangfeng DUAN

Univ. of California at
Los Angeles, USA

"2023 NTC Poineer Awardee"

"Van der Waals Integration beyond 2D Materials: Boundless Opportunities at Bondless Boundaries"

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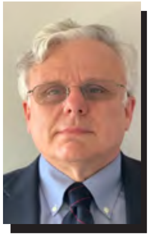
KEYNOTE HIGHLIGHTS

Keynote



Fabrizio LOMBARDI

Northeastern Univ., USA

"Moving AI in the Nanoscale: Challenges & Opportunities"

Moonjoo LEE

Pohang Univ. of Science & Technology, Korea

"Ion-trap Quantum Computer"

Ning XI

Univ. of Hong Kong, Hong Kong, China

"Nano Robot Enabled In Situ Sensing & Manipulation for Biomedical Applications"

Weida HU

Shanghai Inst. of Technical Physics, CAS, China

"Nanoscale Photodectors for Infrared Sensing & Intelligent Recognition"

Gawon LEE

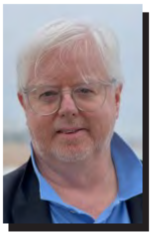
Chungnam Nat'l Univ., Korea

"Temperature Coefficienct of Resistance of PECVD Deposited Hydrogenated Amorphous Silicon for Microbolometer"

Sheng XU

Univ. of California at San Diego, USA

"Controlled Epitaxial growth & Fabrication of Hybrid Halide Perovskites"



Richard B. JACKMAN

Univ. of College London, UK

"Nano-structured Diamond Sensors for Extreme Environments: Taking SERS from the laboratory to the Ocean"

Valentine NOVOSAD

Argonne Nat'l Laboratory, USA

"Superconducting Sensors & Detectors for Large-scale Physics Experiments"

Winnie N. YE

Carleton Univ., Canada

"High Performance Silicon & Silicon Metamaterials for Integrated Photonics"

Deep JARIWALA

Univ. of Pennsylvania, USA

"2023 NTC Early Career Awardee"

"Semiconductor Heterostructures for Low-Power Electronics & Ultrathin Photonics"

Seiji SAMUKAWA

Nat'l Yang Ming Chiao Tung, Univ., Taiwan

"Emerging Plasma Nanotechnology: Atomic Layer Technologies for Nano Materials & Devices"

Yong ZHU

North Carolina State Univ., USA

"Thermal Actuation for Soft Robotics"

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Special Invited Sessions

MoET1, MoGT1 Low Temperature Physics Modeling for Classical & Quantum Devices 1 & 2
Session Chair: Roza KOTLYAR, Intel Corp., USA; Yong-Hoon KIM, Korea Advanced Inst. of Science & Technology, Korea; Josef WEINBUB, Inst. for Microelectronics, Austria

MoET2, MoGT2, TuET2, TuGT2 Nanotechnology for Soft Electronics 1, 2, 3 & 4
Session Chair: Cunjiang YU, Pennsylvania State Univ., USA; Yong ZHU, North Carolina State Univ., USA; Hae-Jin KIM, Yonsei Univ., Korea; Kyoseung SIM, Ulsan Nat'l Inst. of Science & Technology, Korea

MoET3, MoGT3, TuGT3 Nanoscale Photodectors & Intelligent Perceptions 1, 2 & 3
Session Chair: Weida HU; Jinshui MIAO, Shanghai Inst. of Technical Physics, CAS, China

MoET4 2D Nanomaterials & Their Innovative Nanoelectronics
Session Chair: Deji AKINWANDE, Univ. of Texas at Austin, USA; Li TAO, Southeast Univ., China

MoET5 Materials & Devices for Biomedical Applications
Session Chair: Xinge YU, City Univ. of Hong Kong, China; Wei HUANG, Univ. of Electronic Science & Technology, China

MoET6 Nano-biomaterials & Nano-biosensors in Biomedical Applications
Session Chair: Yu-Jui FAN; Yin-Ju CHEN, Taipei Medical Univ., Taiwan

MoGT4 Nano/Micro Approaches for Biomedical Engineering
Session Chair: Hoon SEONWOO, Sunchon Nat'l Univ., Korea; Jangho KIM, Chonnam Nat'l Univ., Korea

MoGT5, TuGT5 Latest Advances in Magnetic Nanotechnology 1 & 2
Session Chair: Valentine NOVOSAD, Argonne Nat'l Laboratory, USA; Cheol Gi KIM, DGIST, Korea

MoGT6 Cutting-Edge of Phonon & Electron Control of Nano-device
Session Chair: Daisuke OHORI; Seiji, Samukawa, Tohoku Univ., Japan

MoGT7, MoIT7 Nano Devices & Their Applications 1 & 2
Session Chair: Chang-Ki BAEK; Moonjoo LEE; Byoung Don KONG, Pohang Univ. of Science & Technology, Korea

MoIT2 Nanoacoustic Sensing for Biological & Biomedical Applications
Session Chair: Priya S. Balasubramanian, Cornell Univ., USA; James B. SPICER, Johns Hopkins Univ., USA

TuET1, TuGT1, TuIT1 Workshop on Nanotechnology for Computing 1, 2 & 3
Session Chair: Sorin COTOFANA, Delft Univ. of Technology, Netherlands; Antonio RUBIO, Universitat Politecnica de Catalunya, Spain; Georgios Ch. SIRAKOULIS, Democritus Univ. of Thrace, Greece; Fabrizio LOMBARDI, Northeastern Univ., USA

TuET3 Nano-bio-microfluidic Platforms in Clinical & Biomedical Applications
Session Chair: Kin Fong LEI, Chang Gung Univ., Taiwan

TuET4 Recent Advances in Micro-/Nano-Robotics
Session Chair:Yu SUN, Univ. of Toronto, Canada; Lixin DONG, City Univ. of Hong Kong, China

TuET5 Spontronic Phenomena in Topological & 2D Materials
Session Chair: Pramey UPADHYAYA, Purdue Univ., USA; Suprioy BANDYOPADHYAY, Virginia Commonwealth Univ., USA

TuET6, TuGT6 First Principles Modeling & Simulation of Plasma Processes for Atomic Scale Precision Semiconductor Device Fabrication: Opportunities & Chanllenges 1 & 2
Session Chair: Peter VENTZEK; Roberto LONGO, Tokyo Electron America, Inc., USA

TuGT4 Advanced Nanofabrication Technologies
Session Chair: Xiaogan LIANG, Univ. of Michigan, USA

WeET1 New Directions & Challenges for Computing in Nanotechnology
Session Chair: Giovanni FINOCCHIO, Univ. of Messina, Italy; Moitreyee MUKHERJEE-ROY, IBM, USA

WeET2 Nanogenerators & Piezotronics
Session Chair: Yunlong ZI, Hong Kong Univ. of Science & Technology, Guangzhou, China

WeET3 Nanomaterials-based Smart Wearables
Session Chair: Wenzou WU, Purdue Univ., USA

WeET4 IEEE NTC Women in Nanotechnology & Diversity Equity Inclusion (WIN/DEI): Interview & Panel Discussion with Leaders
Session Chair: Ed PERKINS, IEEE NTC, USA

WeGT1 Nano Energy & Self-powered Systems
Session Chair: Yannan XIE, Nanjing Univ. of Posts & Telecommunications, China

WeGT2 2D & Nanomaterials
Session Chair: Eui-Hyueok YANG, Stevens Inst. of Technology, USA

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TECHNICAL PROGRAM INDEX

Oral Sessions

"Best Paper Competition" Session

MoET7 Session Chair: Award Committee Chairs
[Da-Jeng YAO; Kremena MAKASHEVA; James B. SPICER]

Quantun, Neuromorphic & Unconventional Computing 1 & 2

MoIT1 Session Chair: Haibo YU, Chinese Academy of Sciences (CAS), China
MoJT1 Session Chair: Vamsi BORRA, Younstown State Univ., USA;
Kyeong-Sik MIN, Kookmin Univ., Korea

Nano-optics, Nanophotonics & Nano-optoelectronics 1, 2, 3 & 4

MoET2 Session Chair: Yang XU, Xhejiang Univ., China
TuIT3 Session Chair: Martin SANDOMIRSKII, ITMO Univ., Russia
TuJT3 Session Chair: Richard B. JACKMAN, Univ. College of London, UK
WeIT1 Session Chair: Xiaoning JIANG, North Carolina State Univ., USA

Nanorobotics & Nanomanufacturing

MoIT4 Session Chair: Vamsi BORRA, Youngstown State Univ., USA

Nanobiomedicine 1, 2 & 3

MoIT5 Session Chair:Yi-Ping HO, Chinese Univ. of Hong Kong, China
TuIT5 Session Chair: Gulsim KULSHAROVA, Nazarbayev Univ., Kazakhstan
WeIT5 Session Chair: Niraj SINHA, Indian Inst. of Technology (IIT) Kanpur, India

Spintronics 1 & 2

MoIT6 Session Chair: Brajesh KAUSHIK, IIT Roorkee, India
TuIT6 Session Chair: Brajesh KAUSHIK, IIT Roorkee, India

Nano-metrology & Characterization

MoIT8 Session Chair: Kremena MAKASHEVA, LAPLACE, France

Nanomaterials 1, 2, 3, 4, 5, 6, 7, 8 & 9

MoIT9 Session Chair: Yuzhao ZHANG; Ye QIU, Shenyang Inst. of Automation (SIA), CAS, China
MoJT8 Session Chair: Ruy SANZ, Nat'l Inst. for Aerospace Technology, Spain
MoJT9 Session Chair: Dan V. NICOLAU, McGill Univ., Canada
TuIT8 Session Chair: Niraj SINHA, IIT Kanpur, India;
Meng Nan CHONG, Monach Univ., Malaysia
TuIT9 Session Chair: Lixin DONG, City Univ. of Hong Kong, China
TuIT10 Session Chair: Kremena MAKASHEVA, LAPLACE, France
TuJT8 Session Chair: Kuo-Pin YU, Nat'l Yang Ming Chiao Tung Univ., Taiwan
TuJT9 Session Chair: Xiaoning JIANG, North Carolina State Univ., USA
TuJT10 Session Chair: Byoung Don KONG, POSTECH, Korea

Modeling & Simulation 1, 2, 3 & 4

MoIT10 Session Chair: Changjian ZHOU, South China Univ. of Technology, China
TuIT7 Session Chair: Yuehang XU, UESTC, China; Matteo Bruno, LODI, Univ. of Cagliari, Italy
TuJT7 Session Chair: Chang-Ki BAEK, POSTECH, Korea
WeIT6 Session Chair: Hyangwoo KIM, POSTECH, Korea

Nanoelectronics 1, 2, 3, 4 & 5

MoJT2 Session Chair: Xinge YU, City Univ. of Hong Kong, China
TuIT2 Session Chair: Mariagrazia GRAZIANO, Politecnico Di Torino, Italy
TuJT2 Session Chair: Shih-Hung LIN, Nat'l Yunlin Univ. of Science & Technology, Taiwan
WeGT4 Session Chair: Yang XU, Zhejiang Univ., China
WeIT4 Session Chair: Chang-Ki BAEK, POSTECH, Korea

Nanosensors & Nanoactuators 1, 2 & 3

MoJT3 Session Chair: Xiaoyang ZOU, City Univ. of Hong Kong, China
TuIT4 Session Chair: Jingwen MA, Univ. of Hong Kong, China
WeGT3 Session Chair: Chadamas SAKONSINSIRI, Khon Kae Univ., Thailand

Nanofabrication 1, 2 & 3

MoJT4 Session Chair: Haibo YU, Jianchen ZHENG, CAS, China
TuJT4 Session Chair: Ye QIU, SIA, CAS, China; Zianchen ZHENG, CAS, China
MoJT4 Session Chair: Eui-Hyeok YANG, Stevens Inst. of Technology, USA

Nano-energy, Environment & Safety 1, 2 & 3

MoJT5 Session Chair: Niraj SINHA, IIT Kanpur, India
TuJT5 Session Chair: Jing-Chie LIN, Nat'l Central Univ., Taiwan
WeIT3 Session Chair: Jin-Woo KIM, Univ. of Arkansas, USA

Nano-acoustic Devices, Processes & Materials 1 & 2

MoJT6 Session Chair: Xiaoning JIANG, North Carolina State Univ., USA
TuJT6 Session Chair: Jiming BAO, Univ. of Houston, USA

AI for Nanotechnology

MoJT10 Session Chair: Juan REN, Iowa State Univ., USA

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Poster Sessions

MoKT11 Poster Session I

TuLT11 Poster Session II

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The 23rd IEEE International Conference on Nanotechnology

Program At A Glance

July 2 (Sun.)

Time	Room A (Ramada Ballroom 1, 2F)	Room B (Ramada Ballroom 2, 2F)	Room C (Ramada Ballroom 3, 2F)	Room D (Ramada Ballroom 4, 2F)	Room E (Tamna Hall, 8F)	Room F (Halla Hall, 8F)	Room G (Ora Hall, 8F)	Room H (Mara, 2F)	Room I (Udo, 2F)	Room J (Biyang, 2F)	Convention Lobby (2F)
09:30~13:00	**NTC AdCom Meeting** (Ara Hall)										
13:00~14:00	**NTC AdCom Lunch**										
14:00~16:00 16:00~18:00	**Registration** (Convention Lobby)					**NTC AdCom Meeting** (Ara Hall)					

July 3 (Mon.)

Time	Room A (Ramada Ballroom 1, 2F)	Room B (Ramada Ballroom 2, 2F)	Room C (Ramada Ballroom 3, 2F)	Room D (Ramada Ballroom 4, 2F)	Room E (Tamna Hall, 8F)	Room F (Halla Hall, 8F)	Room G (Ora Hall, 8F)	Room H (Mara, 2F)	Room I (Udo, 2F)	Room J (Biyang, 2F)	Convention Lobby (2F)
08:00~08:20	**Opening Ceremony** (Ramada Ballroom 1, 2F)										
08:20-09:05	**[Plenary Talk 1] Photonics at Sub-wave Length Scale** Zhang, Xiang (Univ. of Hong Kong, China)										
09:05-09:50	**[Plenary Talk 2] Designed Nanoscale Materials through DNA-Programmable Assembly** Gang, Oleg (Columbia Univ., USA)										
09:50-10:10	Coffee Break										
10:10-10:40	**[MoDT1] Keynote Session:** Lombardi, Fabrizio, Northeastern Univ., USA	**[MoDT2] Keynote Session:** Zhu, Yong, NC State Univ., USA	**[MoDT3] Keynote Session:** Hu, Weida, Shanghai Inst. of Tech. Phys., China	**[MoDT4] Keynote Session:** Lee, Gawon, Chungnam Univ., Korea							
10:40-12:40	**[MoET1] Invited Session:** Low Temp. Physics Modeling for Classical & Quantum Devices 1	**[MoET2] Invited Session:** Nanotechnology for Soft Electronics 1	**[MoET3] Invited Session:** Nanoscale Photodetectors & Intelligent Perceptions 1	**[MoET4] Invited Session:** 2D Nanomaterials & Their Innovative Nanoelectronics	**[MoET5] Invited Session:** Materials and Devices for Biomedical Applications	**[MoET6] Invited Session:** Nano-biomaterials & Nano-biosensors in Biomedical Appl.	**[MoET7] Oral Session:** "Best Paper Competition Session"				
12:40-14:00	Lunch										
14:00-16:00	**[MoGT1] Invited Session:** Low Temp. Physics Modeling for Classical & Quantum Devices 2	**[MoGT2] Invited Session:** Nanotechnology for Soft Electronics 2	**[MoGT3] Invited Session:** Nanoscale Photodetectors & Intelligent Perceptions 2	**[MoGT4] Invited Session:** Nano/Micro Approaches for Biomedical Engineering	**[MoGT5] Invited Session:** Latest Advances in Magnetic Nanotechnology 1	**[MoGT6] Invited Session:** Cutting-Edge of Phonon & Electron Control for Nano-Device	**[MoGT7] Invited Session:** Nano Devices & Their Applications 1				
16:00-16:20	Coffee Break										
16:20-17:20	**[MoIT1] Oral Session:** Quantum, Neuromorphic & Unconventional Computing 1	**[MoIT2] Invited Session:** Nanoacoustic Sensing for Biological & Biomedical Appl.	**[MoIT3] Oral Session:** Nano-optics, Nanophotonics & Nano-optoelectronics 1	**[MoIT4] Oral Session:** Nanorobotics & Nanomanufacturing	**[MoIT5] Oral Session:** Nanobiomedicine 1	**[MoIT6] Oral Session:** Spintronics 1	**[MoIT7] Invited Session:** Nano Devices & Their Applications 2	**[MoIT10] Oral Session:** Modeling & Simulation 1	**[MoIT8] Oral Session:** Nano-metrology & Characterization	**[MoIT9] Oral Session:** Nanomaterials 1	**[MoKT11] Poster Session:** Poster Session 1
17:20-18:20	**[MoJT1] Oral Session:** Quantum, Neuromorphic & Unconventional Computing 2	**[MoJT2] Oral Session:** Nanoelectronics 1	**[MoJT3] Oral Session:** Nanosensors & Nanoactuators 1	**[MoJT4] Oral Session:** Nanofabrication 1	**[MoJT5] Oral Session:** Nano-energy, Environment & Safety 1	**[MoJT6] Oral Session:** Nano-acoustic Devices, Processes & Materials 1		**[MoJT10] Oral Session:** AI for Nanotechnology	**[MoJT8] Oral Session:** Nanomaterials 2	**[MoJT9] Oral Session:** Nanomaterials 3	
18:30-20:00	**Welcome Reception** (Ramada Ballroom1, 2F)										

July 4 (Tue.)

Time	Room A (Ramada Ballroom 1, 2F)	Room B (Ramada Ballroom 2, 2F)	Room C (Ramada Ballroom 3, 2F)	Room D (Ramada Ballroom 4, 2F)	Room E (Tamna Hall, 8F)	Room F (Halla Hall, 8F)	Room G (Ora Hall, 8F)	Room H (Mara, 2F)	Room I (Udo, 2F)	Room J (Biyang, 2F)	Convention Lobby (2F)
08:30-09:15	**[Plenary Talk 3] Intracellular Manipulation & Measurement: Science & Applications** Sun, Yu (Univ. of Toronto, Canada)										
09:15-09:35	Coffee Break										
09:35-10:05	**[TuDT1] Keynote Session:** Jariwala, Deep, Univ. of Pennsylvania, USA	**[TuDT2] Keynote Session:** Samukawa, Seiji, NYMCT Univ., Taiwan	**[TuDT3] Keynote Session:** Xu, Sheng, Univ. of California at San Diego, USA	**[TuDT4] Keynote Session** Ye, Winnie, Carleton Univ., Canada							
10:05-11:45	**[TuET1] Invited Session:** Workshop on Nanotechnology for Computing 1	**[TuET2] Invited Session:** Nanotechnology for Soft Electronics 3	**[TuET3] Invited Session:** Nano-bio-microfluidic Platforms in Clinical & Biomedical Applications	**[TuET4] Invited Session:** Recent Advances in Micro-/NanoRobotics	**[TuET5] Invited Session:** Spintronic Phenomena in Topological & 2D Materials	**[TuET6] Invited Session:** First Principles Modeling & Simulation of Plasma Processes 1					
11:50-13:00	Lunch										
13:00-13:45	**[Plenary Talk 4] Van Der Waals Integration Beyond 2D Materials: Boundless Opportunities at Bondless Boundaries** Duan, Xiangfeng (Univ. of California at Los Angeles, USA)										
14:00-16:00	**[TuGT1] Invited Session:** Workshop on Nanotechnology for Computing 2	**[TuGT2] Invited Session:** Nanotechnology for Soft Electronics 4	**[TuGT3] Invited Session:** Nanoscale Photodetectors & Intelligent Perceptions 3	**[TuGT4] Invited Session:** Advanced Nanofabrication Technologies	**[TuGT5] Invited Session:** Latest Advances in Magnetic Nanotechnology 2	**[TuGT6] Invited Session** First Principles Modeling & Simulation of Plasma Processes 2					
16:00-16:20	Coffee Break										
16:20-17:20	**[TuIT1] Invited Session:** Workshop on Nanotechnology for Computing 3	**[TuIT2] Oral Session:** Nanoelectronics 2	**[TuIT3] Oral Session:** Nano-optics, Nanophotonics & Nano-optoelectronics 2	**[TuIT4] Oral Session:** Nanosensors & Nanoactuators 2	**[TuIT5] Oral Session:** Nanobiomedicine 2	**[TuIT6] Oral Session:** Spintronics 2	**[TuIT7] Oral Session:** Modeling & Simulation 2	**[TuIT8] Oral Session:** Nanomaterials 4	**[TuIT9] Oral Session:** Nanomaterials 5	**[TuIT10] Oral Session:** Nanomaterials 6	**[TuLT11] Poster Session: Poster Session 2**
17:20-18:20		**[TuJT2] Oral Session:** Nanoelectronics 3	**[TuJT3] Oral Session:** Nano-optics, Nanophotonics & Nano-optoelectronics 3	**[TuJT4] Oral Session:** Nanofabrication 2	**[TuJT5] Oral Session:** Nano-energy, Environment & Safety 2	**[TuJT6] Oral Session:** Nano-acoustic Devices, Processes & Materials 2	**[TuJ7] Oral Session:** Modeling & Simulation 3	**[TuJT8] Oral Session:** Nanomaterials 7	**[TuJT9] Oral Session:** Nanomaterials 8	**[TuJT10] Oral Session** Nanomaterials 9	
19:00-21:30	**Banquet** (Ramada Ballroom 1 ~ 4, 2F)										

July 5 (Wed.)

Time	Room E (Tamna Hall, 8F)	Room F (Ora Hall, 8F)	Room K (Ara Hall, 8F)	Room H (Mara, 2F)	Room I (Udo, 2F)	Room J (Biyang, 2F)
08:30-09:15	**[Plenary Talk 5] CMOS-Compatible Microscale & Nanoband Edge Electrodes for Electrochemical Sensing Applications** Underwood, Ian (Univ. of Edinburgh, UK)					
09:15-09:45	**[WeDT1] Keynote Session:** Jackman, Richard B., Univ. College of London, UK	**[WeDT2] Keynote Session: Keynote Talk 10:** Xi, Ning, Univ. of Hong Kong, China	**[WeDT3] Keynote Session:** Novosad, Valentine, Argonne National Lab., USA	**[WeDT4] Keynote Session:** Lee, Moonjoo, POSTECH, Korea		
09:45-10:05	Coffee Break					
10:05-11:45	**[WeET1] Invited Session:** New Directions & Challenges for Computing with Nanotechnology	**[WeET2] Invited Session:** Nanogenerators & Piezotronics	**[WeET3] Invited Session:** Nanomaterials Based Smart Wearables	**[WeET4] Invited Session:** IEEE NTC Women in Nanotechnology & Diversity Equity Inclusion (WIN/DEI): Interview & Panel Discussion with Leaders		
11:50-13:00	Lunch					
13:00-15:00	**[WeGT1] Invited Session:** Nano Energy & Self-powered Systems	**[WeGT2] Invited Session:** 2D & Nanomaterials	**[WeGT3] Oral Session:** Nanosensors & Nanoactuators 3	**[WeGT4] Oral Session:** Nanoelectronics 4		
15:00-16:00	**[WeIT1] Oral Session:** Nano-optics, Nanophotonics & Nano-optoelectronics 4	**[WeIT2] Oral Session:** Nanofabrication 3	**[WeIT3] Oral Session:** Nano-Energy, Environment & Safety 3	**[WeIT4] Oral Session:** Nanoelectronics 5	**[WeIT5] Oral Session:** Nanobiomedicine 3	**[WeIT6] Oral Session:** Modeling & Simulation 4

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Ramada Plaza Jeju Ocean Front, Jeju, Korea
http://2023.ieeenano.org

Photonics at Sub-wave Length Scale

MoBP1: 08:20 – 09:05
Monday July 3, 2023
Location: Ramada Ballroom 1

XIANG ZHANG

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ABSTRACT

Compared with electronics that is already at nanoscale today, photonic circuits remain rather bulky due to optical diffraction limit. I will discuss physics in scaling down of photonics that is important for both optical sciences and modern information technology. We proposed a new optical cavity design using indefinite medium that exhibits an anomalous scaling law than conventional cavities which was confirmed experimentally. I will further present nanoscale waveguide and laser circuits using hybrid plasmons that can be multiplexed into a single waveguide-an effort towards integrated photonics at nano-scale. Finally, I will discuss non-Hermitian optics that is capable to sort color simultaneously at nano-scale for potential ultrahigh resolution camera.

SHORT BIO

Professor Xiang Zhang is currently the President and Vice-Chancellor of the University of Hong Kong. He is also member of Chinese Academy of Sciences (CAS) and US National Academy of Engineering (NAE).

Professor Zhang received his PhD from University of California, Berkeley; MS from University of Minnesota and MS/BS from Nanjing University. Professor Zhang's research focuses on materials physics, metamaterials and nano-photonics. He has published over 400 journal papers including over 90 publications in Science and Nature family series. He has given over 350 Keynote, Plenary and Invited talks at international conferences and institutions. He was a Co-Chair of the NSF Nano-scale Science and Engineering Annual Grantee Conferences in 2004 and 2005, and has served as Chair of the Academic Advisory Board for the Research Center for Applied Science (RCAS), Academia Sinica.

In 2008, Professor Zhang's research was selected by Time Magazine as one of the "Top Ten Scientific Discoveries of the Year" and "50 Best Inventions of the Year", Discover Magazine's "Top 100 Science Stories" in 2007, and R&D Magazine's top 25 Most Innovative Products of 2006. In 2019, his research team's work on "Casimir effect" was selected as one of the Top 10 Breakthroughs for 2019 by Physics World.

Designed Nanoscale Materials through DNA-Programmable Assembly

MoBP2: 09:05 – 09:500
Monday July 3, 2023
Location: Ramada Ballroom 1

Oleg GANG

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Abstract

The diverse emerging nanotechnological applications, from photonics to biomaterials and from computing to sensing, require an integration of functional nanocomponents into the complex engineered architectures for enabling novel materials and devices. However, the current top-down fabrication methods are limited in their ability to create prescribed 3D nanostructures and incorporate nanocomponents in a designed manner. On other side, typical bottom-up assembly methods do not provide a flexibility for an architecture control. The talk will discuss a DNA-programmable self-assembly strategy for a fabrication of large-scale and finite-size nano-architectures from diverse inorganic and biomolecular nanocomponents with a pre-defined organization at different scales in 2D and 3D. The recent advances in creating periodic and hierarchical organizations from inorganic nanoparticles and proteins will be demonstrated. The developed assembly approaches allow for creating functional nanomaterials with nano-optical, electrical, mechanical, and biochemical functions; developed methods and examples of these efforts will be presented. Finally, the progress on establishing nanomaterials with prescribed reconfiguration states will be discussed.

Short Bio

Oleg Gang is a professor of Chemical Engineering and Applied Physics and Materials Science at Columbia University, and a leader of the Soft and Bio-Nanomaterials Group at the Brookhaven National Laboratory's Center for Functional Nanomaterials. His research explores self-assembly strategies for creating nanomaterials with targeted nano-architectures, transformation behavior and functions. Gang received Ph.D. in physics from Bar-Ilan University, following by a postdoc at Harvard University as a Rothschild Fellow. After about a decade of scientific carrier at Brookhaven National Laboratory, Gang joined the Columbia faculty. His group develops novel self-assembly methods for creating designed nanomaterials, studies their structural properties and explores their functions for photonics, sensing, biomedical, mechanical and other applications. Gang is a Fellow of the American Physical Society and has received numerous accolades for his work.

Intracellular Manipulation & Measurement: Science & Applications

TuBP4: 08:30 – 09:15
Tuesday July 4, 2023
Location: Ramada Ballroom 1

Yu SUN

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Abstract

Intracellular manipulation and measurement reveal the properties and functions of structures and organelles inside a cell. For instance, mechanical properties of the cell nucleus are directly linked to cell functions; the properties and organization of the cytoskeleton regulate cell behaviors, such as cell migration and mitosis; and the properties of endoplasmic reticulum control the intracellular ion storage and regulation. The ability to understand intracellular signaling, manipulate subcellular and sub-organelle structures for therapeutics, and measure intracellular biophysics demands tools to directly interrogate intracellular structures inside single cells.

This talk will begin with a brief overview of techniques for single-cell manipulation and characterization, followed by a focused discussion of techniques for performing manipulation and measurement tasks inside single cells and deep in tissue. Examples to discuss are sub-micrometer position control and sub-nanoNewton force control for realizing 3D intracellular and intra-tissue manipulation and measurement, and mechanical nanosurgery of chemoresistant tumors. Challenges and future opportunities in this field will also be introduced.

Short Bio

Yu Sun is a Professor in the Department of Mechanical and Industrial Engineering, with joint appointments in the Institute of Biomedical Engineering, Department of Electrical and Computer Engineering, and Department of Computer Science at the University of Toronto (UofT). He is a Tier I Canada Research Chair and the founding Director of the UofT Robotics Institute. His lab specializes in developing innovative technologies and instruments for manipulating and characterizing cells, molecules, and nanomaterials. He is a Fellow of Canadian Academy of Engineering (CAE), a Fellow of The Academy of Science of Royal Society of Canada (RSC), and a Foreign Member of the Chinese Academy of Engineering. He was also elected Fellow of IEEE, ASME, AIMBE, AAAS, NAI, CSME, and EIC for his work on micro-nano robotic systems and devices.

Van der Waals Integration beyond 2D Materials: Boundless Opportunities at Bondless Boundaries

TuMP5: 13:00 – 13:45
Tuesday July 4, 2023
Location: Ramada Ballroom 1

XIANGFENG DUAN

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ABSTRACT

The heterogeneous integration of dissimilar materials is a long pursuit of material science community and has defined the material foundation for modern electronics and optoelectronics. The typical material integration approaches usually involve strong chemical bonds and aggressive synthetic conditions and are often limited to materials with strict structure match and processing compatibility. Alternatively, van der Waals (vdW) integration, in which freestanding building blocks are assembled together through weak vdW interactions, offers a bond-free material integration strategy without lattice and processing limitations. In this talk, I will discuss the broad opportunities in exploring vdW integration for creating versatile heterostructures and superlattices with designable electronic interfaces to enable high-performing devices and artificial materials not previously possible.

I will start with a brief introduction of some early background on using this approach for damage-free dielectric integration to enable high speed transistors from atomically thin graphene and 2D semiconductors, and then highlight our recent efforts in exploiting this approach for creating pinning-free metal/semiconductor junctions approaching the Schottky-Mott limit, and nearly ideal 2D photodiode approaching the intrinsic exciton physics limit. Next, we further extend this approach for damage-free integration of metal contacts on delicate halide perovskite thin films, realizing high performance van der Waals contacts with an atomically clean contacting interface and greatly reduced contact resistance, allowing systematic electrical transport studies of halide perovskites down to cryogenic temperatures to unravel the complex transport behavior in this unique class of "soft-lattice" materials. These advancements highlight the unique merit of the bond-free vdW integration approach in creating pinning-free heterostructure interfaces.

Beyond the simple vdW heterostructures, I further discuss a broad family of vdW superlattices consisting of alternating crystalline atomic layers and self-assembled molecular layers, with tailored structural symmetry, electronic band modulation and interlayer coupling as an artificial material platform for exploring emergent electronic, photonic, and quantum phenomena; and introduce a unique design of vdW thin films that feature staggered nanosheets with bond-free, pinning-free sliding vdW interfaces to endow unprecedented combination of electronic performance and mechanical stretchability for a new form of adaptable electronic membranes. I will conclude with a brief prospect on exploring such artificial vdW materials to unlock new physical limits and enable new device concepts beyond the reach of

SHORT BIO

Dr. Xiangfeng Duan received his B.S. Degree from University of Science and Technology of China in 1997, and Ph.D. degree from Harvard University in 2002. From 2002-2008, he was a Founding Scientist responsible for advanced technology development at Nanosys Inc., a nanotechnology startup founded based partly on his doctoral research. Dr. Duan joined UCLA with a Howard Reiss Career Development Chair in 2008, and was promoted to Associate Professor in 2012 and Full Professor in 2013. His research interest includes nanoscale materials, devices and their applications in future electronic and energy technologies. He has published over 300 papers with over 90,000 citations, and holds >50 US patents. Dr. Duan has received many awards for his pioneering research in nanoscale science and technology, including MIT Technology Review Top-100 Innovator Award, NIH Director's New Innovator Award, NSF Career Award, Alpha Chi Sigma Glen T. Seaborg Award, Herbert Newby McCoy Research Award, US Presidential Early Career Award for Scientists and Engineers (PECASE), ONR Young Investigator Award, DOE Early Career Scientist Award, Human Frontier Science Program Young Investigator Award, Dupont Young Professor, Journal of Materials Chemistry Lectureship, International Union of Materials Research Society and Singapore Materials Research Society Young Researcher Award, the Beilby Medal and Prize, the Nano Korea Award, International Society of Electrochemistry Zhao-Wu Tian Prize for Energy Electrochemistry, Science China Materials Innovation Award, AIP Horizons Lectureship, NanoMaterials Science Young Scientist Award, Materials Research Society Middle Career Researcher Award, International Union of Materials Research Society Frontier Materials Young Scientists Award, IEEE Nanotechnology Council Distinguished Lectureship, and most recently the IEEE Pioneer Award in Nanotechnology. He is currently an elected Fellow of Royal Society of Chemistry and Fellow of American Association for the Advancement of Science.

CMOS-compatible Microscale & Nanoband Edge Electrodes for Electrochemical Sensing Applications

WeBP5: 08:30 – 09:15
Wednesday July 5, 2023
Location: Tamna Hall

Ian UNDERWOOD

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Abstract

Microscale electrodes have been widely researched for many years with much interest centered on electrochemical sensing applications. We developed a microscale electrode capability that is compatible with fabrication by post-processing foundry CMOS wafers. This approach offers a range of "More-Than-Moore" advantages including integration with active electronics for both addressing electrode(s); scaling from individual – or a small number of – electrodes to high numbers of electrodes in one– and two–dimensional arrays; and the potential for reproducible and economical manufacture at scale. The use of such microelectrodes and arrays of microelectrodes continues to be reported for electrochemical sensing in a range of applications including biosensing and sensing in harsh environments.

Compared to microscale equivalents, electrodes with nanoscale dimensions have been shown – both in simulation and experimentally – to exhibit enhanced characteristics and performance. We have developed a nanoscale electrode system, Microsquare Nanoband Edge Electrode (MNEE), that can be produced using a similar range of microscale lithography and microfabrication techniques that are used for microelectrodes. MNEEs thus offer the promising combination of enhanced performance associated with nanoscale electrode dimensions; the advantages of the microscale "More-Than-Moore" approach.

This plenary will introduce microelectrodes and Microsquare Nanoband Edge Electrodes in the context of electrochemical sensing.

Short Bio

Ian Underwood read for a bachelor's in Natural Philosophy, a master's in Biomedical Engineering, then a doctorate in Applied Optics. As a lecturer in Electronics at the University of Edinburgh (UoE), he became a pioneer in the field of liquid crystal on silicon (LCoS) spatial light modulators. During a Fulbright Fellowship at the University of Colorado in the early 1990s he had his first experience of technology entrepreneurship collaborating with recent spin-out Boulder Nonlinear Systems.

Alongside research in LCoS microdisplays, he supported the formation and early development of Micropix Technologies (now part of Kopin Corp). In the late 1990s, he co-founded OLED microdisplay company – MicroEmissive Displays. Individual awards include Emerging Entrepreneur of the Year and the Gannochy Award for Innovation of the Royal Society of Edinburgh; corporate awards include Top European semiconductor start-up and IEE inaugural Award for Emerging Technology. His favourite accolade is the "smallest tv screen in the world" – a genuine 2004 Guinness World Record. In 2006 he was named one of "twenty Scottish scientists changing the world we live in" by the HERALD newspaper. He was on the Technical Program Committee of IEEE ISSCC, 2007-10 and the Scottish Science Advisory Council, 2008-12.

Since returning to the UoE in 2008 he has added miniature sensor technologies to his research portfolio in a range of applications from implantable biomedical to astrobiology. He has continued to create and/or support university technology start-up companies including Holoxica, Optoscribe, Sofant, BrightPage and was founding Chair of PureLIFI. He has a growing interest in structured, thematic, multi-disciplinary, cohort-based doctoral level training and is Director of the PhD Academy at the Advanced Care Research Centre.

He volunteers as Publications Chair at the Society for Information Display and as a mentor in the Enterprise Hub at the Royal Academy of Engineering. Prof Underwood was elected a Fellow of the Royal Society of Edinburgh, 2005; the Royal Academy of Engineering and the Institute of Physics, 2008; and the Society for Information Display, 2022.

Moving AI in the Nanoscale: Challenges and Opportunities

MoDT1: 10:10 – 10:40
Monday July 3, 2023
Location: Ramada Ballroom 1

Fabrizio LOMBARDI

Department of Electrical & Computer Engineering
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Abstract

Artificial Intelligence (AI) is highly pervasive in modern society. The advancement of AI is based on a diversity of models and paradigms; among them, Machine Learning (ML) has been widely advocated. Different schemes have been proposed for ML to accomplish aggressive goals in terms of high performance (accuracy and speed); among such schemes, neural networks (NNs) have been extensively investigated. However, it has also been widely reported that computation remains problematic due to the exorbitant and unsustainable complexity of training and running models on software in programmable platforms, such as GPUs, CPUs, and FPGAs. Hence, a renewed interest in hardware-based solutions (often using advanced feature technology nodes) has been reported in the academic and industry communities to overcome these challenges. This talk initially proposes and assesses new arithmetic techniques and ASIC-based hardware for implementing nano-scaled MAC (Multiply-ACcumulate) and FMA (Fused Multiply-Add) units for neuron design to improve accuracy and operating frequency by pipelining. Training and inference processes are discussed; considerations such as data format, arithmetic operations, and batch normalization, are addressed. This talk focuses on single NNs with multi-layer perceptions (MLPs) as well as multi-NNs (Siamese and Triplet networks) for specific applicative domains, such as classification. Possible opportunistic directions for future research will also be outlined.

Short Bio

Fabrizio Lombardi graduated in 1977 from the University of Essex (UK) with a B.Sc. in Electronic Engineering. In 1977 he joined the Microwave Research Unit at University College London, where he received the Master in Microwaves and Modern Optics, the Diploma in Microwave Engineering, and the Ph. D. from the University of London. He is currently the holder of the International Test Conference (ITC) Endowed Chair at Northeastern University, Boston. Currently, Dr. Lombardi is the 2022-2023 President; of the IEEE Nanotechnology Council (NTC); in 2021, he was 2nd VP of the IEEE Computer Society (CS) as well as the VP of Publications of the IEEE CS (2019-2020) and the NTC (2020). Moreover, he is currently a member of the IEEE Publication Services and Products Board (PSPB) (2019-2023).

Dr. Lombardi has been Editor-in-Chief of the IEEE Transactions on Computers, IEEE Transactions on Nanotechnology, and the IEEE Transactions on Emerging Topics in Computing. He is a Fellow of the IEEE; he was the recipient of the Meritorious Service Award and elevated to Golden Core membership by the IEEE CS. He has been awarded the NTC Distinguished Service Award, the "Spirit of the CS" Award and the T Michael Elliott Distinguished Service Certificate from the CS. He has received many best paper awards and professional awards such as the Visiting Fellowship at the British Columbia Advanced System Institute, the Halliburton Professorship and an International Research Award from the Ministry of Science and Education of Japan. Dr. Lombardi was the recipient of the 1985/86 Research Initiation Award from the IEEE/Engineering Foundation; since inception, he has always been included in the list of World's Top 2% Scientists, as compiled by Stanford University.

His research interests are emerging technologies (mostly nanoscale circuits and magnetic devices), memory systems, high performance VLSI design and fault/defect tolerance of digital systems.

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Thermal Actuation for Soft Robotics

MoDT2: 10:10 – 10:40
Monday July 3, 2023
Location: Ramada Ballroom 2

Yong ZHU

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Abstract

Soft robots have received extensive interests recently. Different actuation methods have been exploited based on pressure, heat, electrical field, magnetic field, and chemical potential, etc. No actuation method has yet emerged as the dominant method. Trade-offs typically exist in force, speed, displacement, and requirement for auxiliary equipment. Thermal actuation has drawn much attention due to programmable operation, lightweight, low actuation voltage, no need of electrolyte, and potential for untethered operation (e.g., using wireless charging). However, a major limitation is the relatively slow actuation speed.

In this talk, I will present our efforts in exploring thermal actuation for novel capabilities while overcoming its limitation towards soft robotics applications. First, I will talk about a caterpillar-inspired, energy-efficient crawling robot with multiple crawling modes, enabled by joule heating of a patterned soft heater consisting of silver nanowire (AgNW) networks in a liquid crystal elastomer (LCE)–based thermal bimorph actuator [1]. With patterned and distributed heaters and programmable heating, different temperature and hence curvature distribution along the body of the robot are achieved, enabling bidirectional locomotion as a result of the friction competition between the front and rear end with the ground. The thermal bimorph behavior is investigated to predict and optimize the local curvature of the robot under thermal stimuli. The bidirectional actuation modes with the crawling speeds are investigated. The capability of passing through obstacles with limited spacing is demonstrated. The strategy of distributed and programmable heating and actuation with thermal responsive materials offers unprecedented capabilities for smart and multifunctional soft robots.

Second, I will discuss snap-through instability that can lead to significant increase in the actuation speed of a bimorph thermal actuator [2]. The actuator is made of AgNW/elastomer composite. The snap-through instability is enabled by simply applying an

offset displacement to part of the actuator structure. The effects of thermal conductivity of the composite, offset displacement, and actuation frequency on the actuator speed are investigated using both experiments and finite element analysis. The actuator yields a bending speed as high as 28.7 cm−1/s, 10 times that without the snap-through instability. A fast crawling robot with locomotion speed of 1.04 body length per second and a biomimetic Venus flytrap were demonstrated to illustrate the promising potential of the fast bimorph thermal actuators for soft robotic applications.

REFERENCES: [1] S. Wu, Y. Hong, Y. Zhao, J. Yin, Y. Zhu, Caterpillar-inspired soft crawling robot with distributed programmable thermal actuation. Sci. Adv. 9, adf8014 (2023); [2] S. Wu, G. L. Baker, J. Yin, Y. Zhu, Fast thermal actuators for soft robotics. Soft Robot. 9, 1031–1039 (2022).

Short Bio

Yong Zhu is the Andrew Adams Distinguished Professor in the Department of Mechanical and Aerospace Engineering, with affiliated appointments in Materials Science and Engineering, Biomedical Engineering, and Electrical and Computer Engineering, at North Carolina State University. He received his BS degree from the University of Science and Technology of China (Hefei, China) and his MS and PhD degrees from Northwestern University (Evanston, IL, USA). He conducted his postdoctoral training at the University of Texas at Austin before joining the faculty of North Carolina State University in 2007. His group conducts research at the intersection of mechanics of materials and micro/nano-engineering, including nanomaterial-enabled flexible and stretchable electronics. His work has been recognized with numerous awards including James R. Rice Medal from the Society of Engineering Science, Friedrich Wilhelm Bessel Research Award from the Alexander von Humboldt Foundation, ASME Gustus L. Larson Memorial Award and Sia Nemat-Nasser Early Career Award, and Best Wearable Material/Component Development Award at IDTechEx Wearable USA.

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Nanoscale Photodetectors for Infrared Sensing & Intelligent Recognition

MoDT3: 10:10 – 10:40
Monday July 3, 2023
Location: Ramada Ballroom 3

WEIDA HU

State Key Laboratory of Infrared Physics
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Abstract

Infrared photodetectors based on traditional thin-film semiconductors such as InGaAs, InSb, HgCdTe, and QWIP as well as novel type-II superlattice exhibit highly sensitive detection capability. However, these devices always need to work at low temperatures, resulting in an additional large and expensive cooling system. Recently, nanoscale materials, including 0D quantum dots, 1D nanowires, and 2D layered materials, with strong light-matter coupling coefficient, quantum confinement, and ease of heterostructure construction, are emerged as alternative materials for high-performance photodetection technologies at room temperature. Nevertheless, the signal-to-noise ratio could be very low without the suppression of dark current, and intrinsic ultrathin absorption thickness for nanoscale photodetectors suffers low quantum efficiency. Meanwhile, nanomaterials are more vulnerable to surface states and defects which are the main source of dark current including the diffusion current, SRH recombination current, and tunneling current. Here we report the progress on novel uncooled nanoscale photodetectors for infrared sensing and intelligent recognition based on nanomaterials. We fully explore the origins of dark current and improve the signal-to-noise ratio in nanoscale infrared photodetectors by precisely manipulating electrons and photons. We further develop bio-inspired intelligent photodetectors with novel nanoscale structures. Our findings provide a completely new device concept that is capable to detect infrared at room temperature with high sensitivity and develop a more feasible route for the detection-computation-memory integrated chips in artificial intelligence applications.

Short Bio

Weida Hu is currently the Director of State Key Laboratory of Infrared Physics, and a full professor (Principal investigator) on nanoscale photodetectors for infrared sensing and intelligent recognition in Shanghai Institute of Technology Physics, Chinese Academy of Sciences. He has authored or coauthored more than 200 technical journal papers and conference presentations with the total citations of 18726 and h-index of 74 in Google scholar. He received Clarivate Highly Cited Researcher since 2022. He received the National Science Fund for Distinguished Young Scholars in 2017. He is selected as the Royal Society-Newton Advanced Fellowship in 2017. He is also serving as the Associate Editor of Infrared Physics & Technology, chair of IEEE Shanghai Section NTC Chapter, Co-Chair of IEEE Nanotechnology Council - TC3, and Distinguished Lecturers of IEEE Nanotechnology Council.

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Temperature Coefficient of Resistance of PECVD deposited Hydrogenated Amorphous Silicon for Microbolometer

MoDT4: 10:10 – 10:40
Monday July 3, 2023
Location: Ramada Ballroom 4

GA-WON LEE

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Abstract

Microbolometer is a thermal imaging sensor used in applications such as night vision and temperature measurement. It consists of a thin resistive layer which changes resistance as it absorbs infrared radiation. One of the key material parameters of the resistive

layer is temperature coefficient of resistance (TCR). Hydrogenated amorphous silicon (a-Si:H) has been used as a resistive layer for its high sensitivity to infrared radiation, as well as low cost and low power consumption. The temperature dependency of TCR in a-Si:H film, however, can cause inaccuracy in sensing operation. To analyze the TCR properties, PECVD deposited a-Si:H thin films are compared according to the deposition and annealing conditions in view of 1/f noise as well as contact resistance and its activation energy between a-Si:H and metal electrode. Based on these experimental results, the local potential barrier by the numerous trap states in a-Si:H film is suggested as a major factor for TCR characteristics.

Short Bio

Ga-Won Lee received the B.S., M.S., and Ph.D. degrees in electrical engineering from the Korea Advanced Institute of Science and Technology, Daejeon, Korea. In 1999, she joined Hynix Semiconductor Ltd. as senior research engineer, where she was involved in the development of 0.115-μm, 0.09-μm DDRII DRAM technologies. Since 2005, she has been in the Department of Electronics Engineering of Chungnam National University, Daejeon, Korea, as a professor. Her main research fields are flash memory, flexible display, sensor technology including fabrication, electrical analysis and modeling.

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Semiconductor Heterostructures for Low-Power Electronics & Ultrathin Photonics

TuDT1: 09:35 – 10:05
Tuesday July 4, 2023
Location: Ramada Ballroom 1

Deep JARIWALA

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Abstract

The isolation of a growing number of two-dimensional (2D) materials has inspired worldwide efforts to integrate distinct 2D materials into van der Waals (vdW) heterostructures. While a tremendous amount of research activity has occurred in assembling disparate 2D materials into "all-2D" van der Waals heterostructures and making outstanding progress on fundamental studies, practical applications of 2D materials will require a broader integration strategy. I will present our ongoing and recent work on integration of 2D materials with 3D electronic materials to realize logic switches and memory devices with novel functionality that can potentially augment the performance and functionality of Silicon technology. First, I will present our recent work on gate-tunable diode and tunnel junction devices based on integration of 2D chalcogenides with Si. Following this I will present our recent work on non-volatile memories based on Ferroelectric Field Effect Transistors (FE-FETs) made using a heterostructure of MoS2/AlScN and also introduce our work on Ferroelectric Diode (FeD) devices also based on thin AlScN. In addition, I will also present how FeDs provide a unique advantage in compute-in-memory (CIM) architectures for efficient storage, search as well as hardware implementation of neural networks.

If time permits, I will also cover the subject of strong light-matter coupling in excitonic 2D semiconductors, including formation of hybrid states in multilayers and superlattices to achieve photonic devices in the deep-subwavelength regime for control of amplitude and polarization of light. I will further present our recent work on giant linear dichroism in layered anti-ferromagnetic semiconductors as well as scalable, localized quantum emitters from strained 2D semiconductors.

Short Bio

Deep Jariwala is an Assistant Professor in the Department of Electrical and Systems Engineering at the University of Pennsylvania (Penn). Deep completed his undergraduate degree in Metallurgical Engineering from the Indian Institute of Technology Banaras Hindu University and his Ph.D. in Materials Science and Engineering at Northwestern University. Deep was a Resnick Prize Postdoctoral Fellow at Caltech before joining Penn to start his own research group. His research interests broadly lie at the intersection of new materials, surface science and solid-state devices for computing, opto-electronics and energy harvesting applications in addition to the development of correlated and functional imaging techniques. Deep's research has been widely recognized with several awards from professional societies, funding bodies, industries as well as private foundations the most notable ones being the IEEE Photonics Society Young Investigator Award, IEEE Nanotechnology Council Young Investigator Award, IUPAP Early Career Scientist Prize in Semiconductors, the Alfred P. Sloan Fellowship and also the Bell Labs Prize. He has published over 100 journal papers with more than 16000 citations and holds several patents.

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Emerging Plasma Nanotechnology: Atomic Layer Technologies for Nano Materials and Devices

TuDT2: 09:35 – 10:05
Tuesday July 4, 2023
Location: Ramada Ballroom 2

Seiji SAMUKAWA

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Abstract

Reactive plasmas are widely utilized in the fabrication of semiconductor devices for fundamental processes such as microfabrication, surface reforming, and film deposition. Meticulous processing precision is now required at the atomic layer level, along with high deposition accuracy to enable structures to be controlled at the molecular level. While ultra-miniature nanoscale devices are expected to be prevalent in the near future, the use of plasma processes can cause significant issues during fabrication, such as abnormal etching or breakdown of insulating films due to the accumulation of ions or electrons emitted

from the plasma. In the high-density low pressure plasma process, a charge accumulation of the mA order occurs on the substrate surface, and dielectric film breakdown occurs. In order to suppress it, it is necessary to reduce the charge accumulation to the order of μA or less by using a pulse-modulated plasma method or a bypass diode, both of which are extremely difficult to optimize. Another issue is the formation of surface defects (e.g., dangling bonds) to depths over a few tens of nanometers stemming from exposure to ultraviolet (UV) emissions. Since nano-scale devices have a larger surface area than comparable bulk materials, plasma processes can significantly affect the electrical, optical, spintronic, and thermodynamic properties due to process-induced defects stemming from ultraviolet UV exposure. The interface state density due to defect generation in a plasma etching was maintained even after restoration annealing at 450 degree celcius for 30 min. This result suggests that simply restoring a defect (such as E' center) by annealing is not sufficient, and that UV irradiation damage must be completely suppressed during the etching processes. Another challenge is that next-generation nanodevices will require size control of three-dimensional structures with high precision and selectivity at the atomic layer level.

One promising approach to resolving these issues is the use of neutral beam process technology. The neutral beam atomic layer process reduces the incidence of charged particles and UV photon radiation from the plasma onto the substrate so that the substrate is exposed only to the energy-controlled neutral beam. In other words, it is possible to precisely control the kinetic energy of the neutral beam by means of the ion acceleration energy obtained with the applied electric field before neutralization. This subsequently enables ultra-precise nanoscale processing that can suppress the formation of defects at the atomic layer level and control the chemical reactions on the surface atomic layer with high precision. Furthermore, high precision processing can be achieved by selecting various halogen-based gases (F2, Cl2, HBr, HI, etc.) in order to realize the optimum chemistry according to the material. For advanced nano-devices of the future, it is vital to utilize ideal surface chemical reactions that do not cause surface defects and can be controlled at the atomic layer level.

In this talk, I review our developed neutral beam generation technique and its application to atomic layer etching (ALE), deposition (ALD), modification (ALM) and bonding technology (ALB) in 3/2 nm generation onward devices.

Short Bio

Prof. Seiji Samukawa joined NEC in 1981 after graduating from Keio University with an B.S. in Instrumentation Engineering. He worked on the research and development of ultra-precise plasma etching processes for ULSI devices and was later promoted to Principal Researcher in the Microelectronics Laboratory, R&D Group NEC Corporation. He obtained a Ph.D. in Instrumentation Engineering from Keio University in 1992. In July 2000, he was a full professor at Tohoku University, where he worked at the Innovative Energy Research Center of the Institute of Fluid Science (IFS). He was also a Principal Investigator (PI) at the Advanced Institute of Materials Research (AIMR), Tohoku University, and was a Foreign Chair Professor at Taiwan National Yang Ming Chiao Tung University. Since August 2022, he has been a full professor at National Yang Ming Chiao Tung University (NYCU), where he is currently Director of SiC Research and development Center. He is also a professor emeritus at Tohoku University. His significant scientific achievements have earned him an Ichimura Award (2008) in the New Technology Development Foundation, Prizes for Science and Technology, a Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (2009), a Plasma Prize from the American Vacuum Society (2010), and designation as an IEEE NTC Distinguished Lecturer (2019). Additionally, he has been elected as a Distinguished Professor of Tohoku University, Chair Professor of NYCU, a Fellow of the Japan Society of Applied Physics (JSAP) (since 2008), a Fellow of the American Vacuum Society (AVS) (since 2009), and a Fellow of the IEEE (since 2018).

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Controlled Epitaxial Growth and Fabrication of Hybrid Halide Perovskites

TuDT3: 09:35 – 10:05
Tuesday July 4, 2023
Location: Ramada Ballroom 3

Sheng Xu

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Abstract

Organic–inorganic halide perovskites have demonstrated tremendous potential for next-generation electronic and optoelectronic devices due to their remarkable carrier dynamics. Current studies are mostly focused on polycrystals, since controlled growth of high-quality single crystals is challenging. In this presentation, I will discuss strategies that enabled the first chemical epitaxial growth of single-crystal hybrid halide perovskites. Using advanced microfabrication, homo-/hetero-epitaxy, and a low-temperature solution method, single crystals can be grown with controlled locations, morphologies, orientations, and strain levels. By a lifting off approach, single-crystal thin films can be transferred from the epitaxial substrate to a general flexible substrate. Extending this strategy to low-dimensional perovskites yields nanostructured superlattices, based on which a solar cell with an open-circuit voltage exceeding the Shockley-Queisser limit is demonstrated. This approach opens up broad opportunities for hybrid halide perovskite materials based flexible high-performance electronic and optoelectronic devices.

Short Bio

Dr. Sheng Xu holds the position of Associate Professor and Jacobs Faculty Scholar at the University of California San Diego. He earned his B.S. degree in Chemistry from Peking University and his Ph.D. in Materials Science and Engineering from the Georgia Institute of Technology. Subsequently, he engaged in postdoctoral studies at the Materials Research Laboratory at the University of Illinois at Urbana-Champaign. The focus of his research group is the development of new materials and fabrication methods for flexible health monitoring and energy harvesting devices. His research has been presented to the United States Congress as testimony to the significance and impact of funding from the NIH. He has received numerous awards and honors, including the NIH Maximizing

Investigators' Research Award, NIH Trailblazer Award, Sloan Fellowship, Wellcome Trust Innovator Award, MIT Technology Review 35 Innovators Under 35, IEEE EMBS Technical Achievement Award, ISBE Outstanding Youth Award, ETH Zürich Materials Research Prize for Young Investigators, and MRS Outstanding Early Career Investigator Award.

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High Performance Silicon and Silicon Metamaterials for Integrated Photonics

TuDT4: 09:35 – 10:05
Tuesday July 4, 2023
Location: Ramada Ballroom 4

WINNIE N. YE

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ABSTRACT

Silicon based photonics has been under great scrutiny in recent years due to their potential for making highly compact monolithic integration of multifunctional electronic and photonic devices on the same substrate. The most popular platform is the high index contrast silicon-on-insulator (SOI) system. The high refractive index contrast between the silica cladding and the silicon waveguide core facilitates the confinement and guiding of light in structures within submicron or nanometer dimensions. In addition, the mature silicon microfabrication technology establishes a firm foundation for making low-cost and compact integrated photonic devices. A wide range of active and passive optical devices has been realized on the SOI platform. The applications of these devices can be found in high-speed communications, health industry, chemical and biological analysis, environmental monitoring, optical interconnects, and renewable energy. This talk will focus on the research work by Dr. Ye's group at Carleton University, ranging from fundamental metamaterial design using subwavelength gratings, polarization rotators and splitters, polarization-insensitive and broadband grating couplers, mode-division multiplexers, multimode couplers, spectral filters, nano-grating antennas, to optical phased arrays.

SHORT BIO

Dr. Winnie Ye is a Fellow of the Engineering Institute of Canada (EIC) and a Full Professor in the Department of Electronics at Carleton University. She was also a Canada Research Chair (Tier II) in Nano-scale IC Design for Reliable Opto-Electronics and Sensors from 2009 to 2021. Her expertise is in silicon photonics and its applications in telecommunications, data communication, biophotonics, and renewable energy. Dr. Ye received her B.Eng., M.A.Sc. and Ph.D degree in Electrical and Computer Engineering from Carleton University and the University of Toronto, respectively. Dr. Ye returned to Carleton as a faculty member in 2009. Recently, she was shortlisted for the Woman of the Year Award by Women in IT Awards - Canada in 2022. She also won the prestigious 2021 IEEE MGA (Members and Geographic Activities) Leadership Award, and the Partners In Research's 2020 Technology and Engineering Ambassador Award. She is the recipient of the 2018 IEEE Women in Engineering (WIE) Inspiring Member Award, the 2018 Engineering Medal for Research and Development from the Ontario Professional Engineers (PEO), as well as the PEO Ottawa Chapter's 2018 Engineering Excellence Award. In September 2019, Dr. Ye became a Carleton University teaching fellow after receiving the Provost's Fellowship in Teaching Award. She was the recipient of MRI's Early Researcher Award (ERA) in 2012, the Research Achievement Award from Carleton University in 2013, and the Research Award from Carleton's Faculty of Engineering and Design in 2021. She has been the elected Chair of the IEEE Canada Women in Engineering since January 2021. She has also been the elected Chair of Optica's Photonics and Opto-Electronics Technical Division since 2021.

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Nano-structured Diamond Sensors for Extreme Environments: Taking SERS from the Laboratory to the Ocean

WeDT1: 09:15 – 09:45
Wednesday July 5, 2023
Location: Tamna Hall

RICHARD B. JACKMAN

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ABSTRACT

The treasures within the pyramids of ancient Egypt contained much that was gold. In this work, diamond nanopyramids with a base dimension of ~60nm have been fabricated which encase gold nanoparticles (NPs) with a diameter of ~20nm. The plasmonic nature of the gold NPs, along with the optical properties of the diamond host matrix make these nanostructures of great interest in numerous applications; here we will discuss the realisation of robust sensors for marine applications.

Diamond is chemically resilient, and is transparent at optical wavelengths. Diamond has also been shown to resist biofouling in marine environments. This leads to the idea that diamond may be an ideal platform for sensors destined for use in extreme environments, including ocean deployment. Surface plasmon excitations in NPs lead to electromagnetic field enhancement near the metal surface. The NPs effectively act like small antennae, capturing and amplifying the incident light. Their plasmonic natures offers opportunities for Surface Enhanced Raman spectroscopy (SERS) enabling trace levels of chemical detection, being significantly more sensitive than conventional Raman. This is of great interest for use within the marine environment where trace chemical sensing is important for pollution control and for climate change studies. However, SERS substrates tend to degrade over time and are not suitable for re-use. Moreover, they are simply too fragile for use in environmentally challenging situations such as ocean analysis. As a robust substrate for SERS, diamond has near-to ideal optical properties; however, the typical reliance of van-der-Waals forces for NP adhesion to the diamond offers little improvement over other substrates in terms of marine applications. A solution is the *inclusion* of the NPs in diamond, sufficiently near the surface of the diamond to retain their plasmonic enhancement of the SERS signal.

Short Bio

Richard holds UCLs Chair in Electronic Devices and heads UCLs Diamond Electronics Group (DEG) whose laboratories are within the London Centre for Nanotechnology. Richard moved to UCL in 1988, having previously held the Royal Society Eliz. Challenor Research Fellowship at the University of Oxford, to establish one of the first teams dedicated to the then newly emerging material, diamond, grown by chemical vapour deposition (CVD) methods. Since then UCLs DEG has been responsible for licensing some of the first diamond device technology to reach commercial development by industry and has published patents relating to such. Professor Jackman has published more than 250 journal articles and is a Fellow of both the IET and IoP.

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Nano Robot Enabled In Situ Sensing and Manipulation for Biomedical Applications

WeDT2: 09:15 – 09:45
Wednesday July 5, 2023
Location: Ora Hall

Ning Xi

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Abstract

As we enter into the post-genomic era, increasing attention has been focused to characterization of the structure and function of molecules. Understanding the location, structure, and dynamics of these molecules is of fundamental importance to elucidate their function. To gain insights into how these molecules operate, advanced technologies are required for gaining information at the level of cells and molecules. Nano robot technology has been developed to meet such challenges. The unique capability of the nano robot to directly observe and manipulate molecules in their native environments has provided insights into the interaction of proteins that form functionality assemblies. While recognition of individual protein such as specific cell membrane receptor is still a challenge, the technique to use nano robots to recognize and manipulate specific molecules such as antibodies establishes a promising way to identify proteins in a specific manner. This talk will present state-of-the-art techniques enabling in situ sensing and manipulation at cellular and molecular levels using nano robots. Examples of applications such as identification of biomarkers for drug discovery and therapeutic delivery will be discussed.

Short Bio

Ning Xi received his D.Sc. degree in Systems Science and Mathematics from Washington University in St. Louis, Missouri, USA in December 1993. Currently, he is the head of Department of Industrial and Manufacturing Systems Engineering, the Director of Advanced Technologies Institute and Chair professor of Robotics and Automation at the University of Hong Kong. He was a University Distinguished Professor, the John D. Ryder Professor of Electrical and Computer Engineering and Director of Robotics and Automation Laboratory at Michigan State University. Dr. Xi was awarded SPIE Nano Engineering Award in 2007. In addition, he is a recipient of US National Science Foundation CAREER Award. Dr. Xi is a fellow of IEEE. He also served as the President of IEEE Nanotechnology Council (2010-2011) and the President of IEEE Robotics and Automation Society (2018). His research interests include robotics, manufacturing automation, micro/nano manufacturing, nano sensors and devices, nano bio system applications, and intelligent control and systems.

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Superconducting Sensors and Detectors for Large-scale Physics Experiments

WeDT3: 09:15 – 09:45
Wednesday July 5, 2023
Location: Ara Hall

Valentine NOVOSAD

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Abstract

Many ongoing large-scale physics experiments require detection tasks at high rates with high resolution in conditions where current technologies do not have sufficient sensitivity or fail to operate. Such conditions are, e.g., very low temperatures or the presence of strong magnetic fields. All-metallic superconducting detectors emerged as a disruptive and unique candidate technology capable of addressing some of these challenges due to their magnetic field and cryogenic temperature compatibility, superior sensitivity at the quantum limit levels, radiation hardness, and in some cases, intrinsic picosecond timing resolution, and high count rates. In this presentation, we will discuss the work at Argonne toward developing such devices, including superconducting nanowires as particle detectors [1] and Transition Edge Sensors for ground-based cosmological studies [2].

Superconducting nanowires are primarily studied as single-photon detectors. These devices use an avalanche process in current-biased superconducting nanowires to detect individual photons with wavelengths in the range from the deep infrared to ultraviolet, with picosecond timing precision and GHz count rates, by a simple two-terminal voltage readout, without the need for significant preamplification. While it has been sparsely reported in the literature that these devices can detect low-energy charged particles with similarly high rates and timing characteristics as with photons, their capability to detect high-energy particles remains thoroughly studied or used in large-scale physics experiments. To fill this niche, we recently began efforts to develop superconducting nanowire single particle detectors and study their performance in a magnetic field. On the other hand, Transition Edge Sensor (TES) is a more mature technology. TES is a microfabricated bolometric device that operates in the middle of the superconducting transition, typically below 0.5K. Because the change from the normal to the superconducting state represents the sharpest phase transition to be found in nature, properly designed TES detectors are exquisitely sensitive. Furthermore, since thermal principles dictate TES operation, the technique enjoys applicability across the electromagnetic spectrum. We will overview the basic concepts of these devices, touch on some funcamental science aspects and challenges of their fabrication

and related thin film materials science and engineering, and discuss their practical applications in large-scale physics experiments.

The work at Argonne National Laboratory, including the use of the Center for Nanoscale Materials facilities, was supported by the US Department of Energy, Office of Science, and Office of Basic Energy Sciences under Contract No. DE-AC02-06CH11357 and Office of Nuclear Physics under Contract No. DE-FG02-08ER41551.

REFERENCES: [1] "Superconducting nanowires as high-rate photon detectors in strong magnetic fields," T Polakovic, WR Armstrong, V Yefremenko, J. Pearson, K Hafidi, G Karapetrov, Z-E Meziani, and V Novosad, Nuclear Instruments & Methods in Physics Research 9590, 163543 (2020); [2] "SPT-3G: A Multichroic Receiver for the South Pole Telescope", A. J. Anderson, et al. , J. Low Temp. Physics, 193, 1057–1065 (2018)

Short Bio

Valentine Novosad is a Senior Scientist and Principal Investigator at Argonne's Materials Science Division. After earning his MS (with Honors) from Kharkiv Aviation Institute, Ukraine, he joined a Ph.D. program at the Verkin Institute for Low Temperature Physics & Engineering, National Academy of Sciences of Ukraine. During his Ph.D. work, Valentine spent 18 months at the Laboratoire de Magnétisme Louis Néel, CNRS, Grenoble, France, where he studied diffraction magneto-optical Kerr effects. He then completed postdoctoral training at the Department of Materials Science, Graduate School of Engineering, Tohoku University, Sendai, Japan, where he worked on the geometric confinement effects in ferromagnetic dot arrays. Next, Dr. Novosad joined the US Department of Energy's Argonne National Laboratory, where he is currently employed as a Senior Materials Scientist.

Novosad's research interests span from fundamental studies of magnetic and superconducting films and patterned heterostructures to their practical applications, such as in spintronics, nanomedicine, cosmology, and physics. Since his employment at Argonne, Novosad has hosted 11 postdocs and 24 students. He co-authored 280+ papers (Google Scholar h-index: 58, with ~12,500 citations), six patents, and three book chapters. Novosad has given numerous invited talks, including at all major physics and materials science conferences across USA, Europe, and Asia. In addition, he is a co-PI in several major international collaborations, including SPT (South Pole Telescope) and CUPID (Cryogenic Underground Laboratory for Rare Events Upgrade with Particle ID). Valentine Novosad is a Senior IEEE Member, an elected Fellow of the American Physical Society, and a recipient of the University of Chicago Distinguished Performance Award and Medal.

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Ion-trap Quantum Computer

WeDT4: 09:15 – 09:45
Wednesday July 5, 2023
Location: Mara

Moonjoo LEE

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Abstract

Recently quantum technology revolutionize the field. In particular, the trapped ion system is one of the most promising candidates for realizing a quantum computer. Here, we discuss the basic working principle of the ions, the scheme for generation of the ion-ion entanglement, and state-of-the-art achievements with the ions, including high-fidelity qubit control and measurements. We also show the recent progress with the trapped-ion setting in POSTECH.

In order to realize quantum advantage, the trapped-ion system must be scalable: it is highly demanding to miniaturize the trapped-ion quantum computers. At this stage, it requires not simply the physics background but also the insight of the engineers, like nanofabrication, MEMS or NEMS technology, and radiofrequency technology, and even cryogenic capabilities. We review the recent experimental progress along this direction and outline future possibilities.

Short Bio

Moonjoo Lee received his B.S. and Ph.D. degrees in physics from Seoul National University, Seoul, South Korea in 2004 and 2011, respectively. From 2012 to 2014, he was a Postdoctoral Researcher at ETH Zurich, Zurich, Switzerland. From 2014 to 2018, he was a Postdoctoral Fellow at Institute for Quantum Optics and Quantum Information (IQOQI) and University of Innsbruck, Innsbruck, Austria. From 2018 to 2020, he was a Research Fellow at CEA Saclay, Gif-sur-Yvette, France. Since 2020, he has been an Assistant Professor in Department of Electrical Engineering at Pohang University of Science (POSTECH), Pohang, South Korea. His research interests include quantum optics and quantum information. Dr. Lee was a recipient of Lise Meitner Fellowship of Austrian Academy of Science in 2015, and awarded Institute of Physics (IOP) Trusted Reviewer Status in 2022.

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