NYCU-WIN Research WORKSHOP

November 5, 2024

9:00 AM

QNC 1501

Program

UNIVERSITY OF WATERLOO

WATERLOO INSTITUTE FOR nanotechnology

Agenda November 5, 2024

Start	End	EVENT at QNC 1501
9:00 AM	**9:05 AM**	Welcome Address by **Sushanta Mitra**, *WIN Executive Director* Opening Remark by **Bernard Duncker**, *Associate Vice President, Research and International, University of Waterloo*
9:05 AM	**10:20 AM**	**Session 1: Technical Presentations**
9:05 AM	**9:20 AM**	**Hung-Ming Chen**, Institute of Electronics, *NYCU, Taiwan* "Enabling System Design in 3D Integration: Technologies and Methodologies"
9:20 AM	**9:35 AM**	**Kankar Bhattacharya**, *ECE, UW* "Overview of Research Ecosystem in Electrical & Computer Engineering"
9:35 AM	**9:50 AM**	**Ray-Hua Horng**, *Department of Biological Science and Technology, NYCU, Taiwan* "Technology Development of Next Era Wide Bandgap Ga_2O_3 for Power Devices Applications"
9:50 AM	**10:05 AM**	**Kevin Musselman**, *MME, UW* "Spatial Atomic Layer Deposition at The University of Waterloo"
10:05 AM	**10:20 AM**	**Lili Liu**, Faculty of *Health, UW* "Overview of Faculty of Health"
10:20 AM	**10:30 AM**	**Break**
10:30 AM	**12:30 PM**	**Session 2: Technical Presentations**
10:30 AM	**10:45 AM**	**Chia-Ching Chang**, *Department of Biological Science and Technology, NYCU, Taiwan* "Surface-active Metal Aano-thin-film Development for Biosensing and Mem-electronics Application"
10:45 AM	**11:00 AM**	**Evelyn Yim**, *ChemE, UW* "Biomaterials Nanotopography for Regenerative Medicine Application"

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Start	End	EVENT at QNC 1501
11:00 AM	**11:15 AM**	**Bor-Ran Li**, *Institute of Biomedical Engineering, NYCU* "Innovative Microfluidic-Based Progressive Sperm Sorting for Enhanced Assisted Reproductive Technology Outcomes"
11:15 AM	**11:30 AM**	**Carolyn Ren**, *MME, UW* "Microfluidic and Microwave Sensing Platform Technology for Biomedical Applications"
11:30 AM	**11:45 AM**	**Guo-Xing Miao**, *ECE, UW* "Programmable Iontronic Memristor for Neuromorphic Computing Applications"
11:45 AM	**12:00 PM**	**Naixin Zhao**, *ChemE, UW* "Development of Organic Electronics based on Conjugated Polymers"
12:00 PM	**12:15 PM**	**Ben Lin**, *UW* " TFT Active Matrix Displays & Sensors"
12:15 PM	**12:30 PM**	**Ka-Ying Wong**, *Chem, UW* "Aptamers in Ophthalmology: Transforming Ocular Drug Detection and Delivery"
12:30 PM	**2:00 PM**	**Networking lunch**

PRESENTERS

Hung-Ming Chen

Professor

Institute of Electronics

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Prof. Hung-Ming Chen received the B.S. degree in computer science and information engineering from National Chiao Tung University, Hsinchu, Taiwan, and the M.S. and the Ph.D. degrees in computer sciences from University of Texas at Austin.

Dr. Chen is currently a Professor at the Institute of Electronics at National Yang Ming Chiao Tung University, Hsinchu, Taiwan. He has served as the chair of IEEE CEDA Taipei Chapter and the technical program committee members including ACM/IEEE DAC, ASP-DAC, IEEE/ACM ICCAD and ACM ISPD. He also served as EDA track co-chair in IEEE VLSI-DAT and placement track co-chair in ICCAD. He has supervised teams to win the first place at 2014 ISPD Placement Contest and 2023 CAD Contest at ICCAD. His research interests include design automation in digital and analog circuits, beyond-die integration, and VLSI design methodologies.

PRESENTATION:

Enabling System Design in 3D Integration: Technologies and Methodologies

3D integration solutions have been called for in the semiconductor market for a long time to possibly substitute the place of technology scaling. It consists of 3D IC packaging, 3D IC integration, and 3D silicon integration. 3D IC packaging has been in the market, but 3D IC and silicon integrations have obtained more attention and care due to modern system requirements on high performance computing and edge AI applications. In the need of further integration in electronics system development at lower cost, chip and package design are therefore evolving along the years. In this talk, I will introduce some perspectives on 3D integration for system designs, and continue to depict the future of 3D integration as we know of, plus new observations, technologies, and methodologies such as programmable package, building-block-based multi-chiplet methodology.

PRESENTERS

Chia-Ching Chang

Professor

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Professor Chia-Ching Chang is a Biological Physicist. Professor Chang obtained his Bachelor of Science in Physics degree at National Tsing Hua University (NTHU), Hsinchu, Taiwan 1992. He pursued his Ph.D. study in molecular biophysics at the Institute of Life Science, NTHU, in 1992. In 1997, he was awarded a visiting scholarship from MOE, Taiwan, and visited the Department of Biology, Johns Hopkins University, as a pre-doctoral fellow. In 1998, he finished his Ph.D. and became a postdoctoral fellow at the Institute of Zoology, Academia Sinica. In 2000, Dr. Chang accepted the Assistance Professorship in the Department of Physics, at National Dong Hwa University, Taiwan. In 2004, Dr. Chang was promoted to Associate Professor of Physics. In 2005, Dr. Chang accepted the invitation of President Chang, National Chiao Tung University (NCTU), and joined the Department of Biological Science and Technology of NCTU. In 2008, Dr. Chang was promoted to full Professor. In 2009, Dr. Chang was co-appointed as a Research Fellow by the Institute of Physics, Academia Sinica. In 2010, Dr. Chang was invited to be the visiting professor in the Department of Biochemistry, Microbiology, and Immunology at the University of Ottawa. 2014 Dr. Chang was appointed Associate Vice President for International Affairs at NCTU. In 2016, Dr. Chang was appointed as Chairman of Dept Biol. Sci & Tech., NCTU. In 2019, Dr. Chang was appointed Chief Director of the Environmental Protection and Laboratory Safety Center of NCTU. From 2021 to 2023, Dr. Chang was appointed Chief Director of the Environmental Protection and Laboratory Safety Center of NCTU. The research topics include Soft condensed matter and Biological physics, biomaterials synthesis and characterization for protein folding and mechanism study, bio-nanotechnology application, and new functional bio-nano-material development and Biophotonics.

PRESENTATION:

Surface-active metal nano-thin-film development for biosensing and mem-electronics applications

We have created electrochemical electrodes using surface-active metal nano-thin-film (M-NTF) technology for applications in biosensing platforms and memristive devices. These types of M-NTF-based electrochemical electrodes can conjugate biomarkers or their corresponding pairs directly within 20-30 minutes. Therefore, the SARS-CoV-2 virus or specific viral DNAs and their variants can be detected rapidly. Our biosensing system demonstrated that SARS-CoV-2 viruses maintained a higher level of infectiousness after being stored at -20°C compared to storage at 4°C over 30 days. Therefore, it could not rule out the virus introduction from undercooked meats from infected animals, which was concluded by a joint WHO–China investigation team. Moreover, the drugs that affected SARS-CoV-2 infections can be identified, too. Furthermore, this biosensing system with variant DNA probes can be used to determine the virus types of SARS-CoV-2 and Enteroviruses. In spite of the application of biosensing, the thin-film electrode conjugated with nickel ions chelated DNA (Ni-DNA) demonstrated both NDR and memristor behaviours.

Ray Hua Horng

Chair Professor

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Ray-Hua Horng received the B.S., and Ph.D. degrees from National Cheng Kung University and National Sun Yat-Sen University, Taiwan, in 1987 and 1993, respectively, all in electrical engineering. She has worked in the field of III–V compound materials by MOCVD as an Associate Researcher with Telecommunication Laboratories, Chunghwa Telecom Co. Ltd., Taoyuan, Taiwan. She is currently Chair Professor with the Institute of Electronics, National Yang Ming Chiao Tung University. She also is elected to be the president of the society of Taiwan Women in Science and Technology. She has authored or coauthored over 385 technical papers and holds over 100 patents in her fields of expertise. Her main interests are solid-state lighting devices, III–V solar cells, optoelectronic devices, high power devices, nano-surface treatment by natural lithography, power device and gas sensors. In 2000, she vitalized her research on high-brightness LEDs with mirror substrate into practical mass products that enable high-power LEDs. Prof. Horng received numerous awards recognizing her work on high-brightness LEDs. She has been awarded by the Ministry of Education of Taiwan for Industry/ University Corporation Project in 2002, by the Ministry of Science & Technology of Taiwan for the excellent technology transfer of high-power LEDs in 2006, 2008,2009, 2010 and 2011 by Chi Mei Optoelectronics for the first prize of Chi Mei Award in 2008, by the 2007 IEEE Region 10 Academia-Industry Partnership Award and distinguish research award of National Science Council of Taiwan in 2013 and 2021. She became the Fellow of the Australian Institute of Energy since 2012, Fellow of the Institution of Engineering and Technology since 2013, Fellow of SPIE since 2014, Fellow of IEEE since 2015, Fellow of OSA since 2016 and IoP since 2020, Fellow of Chinese Institute of Engineers since 2022, Fellow of Taiwan Vacuum Society since 2023, Fellow of The Chinese Institute of Electrical Engineering since 2023. Prof. Horng awarded 有庠科技講座sine 2023 and APAM (Asia Pacific Academy of Materials) Academicians since 2024.

PRESENTATION:

Technology Development of Next Era Wide Bandgap Ga2O3 for Power Devices Applications

The development of wide bandgap (WBG) materials, particularly Gallium Oxide (Ga_2O_3), presents a significant material characteristics for power device applications. Ga_2O_3 offers exceptional electrical properties, including a large bandgap of approximately 4.8 eV, high breakdown voltage, and excellent thermal stability, making it a promising candidate for next-generation power electronics. This technology aims to enhance the performance and efficiency of power devices, enabling higher power densities, improved energy efficiency, and reduced system sizes. Research and development in Ga_2O_3 technology focus on optimizing material growth techniques, such as bulk crystal growth and epitaxial layer deposition, to achieve high-quality and defect-free substrates. Even though, there exists a challenge about conductive Ga2O3, which limits the power devices applications.

In our study, the heteroepitaxy technology to grow Ga_2O_3 on sapphire substrate is developed. The development of p-type conductive Ga_2O_3 by ion implantation, n-type conductivity Ga_2O_3 by in-situ doping, Ga_2O_3-based devices, including Schottky diodes, metal-oxide-semiconductor field-effect transistors (MOSFETs), and other sensor applications, including deep UV photodetector, x-ray sensor and gas sensor, is crucial for realizing the full potential of this material in practical applications which is our research important topic. The integration of Ga_2O_3 into power devices could revolutionize various industries, including renewable energy systems, electric vehicles, and high-frequency communications, by providing more efficient, compact, and robust solutions. This talk highlights the ongoing efforts including first principle calculation and relative experimental demonstration and future prospects in the technology development of Ga_2O_3 for power device applications, emphasizing the material's advantages, current challenges, and potential impact on the power electronics landscape.

PRESENTERS

Bor-Ran Li

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Prof. Bor-Ran Li is a leading expert in microfluidics and biosensors, with a focus on healthcare and environmental applications. His notable innovations include a wearable exhaled breath condensate collector (Chemical Engineering Journal, 2024) and a trimodal multiplexed lateral flow test strip with portable microfluidic centrifugation (Analytical Chemistry, 2024). He has received several prestigious awards, such as the NSTC FutureTech Demo and Breakthrough Award (2023), the National Innoaward Diligence Award (2020), and the High Cited Author Award from the Royal Society of Chemistry (2021). Prof. Li's impactful contributions have established him as a leader in his field.

PRESENTATION:

Innovative Microfluidic-Based Progressive Sperm Sorting for Enhanced Assisted Reproductive Technology Outcomes

Assisted reproductive technology (ART) is an important invention for the treatment of human infertility, and the isolation of high-quality sperm with progressive motility is one of the most critical steps that eventually affect the fertilization rate. Conventional sperm separation approaches include the swim-up method and density gradient centrifugation. However, the quality of isolated sperm obtained from both approaches can still be improved by improving sorted sperm motility, minimizing the DNA fragmentation rate, and removing abnormal phenotypes. Here, we report a Progressive Sperm Sorting Chip (PSSC) for high-quality sperm isolation. Based on the rheotaxis behavior of sperm, a gradient flow field is created in the chip for progressive sperm sorting. Clinical experiment results for 10 volunteers showed that greater than 90% of isolated sperm exhibit high motility (> 25 μm/s), high linearity (0.8), and a very low DNA fragmentation rate (< 5%). In addition, the whole process is label and chemical free. These features aid in gentle sperm sorting to obtain healthy sperm. This device uniquely enables the selection of high-quality sperm with progressive motility and might be clinically applied for infertility treatment in the near future.

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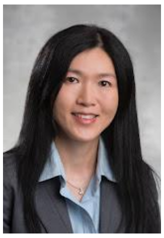

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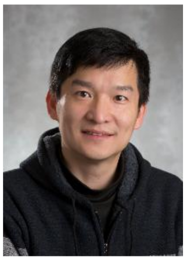

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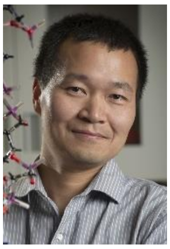

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