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ICSE 2024

19 - 21 August 2024 | Kuala Lumpur, Malaysia

2024 IEEE International Conference on

Semiconductor Electronics

PROGRAM BOOK

19 - 21 August 2024 | Grand Millenium, Kuala Lumpur

The 16th ICSE

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CONFERENCE PROGRAM SUMMARY

Monday, 19th August 2024 DAY 1		
Time	**Millennium Ballroom**	**Millennium IV,V,VI**
08:30 - 09:00	Registration	
09:00 - 10:05	***Session 1A: Device modeling, simulation and design***	***Session 2A: Opto-electronics and photonics technology***
10:05 - 10:20	Coffee Break	
10:20 – 10.50	KEYNOTE : **Prof Dr. Patrick Fay, University of Notre Dame, USA**	KEYNOTE : **Mr. Andree Wibowo, Microlink Devices, USA**
10:50 - 11:45	Opening Ceremony & MOU signing	
11:45 - 12:45	PLENARY SPEAKER: **Prof. Dr. Edward Yi Chang, National Yang Ming Chiao Tung University (NYCU), Taiwan**	
12:45 - 14:00	Lunch Break and Networking	
14:00 - 15:00	PLENARY SPEAKER : **Prof. Dr. Hiroshi Iwai, National Yang-Ming Chiao Tung University (NYCU), Taiwan**	
15:00 - 16:05	***Session 1B: Device modeling, simulation and design***	***Session 2B: Opto-electronics and photonics technology***
16:05 - 16:20	Coffee Break	
16:20 - 17:10	***Session 1C: Device modeling, simulation and design / Device physics and characterization***	***Session 2C: Opto-electronics and photonics technology***
17:10 – 17:40		KEYNOTE : **Prof Dr. Sufian Jusoh, Universiti Kebangsaan Malaysia**
17:40	End of Day 1	
Tuesday, 20th August 2024 DAY 2		
Time	**Millennium Ballroom**	**Millennium IV,V,VI**
08:30 - 09:00	Registration	
09:00 - 10:20	***Session 3A: Electronics Materials / Device Fabrication***	***Session 4A:MEMS/NEMS***
10:20 - 10:35	Coffee Break	
10:35 - 11:35	PLENARY SPEAKER : **Dr. David Lacey, Director ADS R&D ams-OSRAM**	
11:35 – 11:50	SPONSOR TALK: **Mr. KY Tay, Director, Hi-Tech Instruments**	
11:50 - 12:40	***Session 3B: Device modeling, simulation & design /Device physics & charact.***	***Session 4B: Electronics Materials /Process technology / IC Packaging***
12:40 – 14:00	Lunch Break and Networking	
14:00 - 14:45	***Session 3C: Device modeling, simulation & design /Device physics & charact.***	***Session 4C: Electronics Materials /Process technology / IC Packaging***
14:45 - 15:00	Coffee Break	
15:00 - 15:30	Networking 1	
15:30	End of Day 2	
Wednesday, 21st August 2024 DAY 3		
09:00 - 10:20	Networking 2	
10:20 - 10:35	Coffee Break	
10:35 - 11:00	SPONSOR TALK: **CADFEM Ansys & iLab**	
11:00 – 12:30	Closing Ceremony and Awards	
12:30 – 14:00	Lunch Break	
	End of Program	

ICSE 2024

19 - 21 August 2024 | Kuala Lumpur, Malaysia

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Venue: Millennium Ballroom & Millennium 456,
Level 2, Grand Millennium Hotel, Kuala Lumpur, Malaysia

Message from ICSE2024 Conference Chair

S*elamat Datang* to Kuala Lumpur and ICSE2024.

On behalf of the organizing committee, it is with great pleasure to welcome you to the 16th IEEE International Conference on Semiconductor Electronics 2024 (ICSE2024). Over the last thirty-two years, ICSE has become the preeminent international forum on semiconductor electronics embracing all aspects of semiconductor technology from circuit devices, modeling and simulation, photonics and sensor technology, MEMS technology, process and fabrication, packaging technology and manufacturing, failure analysis and reliability, materials and devices, and nanoelectronics.

This time, the conference offers four keynote lectures by distinguished persons in their own fields and 52 oral presentations, which include 10 invited papers contributed by participants from academia. We are also giving away Best Paper Awards and Best Student Presenter Awards. In this year's conference, we are proud to have as the Plenary Speakers Prof. Dr. Edward Yi Chang (National Yang Ming Chiao Tung University, Taiwan), Prof. Dr. Hiroshi Iwai (International College of Semiconductor Technology (ICST), National Yang-Ming Chiao Tung University (NYCU), Taiwan), and Dr. David Lacey (ADS R&D ams-OSRAM).

The conference proceedings provide views into the current advances in semiconductor electronics in the region and we look forward to the presentations of our participants. We hope participants will appreciate the knowledge imparted by the lectures.

To all participants, I hope we can gain knowledge and benefits from the conference while making new contacts with other participants. To participants from overseas, I wish you a pleasant stay in this country and we will endeavor to make your stay here enjoyable.

Terima kasih.

Prof. Dato' Dr. Burhanuddin Yeop Majlis, SMIEEE
Chair, 16th IEEE International Conference on Semiconductor Electronics

Message from 2024 IEEE EDS Chair

Assalamualaikum warahmatullahi wabarakatuh.

Dear esteemed Guests, Distinguished Participants, and Honoured Sponsors,
We are delighted to extend our warmest welcome to all of you to the IEEE International Conference on Semiconductor Electronics 2024 (ICSE 2024). This year, 2024, is the first time after the COVID-19 pandemic we are able to organise a physical event, and hopefully the event will run smoothly. ICSE 2024 brings together exceptional participants, including esteemed lecturers, industry engineers, and researchers from various disciplines, each contributing their expertise to the pursuit of innovative engineering solutions. This vibrant convergence of minds promises to inspire ground-breaking ideas and set new benchmarks for progress in the field of engineering.

On behalf of the organizing committee, we thank you for your active participation in ICSE 2024. Your strong, continuous support in selecting ICSE 2024 as the platform to publish your latest research in semiconductor electronics is greatly appreciated. During the 3-day conference, 52 oral presentations will be delivered across a broad spectrum of technical sessions. These include three keynote speakers: Prof. Dr. Patrick Fay (University of Notre Dame, USA), Mr. Andree Wibowo (Microlink Devices, USA), and Prof. Dr. Sufian Jusoh (Universiti Kebangsaan Malaysia).

This is the 16th ICSE organized by the Electron Devices Chapter of IEEE Malaysia Section and technically co-sponsored by the IEEE Electron Devices Society. Over the last thirty years, the ICSE conference series has become the prominent international forum on semiconductor electronics, embracing all aspects of semiconductor technology under four main clusters, which are Devices, Nanophotonics, IC Design and Manufacturing, and Material, Process, and Products.

As we embark on this remarkable journey of the IEEE International Conference on Semiconductor Electronics 2024 (ICSE2024), we express our profound gratitude to all participants, sponsors, and collaborators for their unwavering support in realizing this exceptional event. Together, let us pave the way for a resilient, sustainable, and transformative future through pioneering solutions. Finally, I hope that ICSE2024 will be successful and enjoyable for all participants.

Thank you and *Terima kasih.*

Dr. Hazian Mamat
Chairman
2024 IEEE EDS Malaysia Chapter

Message from the Director of Institute of Microengineering and Nanoelectronics (IMEN)

Assalamualaikum warahmatullahi wabarakatuh,

On behalf of the Institute of Microengineering and Nanoelectronics (IMEN), UKM, as the co-organizer, it is with great pleasure that we welcome you to the 2024 IEEE International Conference on Semiconductor Electronics (ICSE2024). The vision and mission of IMEN are in line with the objectives of this conference.

As a result of the excellence of IMEN's research throughout 2023, IMEN received approval for UKM's 2024 Development allocation fund in November 2023. This will be used to develop a National Nanofabrication Center, with a budget of RM11,400,000.00, granted by the Malaysian Ministry of Higher Education (MoHE). This center will be dedicated to the field of semiconductor electronics.

IMEN is a leader in the semiconductor industry and has cooperated with various industry players both within and outside of Malaysia since its establishment in 2002. The semiconductor industry contributes significantly to the socio-economy, providing thousands of job opportunities in various disciplines, especially science, technology, and engineering. The Semiconductor Industry Symposium & Showcase 2024, organized by IMEN UKM and held on 28 May 2024, was a collaborative effort to bridge the gap between academia and industry, foster innovation, and prepare the next generation of semiconductor leaders.

Another upcoming center of excellence within IMEN is the Semiconductor Manufacturing Industry Technology Center. This center will serve as a platform for showcasing the excellence of the semiconductor industry manufacturing sector in collaboration with academia, particularly UKM. Existing collaborations with industry partners like Western Digital and Infineon, as well as NGO organizations such as the IEEE Electron Devices Society (EDS), have had a significant impact on UKM in education and research. These collaborations will further contribute directly to the dynamics of the semiconductor industry ecosystem in Malaysia.

IMEN also has a STEM program called the IMEN Junior Electronics and Nanotechnology (IJEN), which focuses on secondary and primary school students to attract the interest of the younger generation in the STEM field. We have received the MOSTI STEM Development Fund of RM28,750 from the Ministry of Science, Technology and Innovation (MOSTI) in conjunction with National Science Week 2024. This program will be held virtually and is open to all students throughout Malaysia on 17 and 18 September 2024. Kindly visit the IMEN booth at ICSE2024 for more information.

As the Director of IMEN, I am very proud to state that most of the IEEE EDS and ICSE organizers and participants are alumni of IMEN and UKM. Last but not least, I would like to thank all the committee members for their hard work and commitment in making this 16th ICSE a reality.

Prof. Dr. Ahmad Rifqi Md Zain
Director
Institute of Microengineering and Nanoelectronics

ABOUT THE ORGANIZERS

IEEE is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity. IEEE and its members inspire a global community through its highly cited publications, conferences, technology standards, and professional and educational activities.

The EDS field-of-interest includes all electron and ion based devices, in their classical or quantum states, using environments and materials in their lowest to highest conducting phase, in simple or engineered assembly, interacting with and delivering photo-electronic, electro-magnetic, electromechanical, electro-thermal, and bio-electronic signals. The Society sponsors and reports on education, research, development and manufacturing aspects and is involved in science, theory, engineering, experimentation, simulation, modeling, design, fabrication, interconnection, reliability of such devices and their applications.

The Institute of Microengineering and Nanoelectronics (IMEN) was officially established in November 2002. The Institute is a strategic initiative for pursuing multidisciplinary research on Microengineering, Nanoelectronics, and Nanotechnology, providing a national R&D center for Malaysia in this area. IMEN research seeks to develop enabling technologies and systems for strategic applications.

The Human Resources Development Fund (HRDF) was established under the legal requirements of the Human Resources Development Act 1992 (currently known as Pembangunan Sumber Manusia Berhad Act 2001 (PSMB)). The PSMB Act, 2001 is to provide for the imposition and collection of a human resources development levy for the purpose of promoting the training and development of employees, apprentices, and trainees, the establishment and the administration of the Fund by the Corporation, and for matters connected therewith.

PLENARY SPEAKER

Title: E-mode GaN HEMT with Ferroelectric Gate Material for EV and PV Applications

Prof. Dr. Edward Yi Chang, Dean of the International College of Semiconductor Technology (ICST), National Yang-Ming Chiao Tung University (NYCU), Taiwan

Abstract: AlGaN/GaN high-electron-mobility transistors (HEMTs) have high saturation velocity, high mobility, and high current density with a high breakdown electric field, which make them promising for next-generation high power and high frequency device applications. However, AlGaN/GaN HEMTs always demonstrate normally-on operation, which is not desirable for electrical vehicle applications due to safety concerns. To achieve normally-off operation for GaN HEMT devices, several methods have been proposed to achieve high positive threshold voltage. For example, p-GaN, recessed-gate, and fluorine-treated AlGaN technologies have been demonstrated. In this work, a new charge storage structure with a hybrid ferroelectric charge-trapping gate stack is used to realize the GaN E-mode MIS-HEMT for power switching applications. This gate stack structure combines ferroelectric film with a charge-trapping layer and current blocking film, resulting in a polarization charge field against the applied gate voltage, and thus achieves a large positive shift of the threshold voltage. As a result, the device has a high Vth; meanwhile, low on-resistance, high I_(DS,MAX), and high breakdown voltage are maintained, perfect for EV applications.

Prof. Dr. Edward Y. Chang is a prominent materials scientist and engineer with a distinguished career in compound semiconductors for wireless communication and high-power electronics. He earned his B.S. from National Tsing Hua University in 1977 and his Ph.D. from the University of Minnesota in 1985. Prof. Chang worked on GaAs MMIC programs at Unisys Corporation and Comsat Labs before joining National Chiao Tung University (NCTU), which was later renamed National Yang-Ming Chiao Tung University (NYCU), in 1992.He played a key role in establishing Taiwan's first GaAs MMIC production line and served as president of Hexawave Inc.

Currently, Prof. Chang is the Dean of Dean of the International College of Semiconductor Technology (ICST), National Yang-Ming Chiao Tung University (NYCU), where he is also a professor in the Departments of Materials Science and Engineering and Electrical Engineering. He directs the Diamond Lab and the NYCU-TSMC Research Center. His research focuses on III-V/Siintegration, GaN-based materials, and advanced packaging for high-frequency and powerapplications. Prof. Chang is a Fellow of IEEE and the Taiwanese Materials Society, and has received numerous awards for his contributions to academia and industry.

PLENARY SPEAKER

Title: Past, present, and future of integrated circuits technologies and their development

Prof. Dr. Hiroshi Iwai, Vice Dean and Distinguished Chair Professor, International College of Semiconductor Technology (ICST), National Yang-Ming Chiao Tung University (NYCU), Taiwan

Abstract: What will be the progress of integrated circuit technology after reaching the limits of miniaturization and 3D integration?Firstly, even after reaching these limitations, it will take a considerable amount of time for the technology to mature and achieve optimization. The development of technology optimization, including cost reduction, will continue in the future.Furthermore, with the advancement of systems in the era of hyperintelligence, new application fields for integrated circuits will expand, and there will be a growing demand for higher performance and functionality. It is believed that optimization for specific applications and the development of new technologies will increase in the future. Currently, in various semiconductor fields, not only logic but also memory, communication, power control, and others, optimization for specific applications has not been fully achieved. From this perspective, even after reaching the limits of miniaturization and 3D integration, the development of semiconductor integrated circuits and the associated technological advancements will continue to progress. Over the long term, spanning beyond centuries, it is expected that ICT technology will advance to an unprecedented level by integrating not only semiconductors but also living tissues, organs, or even entire organisms such as nerve cells and brains, with semiconductor devices. This integration will lead to the development of ICT technologies that surpass anything seen before. As a result, a new intelligent society will be created, bringing about unparalleled evolution.However, it is crucial to remain mindful of the potential threats posed by Al to humanity and the ethical considerations when dealing witt living organisms. In this lecture, I will provide explanations of the history, current state, and future of ICT technology and integrated circuit technology. I will also delve into the background and process of technological innovations that have been made, as well as the directions following technological limits and limitations.

Professor Iwai is a renowned semiconductor device engineer with over 50 years of experience, contributing significantly to the miniaturization of LSIs and the advancement of integrated circuit technologies. He earned his BE and Doctor of Engineering degrees from the University of Tokyo in 1972 and 1993, respectively. His groundbreaking work includes developing Toshiba's first NMOS LSI technology in 1975, pioneering stepper lithography and dry processing for 64k bit DRAM in 1980, and achieving 40 nm CMOS miniaturization in 1993, well ahead of industry standards.

In the mid-1990s, he developed the world's first 0.15 μm RFCMOS technology, laying the foundation for Bluetooth. Professor Iwai has been actively involved with IEEE and EDS, serving as IEEE EDS president and the first IEEE EDS eminent lecturer. He is currently Vice Dean and Distinguished Chair Professor at National Yang Ming Chiao Tung University and Professor Emeritus at Tokyo Institute of Technology. He is a Life Fellow of IEEE, and a Fellow of ECS, JSAP, IEICE, and IEEJ.

PLENARY SPEAKER

Title: Game Changing Semiconductor Technologies - High Power, Miniaturized and Smart LEDs

Dr. David Lacey, Director ADS R&D ams OSRAM

Abstract: With a strong background in academics and research, Dr. David Lacey has two-and-a-half decades of experience in the semiconductor industry, specifically in producing and enhancing organic and inorganic lighting solutions. With 24 publications and about a dozen patents under his belt, Dr. Lacey's foray into innovation stretches across multiple fields; from creating new devices to enhancing the durability and robustness of safety encapsulations to coming up with new methods of increasing production volume in efficient ways. In the area of new device creation, Dr. Lacey holds patents in creating electroluminescent devices, organic light-emitting components comprising an electroluminescent layer and an optoelectronic component including a flexible carrier strip and an optoelectronic semiconductor chip. A large area of his focus over the years has also been centred on the bettering of the protective encapsulation for electronic components, making them less susceptible to damage from moisture and external influences. His patents in this area include the invention of a lead frame for a radiation-emitting component containing a protective layer for the reflective coating and enhancing protective encapsulation for electronic components, particularly electro-optical or optoelectronic components such as an organic light emitting diode (OLED), and producing such products efficiently by reshaping the encapsulation element using heat. They also cover the creation of an electroluminescent device having a protection layer in the cap bonding region that protects the layers below from damage during removal of polymer materials. Aside from that, Dr. Lacey has created different methods of superimposing a plane encapsulation element and a drying agent on top of each other as well as a method of encapsulating an OLED by producing the organic optoelectronic component on a substrate wherein the organic optoelectronic component has an active region and regions with contact pads or scribe / rupture regions. He has also contributed in the improving of encapsulation for electroluminescent devices in relation to homogeneous or uniform deposition of active organic materials.

Dr Lacey obtained his DPhil in Chemistry/Materials Science from the University of Sussex, UK and has held R&D, Engineering and Business responsibilities in semiconductor manufacturing companies across Europe, USA and Asia. He has more than 30 years experience in semiconductor & display technology development & manufacturing, in both start-up and multi-national environments. He has been based in Malaysia since 2001 and is currently Chairman of FREPENCA - the Penang Trade Zone Companies Association & President-elect of SFAM - the Semiconductor Fabrication Association of Malaysia. He was one of the exco committee members involved in the earlier phase of conceptualisation and inception of CREST since March 2012. Dr. Lacey was bestowed with an honorary Doctor of Science by Universiti Sains Malaysia at the Arau Palace in 2021, an accolade reflecting his profound impact on advancing LED technologies and expanding opportunities in Malaysia.

KEYNOTE SPEAKERS

PROF DR. PATRICK FAY

KEYNOTE 1

Title: Advances in Electric Field Control and Exploitation in III-N High-Performance Electronic Devices

Patrick Fay specializes in the design, fabrication, and characterization of microwave, millimeter-wave, and power electronic devices. His recent research focuses on polarization-engineered III-N heterostructures, ferroelectric-augmented III-N devices for RF/mm-wave switching, and wide/ultra-wide band gap semiconductors for RF and high-power applications. He also explores micromachining for RF to sub-millimeter-wave packaging. Fay founded the High Speed Circuits and Devices Lab at Notre Dame, which features device and circuit characterization up to 1 THz. He directed the creation of a 9000 sq. ft. cleanroom in Stinson-Remick Hall and has led it since 2003. An IEEE Fellow and Distinguished Lecturer, he has published 11 book chapters and over 400 scientific articles.

MR. ANDREE WIBOWO

KEYNOTE 2

Title: High Volume Production of High Efficiency Solar Arrays

Mr. Andree Wibowo, Vice President of Corporate Strategy joined MicroLink Devices in 2001 after receiving his B.S in Chemical Engineering from University of Wisconsin at Madison. He has over 20 years experience in the compound semiconductor industry specifically in MOCVD systems and volume manufacturing of GaAs materials including HBT and solar cells. Mr. Wibowo was responsible for transitioning HBT and BiFET devices from R&D to volume manufacturing, successfully earning ISO 9001:2000 certification for high-volume production at MicroLink Devices. In this capacity, he was responsible for establishing solar cell epitaxy production expansion of lightweight, high efficiency solar cells for space and terrestrial application. Mr. Wibowo obtained an MBA from the University of Chicago in 2012,

PROF. DR. SUFIAN JUSOH

KEYNOTE 3

Title: Asean: From Technology Adopted to Technology Frontrunner

Professor Dr. Sufian Jusoh is the Director and Professor of International Trade and Investment at the Institute of Malaysian and International Studies (IKMAS) at Universiti Kebangsaan Malaysia. A globally recognized expert in international trade, ASEAN integration, and development, he advises for UNESCAP, the World Bank, and ERIA. He co-founded the ASEAN Economic Integration Forum and played a pivotal role in Malaysia's APEC 2020 chairmanship. Sufian has led investment policy reforms in several countries, including Bangladesh and Malaysia. He holds an LL.B from Cardiff, an LL.M from University College London, and a Doctor of Law from the University of Bern. He is also a Barrister-at-Law of Lincoln's Inn and a member of Churchill College, Cambridge.

TECHNICAL PROGRAM

KEYNOTE ABSTRACTS

Monday, August 19, 10:20 - 10:50 (Asia/Kuala Lumpur)

KEYNOTE 1: Prof. Dr. Patrick Fay (Session 1A)

Session Chair: P. SusthithaMenon (Universiti Kebangsaan Malaysia & Institute of Microengineering and Nanoelectronics (IMEN), Malaysia)

TITLE: *Advances in Electric Field Control and Exploitation in III-N High-Performance Electronic Devices.*

Prof Dr. Patrick Fay, Department of Electrical Engineering, University of Notre Dame, Notre Dame, USA.

Abstract: Wide bandgap III-N semiconductors are promising for electronic devices operating at high power levels and in harsh environments due to the combination of their excellent carrier transport properties and the ability to operate at high internal electric fields. However, the performance of many current-generation devices is below the fundamental performance limits expected from the material properties. This can be addressed through novel device design concepts. In this talk, recent work on polarization-graded structures for performance enhancement in mm-wave HEMTs, cost-effective edge termination strategies for vertical power devices, and devices exploiting impact ionization and avalanche in GaN will be reviewed. For example, the use of polarization-grading has been shown to decrease the peak electric field in the channel, increase the breakdown voltage, and improve the power scaling of III-N based HEMTs, without the use of field plates that limit high-frequency performance; experimentally-validated power-added efficiency of 50% at 94 GHz has been achieved. In vertical devices, device high-field operation is often limited by edge effects; we report a strategy for edge termination that provides a large process window that is tolerant of both fabrication processing and epitaxial layer thickness and doping variations, and enables robust avalanche operation to be achieved in practice. In addition to increased breakdown voltage, the ability to harness impact ionization and avalanche for device functionality is also critical for avalanche photodiodes and negative-resistance oscillators such as IMPATT diodes. We report the recent demonstration of experimentally-measured negative resistance at microwave frequencies from GaN-based IMPATT diodes, illustrating direct exploitation of the high-field operation of GaN pn junctions for advanced functionality.

Monday, August 19, 10:20 - 10:50 (Asia/Kuala Lumpur)

KEYNOTE 2: Mr. Andree Wibowo (Session 2A)

Session Chair: Bernard Kee Weng Lim (Sandcomm Sdn Bhd, Malaysia)

TITLE: *High Volume Production of High Efficiency Solar Arrays.*

Mr. Andree Wibowo, Microlink Devices, USA.

Abstract: MicroLink Devices began the investigation of Epitaxial Lift Off (ELO) of solar cells in 2007. The initial work was funded by NSF where a stack of solar cells separated by multiple release layers was proposed. The results from this investigation indicated that it was not possible to perform multiple lift-offs simultaneously due to the great difficulties in handling ultrathin semiconductor layers. The work then progressed towards a single large wafer 4-inch GaAs lift off with a high-efficiency inverted metamorphic solar cell device (IMM). There was a large solar cell initiative (Solar America Initiative) which funded numerous solar cell technologies, and MicroLink was selected for IMM solar cells for CPV applications. The Solar America initiative enabled MicroLink to further advance the IMM technology where many of the key problems on the high-efficiency IMM solar cells were solved. Large interest was generated from our large area IMM solar cells which drove numerous programs from many funding agencies. The additional funding enabled MicroLink to produce an array of solar cells, where they were integrated with bypass diodes and interconnects and packaged. One of the very first applications of our solar arrays was to increase the endurance of small electric UAVs where solar arrays were attached to the top surface of the wing. This enabled the UAV to double its endurance in comparison to a standard UAV that is operating on battery alone. This effort led to the integration of MicroLink's solar array onto a stratospheric UAV (Airbus Zephyr) where specific power (W/kg) is the key metric to enable true stratospheric operation throughout its entire mission. Currently, the solar arrays for Zephyr have reached TRL 9 and are in production. MicroLink is in the process of transitioning the standard Zephyr solar arrays towards Space satellites and is currently undergoing qualification.

Monday, August 19, 17:10 - 17:40 (Asia/Kuala Lumpur)

KEYNOTE 3: Prof. Dr. Sufian Jusoh (Session 2C)

Session Chair: Ahmad Sabirin Zoolfakar (Universiti Teknologi MARA, Malaysia)

TITLE: *ASEAN: Building a Technology Frontrunner Generation*

Professor Dr Sufian Jusoh, Universiti Kebangsaan Malaysia

Abstract: The Association of Southeast Asian Nations (ASEAN) is embarking on a new regional integration plan, i.e., the ASEAN Vision 2045. According to the ASEAN Secretariat, there are about 213 million youths in ASEAN in 2021, which is about 30 percent of the population. The youths in 2025 will be the leaders of ASEAN and instrumental for the ASEAN Community Building in the next 20 years. Evidence from countries like India, Korea, and Singapore shows that they have benefited from the technology transfer of hardware and software elements of technology, through a collaborative process that allows scientific findings, knowledge, and intellectual property to flow from creators such as universities and research institutions to public and private users. Technology transfers coupled with domestic-driven innovations by local talents have turned Korea and Singapore into leading technology creators and frontrunners, whereas Malaysia and Vietnam remained as technology adopters. Moving forward to the ASEAN 2045, ASEAN Member States and the youths must be ready to turn ASEAN into a technology frontrunner, instead of a technology adopter. This is to support ASEAN's vision to become a major player in trade, investment, and innovation in advanced and digital technologies.

PROCEEDING ABSTRACTS

Monday, August 19, 09:00 - 10:05 (Asia/Kuala Lumpur)

Session 1A: Device modeling, simulation and design

Session Chair: Azrif Manut (Universiti Teknologi MARA Shah Alam, Malaysia)

9:00 *Development of a PVT Verification Methodology for Robust Ultra-Low Power Dynamic Comparators (Invited Paper)*

Julie Roslita Rusli (Universiti Kuala Lumpur British Malaysia Institute, Malaysia); Suhaidi Shafie (UPM, Malaysia); Wan Zuha Wan Hasan and Mohd Amrallah Mustafa (Universiti Putra Malaysia, Malaysia); Izanoordina Ahmad (University Kuala Lumpur- British Malaysian Institute, Malaysia); Roslina Mohd Sidek (Universiti Putra Malaysia, Malaysia); Hasmayadi Abdul Majid (SMD, Malaysia); Haslina Jaafar (Universiti Putra Malaysia, Malaysia)

Abstract: Variations in oxide thickness and dopant concentration during the fabrication process pose significant challenges to achieving high manufacturing yield for high-resolution successive approximation register (SAR) ADCs. These variations can lead to metastability errors, impacting the overall performance and reliability of the converters. The comparator, essential for quantifying the least significant bit (LSB) in a SAR ADC, must be designed to withstand these fabrication variations. Hence, alongside functionality, the comparator circuit design must also withstand Process, Voltage, and Temperature (PVT) variations, which are crucial for high manufacturing yield. This paper proposes a verification method for evaluating a proposed double-tail dynamic comparator circuit's performance in practical settings. It details a dedicated test scheme to detect and validate worst-case input voltage transitions across 45 PVT corner simulations, considering variations in VDD, operating temperature, and fabrication processes. The proposed PVT test scheme has been validated on both the JRR1 comparator and the conventional double-tail comparator, successfully identifying metastability errors occurring in specific 45-test corner simulations.

9:20 *Analysis of the Electrical Characteristics for Compact SPICE Modelling of STT-MTJ Device with Physical Parameters Variation*

Nurul Ezaila Alias, Melanie Yi Xuan Pai, Michael Loong Peng Tan and Afiq Hamzah (Universiti Teknologi Malaysia, Malaysia); Yasmin Abdul Wahab (Universiti Malaya, Malaysia); Maizan Muhamad (Universiti Teknologi MARA, Malaysia)

Abstract: STT-MRAM (Spin-Transfer Torque Magnetoresistive Random Access Memory) operates on the principle of magnetic anisotropy energy to retain information and magnetoresistance to retrieve information. STT-MRAM consists of an MTJ (Magnetic Tunnel Junction) and a transistor device. The MTJ comprises two layers of ferromagnetic metal separated by an insulator. A major concern in evaluating STT-MRAM technology is developing a scalable MTJ compact model capable of incorporating real variable effects across numerous technical nodes. Therefore, this work involves simulating the compact SPICE modeling of the STT-MTJ device at the device level using a mathematical model and a SPICE subcircuit to analyse the electrical characteristics. The I-V characteristics of parallel and anti-parallel orientations of the STT-MTJ are simulated. The parallel resistance (RP) and anti-parallel resistance (RAP) of the STT-MTJ device are varied from their original values to observe the I-V characteristic graph for each case. The I-V characteristics for different resistance values and variations in width and length are analysed. It is observed that the Tunneling Magnetoresistance (TMR) increases by 230.77% when the resistance for parallel current (IP) is reduced, whereas the TMR increases by 105.56% when the resistance for anti-parallel current (IAP) is reduced. Moreover, as the width and length of the Free Layer (FL) increase (by 222.22%), the write current for the MTJ also increases by 492.55%. The parameters used in the STT-MTJ can be adjusted for different MTJ materials to achieve higher performance efficiency.

9:35 *Methodology to Optimize E-Mode GaN HEMT with P-Type Doping under 2DEG Layer*

Affendy Muhammad Ridzwan (Universiti Kebangsaan Malaysia, Malaysia); Mohd Faizol Abdullah (MIMOS Semiconductor (M) Sdn Bhd, Malaysia); Amir Murtadha MohamadYussof (Universiti Kebangsaan Malaysia (UKM), Malaysia); Norazreen Abd Aziz (Universiti Kebangsaan Malaysia, Malaysia); Hing Wah Lee (Mimos Berhad, Malaysia)

Abstract: This article presents the methodology to optimize the enhancement-mode (E-mode) GaN high electron mobility transistor (HEMT). The focus is on the recessed Schottky gate with a p-type GaN under the two-dimensional electron gas (2DEG) layer. Design of experiment 3 factors (tAlGaN, Lgate, PGaN) at 4 levels for technology computer-aided design (TCAD) simulation produced 2 responses (VT, RON). A total of 128 sets of observations are fed into the analysis of variance (ANOVA) and artificial neural network (ANN) models, where they narrowed down the list of potential optimum E-mode GaN HEMTs. The best device with tAlGaN = 4 nm, Lgate = 2 µm, and PGaN = 1.2 × 10^19 cm^-3 is predicted VT = 1.263 V and RON = 3.317 Ω. The verification by TCAD gives VT = 1.224 V and RON = 3.235 Ω, which is very close to the ANOVA-ANN prediction. The p-type GaN under 2DEG created a local GaN p-n junction that depletes electrons in 2DEG at thermal equilibrium.

9:50 *Effectiveness of the Heat Spreader in GaN HEMT Studied by a Co-Simulation Approach*

Amir Murtadha Mohamad Yussof (Universiti Kebangsaan Malaysia (UKM), Malaysia); Norazreen Abd Aziz (Universiti Kebangsaan Malaysia, Malaysia); Mohd Faizol Abdullah (MIMOS Semiconductor (M) Sdn Bhd, Malaysia)

Abstract: This article investigates thermal management via finite element analysis (FEA) software to scrutinize heat distribution in GaN HEMT devices within transistor packages. Various thermal management strategies, including chip-level and package-level heat spreader approaches, are examined. The simulation model is constructed based on a simplified GaN-on-Si HEMT structure, and the efficacy of Polycrystalline Diamond (PCD) as a heat spreader is assessed at different device locations. Results indicate that PCD exhibits superior thermal dissipation compared to alternative materials such as-

Silicon Carbide and Sapphire. Additionally, the Chip-level Substrate Heat Spreader (CSHS) approach, entailing the integration of PCD material at the substrate level, demonstrates optimal heat dissipation performance. Higher thermal conductivity values of PCD, notably 1200 W/mK, substantially enhance heat dissipation efficiency, offering a promising avenue for device performance optimization. In conclusion, this study underscores the significance of effective thermal management in GaN HEMT devices, emphasizing the effectiveness of PCD material and the CSHS approach in reducing thermal gradients and enhancing device reliability.

Monday, August 19, 09:00 - 10:05 (Asia/Kuala Lumpur)

Session 2A: Opto-electronics and photonics technology

Session Chair: Yasmin Abdul Wahab (Universiti Malaya, Malaysia)

9:00 ***OptimizingMethylammonium Tin Iodide-based Perovskite Solar Cellswith Different Hole Transport Materials (Invited Paper)***

Budi Mulyanti and Jahril Nur Fauzan (Universitas Pendidikan Indonesia, Indonesia); Chandra Wulandari (Institut Teknologi Bandung, Indonesia); Lilik Hasanah and Roer Eka Pawinanto (Universitas Pendidikan Indonesia, Indonesia)

Abstract: Perovskite materials still show great interest in solar cell applications due to their promising performance. Unfortunately, health and environmental risks are associated with using lead (Pb) in the primary material of perovskite solar cells. Therefore, lead (Pb) replacement materials are required to develop environmentally friendly solar cells due to their effectiveness. The efficiency value displayed still needs to be higher, so the development of lead-free solar cells still needs to be overestimated. Methylammonium tin iodide (MASnI3), a lead-free perovskite, is a viable substitute for lead halide-based solar cells due to its stability, non-toxicity, and impressive efficiency. The simulation was carried out using the Solar Cell Capacitance Simulator (SCAPS-1D), using the AM 1.5G spectrum. The main goal of this research is to optimize the hole transport layer materials to achieve high power conversion efficiency (PCE) with MASnI3. Organic and inorganic HTL such as CBTS, PEDOT:PSS+WO3, Spiro-OMeTAD, P3HT, CuSBS2, Cu2O, CuSCN, NiO, CuI, MoOx, SrCu2O2, CuAlO2, and PTAA are required in our simulations. These materials were selected to explore their potential in optimizing device performance due to their distinct properties, such as conductivity, stability, and compatibility with MASnI3. Regarding HTM performance for device construction, our modelling results indicate that the 100 nm CuSBS2 layer works better. We have found that by using the configuration of ITO/TiO2/MASnI3/CuSBS2/Au, a PCE of 27.67% with a Voc of 0.97 V can be achieved.

9:20 ***Effect of pH on Electrochemical, Morphological and Optical Properties of Electrodeposited Molybdenum Sulfide Thin Film***

Iskandar Dzulkarnain Rummaja (Universiti Teknikal Malaysia Melaka (UTeM), Malaysia); Muhammad Idzdihar Bin Idris (FKEKK, Universiti Teknikal Malaysia Melaka, Malaysia); Zul Atfyi Fauzan Mohammed Napiah (Universiti Teknikal Malaysia Melaka (UTeM) & Centre for Telecommunication Research& Innovation (CeTRI),Malaysia); Radi Husin Ramlee (Universiti Teknikal Malaysia Melaka, Malaysia); Marzaini Rashid (Schoolof Physics, Malaysia); Ahmad Muhajer AbdulAziz (Universiti Teknikal Malaysia Melaka, Malaysia)

Abstract: Third-generation dye-sensitized solar cells (DSSC) provide many benefits over ordinary solar cells. DSSCs efficiently convert visible light into electrical energy and work well in low-light environments. Platinum is a common counter electrode due to its electrocatalytic, conductivity, and reflection properties. Due to its drawbacks, alternative counter electrode materials have been explored. The potential counter electrode of DSSC is molybdenum sulphide (MoS2), an inorganic compound of molybdenum and sulphur which has good properties in terms of electrochemical properties and long-term stability. Electrodeposition is one of the deposition techniques used in thin film deposition. Due to several challenges in thin deposition techniques with control over film properties, complexity, and cost, electrodeposition is a good alternative due to its cost-effectiveness, simplicity, and deposition control. In this work, we studied the effect of deposition electrolyte condition (acidic, neutral, alkaline) on the electrochemical, morphological, and optical properties of molybdenum sulfide thin film. Overall, the study reveals that MoS2 films exhibit good hydrogen evolution reaction (HER) activity at pH 6 and pH 8, with pH 6 showing the highest performance, while also indicating minimal variation in grain size across different pH levels and highlighting the influence of pH on optical and electronic properties.

9:35 ***Early detection of hyperuricemia using hybrid Au-ZnO biosensor and Kretschmann-based SPR at visible optical wavelengths***

Muhammad Feidhul Hakim Bin Fatah Yasin, Abdul Halim Abdul Gafor, Noraidatulakma Abdullah and Lee Pey Yee (Universiti Kebangsaan Malaysia, Malaysia); Syara Kassim (University Malaysia Terengganu, Malaysia); Affa Rozana Abdul Rashid (USIM, Malaysia); Kim S Siow (Universiti Kebangsaan Malaysia, Malaysia); Azrul A Hamzah (University Kebangsan Malaysia, Malaysia); Mohd Ambri Mohamed (Universiti Kebangsaan Malaysia (UKM), Malaysia); Siti Nasuha Mustaffa (IMEN, UKM, Malaysia); Nur Akmar Jamil (Universiti Kebangsaan Malaysia, Malaysia); P. Susthitha Menon (Universiti Kebangsaan Malaysia & Institute of Microengineering and Nanoelectronics (IMEN), Malaysia)

Abstract: This study explores surface plasmon resonance based on Kretschmann configuration as a rapid, highly sensitive, and impeccably accurate biosensor. Hyperuricemia is a form of disease that stems from an excessive amount of uric acid due to excessive purine-rich food consumption or insufficient excretion in the human body, hence the need for a reliable non-invasive sensor. Surface plasmon resonance techniques were proven as the best method as they offer label-free detection of biomarkers. Experimental work is done on Bionavis SPR-200 using Au-ZnO hybrid thin film as the sensing layer for uric acid level measurements. Rmin, full-width-at-half-maximum (FWHM), sensitivity, and Q-factor are calculated to determine the-

dependability of these layers as a sensing material. At 670 nm and 785 nm, respectively, the FWHM of Au-ZnO thin films produced in air is 1.271072° and 0.508751°, while their Rmin values are 0.08747 and 0.11343. For Au, we found Rmin values of 0.25817 at 670 nm and 0.17521 at 785 nm. At 670 nm and 785 nm, the computed FWHM is 2.530492° and 1.229111°, respectively. For uric acid sensing, Au-ZnO has a sensitivity of 0.05193°/mM for 670 nm and 0.04150°/mM for 785 nm. Q-factor obtained was 0.04085 mM-1 and 0.04787 mM-1 under 670 nm and 785 nm respectively. Lower detection limit of 0.5 mM was tested resulting in the best sensitivity of 0.0511°/mM using 670 nm wavelength.

9:50 ***Synthesis of Multi-Spike Gold Nanostar using the Surfactant-Free Method as LSPR Substrate Material***

Tita Oktavia Cahya Rahayu (Universiti Kebangsaan Malaysia, Malaysia); Izzah Hanaanah Ab Aziz (National University of Malaysia (UKM), Malaysia); Nur Hidayah Azeman, Tengku Hasnan Tengku Abdul Aziz and Mohd Suzeren Md Jamil (Universiti Kebangsaan Malaysia, Malaysia); Ahmad Rifqi Md Zain (UKM, Malaysia)

Abstract: Gold nanostars were synthesized by a surfactant-free wet-chemistry method. The UV-Vis spectra and surface morphology showed the formation of gold nanostars with average diameters of 20-30 nm and 100 nm including those spikes. From the EDX and AFM analysis, the sample has high purity (above 79 wt%) and was successfully deposited on ITO glass with a 100-300 nm thickness. These findings are important for various optical sensor applications. As an initial measurement, gold nanostar was promising to be used as an LSPR substrate material and applied to biosensors. Synthesis of gold nanostar and the initial optical performance using LSPR for creatinine detection is highlighted in this study.

Monday, August 19 15:00 - 16:05 (Asia/Kuala Lumpur)

Session 1B: Device modeling, simulation and design

Session Chair: SharifahFatmadiana Wan MuhamadHatta (University of Malaya, Malaysia)

15:00 ***Reliability Analysis of Multibridge Channel Field Effect Transistor (Invited Paper)***

Nurul Ezaila Alias (Universiti Teknologi Malaysia, Malaysia); Ganlin Huang (Universiti Teknologi Malaysia, UTM, China); Muhammad Naziruddin Hamzah and Michael Loong Peng Tan (Universiti Teknologi Malaysia, Malaysia); Hanim Hussin (Universiti Teknologi MARA, Malaysia); Yasmin Abdul Wahab (Universiti Malaya, Malaysia)

Abstract: In this paper, reliability studies of Positive Bias Temperature Instability (PBTI) characteristics in n-channel MBCFETs and Negative Bias Temperature Instability (NBTI) in p-channel MBCFETs are conducted. Similar to NBTI, PBTI is also a significant reliability issue in transistors. An analytical study of MBCFET concerning the degradation/shifting and recovery of threshold voltage (ΔVth) and on-current (ΔIon) by varying different device parameters such as channel length, stress voltage, and stress time was carried out before and after stress application. This project aims to provide extensive data on the degradation mechanism of PBTI and NBTI in MBCFETs. This is achieved by simulating the 12nm MBCFET's device structure and applying stress tests on the proposed device. Several sets of stress voltages ranging from -2 to -5V are applied to the gate terminal of p-MBCFETs for a stress time up to 900 seconds to observe NBTI degradation, and stress voltages ranging from +2 to +5V are applied to the gate terminal of n-MBCFETs for a stress time up to 900 seconds to observe PBTI degradation. NBTI degradation results in a notable Vth shift, ranging from 19.5mV to 31.6mV, attributed to a temporary trap charge, which is comparatively larger than PBTI. It exhibits a significant recovery effect over time, with a Vth shift due to a permanent trap charge ranging from 0.2mV to 0.6mV. In contrast, PBTI degradation induces a smaller Vth shift of about 4.4mV, with limited and prolonged recovery.

15:20 ***An investigation on the interplay between strain and defects on the thermal conductivity of monolayer graphene***

Dharma Darren Ram (Universiti Kebangsaan Malaysia, Malaysia); Muhammad Aniq Shazni Mohammad Haniff (Insititute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, Malaysia); Abdul Manaf Hashim (MJIIT, Universiti Teknologi Malaysia, Malaysia); Mohd Ambri Mohamed (Universiti Kebangsaan Malaysia (UKM), Malaysia).

Abstract: Strain engineering is rapidly gaining momentum as a method to tune the thermal properties of materials. We have performed extensive molecular dynamics studies on the thermal properties of defective monolayer graphene to understand its effects on its thermal conductivity. We have created a model of defective graphene and we have then applied a varying strain amount onto the graphene model in order to determine if it is possible to rectify the defect-induced thermal conductivity reduction. Using a Tersoff many-body potential, we have calculated the thermal conductivity of our model. Our results show a quantitative ability of strain to rectify thermal conductivity reductions up to a point. We have then explained this phenomenon using the models of phonon-phonon and phonon-defect scattering. We believe this research can be applied to different 2D materials and advance our understanding of thermal transport in these low-dimensional materials in heat management applications.

15:35 ***Biomimetic Microstructure Design for Superhydrophobic Structure in Triboelectric Nanogenerator Device***

Firdaus Jamal Rashid (Universiti Kebangsaan Malaysia, Malaysia); Abang Annuar Ehsan (Universiti Kebangsaan Malaysia & NXPhotonics, Malaysia); Muhammad Aniq Shazni Mohammad Haniff (Insititute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, Malaysia).

Abstract: Triboelectric nanogenerators (TENGs) convert kinetic energy into electrical charge, with liquid-solid TENGs utilizing the movement of water droplets for energy generation. To optimize efficiency, the surface must be superhydrophobic, inspired by the natural properties of taro leaves. These leaves exhibit contact angles exceeding 150°, indicating superhydrophobicity. By mimicking the unique surface structure of taro leaves, biomimetic technology has been developed to achieve similar properties. Using Field Emission Scanning Electron Microscopy (FESEM), the specific design responsible for these characteristics was analyzed. An equation derived from the Cassie-Baxter theory confirmed high contact angles, with the maximum observed angle of 168.45° achieved using a 10 µm cylindrical pillar diameter and a 30 µm distance between pillars. This study demonstrates that replicating the microstructure of taro leaves can effectively create superhydrophobic surfaces.

15:50 ***Unveiling the photovoltaic properties of ETL-free, lead-free, and graphene-based PSC.***

Nabilah Ahmad Jalaludin, Fauziyah Salehuddin, Faiz Arith, Anis Suhaila Mohd Zain, Khairil Ezwan Kaharudin and Siti Aisah (Universiti Teknikal Malaysia Melaka, Malaysia); Ibrahim Ahmad (Universiti Tenaga Nasional, Malaysia)

Abstract: The entire photovoltaic field has recently experienced significant achievement in perovskite solar cell (PSC) research with remarkable progress in device performance and power conversion efficiency (PCE). High-performance perovskite solar cells typically utilize n-i-p and p-i-n device structures, with separate electron transport layers (ETL) and hole transport layers (HTL), which are considered necessary components for effective photogenerated carrier extraction. However, conventional PSCs are sensitive to heat, humidity, and light, leading to prolonged instability. Herein, an ETL-free approach was investigated, combining lead-free methylammonium tin triiodide (MASnI3) as the absorber with graphene oxide (GO) as the hole transport layer. The study yielded notable results with a PCE of 17.94%. The insights revealed in this research have the potential to be applied in the development of cost-effective ETL-free PSCs with enhanced performance.

Monday, August 19 15:00 - 16:05 (Asia/Kuala Lumpur)

Session 2B: Opto-electronics and photonics technology

Session Chair: Maizatul Zolkapli (Universiti Teknologi MARA, Malaysia)

15:00 ***Kretschmann-based Surface Plasmon Resonance sensor using Au/Graphene for Glucose Detection (Invited Paper)***

Nur Akmar Jamil, Abdul Halim Abdul Gafor, Noraidatulakma Abdullah and Lee Pey Yee (Universiti Kebangsaan Malaysia, Malaysia); Syara Kassim(University Malaysia Terengganu, Malaysia); Kim S Siow (Universiti Kebangsaan Malaysia, Malaysia); Azrul A Hamzah (University Kebangsan Malaysia, Malaysia); Mohd Ambri Mohamed (Universiti Kebangsaan Malaysia (UKM), Malaysia); Muhammad Feidhul Hakim Bin Fatah Yasin (Universiti Kebangsaan Malaysia, Malaysia); P.

Abstract: Diabetes is a chronic condition characterized by high blood sugar (glucose) levels. Early and accurate detection of diabetes is crucial to prevent serious complications. Surface Plasmon Resonance (SPR) sensors offer a label-free, real-time approach to glucose detection. A hybrid layer Kretschmann-based SPR (K-SPR)sensor for detecting glucose is presented using a gold thin film and graphene layer (Au-Gr)over a BK7 prism at the visible-light interrogation. Our findings demonstrate an average sensitivity of 5.0 °/M and 3.9 °/M for detecting glucose levels ranging from 4 mM to 20 mM at 670 nm and 785 nm respectively. This study highlights the need for optical biosensing that convenient and patient-friendly method for diabetes management, prompting the development of non-invasive biosensors for early detection.

15:20 ***VCSELs-based Optoelectronics Transceiver for Free Space Photonics Packet Switching Network***

Clarence Augustine TH Tee, Hanbin Sun and W P Yeo (Zhejiang Normal University, China); Burhanuddin Yeop Majlis (Universiti Kebangsaan Malaysia, Malaysia); Muhamad Ramdzan Buyongand Ahmad Rifqi Md Zain (UKM, Malaysia); Le Song and Zheng Yelong (Tianjin University, China); Sheng Li (Zhejiang Institute of Optoelectronics, China)

Abstract: For the realization of a large packet switch with throughput in the range of Tera-to-Petabits/s, an optoelectronic transceiver is one of the crucial modules in the free space photonics link. Here, a novel high-speed and capacity free space optoelectronic communication transceiver of 850nm, single-moded and polarization-stable VCSELs, has been designed. The VCSELs transceiver with its driving interface system contains a dual operational amplifier with constant current source module and direct digital synthesizer (DDS) enabling high-frequency signal generation module up to 500MHz and beyond, for the realization of the specification for an optoelectronic switching module suitable for a packet router. The designed module could be scaled up for a throughput of 500 Gb/s and act as the basic building block for a larger switch with a throughput of 131 Tb/s.

15:35 ***Gold Nanorods as Plasmonic-based Optical Biosensor for Creatinine Detection***

Basyirah Zulkifli (Universiti Kebangsaan Malaysia, Malaysia); Ahmad Rifqi Md Zain (UKM, Malaysia); Tengku Hasnan Tengku Abdul Aziz, Nur Hidayah Azeman and Mohd Suzeren Md Jamil (Universiti Kebangsaan Malaysia, Malaysia)

Abstract: This work investigates the optical response of gold nanorods' localized surface plasmon resonance (LSPR) towards low-concentration creatinine biomarker. Utilizing the electrostatic adsorption from piranha substrate treatment, an adequate interparticle separation and uniform distribution of immobilized gold nanorods is obtained, allowing plasmon localization to be preserved for analyte sensing. The electrostatic interaction between the carbonyl group present in creatinine molecules with the cationic head group capping the AuNRs serves towards the adsorbate-induced sensing principle. The longitudinal LSPR mode shift yielded a linear relationship with increasing creatinine concentration, with sensitivity as high as 9.064 µm dL g-1 recorded. The limit of detection (LOD) and the limit of quantification (LOQ) of the biosensor are determined to be 0.645 mg/dl and 0.712 mg/dl, respectively.

15:50 ***Modeling of piezoelectric energy harvester: influence of electrode/piezoelectric width ratio on induced voltage***

Ghulam Ali, Feng Xu and Faisal Mohd-Yasin (Griffith University, Australia)

Abstract: Research in piezoelectric energy harvester (PEH) for powering micro-scale devices has been gaining momentum in the past decade. The modeling works are critical to accurately predict performances of PEH structures with different dimensions and active materials prior to expensive fabrication processes. In this paper, we perform static modeling of unimorph PEH in transverse mode. We derive equations for induced voltage, taking into consideration different widths between electrode and piezoelectric layers (referred to as width ratio). To illustrate the impact of this model, we plot the induced voltage versus input force and width ratio of PEH, employing five variants of Lead Zirconate Titanate (PZT) materials with parameters from commercial datasheets.

Monday, August 19, 16:20 - 17:40 (Asia/Kuala Lumpur)

Session 1C: Device modelling, simulation and design / Device physics and characterization

Session Chair: Maizan Muhamad (Universiti Teknologi MARA, Malaysia)

16:20 ***Investigation of TID effectson electrical characteristics of GaN MIS-HEMTwith LPCVD-grown SiN passivation (Invited Paper)***

Chih-Yi Yang, Chin-Han Chung, You-Chen WENG, Jui-Sheng Wu and Tsung-Ying Yang (National Yang Ming Chiao Tung University, Taiwan); Edward Chang (National Chiao Tung University, Taiwan)

Abstract: In this work, the advanced effect of Total Ionizing Dose (TID) on the performance of GaN on Si MIS-HEMT power devices with different SiN passivation layers is investigated. Samples with PECVD or LPCVD SiN passivation were exposed to different accumulated doses (100 krad and 400 krad) of Co60 γ-ray irradiation with grounded bias condition. The characteristics of the devices after the irradiation experiment were evaluated by measuring gate leakage current, VTH shift, on-resistance (RON), and dynamic RON. The advanced TID effect on GaN MIS-HEMTs with different dielectric layers is demonstrated to verify different mechanisms and their interactions. Simulations using PHITS were also carried out to further confirm the damages in the epitaxial structure by the accumulated dose.

16:40 ***The Effects of Al2O3 Interlayer on the Ferroelectric Behavior of Hf0.5Zr0.5O2 Thin Film for E-mode Ferroelectric Charge Trap Gate GaN HEMT***

Jui-Sheng Wu, Tsung-Ying Yang, You-Chen WENG, Chih-Yi Yang, Yu-Tung Du and Yi-Hsiang Wei (National Yang Ming Chiao Tung University, Taiwan); Edward Chang (National Chiao Tung University, Taiwan)

Abstract: In recent years, hafnium-zirconium oxide (HfxZr1-xO2) has gained attention for its ferroelectric properties, offering distinct advantages over traditional ferroelectric materials. Hafnium-zirconium oxide exhibits remarkable thinness, good remnant polarization, a wide bandgap, and could be deposited by atomic layer deposition (ALD) systems [1][2]. The compatibility of HfxZr1-xO2 thin film with semiconductor fabrication processes makes it an attractive candidate for memory materials, including ferroelectric random-access memory(FeRAM) and ferroelectric gate field-effect transistors (FeFET). Furthermore, the ferroelectric- charge-trapping gate stack has attracted a great deal of attention due to the concept of realizing E-mode operation for GaN- based HEMTs. C.-H. Wu et al. [3] realized a high Vth normally-OFF GaN HEMT with high drain current density by the implementation of a hybrid ferroelectric charge trap gate stack (FEG-HEMT), with a laminated Hf0.5Zr0.5O2 ferroelectric layer stacked on top of a charge trapping layer. The FEG-HEMT exhibits a higher positive Vth shift after charge injection, higher Vth stability, and reliable gate oxide with higher breakdown. To induce ferroelectricity in hafnium-zirconium oxide thin films, the prevailing approach involves high-temperature annealing with titanium nitride (TiN) capping layers to induce a phase transition, resulting in an orthorhombic structure with ferroelectric properties. However, experimental observations have revealed that during high-temperature processing, oxygen atoms tend to migrate, leading to the formation of titanium oxynitride (TiOxNy). The presence of TiOxNy has been associated with ferroelectric fatigue, compromising the material's reliability. This study focuses on investigating the impact of adding additional aluminum oxide (Al2O3) interlayers on the ferroelectric properties of hafnium- zirconium oxide (Hf0.5Zr0.5O2) thin films. Extensive characterization techniques were employed, including ferroelectric hysteresis measurements, pulse and negative voltage (PUND) measurements, X-ray diffraction (XRD) analysis, and transmission electron microscopy (TEM) analysis, to assess the influence of the aluminum oxide interlayer on the ferroelectric behavior and crystalline characteristics of hafnium-zirconium oxide.

16:55 ***Low Noise with High Linearity AlGaN/GaN HEMT Using Γ-Shaped Gate for Ka-Band Applications***

Howie Tseng, Neng-Da Li and Yueh-Chin Lin (National Yang Ming Chiao Tung University, Taiwan); MuYu Chen (National Yang Ming Chiao Tung University, Afghanistan); Edward-Yi Chang (National Yang Ming Chiao Tung University, Taiwan)

Abstract: In this study, AlGaN/GaN high-electron mobility transistors (HEMT) with Γ-shaped gate structure were developed and analyzed for Ka-band application. Under the frequency of 28 GHz, the proposed device exhibits a great minimum noise figure (NFmin) of 1.51 dB, which can be attributed to the enlarged cross-sectional area caused by the Γ-shaped gate structure. Besides, a high third-order intercept point (OIP3) value of 35.8 dBm is achieved, which results from the field plate structure of the Γ-shaped gate. The results prove that the AlGaN/GaN HEMT with Γ-shaped gate structure is capable of having great microwave noise performance and high linearity for Ka-band applications.

17:10 ***Threshold Voltage Instability of GaN HEMTs with Thin Barrier AlGaN Technology***

Tsung-Ying Yang, Jui-Sheng Wu, You-Chen WENG, Chih-Yi Yang and Edward-Yi Chang (National Yang Ming Chiao Tung University, Taiwan)

Abstract: In this work, the effect on threshold voltage (Vth) instability of AlGaN barriers using higher aluminum concentrations (29%) but only 5 nm will be discussed and compared to enhancement-mode (E-mode) devices using the gate recess process. The devices exhibit varying degrees of threshold voltage shift in the positive bias stress (PBS) test and the negative bias test (NBS) test. From the results, the FEG-HEMTs were able to have better Vth stability in the presence of PBS. In the case of NBS, the negative VG influence will lose the electrons stored in the charge trap layer and cause the Vth to be shifted more.

17:25 ***1kV Vertical Breakdown Voltage AlGaN/GaN HEMTs on Si with AlN and AlGaN/AlN Superlattice Buffer Engineering***

You-Chen WENG, Chih-Yi Yang, Tsung-Ying Yang and Chin-Han Chung (National Yang Ming Chiao Tung University, Taiwan); Chiang Tsung-Han (NYCU, Taiwan); Fu-ChingTung and Shih-Hsiang Lai (Industrial Technology Research Institute, Taiwan); Hung-Wei Yu and Edward-Yi Chang (National Yang Ming Chiao Tung University, Taiwan)

Abstract: In this study, we investigated the device characteristics of AlGaN/GaN High-Electron-Mobility Transistors (HEMTs) fabricated on 6-inch silicon substrates using AlN and an Al0.07GaN/AlN superlattice. Transmission electron microscopic imaging revealed a sharp interface between AlN and the Si substrate, which can reduce leakage from the Si. Additionally, it revealed a distinct interface between the AlGaN and AlN layers within the superlattice structure. The AlGaN/GaN HEMTs exhibited a vertical breakdown voltage of approximately 1000 V and maintained ultra-low leakage up to 700 V, with a three-terminal off breakdown voltage exceeding 1500 V. These results underscore the significant potential of both AlN and the AlGaN/AlN superlattice on silicon substrates for high-power switching applications.

Monday, August 19, 16:20 - 17:10 (Asia/Kuala Lumpur)

Session 2C: Opto-electronics and photonics technology

Session Chair: Hanim Hussin (Universiti Teknologi MARA, Malaysia)

16:20 ***Effect of Silver Nanotriangle Orientation on Localised Surface Plasmon Resonance Sensing Performance (Invited Paper)***

Muhammad Asif A. Khushaini (The National University of Malaysia, Malaysia); Ahmad Rifqi Md Zain (UKM, Malaysia); Nur Hidayah Azeman, Tengku Hasnan Tengku Abdul Aziz, Ahmad Ashrif A. Bakar and Basyirah Zulkifli (Universiti Kebangsaan Malaysia, Malaysia)

Abstract: Because of their strong plasmonic characteristics and great sensitivity, silver nanotriangles (AgNT) are extremely useful in localized surface plasmon resonance (LSPR) sensing applications. Among the fabrication techniques of AgNT, colloidal AgNTs not only offer a cheaper alternative but are also relatively easy to prepare. However, the disordered distribution of AgNTs in colloids has an impact on sensor reliability. In this study, using the FDTD simulation method, we demonstrate that the disorderly ensemble of AgNTs in colloids leads to uneven plasmonic properties. We also showed that the non-monotonic response of the LSPR sensor based on colloidal AgNTs may be contributed by the modal strong coupling phenomenon.

16:40 ***Comparative performances of 60nm and 80nm gold nanoparticles based mode-locker for erbium doped fiber laser***

Noor Zirwatul Ahlam Naharuddin (UMPSA, Malaysia); Mohd. Adzir b. Mahdi (Photonics Laboratory, Department of Computer, Malaysia); Maisarah Mansor (Sunway University, Malaysia); Nor Hadzfizah Mohd Radi and Rosyati Hamid (UMPSA, Malaysia)

Abstract: The study compared the optical performance of an erbium-doped fiber laser mode locker using gold nanoparticles (Au-NPs) sized at 60nm and 80nm as saturable absorbers (SAs). The approach involved applying a composite of Au-NPs with polydimethylsiloxane to a microfiber waveguide surface through spin coating. The resulting Au-NP-based SA was incorporated into a ring cavity erbium-doped fiber laser, and its lasing performance underwent assessment by comparing SA characteristics and pulse qualities for both Au-NP sizes. Beyond 60nm, the optical performance proved unsuitable for mode locker applications. This decline manifested in the shift of the central wavelength of the optical spectrum from approximately 1559nm to 1532nm and an increase in pulse duration from 940fs using 60nm Au-NPs SA to 1229fs using 80nm Au-NPs SA. The findings emphasize that the optimal size for Au-NPs, ensuring an efficient mode-locker, should not exceed 60nm. This discovery, to the best of our knowledge, has not been reported before and holds significant importance for tailoring ultrashort pulse output to specific system performance requirements.

16:55 ***Enhancing Localized Surface Plasmon Resonance Response for Albumin Detection by Optimizing the Lateral Size of Hexagonal Gold Nanoparticles***

Lilik Hasanah and Silva Nurfasha (Universitas Pendidikan Indonesia, Indonesia); Chandra Wulandari (InstitutTeknologi Bandung, Indonesia); AhmadAminudin (Universitas Pendidikan Indonesia, Indonesia); YanuritaDwi Hapsari (Institut Teknologi Sepuluh Nopember, Indonesia); Mohammad Arifin, Roer Eka Pawinanto and Budi Mulyanti (Universitas Pendidikan Indonesia, Indonesia)

Abstract: The kidney is a human organ with numerous vital functions, mainly for blood filtration. Kidney damage disrupts the filtering of waste fluids in the body and causes health complications. Damage to the kidneys can be detected from albumin levels in urine; higher levels of albumin in urine indicate the kidney's filtration function is impaired. The latest breakthrough in the medical field is the use of localized surface plasmon resonance (LSPR) in the field of biosensors to detect albumin protein in urine. Using Finite-Difference Time-Domain (FDTD) simulation, the lateral size of hexagonal gold nanoparticles (AuNPs) is varied to increase the optimal LSPR. AuNPs are well-known as the most promising material for plasmonic applications. In several studies, the hexagonal geometry was reported to increase the surface area of nanoparticles as well as enhance the LSPR signal. Varying the geometry of the hexagonal AuNPs will affect their sensitivity and optical properties. In this study, the lateral size of the hexagonal AuNPs varied from 10 nm to 60 nm, with a controlled thickness of 30 nm. The absorption graph blue shifts with the peak decreasing until the graph has almost no peak as the lateral size decreases. However, the lateral size of 30 nm was found to have the highest shifting response towards the change of refractive index, indicating good sensitivity for sensors. Simulation of hexagonal AuNPs-based LSPR detection of albumin concentrations of 0.35 - 5.71 mM produces a sensitivity of 2.59 nm/mM, equivalent to 245.96 nm/RIU. The competitive performance and ease of detection procedures in real applications show the potential of the hexagonal AuNPs-based LSPR sensor to be further explored in developing alternative albumin detection techniques.

Tuesday, August 20 09:00 - 10:20 (Asia/Kuala Lumpur)

Session 3A: Electronics Materials / Device Fabrication

Session Chair: Rosminazuin Ab Rahim (International Islamic University Malaysia, Malaysia)

9:00 ***Bright-dark soliton pairs generation in an erbium-doped fiber laser utilizing gamma alumina saturable absorber (Invited paper)***

Norita Mohd Yusoff (Institute of Nanoscience and Nanotechnology (ION2), Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia); Eng Khoon Ng (University of Cambridge, UnitedKingdom (Great Britain)); Mohd Zul HilmiMayzan (Universiti Tun HusseinOnn Malaysia, Malaysia); Mohd. Adzir b. Mahdi (Photonics Laboratory, Department of Computer, Malaysia)

Abstract: We report the experimental observation of bright-dark soliton pairs in an erbium-doped fiber laser utilizing gamma aluminum oxide saturable absorber (γ-Al2O3-SA) operating at 1.56 μm for the first time. The γ-Al2O3-SA was fabricated using simple adhesion of the material on the ferrule tip using index-matching gel. Dual-wavelength and narrow linewidths in the optical domain and alternate intensity spike and dip that repeats for every 9.0 MHz repetition frequency manifested the formation of bright-dark soliton pairs. These findings contribute to the future exploration of metal oxide as a saturable absorbing material for various pulse dynamics and fundamental laser physics in the topic of ultrafast photonics.

9:20 ***Physical Characterization of Immersion Method-Based Porous Paper Towards Sensing Application***

Gan Shin Pyng (Universiti Teknologi Malaysia (UTM), Malaysia); Mastura Shafinaz Zainal Abidin (Universiti Teknologi Malaysia, Malaysia)

Abstract: Humidity sensors are essential to many applications, from climate control systems to healthcare. Paper-based humidity sensors have recently gained significant interest due to their simplicity, cost-effectiveness, and unique paper substrate properties. Paper is made of cellulose fibers that are woven together in a complex way to form a porous structure. These pores allow liquids to permeate the paper and stay inside the structure, which determines the absorption capacity. This study investigates the characterization of porous paper that has been formed through the immersion technique. The normal printing paper samples were immersed in different solutions, such as hydrochloric acid (HCl) and sodium hydroxide (NaOH), to yield porous paper. The effect of solution concentration on paper porosity and morphology has been observed. Based on the present findings, the use of HCl has demonstrated superior outcomes compared to NaOH in modifying paper porosity properties. The higher concentrations of HCl have been associated with enhanced porosity in the modified paper samples. The changes in porosity properties were achieved due to the removal of carbonate (CO3) filler from the paper cellulose structure. The highest percentage of porosity is 56.5%. These results offer important new understandings of optimizing chemical treatment techniques for customizing paper characteristics to fulfill certain application needs in humidity sensors.

9:35 ***Effects of Growth Parameters on the Morphology of ReS_2 Nanoflakes Prepared by Chemical Vapor Deposition.***

Muhammad Faris Musawwi Bin Ruslan and Abdul Rahman Mohmad (Universiti Kebangsaan Malaysia, Malaysia); Muhammad Hilmi Johari (Institute of Microengineering and Nanoelectronics (IMEN-UKM), Malaysia); P. Susthitha Menon (Universiti Kebangsaan Malaysia & Institute of Microengineering and Nanoelectronics (IMEN),Malaysia); Syahira binti A. Hinayadullah (Universiti Kebangsaan Malaysia, Malaysia)

Abstract: The development of efficient ReS2-based optoelectronic devices depends on the ability to synthesize high-quality nanoflakes with the desired morphology. In this work, we report the synthesis of ReS2 nanoflakes with vertical and horizontal orientations via chemical vapor deposition (CVD) on SiO2/Si substrates at atmospheric pressure. The ReS2 samples were grown using rhenium trioxide (ReO3) and sulfur precursors. It was found that growth temperature and ReO3-substrate distance significantly influenced the nucleation density and morphology of the ReS2 flakes, as observed by optical and field-emission scanning electron microscope images. High Re vapor environment favors the formation of vertical flakes. The growth then switches to a mixture of both vertical and horizontal flakes as the Re concentration decreases. Raman spectroscopy data show the characteristic Eg and Cp vibrational modes which belong to the ReS2. The full-width-at-half-maximum of the 210.3 cm-1 peak is 8 cm-1 which is comparable to the high-quality ReS2 flakes prepared by mechanical exfoliation. This work provides valuable insights on the effect of CVD parameters on the growth and morphology of ReS2 nanoflakes.

9:50 ***Impact of Varied Ag-GO Ratios on the Electrochemical Enhancement of Vitamin D Detection***

Kiki Chan (Universiti Kebangsaan Malaysia, Malaysia &Institute of Microengineering and Nanoelectronics, Malaysia); Nur Azura Mohd Said (Malaysian Agricultural Research & Development Institute (MARDI), Malaysia); Muhammad Aniq Shazni Mohammad Haniff (Insititute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, Malaysia); Mohd Hazani Mat Zaid (Duopharma Innovation Sdn Bhd, Malaysia); Siti Nur AshakirinMohd Nashruddin (Institute of Informatics and Computingin Energy (IICE),Malaysia); Farhanulhakim Mohd razip wee (IMEN, Malaysia); P. Susthitha Menon (Universiti Kebangsaan Malaysia & Institute of Microengineering and Nanoelectronics (IMEN), Malaysia)

Abstract: Rapid detection of vitamin D levels in human serum presents significant benefits for diagnosing deficiency and managing treatments. This work reports the preparation and application of silver-graphene oxide (AgGO) composites for the development of vitamin D biosensors through the chemical reduction method of silver nanoparticles (AgNPs) in an aqueous suspension of graphene oxide (GO). Different concentrations of graphene oxide (GO) and silver (Ag) were tested to identify optimal electrochemical enhancements of screen-printed carbon electrodes (SPCE). By synthesizing silver-graphene oxide (AgGO) composites and modifying screen-printed carbon electrodes (SPCE), the electrochemical behavior was investigated using differential pulse voltammetry (DPV). The AgGO composite prepared was characterized using Fourier-transform infrared spectroscopy (FTIR) and field-emission scanning electron microscopy with energy-dispersive X-ray spectroscopy (FESEM-EDX). AgGO synthesized from 2×10−3 mol dm−3 AgNO3 and 1.0 g/L GO provided the most favorable conducting environment for electron transfer from the electrolyte to the electrode. The modified SPCE exhibited more than a threefold enhancement in peak current, reaching 37.98 μA, compared to an unmodified electrode.

10:05 *PiezoelectricEnergy Harvesting from Thermal Vibrations Using Doped Graphene-MXene Heterostructures*

Kou Lijie (Universiti Kebangsaan Malaysia, Afghanistan); Poh Choon Ooi (IMEN, UKM, Malaysia); Chang Fu Dee (Universiti Kebangsaan Malaysia (UKM),Malaysia); Muhammad Aniq Shazni MohammadHaniff (Insititute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, Malaysia)

Abstract: Piezoelectric nanogenerators (PENG) can face challenges when integrated into high-temperature applications because of their temperature sensitivity. Heterostructures of specific 2D nanomaterials can potentially enhance PENG performance for practical applications at high temperatures. This study incorporated nitrogen-doped graphene (NGr) and Ti3C2Tx MXene heterostructure nanofillers into the polyvinylidene difluoride (PVDF) matrix for energy harvesting in a high-temperature vibration environment. The solution-processable nanogenerator device is achieved by optimizing the appropriate ratio of NGr to Ti3C2Tx. At room temperature, the nanogenerator showed an optimum output voltage of ~9.0 V and ~1.5 µA of current. Thereby, it raised to 24.0 V and 1.75 µA when the temperature increased to 90 oC, obtaining a power density of 3.85 µW/cm2. This outstanding performance is attributed to the designed NGr-Ti3C2Tx quasi-3D heterostructure, where its rich interfacial features, excellent electrical conductivity, and localized elastic complexes synergistically promote the piezoelectric output of the energy harvester. Placing the device on the road could be used to collect the mechanical energy generated by the vibration of the car's movement and convert it into electrical energy, which opens up new development possibilities for addressing emerging energy issues.

Tuesday, August 20 09:00 - 10:05 (Asia/Kuala Lumpur)

Session 4A: MEMS / NEMS

Session Chair: Ir. Hazian Bin Mamat (Mimos Berhad, Malaysia)

9:00 *AI-based Image Processing Technique for Dielectrophoresis (DEP) In BioMEMs Applications*

Clarence Augustine TH Tee, EnHao Yu and W P Yeo (Zhejiang Normal University, China); Burhanuddin Yeop Majlis (Universiti Kebangsaan Malaysia, Malaysia); Muhamad Ramdzan Buyong and Ahmad Rifqi Md Zain (UKM, Malaysia); Le Song and Zheng Yelong (Tianjin University, China); Sheng Li (Zhejiang Institute of Optoelectronics, China)

Abstract: The integration of artificial intelligence (AI) methodology in the flexible electronics, BioMEMs, and Dielectrophoresis (DEP) system provides an accurate, comprehensive, simple, and cost-effective approach, especially in real-time cell sorting, target identification, monitoring, biological entities separation, analysis, and postulation. Here, a novel approach integrating AI algorithms with DEP technology for the BioMEMs system has been demonstrated in real-time bacteria identification via detecting, identifying simultaneously, lock-in monitoring bacterial movement trajectories, analyzing, measuring, and calculating bacteria's velocities at different frequencies. The AI-based bacterial recognition system creates real-time, fast, accurate, unlimited bacteria lock-in monitoring with high accuracy. Furthermore, the bacteria can be tracked, monitored, and analyzed using big data analysis and Deep Learning (DL) in real-time via a visual control interface system, as part of the Internet of Things (IoT) and intelligent information sharing between BioMEMS sensors and IoT networks.

9:20 *Enhancing Dielectrophoresis Analysis via Artificial Intelligence Integration*

Muhamad Ramdzan Buyong (UKM, Malaysia); Muhammad Akmal Suhaimi, Arash Zulkarnain Rozaini and Burhanuddin Yeop Majlis (Universiti Kebangsaan Malaysia,Malaysia); Farahdiana Wan Yunus (Xiamen University Malaysia, Malaysia); Noratiqah Yaakop (SilTerra Malaysia Sdn. Bhd., Malaysia); Clarence Augustine TH Tee (Zhejiang Normal University China,China); Céline Elie Caille (Institute FEMTO-ST, France); Abdullah Abdulhameed (Center for Communication Systems and Sensing, King Fahd University of Petroleum & Minerals, Dhahran,Malaysia); Aminuddin Ahmad Kayani (RMIT University, Australia); Noraziah Zin (Universiti Kebangsaan Malaysia & Faculty of Health Sciences, Malaysia)

Abstract: Dielectrophoresis (DEP) has emerged as a powerful technique for manipulating and analyzing particles based on their polarizability differences in electric fields. However, the analysis of DEP data often involves complex computational analysis methods and requires significant expertise. In this study, we propose a novel approach to enhance DEP analysis through the integration of artificial intelligence (AI) techniques. By leveraging AI algorithms such as machine learning and pattern recognition, we aim to streamline the analysis process, improve accuracy, and enable real-time decision-making. This integration allows for automated classification of particles, identification of subtle patterns, and optimization of experimental parameters. We present the integration of DEP with AI procedures and demonstrate the effectiveness of our approach in improving the efficiency and accuracy of DEP analysis. Our findings highlight the potential of AI integration to revolutionize DEP analysis, paving the way for advancements in various fields such as biotechnology, nanotechnology, and medical diagnostics.

9:35 *ZnO and PZT Thin Film Piezoelectric MEMS Vibrational Energy Harvesters for Cardiac Pacemaker*

Yap Jia Xui Yap, Avinash Kumaresan, Jumril Yunas, Seri Mastura Mustaza, Huda Abdullah and Iskandar Yahya (Universiti Kebangsaan Malaysia, Malaysia)

Abstract: MEMS piezoelectric energy harvesters (PEHs) have the potential to convert the mechanical energy of human heart vibrations into electrical energy to power the pacemaker. Challenges exist to match the resonant frequency of PEHs to the heart wall's low vibrational frequency and the pacemaker size constraints to fit the PEH. Moreover, the output performance of PEH with hybrid piezoelectric materials is not studied in the literature. This work aims to design a MEMS PEH element with a resonant frequency <50 Hz, output voltage of 2.5 - 2.8 V, dimension of 40 mm by 6 mm and optimize its output performance via a hybrid of ZnO and PZT. Correlation studies between the PEH design and output performance were performed to derive design strategies. The split-cantilever energy harvester (SCEH) structure was built using COMSOL Multiphysics. SCEH has resonant frequencies at 3.1 Hz and 4.9 Hz, with voltages of 36.21 V and 38 V respectively. The simulation results successfully meet the requirements for powering the pacemaker in terms of dimensions, resonant frequency, and generated voltage.

9:50 ***Dielectrophoretic Rapid characterization of Antimicrobial resistance bacteria Escherichia coli***

Arash Zulkarnain Rozaini and Muhammad Akmal Suhaimi (Universiti Kebangsaan Malaysia, Malaysia); Aminuddin Ahmad Kayani (RMIT University, Australia); Abdullah Abdulhameed (Center for Communication Systems and Sensing, King Fahd University of Petroleum & Minerals, Dhahran, Malaysia); Burhanuddin Yeop Majlis (Universiti Kebangsaan Malaysia, Malaysia); Noraziah Zin (Universiti Kebangsaan Malaysia & Faculty of Health Sciences, Malaysia); Wan Hanna Melini Wan Mohtar (Universiti Kebangsaan Malaysia, Malaysia); Muhamad Ramdzan Buyong (UKM, Malaysia)

Abstract: Rapid characterization antimicrobial resistance bacteria are crucial for critical solving of Antimicrobial resistance (AMR) increases around the world. Antibiotic resistance bacteria contribute to the numerous infections all around the world which lead to death over 4.95 million. Escherichia Coli is part of multidrug resistant bacteria and in this study, we present experimental of susceptible and resistant strain of Escherichia Coli on one single frequency point-based simulation model which is crossover frequency to differentiate the dielectrophoresis (DEP) response between susceptible and resistant strain. This experimental will observe the reaction of susceptible and resistant type of E. coli using crossover frequency thus support the rapid bacterial cell characterization to be an alternative aid in faster diagnosis of bacterial infections and benefit the clinical decision-making process for antibiotic treatment, addressing the critical issue of AMR.

10:05 ***Electronic Properties of AB-Stacked Bilayer Graphene Nanoribbons with Zigzag and Armchair Orientations***

Yuki Wong, Nurul Ezaila Alias and Cheng Siong Lim (Universiti TeknologiMalaysia, Malaysia); Choon Min Cheong(INTI International University, Malaysia); Michael Loong Peng Tan (Universiti Teknologi Malaysia, Malaysia)

Abstract: The electronic properties of AB-stacked bilayer graphene nanoribbons (BGNRs) with zigzag and armchair orientations are investigated in this study using a nearest-neighbour tight-binding (NNTB) approach combined with the non-equilibrium Green's function (NEGF) method via numeric computation methods on MATLAB. The final model is derived through the implementation of justifiable simplifying assumptions, such as the application of basis functions, discretization of the Hamiltonian operator, and utilization of the plane wave approximation, all grounded in many-body theories and the modified Hartree simplification theory. The Hamiltonian matrices for both armchair and zigzag orientations of AB-stacked Bilayer Graphene Nanoribbons (AB-BGNRs) are constructed with open boundary conditions to mimic real-world structures. Insights into the dispersion relation and density of states of AB-BGNRs in both orientations are provided through our analysis. This research contributes to our understanding of AB-BGNRs' electronic characteristics and lays a foundation for future advancements in graphene-based electronic devices.

Tuesday, August 20 11:50 - 12:40 (Asia/Kuala Lumpur)

Session 3B: Device modeling, simulation and design / Device physics and characterization

Session Chair: Aliza Aini Md Ralib (International Islamic University Malaysia, Malaysia)

11:50 ***Reduction of Subthreshold Leakage Current in Resonant Gate Transistor (Invited Paper)***

Rhonira Latif (Universiti Kebangsaan Malaysia, Malaysia); MohamadZain Azreen Ramli (PEC SE Asia Sdn Bhd, Malaysia); Arjuna Marzuki (Wawasan Open University, Malaysia); Masuri Othman (Universiti KebangsaanMalaysia (UKM), Malaysia)

Abstract: The channel in a resonant gate transistor (RGT) transduces the resonator's mechanical movement into electrical signals. The device finds its application in acoustic sensing as a mechanoelectrical transducer. The channel region plays an eminent role in efficiently converting the resonator's vibration displacement into current flow between source and drain. In this paper, the subthreshold current for the channel is studied. The enhancement mode n-channel RGT and metal-oxide-semiconductor field-effect transistor (MOSFET) are fabricated. The channel width and length have been varied from 25 µm-540 µm and 10 µm-20 µm, respectively. The temperature to grow gate oxide and to anneal the ion-implanted source/drain has been altered from 950C-1100C. We have found that the subthreshold leakage current can be reduced by increasing the channel length, decreasing the channel width, decreasing the annealing and gate oxidation temperature, and incorporating p-channel into the transistor device instead of n-channel. It is crucial for the subthreshold current to be small with no channel breakdown issue, so that the device can operate with high reliability and low power consumption.

12:10 Comparative Electrochemical Performance of Screen Printed Carbon, Gold and Graphene Electrodes

Yasmin Abdul Wahab, Mohammad Al Mamun and M. A. Motalib Hossain (Universiti Malaya, Malaysia); Mohd Rafie Johan (University of Malaya, Malaysia); Nurul Ezaila Alias (Universiti Teknologi Malaysia, Malaysia); Hanim Hussin and Maizan Muhamad (Universiti Teknologi MARA, Malaysia); Hui Yin Nam (Universiti Malaya, Malaysia)

Abstract: A comparative analysis of the electrochemical performance of screen-printed carbon (SPCE), gold (SPGE), and graphene (SPGrE) electrodes is presented before integration into electrochemical biosensors. The electrodes were systematically examined based on key electrochemical parameters, including charge transfer kinetics, electrochemical reproducibility, and stability, considering [Fe(CN)6]3−/4− as a typical redox analyte using cyclic voltammetry (CV), differential pulse voltammetry (DPV), and electrochemical impedance spectroscopy (EIS). Results indicate that all the bare screen-printed electrodes (SPEs) demonstrate significant irreproducibility (>10% of RSD) with poor stability of the electroactive surface. The graphene electrodes exhibit superior electrocatalytic properties with a higher interfacial charge transfer rate constant (2.30x10-6 cms-1) compared to the SPCE (1.40x10-6 cms-1) and SPGE (1.72x10-6 cms-1) surfaces. The findings provide valuable insights into the relative merits and drawbacks of SPEs, guiding the selection of suitable electrode materials for diverse biosensing applications.

12:25 ***Evaluating the Impact of Upright and Inverted Pyramid Microstructures on the Optical Performance of Single Crystalline Silicon Solar Cells.***

Yasmin Abdul Wahab and Md. Yasir Arafat (Universiti Malaya, Malaysia); Sharifah Fatmadiana Wan Muhamad Hatta (University of Malaya, Malaysia); Mohammad Aminul Islam (Universiti Kebangsaan Malaysia, Malaysia); Nurul Ezaila Alias (Universiti Teknologi Malaysia, Malaysia); Mohd Rafie Johan (University of Malaya, Malaysia); Hanim Hussin (Universiti Teknologi MARA, Malaysia)

Abstract: This study examines the optical performance of single crystalline silicon solar cells with upright and inverted pyramid microstructures fabricated via Alkaline Chemical Etching and Metal Assisted Chemical Etching (MACE), respectively. Spectrophotometric and Finite Difference Time Domain (FDTD) analyses were used to evaluate light absorption and optical confinement. The weighted average reflectance results showed that inverted pyramids made with MACE had a significantly lower reflectance of 4.40% compared to 7.89% for upright pyramids, indicating superior light-trapping efficiency. This advantage is attributed to the favorable angular geometry and finer resolution of the MACE-fabricated inverted pyramids. These findings emphasize the importance of microstructural design and advanced fabrication techniques in enhancing the optical properties of photovoltaic materials, suggesting that tailored microfabrication strategies could significantly improve solar cell efficiency.

Tuesday, August 20 11:50 - 12:40 (Asia/Kuala Lumpur)

Session 4B: Electronics Materials /Process Technology/ IC Packaging

Session Chair: Nurul Ezaila Alias (Universiti Teknologi Malaysia, Malaysia)

11:50 ***Effect of Seed Layer Cycles on ZnO Nanowires Characteristics for Piezoelectric Nanogenerator Applications (Invited Paper)***

Suhana Mohamed Sultan (Universiti Teknologi Malaysia,Malaysia); Izzaty Mohd Zambri (Universiti Teknologi Malaysia (UTM) & Malaysia, Malaysia); Fong Jun Xian (Universiti Teknologi Malaysia, Malaysia); Pg Rafidah Pg Hj Petra (UTB, Malaysia); Khoo Wei How (Universiti Teknologi Malaysia, Malaysia)

Abstract: This study investigates a low-temperature and cost-effective method for fabricating ZnO-based piezoelectric nanogenerators (PENGs). The hydrothermal method is employed to grow Zinc Oxide (ZnO) nanowires on flexible Indium-Tin-Oxide coated polyethylene terephthalate (ITO-PET) substrates, predeposited with seed layers for 5, 8, and 10 seed layer cycles. The aim is to assess the effect of different seed layer cycles on the alignment and dimensions of the ZnO nanowire grown. Field-emission Scanning Electron Microscopy (FESEM) is utilized to examine the alignment and dimensions of the nanowire arrays, while energy-dispersive X-ray Spectroscopy (EDX) analyses are employed to assess the elementary compositions. The alignment of ZnO nanowires improved with an increase in the number of seed layer cycles. In addition, it is found that an increased number of seed layer cycles resulted in an increase in the average diameter of ZnO nanowires from 89.5 nm to 122.31 nm, while the length was decreased from 831.67 nm to 548.67 nm. This may be attributed to variations in grain size and crystallinity of nanoparticles on the seed layers grown. These results contribute to the understanding of the growth process of ZnO nanowires for PENG applications and hold potential for advancements in green energy harvesting technologies.

12:10 ***A Low Power Scan Cell Design using FreePDK3***

Ahmad Awalluddin Mohd Ghazali and Chia Yee Ooi (Universiti Teknologi Malaysia, Malaysia); Hau Sim Choo (Intelligent Circuits Engineering, Malaysia); Nordinah Ismail (Universiti Teknologi Malaysia (UTM), Malaysia); Siti Rahmah Aid (Universiti Teknologi Malaysia, Malaysia)

Abstract: Test power has always been the major restriction for the test domain as the power that dissipates has a serious negative impact on computer chip reliability. This paper introduces a low-power scan cell with efficient state-preserving and gating logic to mitigate the negative impact of test power consumption and unnecessary switching in scan-based designs, particularly during shifting mode. Experimental results have shown that our proposed scan achieves a significant reduction of ~48% in total average power compared to conventional scan cells, as well as a reduction of ~38% in most of the shift cycles when compared to one of the prevalent existing gating architectures, FLS. In summary, this innovative approach presents a promising solution for reducing test power consumption and unnecessary switching in scan-based designs, particularly during shift mode, while maintaining efficiency and minimizing impact on peak power during capture cycles.

12:25 ***Exploring the Characterization of Electrodeposited MoS2 as a Hole Transport Layer in Methylammonium Perovskite Solar Cells***

Ahmad Muhajer Abdul Aziz (Universiti Teknikal Malaysia Melaka, Malaysia); Muhammad Idzdihar Bin Idris (FKEKK, Universiti Teknikal Malaysia Melaka, Malaysia); Zul Atfyi Fauzan MohammedNapiah (Universiti Teknikal Malaysia Melaka (UTeM) & Centre for Telecommunication Research & Innovation (CeTRI),Malaysia); Radi Husin Ramlee and Muhammad Noorazlan Shah Zainudin (Universiti Teknikal Malaysia Melaka, Malaysia); Marzaini Rashid (School of Physics, Malaysia); Mohd Iskandar Dzulkarnain M. Rummaja (Universiti Teknikal Malaysia Melaka, Malaysia)

Abstract: The study explores the characterization of electrodeposited Molybdenum Disulfide (MoS2) as a hole transport layer (HTL) in Methylammonium Perovskite Solar Cells. MoS2, a two-dimensional material, is meticulously deposited to ensure uniformity and then optimized to enhance its hole transport capabilities for efficient charge extraction. Comprehensive characterization techniques, including photovoltaic measurements, impedance spectroscopy, and morphology studies, evaluate the impact of MoS2 on the performance of Methylammonium Perovskite Solar Cells. The findings suggest that electrodeposited MoS2 exhibits promising potential as a high-performance HTL, offering insights into improving the efficiency and stability of Methylammonium Perovskite Solar Cells. This study contributes to advancing the understanding and development of efficient and stable solar cell technologies through the integration of MoS2 as a hole transport layer in Methylammonium Perovskite Solar Cells.

Tuesday, August 20 14:00 - 14:45 (Asia/Kuala Lumpur)

Session 3C: Device modeling, simulation and design / Device physics and characterization

Session Chair: Dr. Rhonira Latif (Universiti Kebangsaan Malaysia)

14:00 ***A Flexible Framework Based on Finite-Element Method for Capacitance Extraction of 3-Dimensional Interconnects***

Ye Wu (Xi'an Jiaotong-Liverpool University, China); Qiwen Zheng (Xi'an Jiaotong-Liverpool University, China); Zichang Zhang (Southern Illinois University Carbondale, USA)

Abstract: This paper proposes a capacitance extraction framework based on finite-element methods (FEM) to obtain the capacitance of three-dimensional (3-D) interconnect structures with multi-layer dielectrics. The proposed framework is demonstrated through its application to various 3-D interconnect configurations, revealing an error of no more than 8.03% when compared to the commercial software Q3D, and 3.44% compared to published papers. Notably, this framework exhibits enhanced flexibility in modeling and meshing, leading to a 1.5% decrease in CPU time and a 40.7% reduction in memory consumption compared to Q3D by optimizing the meshing strategy. Meanwhile, the proposed approach is based on the open-source software Gmsh and GetDP, ensuring high portability. Consequently, it can be adapted to various 3D interconnect structures, offering significant potential in designing very large-scale integrated circuits (VLSI) and enabling highly accurate parasitic extraction in post-layout simulations.

14:15 ***Bandgap Modification of ZnO Nanorodsfor Enhanced Photocatalytic Application***

Aini Ayunni Mohd Raub (Universiti Kebangsaan Malaysia, Malaysia); Siti Nur Ashakirin Mohd Nashruddin (Institute of Informatics and Computing in Energy (IICE), Malaysia); Mohd Ambri Mohamed (Universiti Kebangsaan Malaysia (UKM), Malaysia); Jumril Yunas (Universiti Kebangsaan Malaysia, Malaysia)

Abstract: In this paper, we report the bandgap modification of ZnO-based nanorods (ZnO NRs) through carbon-based nanocomposite (ZnO/rGO) and metal doping using Cu, Ni, Bi, Co, and Mg ions as the dopants. The hydrothermal method was used to grow the nanorod's structure by incorporating a metal doping solution during the growing process and rGO coating. The analysis of the synthesized materials shows that metal doping affects the bandgap of the ZnO NRs. Cu-doped ZnO NRs have the most significant reduction in bandgap energy compared to other metal-doped ZnO NRs. Meanwhile, the rGO coating causes bandgap reduction of ZnO NRs from 3.25 to 3.17 eV.

14:30 ***Simulation-Based Approach to Detecting Pulmonary Embolism Using Capacitive Micromachined Ultrasonic Transducers***

Hussnain Shahid (Universiti kebangsaan malaysia, Malaysia); Dilla Duryha (IMEN, UKM, Malaysia); Rhonira Latif and Poh Choon Ooi (Universiti Kebangsaan Malaysia, Malaysia); Tehseen Batool (Government College University Faisalabad (GCUF), Pakistan)

Abstract: MEMS piezoelectric energy harvesters (PEHs) have the potential to convert the mechanical energy of human heart vibrations into electrical energy to power the pacemaker. Challenges exist to match the resonant frequency of PEHs to the heart wall's low vibrational frequency and the pacemaker size constraints to fit the PEH. Moreover, the output performance of PEH with hybrid piezoelectric materials is not studied in the literature. This work aims to design a MEMS PEH element with a resonant frequency <50 Hz, output voltage of 2.5 - 2.8 V, dimension of 40 mm by 6 mm and optimize its output performance via a hybrid of ZnO and PZT. Correlation studies between the PEH design and output performance were performed to derive design strategies. The split-cantilever energy harvester (SCEH) structure was built using COMSOL Multiphysics. SCEH has resonant frequencies at 3.1 Hz and 4.9 Hz, with voltages of 36.21 V and 38 V respectively. The simulation results successfully meet the requirements for powering the pacemaker in terms of dimensions, resonant frequency, and generated voltage.

Tuesday, August 20 14:00 - 14:45 (Asia/Kuala Lumpur)

Session 4C: Electronics Materials /Process Technology/ IC Packaging

Session Chair: Dr Iskandar Yahya (Universiti Kebangsaan Malaysia)

14:00 *Piezoelectric Nanogenerator based on Grapheneand MXene Heterostructure*

Kou Lijie (Universiti Kebangsaan Malaysia, Malaysia); Rawhan Mohammad Safiul Haque and Poh Choon Ooi (UniversitiKebangsaan Malaysia, Malaysia); Muhammad Aniq Shazni Mohammad Haniff (Insititute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, Malaysia); Chang Fu Dee (Universiti Kebangsaan Malaysia (UKM), Malaysia)

Abstract: This paper proposes a capacitance extraction framework based on finite-element methods (FEM) to obtain the capacitance of three-dimensional (3-D) interconnect structures with multi-layer dielectrics. The proposed framework is demonstrated through its application to various 3-D interconnect configurations, revealing an error of no more than 8.03% when compared to the commercial software Q3D, and 3.44% compared to published papers. Notably, this framework exhibits enhanced flexibility in modeling and meshing, leading to a 1.5% decrease in CPU time and a 40.7% reduction in memory consumption compared to Q3D by optimizing the meshing strategy. Meanwhile, the proposed approach is based on the open-source software Gmsh and GetDP, ensuring high portability. Consequently, it can be adapted to various 3D interconnect structures, offering significant potential in designing very large-scale integrated circuits (VLSI) and enabling highly accurate parasitic extraction in post-layout simulations.

14:15 *Thermal-Aware Test Scheduling with Floorplanning for Three-Dimensional Stacked Integrated Circuit*

Patmanathan Ganesan (University of Technology Malaysia (UTM), Malaysia); Chia Yee Ooi, Nordinah Ismail and Siti Rahmah Aid (Universiti Teknologi Malaysia, Malaysia)

Abstract: Testing a three-dimensional stacked integrated circuit (3D-SIC) remains a challenging problem, as generating an optimized test schedule to minimize test time is complicated due to the numerous variables involved. Accessing upper dies is only feasible through the bottom die, necessitating the extension of Test Access Mechanisms (TAMs) via Through-Silicon Vias (TSVs). Limited primary I/O pins, TSVs, and TAM width require efficient resource allocation. Thermal management is crucial due to high core power consumption and uneven distribution, which pose the risk of overheating. Advanced concurrent test scheduling is essential to effectively allocate resources and maintain power and temperature limits. This research proposes thermal-aware test scheduling optimization combined with floor planning for 3D-SICs, aiming to minimize test schedule time while addressing resource and power constraints. Experimental results using several ITC'02 benchmark circuits demonstrate an average estimated improvement of 0.2% in test schedule time when utilizing test scheduling with floor planning compared to test scheduling without floor planning.

14:30 *Deep Learning (DL) based Computer Generated Hologram (CGH) for Beamsteering in Reconfigurable Holographic Switches*

Clarence Augustine TH Tee, Hanbin Sun and W P Yeo (Zhejiang Normal University, China); Burhanuddin Yeop Majlis (Universiti Kebangsaan Malaysia, Malaysia); Muhamad Ramdzan Buyongand Ahmad Rifqi Md Zain (UKM, Malaysia); Le Song and Zheng Yelong (Tianjin University, China); Sheng Li (Zhejiang Institute of Optoelectronics, China)

Abstract: Beamsteering application via dynamic holography with recorded dynamic holograms onto Spatial Light Modulators (SLM) has been used for optical interconnections, especially in all-optical networks within reconfigurable holographic switches. A novel AI-based approach using Deep Learning (DL) methodology has been proposed for the generation of a new Computer Generated Hologram (CGH) with improved performance metrics, i.e., peak signal-to-noise ratio (PSNR) and fast generation of prediction time, resulting in higher accuracy, controllable, and precise predicted beamsteering application. The requirements of a high PSNR, fast-generated CGH, low crosstalk, diffraction efficiency, and polarization sensitivity for a Liquid Crystal (LC) 2D SLM for reconfigurable beamsteering, among others, necessitate the integration of the superior features of DL into CGH production, i.e., proposed herewith the AI-based DL-CGH. The DL-CGH methodology proposed here has simplified input data channels, residual network, and attention mechanism, which performed better in comparison with Gerchberg-Saxton (G-S) and Holo-encoder CGH.

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