ABSTRACT BOOK

International Forum on Semiconductors and Optoelectronics

SEMICONFORUM2023

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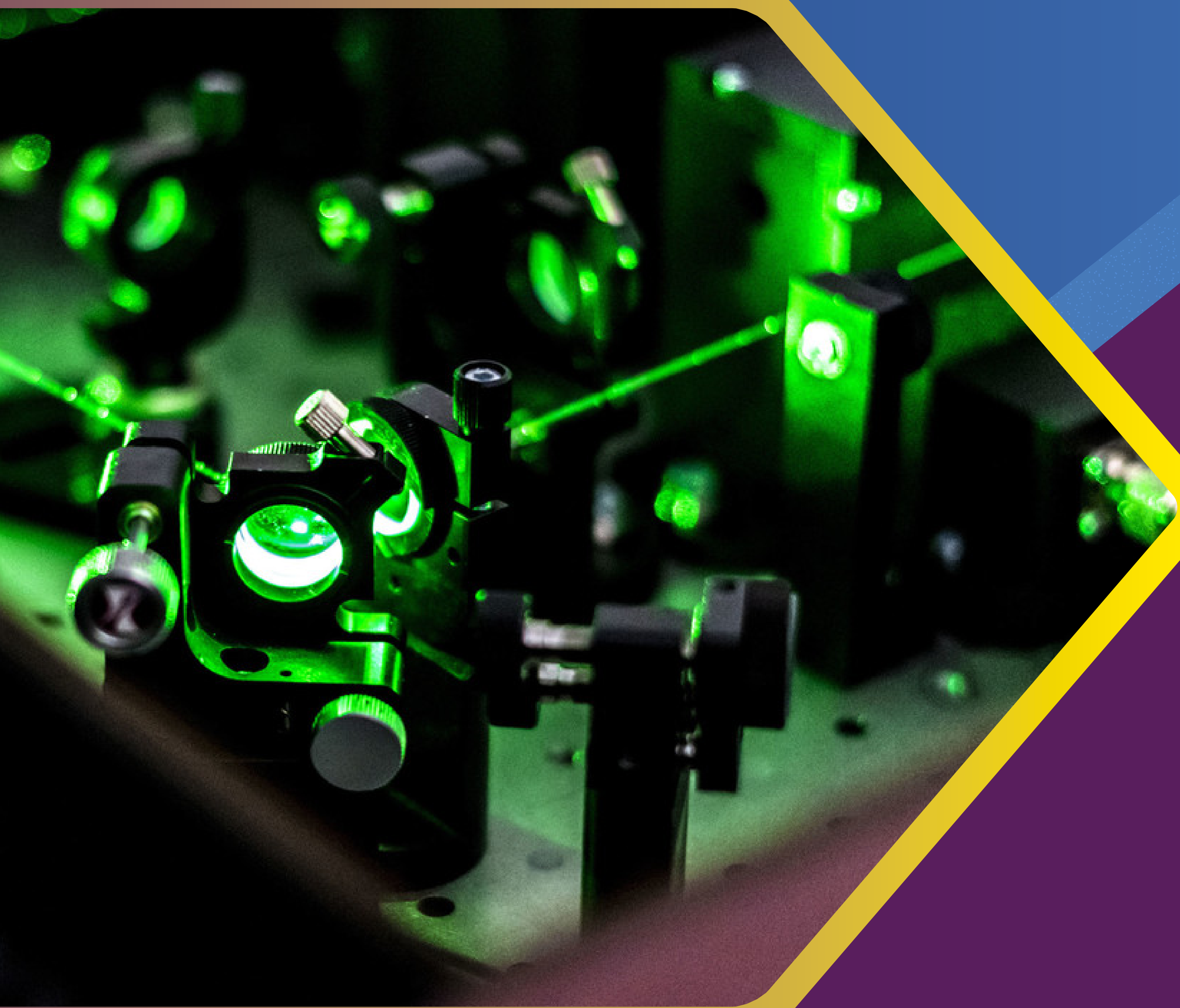

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Virtual

Recent Progress in Silicon Photonic Chip Design for 5G Wireless Fronthaul Application

Amin Malek
California State University
USA

Abstract:
It is estimated that by 2020 there will be 20 billion Internet of Things (IoT) connections. Additionally, global mobile data traffic will increase sevenfold between 2016 and 2021, growing at a compound annual growth rate (CAGR) of 47 percent from 2016 to 2022, reaching 49 exabytes per month by 2022 Most of this traffic will be video streamingalong with new use cases such as augmented reality, virtual reality, and machine-to-machine communications. The current network doesn't have the capacity to gracefully handle this explosion of traffic. The current 4G network doesn't have the capacity to handle this explosion of traffic gracefully. 5G networks target an approximately 1000x increase in wireless traffic capacity [2]. This additional capacity will enable significant advances in smart cities, smart grids, robust disaster response, self-driving cars, and more.

Silicon Photonics transceivers are an innovative on-die integration of a silicon circuit and a laser. Silicon Photonics transceivers are expected to become an important part of 5G fronthaul networks because they support high bandwidth rates, long transmission distances (up to 10 km), and extended temperature ranges (-40° to 85° C as opposed to 0° to 70° C for standard commercial-grade transceivers

In this talk I will focus on our latest Silicon Photonics Transceivers Design, Fabrication and Data Analysis for high-bandwidth digital communications for short reaches applications. Our main focus is design and fabrication of integrated platforms with modulators, detectors, waveguides and other components on the same chip, all talking to one another.

References:
5G Wireless Communications Silicon Photonics, Exploring 5G Fronthaul Network Architecture Intelligence Splits and Connectivity, Intel white paper
Cisco, February 2017, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016-2021." cisco.com/c/en/us/solutions/ collateral/service-provider/visual-networking-index-vni/mobile-white paper-c11-520862.pdf

Biography
Dr. Malek is an experienced researcher with a specific discipline in Silicon Photonics, Design, Fabrication, and Data Analysis. He is a Fellow of the UK Higher Education Academy (FHEA) and a Senior Member of IEEE, a member of the Engineering Council (CEng), IET, and Optical Society of America (OSA). Currently, Dr. Malek is a faculty member at California State University, Bakersfield, California, USA. He has been awarded over USD 1,00,000 in grant monies and endowments and has published over 100 scientific research papers, and a postgraduate textbook, as well as delivered a few keynote speeches at different international scientific conferences around the Globe. Up to now, he is the holder of 4 optical fiber communication systems patents.

Investigation of Robustness Against Radiation for GaN MIS-HEMT in Space

Chin-Han Chung, Chih Yi Yang, Cheng Jun Ma, Yu Wei, Yi-EnChang-Chien and Edward Yi Chang

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Abstract.
Gallium nitride (GaN) high electron mobility transistors (HEMTs) exhibit superior performance for high power and high frequency applications due to properties such as the two-dimensional electron gas (2DEG) and the large bandgap (~3.4 eV), enabling enhanced carrier mobility and higher breakdown voltage (BV),-compared to traditional silicon-based devices. Additionally, GaN HEMTs have a higher tolerance to ionizing radiation, which is a critical factor for important applications such as space, nuclear power facilities, and accelerator facilities.Despite these advantages, the reliability of conventional GaN HEMTs has posed many challenges, such as the current collapse phenomenon and the high gate leakage current that lead to degraded device performance. To address these issues, a Metal-Insulator-Semiconductor HEMT (MIS-HEMT) structure has been proposed as a potential solution. However, the gate dielectric introduces additional concerns regarding the device's response to total ionizing dose (TID) effects, and it's reasonable to expect the quality of the gate dielectric to impact the robustness of the device against radiation. With SiN being one of the most common materials for the gate dielectric, this work investigated the mechanisms and trends of TID effects in MIS-HEMTs adopting different growth methods of the SiNgate dielectric. It was discovered that after Co60 gamma ray irradiation testing up to 400 krad, devices with a PEVCD-grown SiNgate dielectric showed better overall performance compared to ones adopting the LPCVD as the dielectric growth method. This result provides clues on the optimization of device fabrication process to achieve a reliable GaN technology for power applications in space.

Biography.
Chin-Han Chung, assistant professor
Dr. Chin-Han Chung obtained his PhD in the University of Tokyo and is currently an assistant professor at International College of Semiconductor Technology, National Yang Ming Chiao Tung University, Taiwan. He is also the head of the Division of Strategic Planning, Office of International Affairs in NYCU. His field of interest includes the investigation of reliability of wide bandgap devices and memory devices, especially for applications in space.

Direct Laser Writing of SERS Hollow Fibers

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Abstract.

We report the direct laser writing (DLW) of surface-enhanced Raman scattering (SERS) structures on the inner wall of a hollow fiber. Colloidal gold–silver alloy nanoparticles (Au–Ag ANPs) are firstly coated onto the inner wall of a hollow fiber. A green laser beam is focused through the outer surface of the hollow fiber to interact with colloidal Au–Ag ANPs so that they become melted and aggregated on the surface of the inner wall with strong adhesion. Such randomly distributed plasmonic nanostructures with high density and small gaps favor the SERS detection of low-concentration molecules in liquids flowing through the hollow fiber. Such a SERS device also supplies a three-dimensional microcavity for the interaction between excitation laser and the target molecules. The DLW system consists mainly of the flexible connection between the motor shaft and the hollow fiber, the program-controlled translation of the hollow fiber along its symmetric axis and rotation about the axis, as well as the mechanical design and the computer control system.This DLW technique enables high production, high stability , high reproducibility , high precision, and a high-flexibility fabrication of the hollow fiber SERS device. The resultant microcavity SERS scheme enables the high-sensitivity detection of R6G molecules in ethanol with a concentration of 10^{-7} mol/L.

Biography.

Jiajun Li is currently studying for a Ph.D. degree at Beijing University of Technology in China. At present, he is mainly engaged in nano-photonics research. His research work includes micro-nano optical manufacturing, development of biosensors and application of artificial intelligence in spectral physical information extraction.

Phase-Engineered Synthesis of Atomically Thin Te Single Crystals with High ON-State Currents

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Abstract.
Multiple structural phases in two-dimensional (2D) materials have opened up new opportunities for bandgap engineering, which is crucial for tunable electronic and optical applications of these materials. However, precise thermodynamic modulation to realize phase-engineered synthesis of 2D materials at the atomic level remains a substantial challenge. Herein, we design an atomic cluster density and interface-guided multiple control strategy for phase- and thickness-controlled synthesis of α-Te nanosheets and β-Te nanowires. Phase engineering is triggered by precise control of the binding/formation energies induced by van der Waals (vdW) epitaxy. The α-Te nanosheets exhibit a transition from a metal to an n-type semiconductor, whereas the β-Te nanowires are always a p-type semiconductor as the thickness declines. Furthermore, the reduced thickness restricts the transport of carriers in the atomic channel and makes the β-Te nanowires present an exceptional ON-state current density and a considerable mobility at room temperature, surpassing the 2028 roadmap target for high-performance FETs.

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Graphene Heterojunction Devices based on Lateral Photovoltaic Effect

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Abstract

Designing optoelectronic detectors using two-dimensional (2D) materials that fulfill actual application requirements is expected to be a significant challenge in the coming decades. Incorporating Graphene, a 2D material, with technologically advanced semiconductors can be considered a practical approach for creating high-performance and multifunctional optoelectronic devices. This presentation provides insights on research based on graphene heterostructure optoelectronic devices:

A millimeter-scale infrared position-sensitive detector that utilizes the graphene-germanium Schottky junction. This detector device achieves numerous non-contact optical measurements such as high-frequency signal acquisition, small angle measurement, and infrared target trajectory tracking.

A 'time-divisional' position-sensitive detector comprising multi-target imaging and tracking capabilities with a theoretical detection frame rate of 62,000 and sub-micron spatial resolution. In addition, this device utilizes frequency-related image preprocessing that enables multi-channel target detection and image denoising, making it an ideal choice for complex environments.

A spatial information extractor based on the lateral photovoltage effect. This device performs both human motion recognition and imaging, and in comparison to traditional array-type photoelectric detectors, it extracts spatial information for recognition with more intuitive and optimized data output.

Biography

Kaiyang Liu is a Ph.D. candidate in the School of Physics at Southeast University, China, where his research focuses on the development of optoelectronic devices utilizing two-dimensional materials. Throughout his doctoral studies, he has secured a foundation in the growth, transfer, fabrication, surface modulation, and optoelectrical system measurement of graphene.

Electrically-Driven Active VO2/MXene Metasurface for the Terahertz Modulation

Yuan Li, He Ma, Yu Wang, Jun Ding, Limei Qi, Yulan Fu, Ran Ning, Lu Rong, Dayong Wang, and Xinping Zhang

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Abstract.
With the growing demand for broadband wireless communication, high-resolution radar, security inspection, and biological analysis, terahertz (THz) technology has made significant progress in recent years. The wide applications of THz technology benefited from the rapid development of various THz functional devices. Metasurface, an essential means of manipulating THz waves, has been widely applied in multiple THz functional devices. However, it is still a great challenge to construct flexible THz metasurface devices due to the lack of flexibility of traditional semiconductor and metal materials. In this work, a novel two-dimensional material, MXene, is used to prepare flexible metasurfaces with frequency filtering and polarization functions. By further combining with the phase-transition-material vanadium dioxide (VO2), the VO2/MXene metasurface exhibits good performance in amplitude modulation under electrical stimulation. The modulation depth of the device reaches 86% under a lower trigger power of 11.6 mW/mm2 and the response time is only ~100 ms. Such a flexible active metasurface with superior performance and high integration will be useful in THz imaging systems, THz sensing systems, etc.

Biography.
Li Yuan, PhD student.
She studied at Hebei Normal University in Shijiazhuang with her undergraduate degree, and studied at Beijing University of Technology with her master’s degree and doctoral degree. The postgraduate supervisor is an associate researcher of Mach. At present, the first author has published two articles, mainly on the preparation, growth mechanism and application of vanadium dioxide thin films. Diligent and hardworking in learning and loving scientific research.

Analogue and RF design – It is not all a Question of Ft

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Abstract.
After the "semiconductor shortage" that started in 2020there was a sudden interest, after decades of neglect, in semiconductor manufacturing amongst the political class of many countries. This was entirely focused on leading edge processes even though originally it was the auto industry that suffered from shortages and those shortages were not in leading edge nodes. Analogue, power management, and RF circuits are crucial to all practical systems and yet do not receive the focus that their digital brethren receive. Often the analogue and RF designers are expected to use the same process as the digital designers and are told "all you need is higher ft so your circuits should work better". In this talk I examine why the ft of a process is not the only parameter affecting a design in RF and analogue circuits and systems and what is important for various functions in a design. I also highlight why a CMOS process and integration is not necessarily the best path forward for many systems and suggest an alternative path.

Biography.
Malcolm H. Smith is an independent consultant and entrepreneur based in Osaka, Japan, with over 30 years post-Ph.D. industrial experience in the design of analogue and RF circuits and systems. Before becoming a consultant, Dr. Smith worked at STC Semiconductors in the UK, Matsushita Electric Works (now renamed Panasonic) in Osaka, Japan, and Bell Labs, Intel, Amalfi Semiconductor, and RFMD in the USA. From 2014 he worked as a consultant in Silicon Valley. Dr. Smith moved back to Osaka in 2018 to concentrate on the Asian market but has done work for clients in Africa, Europe, and North America as well as Asia. He operates in Japan under the Sumisutek monicker and runs a design company in Singapore, Analoue Smith (S) Pte. Ltd., through which he offers design services worldwide. Dr Smith is an inventor on over 40 patents, has delivered invited tutorials at conferences in the US, Asia, and Europe and has published several journal and conference papers. He has also delivered courses on CMOS PA Design for Besser Associates in the US and RF topics for Wizlogix in Singapore. Dr. Smith was awarded the B.Sc (Hons) degree in Microelectronics from the University of Edinburgh, the M.Sc. from the University of Westminster and the Ph.D. Degree from the University of Kent all in the UK. He is a Senior Member of the IEEE and a Member of the IET in the UK.

Navigating the Global Value Chain: Can China's Semiconductor Industry Weather the Technology Decoupling?

Marina Yue Zhang
University of Technology Sydney
Australia

Abstract:
The semiconductor industry is one of the world's most globalised industries and is also of great strategic importance. The global nature of the semiconductor industry has resulted in an interdependent relationship between China and the US-led allies, which control critical inputs into the global value chain (GVC). Growing tensions between the US and China have created uncertainty about the semiconductor industry's future. The technology sanctions and export controls have further highlighted China's dependence on critical foreign suppliers. Latecomer nations face many barriers to technology upgrading, particularly in highly globalised sectors, such as semiconductors. China has made significant investments in its domestic semiconductor industry in recent years to become self-sufficient in advanced chip production. These initiatives include the "Made in China 2025" plan, which seeks to upgrade China's manufacturing capabilities in several key industries, including semiconductors, and the semiconductor "Big Fund" to support entrepreneurship and innovation. The success of these initiatives will depend on two factors: the government's return to a pragmatic industrial policy that provides a top-down framework while allowing the market to choose the winners and China's continued participation and contribution to the GVC.

Biography.
Dr Marina Zhang is an Associate Professor – Research at the Australia-China Relations Institute, University of Technology Sydney (UTS:ACRI).
Dr Zhang holds a bachelor's degree in biological sciences from Peking University and an MBA and a PhD from the Australian National University. Before joining UTS, she held academic positions at Tsinghua University, UNSW and Swinburne University of Technology. Her research interests cover digital transformation, emerging technologies, and latecomer catch-up in innovation. Specifically, her research investigates innovation in advanced manufacturing, semiconductors, biopharmaceuticals, new energy vehicles, and the global value chain (GVC), exploring their impact on Australia-China relations.
Dr Zhang is the author of three books. Her most recent, Demystifying China's Innovation Machine: Chaotic Order (304pp), with Mark Dodgson, and David Gann, was published by Oxford University Press (2022). The book was endorsed by Lee Howell, Senior Advisor & Former Managing Director, World Economic Forum, and Justin Yifu Lin, Institute of New Structural Economics, Peking University, Former Chief Economist, World Bank.

Distributed and Parallel Processing of Complex Modular Calculations in IoT

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Abstract.

The Internet of Things [IoT] refers to a set of sensors and other tiny devices connected to the Internet. Sensors have insufficient resources and security measurements, exposing their and the Internet networks to severe security risks. Commonly used security technologies require considerable computation resources, which are much beyond the capacity of existing sensors and tiny devices. A combination of symmetric and asymmetric encryption systems is frequently used in the industry. Symmetric cryptography requires moderate computation resources, so they are implemented successfully in IoT for all data-streaming cryptography. However, the critical security risk is distributing the symmetric key amongst the network devices. A common practice of distributing the key is using a public key asymmetric cryptography based on the integer factorization problem, which entails intensive calculations of modular Power, affecting its performance and cannot be executed by most IoT devices. To cope with this limitation, we propose a distributed and parallel implementation of asymmetric cryptography by downsizing each complex calculation into a collection of micro-calculations, which is possible due to a unique feature of modular analyses. One of the devices in the network is announced as the distributor. The distributor allocates each micro-calculation to a device based on its computing power. Once all the micro-calculations are completed, the results are transferred back to the distributor device, which integrates them into the final modular result. Using this approach, the distributor calculates the asymmetric key and uses it to encrypt the symmetric key. The distributor distributes the encrypted key to all the devices in the network. This proposal has been implemented on a sizable IoT network and a comprehensive feasibility simulation, proving the proposed asymmetric implementation is ready for IoT security implementation.

Biography.

Menachem Domb, Associate Profesor, Head of the Computer Science department at the Ashkelon Academy DSc. in OR and Systems Analysis Engineering, Technion, Israel. Master's degree in Applied Mathematics, NYU, Computer Science, QC, and an MBA, TA universities. Has over 30 years of lecturing and research in Computer Science, focusing on Cyber-Security, Telecom, Computer-vision, and IoT. He has published research and Conference papers and five patents. In parallel, he has 35 years of professional experience in the IT industry in technical and executive positions in international IT companies in the following domains; Security, Health, and Telecom. He gained experience managing large software projects, R&D, change management, and business process modeling.

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Carbon Nano Materials with Non-Noble Metals as Highly Efficient Electrolytes

Noureen Syed, and Yongqiang Feng

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Abstract.

In recent years, there has been growing interest in the use of carbon nano materials with non-noble metals as highly efficient electrolytes. Carbon nano materials, including graphene, carbon nanotubes, and carbon black, exhibit unique properties such as high electrical conductivity, high surface area, excellent chemical stability, and tunable properties, which make them promising candidates for electrolyte applications. When combined with non-noble metals, such as nickel, cobalt, and iron, which are abundant and cost-effective compared to noble metals, carbon nano materials can form composites or hybrids that exhibit synergistic effects, resulting in highly efficient electrolytes. Overall, carbon nano materials with non-noble metals offer promising opportunities for highly efficient electrolytes in various electrochemical applications, providing advantages such as enhanced electro catalytic activity, tailorable properties, stability, and sustainability. Further research and development in this area can lead to breakthroughs in electrochemical technologies and contribute to the advancement of clean and sustainable energy systems.

Biography.

Noureen. Syed, PhD scholar. Noureen Syed is a PhD student at Shaanxi University of Science and Technology (SUST) in Xi'an, China. She is pursuing her doctoral degree in the School of Materials Science and Engineering under the supervision of Professor Jian-Feng Huang. She is working on the design and application of carbon-based nanomaterials via Heterojunction serving as photo catalyst. She has participated in the 4th International Symposium on Energy and Environmental Photo catalytic Materials (EEPM) held at SUST in 2023. She is also a member of the Frontier Research Academy of SUST.

Light Matter Interactions in 2D Materials

Qiaoliang Bao
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Abstract.
Our research interests are mainly focused on optical characterization of 2D materials, more specifically, the light-matter interactions in the forms of nonlinear light absorption, light modulation (amplitude, phase and polarisation), photo-electrical conversion, wave-guiding and polaritonic manipulation. This talk will give a particular overview of the polaritons relatedphenomena in 2D materials. The THz light modulations associated with plasmonic excitation in graphene/Bi_2Te_3, topological insulator Bi_2Te_3, graphene nanoribbon and 3D graphene were investigated using both spectroscopic and real space imaging techniques [1-3]. We developed a surface plasmon resonance (SPR) sensor using 2D antimonenenanosheets, and demonstrated 10,000 times improvement in sensitivity. [3] Inparticular, we update our recent progress on the observation of anisotropic and ultra-low-loss polariton propagation along the natural vdW material α-MoO_3.[4] We will also present how the hyperbolic polaritons in α-MoO_3 thin slabs are delicately manipulated by controlling the interlayer twist angle.[5] We experimentally observed tunable topological transitions from open (hyperbolic) to closed (elliptical) dispersion contours in twisted α-MoO_3 bilayers at a photonic magic twist angle. We further demonstrated the manipulation and steering of the hyperbolic polaritons in this exotic material by chemical intercalation [6] and edge orientation [7], an important step for building polaritonic circuitry[8]. In summary, we have performed intensive researches on 2D materials integrated photonic and optoelectronic devices ranging from pulse lasers, waveguide, modulators to photodetectors, which are essential building blocks for constructing next generation integrated photonic circuitries and neuromorphic photonic processors.

References
Light:Sci. App., 2017,6:e16204.
ACS Photon., 2017, 4 : 3055.
Nat. Commun., 2019, 10:28.
Nature, 2018, 562: 557.
Nature, 2020, 582: 209.
Nature Commun., 2020,11 :2646.
Nature Commun., 2020,11:6086
Nature Rev. Phys., 2022, 4 (9), 578-594

Biography.
Dr. Qiaoliang Bao received his Ph. D from Department of Physics, Wuhan University (2007). He has ever worked as a postdoctoral fellow at Nanyang Technological University (2007-2008) and National University of Singapore (2008-2012). He was appointed as a tenured Associate Professor at Monash University (Australia) upon the award of ARC Future Fellowship. He has authored or co-authored more than 250 refereed journal articles with more than 40,000 total citations and an H-index of 88 (Google Scholar). Dr. Bao was listed as Highly Cited (HiCi) researcher by Clarivate Analytics from 2018 to 2022.He co-founded Nanjing

kLIGHT Laser Technology Co. Ltd. and is now a specially appointed professor at USST.His research involves the investigation of waveguide-coupled 2D materials and devices, focusing on the effect of confined-space light-matter interactions on the transport of polaritons and the construction of emerging photoniccircuitries forneuromorphic hardware.

Heterogeneous 3D Integration and Advanced Thermal Packaging Technologies

Tiwei Wei
Purdue University
USA

Abstract:
Advanced semiconductor packaging is playing a crucial role to drive system performance and functionality. With the increasing demand for emerging and growing computing needs, heterogeneous three-dimensional (3D) integration with fine-pitch, high-density interconnections, and multi-chip stacks are very promising in the future. The aggressive interconnects pitch scaling and nanoscale via interconnections make the process development and reliability more and more challenging. On the other hand, this high-density 3D integration system has resulted in a substantial increase in both heat flux and power density (W/cm3). High-performance, energy-efficient thermal management solutions are needed to tackle this thermal challenge. During this talk, I will first present the copper 3D interconnects manufacturing technologies and their applications in different heterogeneous 3D integration systems. The second part of this talk will focus on theadvanced thermal packaging technologies to deal with the thermal challenges of future high-performance 3D integration system.

Biography:
Dr. Tiwei Wei is currently an Assistant Professor of Mechanical Engineering at Purdue University. He was the postdoc research scholar at NanoHeat group at Stanford University between 2020 and 2022. He received his Ph.D. degree at the Interuniversity Microelectronics Centre (imec) and KU Leuven, Belgium in 2020. He joined imec in 2015, starting his Ph.D. research by developing electronic cooling solutions for 3D integration systems. Before joining imec, he worked as a researcher staff at Tsinghua University and Hong Kong University of Science and Technology, from 2011 until 2015, where he worked on advanced microelectronic packaging techniques. He received the "Imec excellence Ph.D. award" in 2020, and "Belgium FWO Fellowship" in 2019. He also got the EPS / ECTC 2019 Student Travel Award (10 recipients), IEEE ICEPT 2013 outstanding paper award, and ITherm 2019 Student Travel Grant. His current research interests include advanced semiconductor packaging and efficient thermal management technologies.

GaAs Microwave Mixers

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Abstract.
The selection of a semiconductor material for a microwave mixer depends on various factors such as frequency range and low noise requirements. A common semiconductor material used for microwave mixers is Gallium Arsenide (GaAs) because of its high electron mobility and low noise characteristics, which make it ideal for high frequency applications. Apart from those two things, the following characteristics are also the reasons for selecting GaAs as a semiconductor material for microwave mixers, namely: non-linear properties, low power consumption, and temperature stability. All of these characteristics have come to the attention of our on-going literature study which preliminary results will be presented at this conference. We hope that the results of this literature study can contribute to complete information about the reasons for using GaAs as a material for microwave mixers, so that they can help determine directions for its improvement that can still be explored by interested parties.

Biography.
Tjahjo Adiprabowo, Post-Doctoral Researcher of BRIN, Indonesia.
He received his B. Eng. degree in Telecommunication Engineering from ITB, Indonesia, in 1987, and his M. Eng. degree in Telecommunication Engineering from RMIT, Australia, in 2001. He received his Ph.D. degree in Wireless Engineering from NTUST, Taiwan, in 2022. His working experiences are: Satellite Ground Station Engineer of PT. Elektrindo Nusantara in Indonesia; Mainframe System Programmer of PT. Telekomunikasi Indonesia in Indonesia; Network Performance Engineer of PT. Telekomunikasi Indonesia in Indonesia; Lecturer in School of Electrical Engineering in Telkom University in Indonesia. Since 2023 he works for BRIN as a Post-Doctoral Researcher. His research interests include Wireless Engineering, Wireless Sensor Networks, Semiconductor, Radar Engineering, and Common-Mode Noise Filters.

Yuyu Wahyu, Main Expert Researcher of BRIN, Indonesia.
He received his B. Eng. degree in Physics Engineering from ITB, Indonesia, in 1990, and his M. Eng. degree in Telecommunication Information System from ITB, Indonesia, in 2000. He received his Doctoral degree in Global Information and Telecommunication Studies from ITB, Indonesia, in 2010. His working experience is: Main Expert Researcher in Telecommunications Research Center of BRIN, Indonesia. His research interests include Radar, Antenna, Microwave, and Propagation.

Nasrullah Armi, Head of Telecommunications Research Center of BRIN, Indonesia. He received his B. Eng. degree in Telecommunication Engineering from ITENAS, Indonesia, in 1997, and his M. Eng. degree in Wireless Communication, Baseband W- CDMA, and Signal Processing from Toyohashi University of Technology, Japan, in 2004. He received his Ph.D degree in Wireless Communication and Network Systems from University of Technology Petronas, Malaysia, in 2013. His working experience is: Head of Telecommunications Research Center of BRIN, Indonesia. His research interests include Radar, Antenna, Propagation, Microwave, Electronics, and Telecommunications.

Comparative Analysis of Ln and Bto Platforms for Implementing Electro-Optically Tunable General-Purpose Photonic Processors (Gppps)

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2 Dept. of Aerospace Engineering, Indian Institute of Science, Bangalore, India

Abstract.
Optically transmitted information is processedusing photonic integrated circuits (PICs). However, today most of these PICs are application specific, which means a new fabrication is required each time for a new application, which makes them time-consuming and costly to implement. Thus, raising a need for reconfigurable photonic hardware similar to electronic reconfigurable multi-processing cores. General-purpose photonic processor (GPPPs) is an emerging technology aiming to design a standard integrated photonic hardware enabling reconfiguration of the same PIC to implement various functionalities through suitable programming. A GPPP is designed using waveguide meshes comprising interconnected tunable units (directional couplers/MZIs) in a particular topology to control the light flow within the circuit. These tunable units can be tuned using thermo-optic effect, plasma-dispersion effect, micro optoelectromechanical systems (MOEMS) and linear electro-optic effect. Among these mechanisms, electro-optic tuning using Pockel's effect provides the best alternative for implementing high-speed GPPPs. Among various material platforms enabling linear electro-optic effect, Lithium Niobate (LN) and Barium Titanate (BTO) on Silicon provide the most compatible solutions for implementing GPPPs.

A GPPP consists of devices in several orientations that must perform similarly. However, due to the inherent anisotropy associated with the electro-optic materials, the device performance is altered by the change in device orientation, which opens up the challenge for device placement in these two platforms. The device's performance for LN is affected only due to anisotropic behaviour. While, for BTO, in addition to anisotropy, the spontaneous polarization domains formed due to its ferroelectric behaviour also affect the device's performance. Thus, studying and analyzing the effect of orientation on the device's performance for the two platforms becomes essential. In this work, we comparatively analyze the two platforms for implementing GPPPs while discussing various factors determining the device performance and solving the device placement issue in the two platforms.

Biography.
Tushar Gaur received a bachelor's in technology degree in Electronics and Communication Engineering in 2013 from Rajasthan Technical University, India. He received his master's in technology degree in Photonic Science and Engineering from the Indian Institute of Technology, Kanpur, where he was also awarded the Academic Excellence award twice. He is currently a research scholar in the Department of Electrical Communication Engineering at the Indian Institute of Science, Bangalore, India. As a researcher, he is granted the prestigious Prime Minister Research Fellowship by Govt. of India. His current research interest includes photonic integrated circuits and general-purpose microwave photonic processors. He has authored journal papers in prestigious international journals like MDPI and Elsevier and presented his team's work in various international conferences.

Advanced ZnO Based Piezo-Phototronic Optoelectronics

Wenbo Peng

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Abstract.

Since its invention in 2010, piezo-phototronic effect has been widely used in piezoelectric semiconductor materials and optoelectronic devices, e.g., solar cells, light-emitting diodes, and photodetectors, for both fundamentally physical research and potential applications. However, so far, the most related researches are mainly focused on whether piezo-phototronic effect could modulate the devices' performance, and the reported piezo-phototronic effect induced enhancement is varying from a few dozen percent to thousands of percent. Why the piezo-phototronic effect could induce such different performance improvements in different optoelectronic devices? In some special cases, the piezo-phototronic effect even causes performance degradation. Therefore, it is of great significance to carefully investigate the role of the piezo-phototronic effect plays in different optoelectronic devices, which might possibly give us more clear understandings of the piezo-phototronic effect and further constructive suggestions of how to utilize it more effectively. In our recent works in the past a few years, we have systematically studied the piezo-phototronic effect in optoelectronic devices using ZnO as the piezoelectric semiconductor material, including: photodiodes with different device structures, thin-film transistors with different charge carrier concentrations, and heterojunctions with different energy band diagram alignments, to reveal the underlying physics in piezo-phototronic effect. Our experimental and theoretical results indicate that: (1) the charge carrier concentration in ZnO is of great importance, should not being too small or too large; (2) compared to isotype photodiodes, anis type photodiodes are preferred; (3) energy band diagram alignment is also preferred since misalignment would cause negative effects when introducing the piezo-phototronic effect. At last, we give a systematic instruction on how to utilize the piezo-phototronic effect more effectively and also our most recent research progresses about the experimental and theoretical results of piezo-phototronic and pyro-phototronic effects in multi-layered ZnO based optoelectronic devices.

Biography.

Wenbo Peng, Associate Professor

Dr. Wenbo Peng is now an Associate Professor at School of Microelectronics, Xi'an Jiaotong University. He received his PhD degree in major of Electronic Science and Technology at 2016 and bachelor degree in major of Microelectronics at 2010, from Xi'an Jiaotong University. He has been a visiting scholar in School of Materials Science and Engineering, Georgia Institute of Technology from Aug 2014 to Jul 2016, working on the research fields of piezotronics and piezo-phototronics under the supervision of Prof. Zhong Lin Wang.

His research interests mainly focus on advanced low dimensional piezoelectric semiconductor materials, devices and physics, and novel intelligent sensing integrated chips. He has received several fundings from NSFC, Shaanxi Province and companies. He has authored and co-authored over 50 peer-reviewed journal publications in related research fields, parts of which are published on high quality international journals, including Advanced Materials, Advanced Functional Materials, Advanced Energy Materials, Nano Energy, ACS Nano, Nano Letters, etc. His publications have been cited over 2200 times, as documented at Google Scholar (h-index: 26). He has given several Invited Talks in renowned international conferences. He is the Fellow of International Association of Advanced Materials.

Enhanced Solar-to-thermal Conversion Efficiency of Plasmonic Semiconductor Nanocrystal by Heterostructure

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Abstract:
Plasmonic sensing has arose huge attention in the past ten years, due to its capability of transforming incoming electromagnetic radiation into surface charge oscillations. Over the following half century, gold and silver were the most-studied plasmonic materials because of the strong light-matter interactions. Plasmonics has been utilized in many applications, including biotechnology, nano-spectroscopy, smart optics, energy harvesting and catalysis. The basic SPR principle is to convert optical energy into locally enhanced and related effects, producing extra-ordinary performance.

Semiconductor-based plasmonic materials have generated significant interest. Heavily doped semiconductor nanocrystals (NCs), which exhibit a localized surface plasmon resonance (LSPR) in the near infrared region (NIR), offer plasmonic properties that can be tuned by varying their doping level and composition. This NIR absorption peak originates from the collective oscillation of free holes (positive charge carriers) in the valence band of these semiconductors. Compared with metals, semiconductor NCs provide an additional degree of freedom in tailoring the plasmonic response and the associated electronic and optical properties. Recently, heterostructures, which integrate at least two nanodomains into one system, have attracted tremendous attention. In these structures, the metallic domain can serve as an electromagnetic antenna. Coupling of the metal and semiconductor domains has great potential to enhance the performance of the semiconductor by plasmonic energy transfer.

In this work, we studied plasmonic heterostructures created by fusing metallic nanoparticles with copper-based semiconductor NCs. We attempted to enhance the solar-to-thermal conversion efficiency by integrating the individual advantages of the two domains into one system and manipulating their plasmonic interactions. The enhancement could be due to the following factors: (i) local electromagnetic field enhancement, (ii) hot carrier-transfer and (iii) plasmonic resonance energy-transfer between two domains. The energy transfer mechanisms in these heterostructures was also studied and will be presented in the conference.

Biography:
Wing-Cheung Law, Associate Professor

Dr Law obtained his BEng and MPhil degrees in Electronic Engineering from The Chinese University of Hong Kong in 2003 and 2005 respectively. He received PhD degree in Electrical Engineering from State University of New York at Buffalo, USA in 2011.

Prior to join The Hong Kong Polytechnic University as an Assistant Professor in the Industrial and Systems Engineering, Dr Law has been serving as Postdoctoral Fellow in the Institute for Lasers, Photonics and Biophotonics of State University of New York at Buffalo, USA, conducting researches in the field of biophotonics and nanomedicine. His research interest is on studying plasmonic materials and building nanoparticle-based devices. He has published more than 150 peer reviewed journals with h-index 50.

Will Nanotechnology Solve the Energy Crisis?

Prof. Dr. Yarub Al-Douri

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Abstract:

The nanotechnology could deliver world-altering changes in the ways we create, transmit, store, and use energy. The scientists are working to develop super-efficient batteries, low-resistance transmission lines, and cheaper solar cells. However, the likelihood and time frame of these developments is unknown for the moment. The next generation of solar cells is thin film solar cells—flexible sheets of solar panels—that are easier to produce and install, use less material, and are cheaper to manufacture. These sheets can be incorporated into a briefcase that charges your laptop, woven into wearable fabrics that charge your cell phone and iPod, or incorporated into windows that can supply power to high-rise buildings.

In different parts of the world, the people do not have access to safe drinking water. But the new nanofiber water filters can remove bacteria, viruses, heavy metals and organic materials from water. They are re relatively inexpensive and easy to use, so the nanofilter could be widely employed easily. Providing pure drinking water would help prevent disease in many parts of the world, but it would not resolve many basic inequalities.

The nanotechnology has unique properties. The electrical properties, durability, strength and activity of nanomaterials are enhanced and engineered to obtain desired features through nanotechnology. Nanotechnology focusses on solar, hydrogen and biomass energy. The nanostructured catalysts are used to increase the efficiency of fuel cells while porous nanomaterials are used for hydrogen storage. The quantum dots and carbon nanotubes increase the energy absorption properties of solar cells. The development of cost-effective renewable energy systems will contribute to the urgent energy goals of our world and reduce the destructive effect of human activities.

Biography:

Prof. Dr. YarubAl-Douri is one of the Middle-East, North of Africa, Malaysia and Southeast Asia's most renowned scientists known for his contributions in Nanotechnology and renewable energy. He has PhD in Materials Science (2000). Al-Douri has initiated Nanotechnology Engineering MSc Program and Nano Computing Laboratory, the first in Malaysia and Southeast Asia, in addition to founding Applied Materials Laboratory in Algeria. Also, Head of Department of Nanomaterials and Department of International Networking and Collaboration, additionally to Secretary of Department of Physics. He has received 71 national and international prizes and awards from USA, Austria, Japan, China, Iraq, UK, Malaysia Italy and others. He has more than 817 publications, US$ 5.1M research grants. Al-Douri has notable citations = 9459, h-index = 51& i10-index = 224. He is Associate Editor of Nano-Micro Letters (Springer, Q1, IF= 23.655), Editor-in-Chief of Experimental and Theoretical NANOTECHNOLOGY, Editor-in-Chief of World Journal of Nano Science and Engineering, His research field focuses on nanotechnology, renewable energy, nanoelectronics, nanomaterials, modelling and simulation, semiconductors, optical studies. Finally, Al-Douri is a public figure at international media in the UK, Singapore, Malaysia, Qatar and UAE.

On-Chip Optical Analog-to-Digital Conversion Based on Cascaded Optical Quantization

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Abstract.
As a key unit of future high-throughput communications, optical analog to digital converter (OADC) with all-optical quantizer element that simultaneously possesses high resolution, large bandwidth and compact size is highly promising. A pending issue of conventional OADC methods is that a higher resolution is always accompanied with dramatically increased system size and complexity, consequently magnified impact of system error on the performance index such as bandwidth, which fails the inherent superiority of OADC. In this paper, we propose and numerically investigate a cascaded optical quantization (COQ) solution aiming to address the wavelength sensitivity issue of integrable optical phase-shifted quantizers at high resolution (>= 5-bit). Harnessing a step-size multimode interference coupler and a shape-optimized power splitter, we predict the operation bandwidth for 1-bit degradation can be up to 20 nm, 15.8 nm and 11.9 nm for the quantization resolution of 5-, 6- and 7-bit respectively, indicating a bandwidth improvement of > 1 THz compared to those without COQ. Meanwhile, the total insertion loss can be maintained below −1 dB. This proposed quantizer is CMOS-compatible, which can be monolithically integrated on the silicon-on-insulator (SOI) platform and fabricated through a commercial Multi-Project Wafer (MPW) run. It paves the path to achieve high-resolution and large bandwidth OADC chips in a cost-effective way.

Biography.
Ye Tian, Ningbo University.
Ye Tian received a Ph.D. degree in electronics science and technology in 2019 from Beijing University of Posts and Telecommunications (BUPT), Beijing, China. From 2019-2020, he was a post-doc with the Center for Optics, Photonics and Lasers (COPL), Laval University, Canada. Since 2020, he has been a lecture with the Department of Electrical Engineering and Computer Science, Ningbo University, China. His research focuses on the design and fabrication of silicon photonics devices, especially target to system applications such as OSNR monitor and all-optical analog-to-digital converter (OADC), etc.

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Spectroscopic Perception of Trap States on the Performance of Methylammonium and Formamidinium Lead Iodide Perovskite Solar Cells

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Abstract.
To enhance the efficiency and stability of the organic-inorganic hybrid perov-skite (OIHP) solar cells, doping has been demonstrated as a straightforward method. Nevertheless, the perception of trap states regulated by doping and their effects on the performance of solar cells is not in-depth. Herein, typical OIHPs ($CH_3NH_3PbI_3$ and $Cs_{0.05}FA_{0.85}MA_{0.10}Pb(I_{0.97}Br_{0.03})_3$) doped with RbI are employed to expound the doping mechanism in affecting the efficiency of devices. Systematic spectroscopic characterizations indicate that doping sig-nificantly influences the photocarrier dynamics via directly regulating the trap states. The results indicate that doping would reduce the trap density by pas-sivating defects and induce extra trapping centers. This directly manipulates the transient transport of the photocarriers and finally influences the output of devices. The optimization of solar cell performance requires the tradeoff of competitive relation between the passivation and introduction of trapping centers. The results provide the spectroscopic perception on how doping concentration affects trap density, carrier dynamics, transport behavior, and ultimately the parameters of devices. It provides a straightforward guidance to the design and optimization of OIHP-based solar cells.

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Aggregation-Dependent Dielectric Permittivity in Two-Dimensional Molecular Crystal

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Abstract.
The functionality of two-dimensional molecular crystal-based devices crucially depends on their intrinsic properties, such as molecular energy levels, light absorption efficiency, and dielectric permittivity, which are highly sensitive to molecular aggregation. Here, we demonstrate that the dielectric permittivity of the 2,7-dioctyl[1]benzothieno[3,2-b][1]benzothiophene ($C_{8\text{-BTBT)}}$ molecular crystal on monolayer WS2 substrate can be tuned from 4.62 in the wetting layerto 2.25 in the second layer.Its origin lies in the different molecular orientations in the wetting layer (lying-down) and in the subsequently stacked layers (1L-5L, standing-up), which lead to positive Coulomb coupling (JCoup) value (H-aggregation) and negative JCoupvalue (J-aggregation), respectively. The polarized optical contrast spectroscopy reveals that the permittivity of the C8-BTBT is anisotropic, and its direction is related to the underlying substrate. Our study offers guidelines for future manipulation of the permittivity of 2D molecular crystals, which may promote their applications towards various electronic and opto-electronic devices.

Biography.
Yutian Yang is currently working toward the Ph.D. degree under the supervision of Prof. Zhenhua Ni and Prof. Junpeng Luat Southeast University. He received the B.S. degree in physics from Hubei Normal University, Huangshi, China, in 2017 and an M.S. degree in physics from Southeast University, Nanjing, China, in 2019. His research interests include the synthesis and characterization of 2D organic molecular crystals and 2D TMDs for photoelectric devices.