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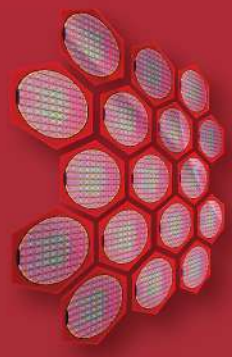

ICoSeMT 2023

18TH - 19TH SEPTEMBER 2023

3RD International Conference on Semiconductor Materials & Technology (ICoSeMT 2023)

SHANGRI-LA RASA SAYANG, PENANG

ABSTRACT BOOK

Innovation Towards a Sustainable Tomorrow

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ABOUT THE CONFERENCE

3rd International Conference on Semiconductor Materials and Technology (3rd ICoSeMT 2023) is a biennial event that is jointly organized by Institute of Nano Optoelectronics Research and Technology (INOR), Universiti Sains Malaysia (USM), Universiti Teknologi MARA Cawangan Pulau Pinang (UiTMCPP), National Nanotechnology Centre (NNC), Ministry of Science, Technology and Innovation of Malaysia (MOSTI), MIMOS Berhad and Collaborative Research in Engineering, Science & Technology (CREST) with the Theme "Innovation Towards A Sustainable Tomorrow". The primary focus of the conference is to create an effective medium for institutions and industries to share ideas, knowledge, and expertise in the fields related to Semiconductor Materials and Technology.

This year, with the aim to promote positive innovation culture and and encourage innovation activities and from different walks of life, a sub-event entitled International Invention, Innovation & Design Expo (INoDEx 2023) is going to be held concurrently. This sub-event will be a great platform in creating opportunities for local and international participants to present their innovations and inventions. Eventually, both events will lead to interaction and future collaboration among the local and international participants.

3rd ICoSeMT 2023 solicits contributions of abstracts and papers, featuring the theme and four main topics of the conference, encompassing:

a) Optical and Electronic Materials

- Narrow and Wide Band Gap Semiconductors
- Diamond, Graphene, and Carbon Nanotubes
- Piezoelectric and Ferroelectric Materials
- Electroluminescent Materials
- Colour-Changing Materials
- Energy Storage Materials
- Dielectric Materials
- Porous Structures
- Nanostructures
- Superconductors

b) Devices

- Optoelectronics
- Sensors and Actuators
- Power Devices
- Novel Devices
- Photovoltaics
- MEMS/NEMS
- Contacts and Interconnects
- Fabrication Processes
- Integrated System Design
- Modelling and Simulation

c) Organic and Polymeric Materials

- Organic Semiconductors
- Conductive Polymers
- Polymer Electronics and Coatings
- Polymer Catalysts and Characterization
- Composite Polymers and Biopolymers
- Functional Polymers and Polymer Hybrid Materials

d) Packaging Technology

- Phosphor Technology
- Lens and Optics
- Thermal Management
- Front End Assembly Processes
- Back End Processes and Applications
- Failure Analysis and Reliability

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KEYNOTE TALK

S1

DIAMOND p-FETs PLATFORM FOR WIDE BANDGAP n-FET

Hiroshi Kawarada[1,*]
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ABSTRACT- Semiconductor circuits are typically constructed of both n-channel FETs (n-FETs) and p-channel FETs (p-FETs), whose dual polarity capabilities provide advantages in switching speed and energy efficiency. However, in high voltage circuits such as inverters and converters, both the upper and lower arms are composed of n-FETs. The circuit is not symmetrical and requires additional components to work properly, but at the cost of lower efficiency and switching speed. Here, we propose a complementary circuit based on symmetrical operation by adding a power p-FET with performance equivalent to a power n-FET. There are no power p-FETs other than Diamond. Diamond p-FETs now approach or exceed the characteristics of SiC or GaN n-FETs. While single-crystalline diamonds are still 1 to 2 inches in diameter, polycrystalline diamonds are larger than 4 inches and can be used in power and high-frequency FETs. Grain boundaries are not leakage paths for hole conduction in p-FETs. We are close to realizing complementary high-voltage circuits that have never existed in electronics.

KEYNOTE TALK

S2

TRENDS IN OPTOELECTRONICS DEVICES & APPLICATIONS

David Lacey[1,*]
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ABSTRACT- The talk will discuss application trends in the optoelectronics industry and the underlying technical challenges that must be addressed to serve those markets. Applications of monolithic multi-pixel devices, discrete microLED devices and laser devices will be explored and recent progress & future challenges discussed.

KEYNOTE TALK

S3

CATALYSING MALAYSIA'S SEMICONDUCTOR INDUSTRY DEVELOPMENT WITH HIGH-VALUE SEMICONDUCTOR TECHNOLOGY RESEARCH & INNOVATION

Hing Wah Lee[1,*]
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ABSTRACT- The Malaysian Electronics and Electrical (E&E) industry has stood as a pillar of the nation's economy for the past five decades, consistently ranking as the country's top exporter. Traditionally, Malaysia has excelled in the semiconductor value chain, particularly in the back-end activites, with ATP (Assembly, Testing, and Packaging) operations, boasting a significant 13% share of the global market in this domain. However, despite these achievements, the industry's overall contribution to the nation's GDP remains relatively modest, hovering around 6.9%.

Recognising the imperative for our local E&E sector to ascend to the higher value chain, it is essential to bolster its role in driving higher GDP growth for the nation. This endeavor aligns seamlessly with the objectives outlined in the recently launched New Industrial Master Plan (NIMP 2030) and the E&E Roadmap: Technology Development 2021-2030.

In this keynote presentation, our speaker will delve into a comprehensive analysis of the global and local E&E Semiconductor industry. More importantly, they will explore strategies to propel our nation up the E&E value chain though high-value semiconductor technology (HVST), harmonising with national policies and leveraging the pivotal role of strategic agencies such as MIMOS in order to collectively work towards realising our national aspirations and fostering sustainable economic growth.

Keywords: Semiconductor, E&E, high-value semiconductor technology, HVST, NIMP 2030, MIMOS

PLENARY TALK

S4

TRENDS IN FUNCTIONAL OPTICAL STRUCTURES

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ABSTRACT- This talk will review some of the recent trends in functional optical structures and particularly focus on the aspects of increased light-matter interaction via the design of optical micro-nano structures and integration of the micro-nano structures on a chip. Structures sustaining surface waves are first reviewed with a particular emphasis on their propagation lengths and ability to support on-chip integrated functional devices. Semiconductor microcavities supporting strong interaction between excitons and photons and leading to the formation of exciton-polaritons that can be applied in interferometric microdevices are then presented. Structures supporting bound states in the continuum with applications in lasing are also introduced. Finally, the enhancement of chiral signal in a cavity using 2D chiroptical material property is presented.

PLENARY TALK

S5

IC SUBSTRATE TECHNOLOGY FOR ADVANCED PACKAGING

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ABSTRACT- IC Substrates are one of the key elements of advanced packaging and provide translation from the nano world of IC`s to the micro world of printed circuit boards. There they serve aspects including data transport, reliable electrical supply, thermal management and mechanical stability. Most of the advanced packaging concepts are built on the IC Substrate technology, including so-called chip first panel level packages and fan out packages.

I will introduce AT&S and the main concepts for substrate based advanced packaging technologies. In the second part, focuses on packages and modules highlight actual developments. Third, the materials and the support of advanced simulation technologies for the development of reliable packages will be targeted. The presentation with be closed with a summary.

Keywords: IC substrates, packaging, materials, virtual development.

INVITED TALK

1A1

ROLE OF PHYSICAL MODELLING AND OPTIMIZATION IN OPTICAL PRODUCT DEVELOPMENT

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ABSTRACT- Optical product development is complex, expensive, risky and time consuming. A standard product development lifecycle covers ideation, demand validation, prototype, optimization, followed by manufacturing and commercialization. In practice, experimental design and assessment of product quality require long period of time and high resource consumption. To reduce complexity in experimentation, multiphysics simulations together with appropriate optimization techniques are usually carried out to find optimal design and materials until the product reaches satisfaction between performance, quality, manufacturability and cost. This presentation aims to highlight the role of physical modelling and optimization in optical product development. A few practical examples will be presented at a glance. First example is about the use of electro-optical modelling and a famous paradigm of swarm intelligence, namely, particle swarm optimization (PSO), to simplify the performance evaluation of different LED chip layout designs. The workability of PSO to solve design-optics problem was justified by the good agreement between experiment and simulation-proposed solution. Followed by the success of PSO, another example is given to the assessment of an improved version of PSO, namely, multi-objective PSO (MOPSO). Finally, examples are given to the optical modelling of LED packages for failure analysis and materials quality control.

Keywords: Product development, LED, particle swarm optimization.

INVITED TALK

1B1

A STUDY ON THE EFFECT OF PECVD NITRIDE PROCESS PARAMETERS ON STRESS HYSTERESIS

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ABSTRACT- In this paper we discuss the effect of the nitride process parameter which affects stress hysteresis response, we are looking into each process parameters based on existing production chamber which are Silane, Ammonia, Nitrogen flow, electrode Spacing, RF Power and chamber pressure. A definitive screening design method was adopted to analyze and model the effect of the response on the molecular bonding and the stress hysteresis. Analysis on the molecular bonding using the FTIR analysis was also conducted to understand the bonding construction of the film based on these different process conditions. From the result it shows that the stress hysteresis relies on the hydrogen content of the nitride film. Silane, Ammonia and RF power shows the most significant effect that affects the bonding behavior in the nitride film. The hysteresis response shows that the Silane flow is the only parameter affecting the nitride film hysteresis with a total change of a 20-unit change from the low setting to the highest Silane flow setting. This behavior is attributed to the temperature range of the hysteresis setup which is done from 25 ^{0}C to 450 ^{0}C. From the correlation matrix we also observed that the stress hysteresis is highly correlated with the hydrogen content of the film based on the FTIR measurement. This entails that the hydrogen content is a critical parameter to be understood in a nitride film since the final layer stress will change with thermal annealing which is ubiquitous in semiconductor.

Keywords: PECVD, silicon nitride, FTIR, stress hysteresis.

INVITED TALK

2A1

FABRICATION OF CHEMICAL SOLUTION GROWN ZINC OXIDE NANOMATERIALS FOR HUMIDITY SENSING APPLICATIONS

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ABSTRACT- In the past decade, humidity sensors have been the subject of extensive research and consideration in a wide variety of applications, including agriculture, food industries, climate monitoring, chemical storage, healthcare, and semiconductor industries, to name a few. The studies have been centred on the preparation of humidity sensors with good humidity sensing performance and low cost. These sensors are required to be manufactured on a large scale and must fulfil the stringent performance obligations of emerging areas. In this investigation, resistive-type humidity sensors made of zinc oxide (ZnO) nanomaterials were developed. The chemical solution immersion technique was utilised during the production of the ZnO nanomaterials. It is possible to produce nanostructured films on a large scale using this chemical solution immersion method, which is a fabrication process that is both cost-effective and efficient. The findings of this research indicate that ZnO nanomaterials could be promising candidates for use in applications involving humidity sensing. ZnO nanomaterials have a high sensitivity to humidity sensing, and they could provide potential applications for humidity sensing in emerging areas.

Keywords: Humidity sensor; ZnO; nanostructures; chemical solution.

INVITED TALK

2B1

LOW TEMPERATURE GROWN AlN

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ABSTRACT- Epitaxial growth of compound-semiconductor thin films by metal-organic chemical vapor deposition (MOCVD) has been regarded as a standard and matured technology, especially for aluminum nitride (AlN). This talk presents results of thin AlN layers which were grown on flat and patterned sapphire substrates through a unique process, called Next Level Epitaxy (NLE). Essentially, the NLE process is a combination of PVD (physical vapor deposition) and CVD (chemical vapor deposition). In this work, all steps in the NLE process utilized different plasma sources in various combinations, including one DC (direct current) bias and one RF (radio frequency)-bias. In total, four different plasma sources were introduced. The Al-source was 99.999% pure, while for nitrogen source, nitrogen gas with a purity of 99.9995% was used, which was introduced by a homemade ion gun. Argon, oxygen and hydrogen were also used in the process. The plasma sources were all designed as stripe sources. The advantage of this process is the AlN layers can be grown at the temperature below 250°C surface temperature with high quality materials, as opposed to a conventional way. From X-ray diffraction (XRD) rocking curve measurement, the FWHM in (002) of the NLE-AlN was around 110 arcsec for a 50 nm thick AlN on flat sapphire substrate. Subsequently, the NLE-AlN on sapphire was overgrown with UV-A LED structures through MOCVD process. The starting conditions were modified with respect to conventional LEDs epi-process. The in-situ cleaning, the nucleation layer growth and the 3D-2D growth were skipped and the total thickness was in comparison to 2 µm thinner. The XRD FWHM were around 240 arcsec and 230 arcsec for 0002 and 10-12 reflections, respectively, which were close to the 4 µm thicker pure MOCVD layer with 255 arcsec and 250 arcsec for 002 and 102 reflections, respectively. From indium-dots contact on the LED epi-wafer, the optical power was 5.31 mW and the forward voltage was 6.7 V. The emission wavelength was 387 nm with FWHM of 8.6 nm. In comparison, the performance of the pure MOCVD LED layer for optical power, forward voltage, wavelength and FWHM were 4.59 mW, 3.98 V, 387 nm and 8.1 nm, respectively.

Keywords: AlN, GaN, plasma, low temperature, MOCVD, LED.

INVITED TALK

3A1

DEVELOPMENT OF InGaN EPITAXIAL FILMS FOR LONG-WAVELENGTH LEDs AND HIGH-EFFICIENCY SOLAR CELLS APPLICATIONS

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ABSTRACT- The exponential increase in electrical energy demand has raised the need for renewable energy and energy-efficient devices. Indium gallium nitride (InGaN) alloys with direct and tunable bandgap from 0.64 eV to 3.42 eV, which can cover the whole solar spectrum, are promising materials for energy-saving solutions such as light emitting diodes (LEDs) and high-efficiency solar cell. However, these applications are confronted with the difficulty of producing good quality indium (In)-rich and p-type InGaN epilayers. In this article, an overview of the InGaN semiconductor characteristics that make it suitable for long-wavelength LEDs and high-efficiency solar cell applications will first be presented. Next, the key challenges related to the growth of high-quality In-rich and p-type InGaN epitaxial films will be discussed. Finally, the recent development of InGaN epitaxial films at INOR, USM will be presented.

Keywords: III-V nitrides, indium gallium nitride, bandgap engineering, light emitting diodes, solar cells, epitaxial growth, indium-rich.

INVITED TALK

3B1

EPITAXY OF AlN/SAPPHIRE TEMPLATES FOR UV LEDs

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ABSTRACT- Aluminum gallium nitride based ultra-violet light emitting diodes (AlGaN based UV LEDs) have recently gained much attentions owing to their potential in various areas of applications, including virus disinfection and water purification. Nonetheless, commercially available UV LEDs today are only few percent efficient, making them are not energy- and cost-efficient for large-scale environments. Of the key approach to increase the LEDs efficiency is to grow the LEDs on low threading dislocation density (TDD) aluminum nitride (AlN) layer. An ideal route to obtain such AlN layer is by growing the layer on native AlN substrate. However, such substrate is currently expensive and available in limited sizes. To date, most of AlN layers are grown on sapphire substrate (AlN/sapphire templates), which commonly serve as pseudo-substrates for the UV LEDs. At this point, it is still a challenge to obtain AlN/sapphire templates with the TDD of lower than 10^9 cm^{-2} in the effort towards improving the UV LEDs efficiency.

This talk will present results from optimization works for the growth of AlN/sapphire templates at INOR, USM. In particular, the first part of this talk discusses on the effect of nitridation time, nitridation temperature, nucleation time on reducing the TDD in the AlN/sapphire template with the growth temperature, T_g above 1200 °C. With the optimum parameters, the TDD in the template can be as low as ~8.6×10^8 cm^{-2}. Meanwhile, the surface is atomically smooth with improved steps-like structure. The second describes the role of trimethylaluminum (TMAl) preflow in maintaining the material quality of the AlN/sapphire templates when the templates were grown at a lower T_g , of which around 1175 °C. The last part proposes the potential of our AlN/sapphire in realizing workable UV LEDs.

Keywords: AlN/sapphire template, MOCVD epitaxy, UV LEDs.

INVITED TALK

4A1

HIGH-QUALITY GALLIUM NITRIDE ON SILICON USING ALUMINUM NITRIDE PULSED-ATOMIC LAYER EPITAXY INSERTED BUFFER

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ABSTRACT- Nitride-based wide-bandgap compound semiconductors, such as gallium nitride (GaN) and its tertiary and quaternary alloys are very promising materials for fabrication of new-generation energy-efficient optoelectronic and power devices.

Crystal polarization at the interlayer of aluminum gallium nitride (AlGaN) and gallium nitride (GaN) produces 2-dimensional electron gas (2DEG) that works similar to channel region in typical silicon-based metal-oxide semiconductor (MOS). AlGaN/GaN transistors excel in terms of carrier mobility, operating temperature and operating voltage over conventional silicon (Si) - based transistors making it suitable as next-generation high-frequency switching and power devices.

The presentation is focused on the insertion of aluminum nitride (AlN) layer grown by pulsed-atomic layer epitaxy (PALE) technique to significantly reduce threading dislocation density (TDD) and prevent surface cracks in GaN on Si epitaxy. The presentation evaluates the TDD when AlN PALE is combined with AlN/GaN strained-layer superlattice (SLS), and when AlN PALE is combined with AlGaN step-graded buffers.

The effect of AlN PALE buffer with 0, 35, 70, and 140 cycle numbers towards the quality of grown GaN on Si(111) substrate is studied. All samples have been observed using AFM, FESEM and HRXRD. AFM imaging revealed a fully-coalesced and clear step flow GaN layer with the lowest RMS roughness of 0.606 nm. FESEM surface morphology shows a crack occurs on a sample without AlN PALE (0 pulse cycle) while crack-free GaN is obtained for samples with AlN PALE layer (35, 70 and 140 cycles). It was observed by XRD that the AlN PALE pulse cycle number greatly affects the structural properties of the top GaN layer where the lowest x-ray rocking curve for (002) and (102) achieves at 70 cycles, indicating the reduction of TDD in the growth structure. The presentation also shows the fabrication process and demonstrates a working AlGaN/GaN HEMT grown on Si (111). Furthermore, the HEMT characteristics are compared to a similar structure grown on sapphire substrate

Keywords: GaN on Si substrate, AlN, pulsed atomic layer epitaxy (PALE), high electron mobility transistor (HEMT).

INVITED TALK

4B1

EPITAXY DEVELOPMENT FOR HIGH VOLUME PRODUCTION OF LEDs

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ABSTRACT- This slot aims to introduce the presence of epitaxy development department in ams-OSRAM located in Kulim, Kedah. The talk will begin with introducing an Intelligent Forward Lighting and Projection system that is capable of eliminating the risk of dazzling oncoming traffic and projecting warning symbols on the road for communication purposes. Aside from the advanced optics and drivers that made such lighting possible, the beating heart of this system is the light emitting diode (LEDs) layers that is grown by epitaxy. This talk will focus high volume production challenges when increasing the wafer diameter, and this is followed by potential solutions that can alleviate such issues.

Keywords: Epitaxy, III-Nitrides, LED.

VENDOR TALK

V1

ATOMIC RESOLUTION OBSERVATION AND ANALYSIS ON NANOMATERIALS AND NANODEVICES BY USING ADVANCED ABERRATION-CORRECTED SEM/STEM/TEM TECHNOLOGIES AND TRIPLE BEAM SYSTEM (FIB/SEM/ARGON) FOR HIGH QUALITY LAMELLA PREPARATION

Abby Soo Mun Teng[1], Tay Khoon Yang
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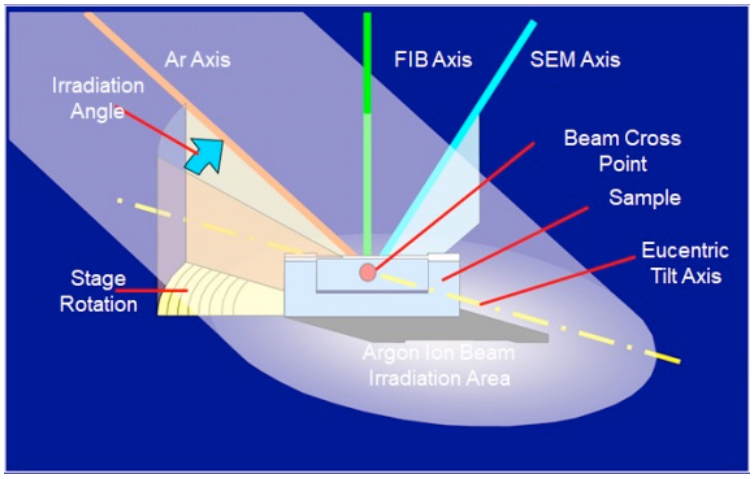
ABSTRACT- Performance and process yield of advanced 3D semiconductor devices such as 3D Fin-FET or 3D NAND composed of nanomaterials and nanodevices are considerably affected by atomic order structures such as growth's thickness, atomic arrangement, crystalline defect, impurity and chemical bonding state. In the perspective of development time, production yield and reliability of semiconductor integrated circuit reliability smart root-cause analysis by aberration-corrected SEM/STEM and Triple Beam System (FIB/SEM/Argon) are most powerful instruments for addressing these issues.

A sub-Angstrom resolution SEM/STEM/TEM reveal directly atomic arrangements and atomic defects in the specimen by combining a fully automated spherical aberration (Cs) corrector for the electromagnetic lens. The atomic order elemental and chemical bonding analysis also have been enabled by Cs-corrected SEM/STEM equipped with Dual-SDD (EDX) and EELS (Electron Energy Loss Spectroscopy).



High quality lamella can be routinely prepared in an automated fashion from lift-out site-specific ROI to final lamella finishing at multi-sites over full wafer by using triple beam geometry where three sources coincide at the same point. The traditional Ga-FIB associated chemical and mechanical damages are reduced and controlled using low energy argon source, 360° rotatable micro-sampling needle and slant/swing axis freedom in additional to the five axis movements (XYZRT). Highly reproducible ultrathin Ga-free lamella for Ga-beam sensitive materials can be prepared routinely.

The automated capabilities of both aberration-corrected SEM/STEM/TEM and Triple Beam System enables smart root-cause analysis achievable independent of the users in a highly reproducible fashion.

VENDOR TALK

V2

FROM SCIENCE TO INDUSTRY FOR DEFECTS ANALYSIS OF 2 D MATERIALS AND SiC WAFERS BY ULTRA-FAST RAMAN IMAGING MICROSCOPY

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ABSTRACT- 2D materials are a new generation of materials consisting of a single or several atomic layers in a one-dimensional structure. Due to these structural properties, compared to general bulk samples, 2D materials have unique optical and electrical properties. These 2D materials are expected to be used as photonic and optoelectronic devices such as photodetectors, optical modulators and switches, light emitting devices, transistors, and sensors. Recently, MoS2 is potentail for new 2D materials for commertial production. The most important thing in the commercialization of these 2D materials is to produce high-quality products, and for this, the physical properties and basic structure determine the characteristics. crystalline disorder, vacancies, substitutional and interstitial impurity and edge and grain boundaries type of concentration of dopants. To measure these properties, Raman microscopy is a very powerful non-destructive optical measurement method. However, since Raman microscopy basically measures the sample in points using a laser with a beam size of 1um or less, it is very difficult to analyze the characteristics of the entire wafer . In order to solve this problem, the laser beam is extended to a line beam so that can measure 400 data points simlutaneouly with 2D-CCD (400 x1350 pixels) In this study, very unique techniqe combine this line beam and a laser beam scanning make a less than 0.1 sec for 80um x 80um FOV area (100x lens) so that the entire 4-inch SiC wafer can be inspected within 30 minutes. In this presentation, we will introduce a method of fast measuring the number of layers of graphene and MoS2 using Raman microscopy. In addition, defects in SiC wafers by measuring micropipes, (MPs), screw-dislocations (SDs) and threading dislocations (TDs) are demonstrated in SiC wafers.

Keywords: 2D materials, MoS2, SiC, graphene, optical inspection, RAMAN microscopy, ultra-fast imaging.

VENDOR TALK

V3

AFM-BASED FAILURE ANALYSIS FOR ELECTRONICS AND SEMICONDUCTOR MANUFACTURING

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ABSTRACT- Understanding failure modes, failure mechanisms, and root causes is crucial in the manufacturing of semiconductors and electronic devices. Determining the primary cause leading to a failure helps prevent it in the future, and therefore, improves product quality, reduces costs, and improves customer satisfaction. In the semiconductor manufacturing industry, failure analysis is related to the inspection and characterization of local defects on bare wafers, quality assessment of multi-stage processes, or function and performance analyses of finished devices. With the ever-progressing miniaturization of key functional parts of electronic devices, failure analysis is likewise becoming increasingly challenging due to the small dimensions and complicated structures of micro- and nano-scale devices. Accordingly, a powerful analysis yet easy-to-use tool is considerably needed to inspect, isolate, and characterize the defects. This presentation reviews some aspects of failure analysis methodologies in the fields of semiconductors and electronic device manufacturing. In particular, an overview of failure analysis based on atomic force microscopy (AFM) will be introduced. The AFM allows non-destructive characterization of various surface, chemical, and physical properties of a target material. The automation of data acquisition and analysis along with advanced methodologies of Park Systems AFMs help accelerate mass adoption of AFM technology across various industrial applications.

Keywords: Atomic force microscopy, electronics manufacturing, failure analysis, nanometrology solutions, semiconductor manufacturing.

VENDOR TALK

V4

ADVANCED DUALBEAM'S APPLICATIONS FOR THE RESEARCH IN SEMICONDUCTOR'S MATERIALS AND TECHNOLOGY

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ABSTRACT- The Dualbeam (FIB-SEM) technique is an important solution for understanding the structure of electronic devices. Thermo Fisher Scientific is the industry leader in FIB-SEM technology with more than 30 years of experience with DualBeams. The technology's novel ability to reveal subsurface structural detail, by making precise cuts with a FIB and then imaging the exposed surface with a high-resolution SEM, has led to its acceptance by researchers and engineers in a wide variety of applications. The combination of FIB and SEM opens the door to many advanced applications for semiconductor materials and structures research. For example, 1) Dualbeam is the best tool for site-specific TEM sample preparation. 2) As the semiconductor structure is getting more and more complex and 3D, the slice-and-view function on Dualbeam is a great way to do 3D studies. 3) There are many different types of materials in semiconductor devices, e.g. Si and III-V semiconductors. Different materials require different ion species for milling. A well-known problem is that Ga is reacting with III-V semiconductor materials. To solve this problem, Thermo Fisher provides non-Ga FIB ion species, e.g. Xe, Ar, O, and N to meet all kinds of challenges in the FIB milling. Please be invited to this talk to understand the latest Dualbeam applications/solutions from Thermo Fisher.

VENDOR TALK

V5

THIN FILM ANALYSIS BY XRF – AN OVERVIEW

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ABSTRACT- XRF is an established method for elemental analysis. However, it also offers a simple, non-destructive method for determining the thickness of single or multi layers on a particular substrate. The layer thickness is determined by quantifying the fluorescence intensity of the coating material or substrate. This technique can be applied in research development of new coatings as well as process control.

ORAL PRESENTATION

ORAL SESSION 1

1A2

ADVANCED POTENTIOMETRIC WATER-GATED CONFIGURATION USING AlGaN/GaN HIGH ELECTRON MOBILITY TRANSISTOR (WGHEMT)

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ABSTRACT- Advanced potentiometric water-gated configuration using an Aluminum Gallium Nitride/ Gallium Nitride High Electron Mobility Transistor (AlGaN/GaN WGHEMT) system is demonstrated for the first time. The WGHEMT configuration which consists of HEMT, and interchangeable ion-selective membrane (ISM) offers high electron mobility, thermal stability, and sensitivity. The use of HEMT in this configuration is due to its low noise performance which is ideal for a sensor. The ISM which is made from silicon is placed between two pools consisting of an inner pool and an outer pool in the WGHEMT configuration. HEMT is inserted in the inner pool while a reference electrode Ag/AgCl that acts as a gate is inserted into the outer pool. As with all electrolyte-gated transistors, the potential applied to the gate contact is connected to the semiconductor surface via an interfacial electric double layer (EDL). The results show that the potential difference between the inner pool and the outer pool is determined by the presence of the EDL. This confirms that the EDL is essential for the functionality of the WGHEMT system.

Keywords: HEMT, AlGaN/GaN, WGHEMT, ISM, EDL, sensor.

1A3

AN EXPERIMENTAL MODEL ANALYSIS ON AEROFOIL SHAPED PIN FIN ARRAYS

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ABSTRACT- It is an experimental model analysis on aerofoil shaped pin-fins having perforation, no perforation, inline and staggered arrangements. The material of construction of this test plate array is aluminum. It is made by machining and fabrication process. The experimental thermal analysis is carried out inside a wind tunnel. A forced convection heat dissipation rate has been investigated. An electric heater, fan, anemometer, thermocouple, pressure transmitter, data logger and computer system has been utilized in this design of experiment. The friction factor, thermal efficiency, performance effectiveness and pressure drop has been evaluated. A comparative experimentation has been carried out with and without perforations, and inline and staggered arrangements. The obtained results show that performance effectiveness of perforated staggered arrangements is 10% higher than inline arrangements. On top of that 50% pressure drop reduced in staggered arrangements.

Keywords: Aerofoil pin-fin array (APFA), perforation and no perforation, inline and staggered arrangements, heat dissipation rate (Q), pin fin efficiency (η_{APF}).

1A4

IMPACT OF PROTECTION DIODES ON BIAS TEMPERATURE INSTABILITY IN SOI TECHNOLOGY

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ABSTRACT- Silicon-On-Insulator (SOI) technology has gained popularity for its advantages such as reduced substrate noise and compatibility with advanced device architectures. However, there is still limited understanding of its reliability and underlying mechanisms. This study specifically investigates the recently discovered drift mechanisms in Bias Temperature Instability (BTI) stress on 5V MOSFETs in SOI technology. Wafer-level BTI tests revealed increased drift in the linear and saturation characteristics after stress, indicating a high stress current created by Gate protection diodes during the test. These diodes (p-n junctions connected between Gate, Source, and Drain to the substrate) are implemented in SOI to suppress plasma-induced-damage in CMOS device application. These tests were performed on 5V MOSFETs with specific dimensions. MOSFETs with protection diodes exhibited lower saturation current and threshold voltage, suggesting faster turn-on. However, MOSFETs with protection diodes exhibited higher Gate leakage current (IGate) of approximately 10nA, while those without showed lower leakage current of approximately 0.1pA. It was suggested that the protection diodes turned on parasitically, leading to higher IGate. Absolute leakage current measurements confirmed the reverse breakdown of Zener diodes at ~17V Gate biasing, indicating potential Zener diode damage and shorting of the Gate oxide path during 24V BTI stress. Additional stress tests conducted at 24V with a temperature of 175ºC revealed that MOSFETs with protection diodes had a lifetime of approximately 20 hours. In contrast, MOSFETs without protection diodes demonstrated a significantly longer lifetime, lasting around 1700 hours. The parasitic current from protection diodes contributed to increased degradation at channel interface during BTI stress. Preventing degradation caused by this parasitic current is crucial for improved reliability. This study provides valuable insights into SOI technology's reliability and mechanisms, both with and without protection diodes, thereby accelerating the development of future SOI technology for consumer and automotive applications.

Keywords: Reliability, plasma induced damage, bias temperature instability.

1A5

ACCELERATING FORWARD ELECTROMAGNETIC SCATTERING PREDICTION USING NEURAL NETWORKS AND GENERALIZED MIE THEORY

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ABSTRACT- Electromagnetic scattering applications often require a large number of computationally expensive simulations, demanding valuable resources and time. In this research, we explore the potential of machine learning to enhance forward electromagnetic scattering prediction. Specifically, we investigate the utilization of neural networks to establish the relationship between a generic scatterer and its resulting scattering characteristics, enabling rapid predictions of the optical output in the form of a scattering extinction cross section by the Generalized Multiparticle Mie-solutions (GMM) code, a computational package implementing the Generalized Lorentz-Mie Theory. We propose NNGMM, a forward modeling neural network, designed to predict the electromagnetic scattering of an aggregate of spherical spheres. The NNGMM model is trained on a synthetic dataset generated by the GMM code. We extensively validate and stress-test the NNGMM with a diverse set of synthetic data. Our results demonstrate that NNGMM accurately predicts the extinction cross section for arbitrary aggregates with outstanding precision, achieving an R-squared value exceeding 99%. Consequently, NNGMM proves to be a reliable alternative to the GMM code for calculating extinction cross sections, offering a substantial gain in efficiency, and significantly reduced computational cost. The integration of neural networks and the GMM physical simulator presents a powerful approach to accelerate the computation of forward electromagnetic problems. As a result, this combined approach holds the potential to serve as a key component in constructing an efficient inverse electromagnetic problem solver in the future. The successful application of NNGMM in predicting scattering characteristics opens up promising avenues for optimizing electromagnetic simulations in various practical applications.

Keywords: Generalized mie theory; scattering cross section, neural networks.

1B2

$CsPbBr_3$ PLASMONIC-WAVEGUIDE SMALL LASER

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ABSTRACT- The recent development of lead halide perovskite (LHP) lasers has highlighted the material's outstanding capability as a gain medium for small lasers (microlasers and nanolasers) due to its high absorption coefficient and high quantum yield. Because of this, LHP-based small lasers, which has superior performance in terms of cost-efectiveness and multicolor tunability, have drawn tremendous attention in optical interconnects, optical computing, and lab-on-chip applications. These applications require the lasers to be precisely positioned on a chip, which then require the use of the well-known lithography process. The main challenge in utilizing LHP is its incompatibility with the standard lithography process due to LHP can be easily damaged by the solvents used in the process. In this work, we demonstrate several LHP-based plasmonic lasers that were fabricated by using a non-standard lithography process, which is called lithographic in-mold patterning method. The laser structure is composed of a rectangular plasmonic waveguide that is sandwiched by plasmonic DBR gratings at both ends to form a plasmonic Fabry-Perot cavity with high reflectance. The lasing threshold of the laser is 42.5 μJ/cm^2 with a linewidth of 0.6 nm (FWHM) and the lasing occur at room temperature. The results of this work should enable the fabrication of low-cost coherent light source arrays on a chip covering a broad range of wavelengths for the use in optical information processing and multidimensional sensing.

Keywords: Perovskite laser, plasmonic laser, plasmonic DBR waveguide, perovskite nanocrystals.

1B3

RECOVERY OF PRECIOUS METALS FROM ELECTRONIC WASTE THROUGH ACID LEACHING

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ABSTRACT- The recovery of precious metals, especially gold (Au) and copper (Cu) from electronic waste (e-waste) has garnered significant interest due to the substantial annual production volume. The electronic market's high rate of obsolescence is a significant factor contributing to the swift generation of e-waste. Because of that, this study focused on extracting precious metals using three different sources of e-waste, including SIM cards, computer-printed circuit boards (PCB), and mobile PCBB waste. Agua regia using 68% concentrated nitric acid and 37% concentrated hydrochloric acid (HNO_3: HCl = 1:3) was used as a leachant under various leaching conditions such as e-waste pulp density, temperature, and leaching time. By employing acid leaching at a 1% (w/v) e-waste pulp density, 100°C for a 1-hour leaching time, the successful recovery of Au was achieved at approximately 99.90%, 99.75%, and 99.60% (w/w) for mobile-PCB, computer-PCB, and SIM card waste, respectively. Under this condition, the recovery of Cu for these wastes was obtained with 99.01%, 98.10%, and 97.59%, respectively. In conclusion, this study demonstrates the feasibility of precious metals recovery using acid leaching from e-waste without the need for further chemical treatment.

Keywords: Electronic waste, aqua regia, acid leaching, precious metals recovery.

1B4

ANCHORING Pt-Ni NANOSPONGES ON GRAPHENE FOR EFFICIENT METHANOL OXIDATION REACTION

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ABSTRACT- In pursuit of creating an alternative power system for a sustainable future, fuel cells notches up as a clean power source to fight against climate change. Among the fuel cells, direct methanol fuel cells have been recognised as an alternative power generation device and notched up as a clean power source to fight against climate change. Nonetheless, this type of fuel cell relies on platinum (Pt) metal as the electrocatalyst. To solve this issue, researchers have adapted low loading of Pt on electrode components and added non-platinum metal catalysts to minimise dependency on Pt catalyst converters. The main goals of this study are to accentuate the potential of Ni-loaded Pt catalyst via the chemical reduction method, and sodium borohydride ($NaBH_4$) acts as the reducing agent to reduce chloroplatinic acid solution (H_2PtCl_6) and nickel chloride ($NiCl_2$). A preliminary study was done by varying the volume ratio of H_2PtCl_6 and $NiCl_2$ at 1:1, 1:2, 1:3, 2:1, and 3:1 during synthesis, while the volume of $NaBH_4$ was fixed at 0.5 mL. Nanosponges structures were identified in all the samples with 100kx magnification, and the Scherrer equation from the XRD result determined the average crystallite size. Cyclic voltammetry (CV) was run to analyse its electrocatalytic activity. From the CV result, it showed that Pt-Ni anchoring with GO was the best, with the highest ECSA value of 150.49405 cm^2/g and 33.75 times higher than Pt-Ni alone, whereas Pt-Ni/rGO was only 2.13 times higher but way too less compared to Pt-Ni/GO. Also, the XRD result pf Pt-Ni/GO showed the highest intensity compared to others implying it had the highest electron density.

Keywords: Bimetallic alloy, PtNi, nanosponges, graphene oxide, chemical reduction.

1B5

THE PHYSICAL AND RACAH PARAMETER OF ERBIUM-SAMARIUM CO-DOPED ZINC SODIUM TELLURITE GLASS FOR SOLID-STATE LASER USE: THE IMPACT OF RICE HUSK-DERIVED MICRO/NANO-SILICA

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ABSTRACT- The influence of low content of SiO_2 extracted from rice husk as incorporated into sodium zinc tellurite glass containing Er^{3+}/Sm^{3+} ion for solid-state laser use is highlighted. These glass samples were synthesized via melt-quenching technique where the SiO_2 concentrations embedded into the glass is varied from 0.0 to 5.0 mol%. The glass is characterized using selected analytical tools; XRD, and UV-Vis-NIR absorption spectrometer. The absorption feature and Racah parameter of prepared glass is discussed. The XRD confirmed the amorphous nature of the prepared glass. The glass containing 3 and 5 mol% SiO_2 reveals unusual transparent-ceramic nature where a crystal peak of SiO_2 is detected. The density shows a fluctuation pattern with SiO_2 concentration due to polymorphs and the anomaly of SiO_2 in the micro/nanoscale. Fifteen absorption bands range 377-1595 nm corresponding to the electronic transition of Er^{3+}/Sm^{3+} ions is evidence. The absorbance increases with SiO_2 concentrations. Glass with 4.0 mol% of SiO_2 elucidates the lowest B parameter (44.76), Dq/B ratio (17.96), and h_b value (2.029), indicating the notable increase of crystal field strength that allowed energy levels splitting or shifted; resulting changes in absorption of Er^{3+}/Sm^{3+} ion. The SiO_2 elucidates a pivotal role in altering the absorption properties of prepared glass; making them a potential candidate for versatile solid-state laser and optical fiber amplifier applications.

Keywords: Silica, rice husk, erbium, samarium, tellurite glass, Racah parameter.

ORAL SESSION 2

2A2

THE STUDY OF NONLINEAR OPTICAL BEHAVIOR OF GOLD, SILVER NANOPARTICLES AND THEIR COMBINATIONS SYNTHESIZED BY PALSED LASER ABLATION IN LIQUID

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ABSTRACT- This research paper investigates the nonlinear optical characteristics such as nonlinear absorption coefficient β, nonlinear refraction index n_2, and nonlinear optical susceptibility ($\chi 3$) of Gold (Au), Silver (Ag) nanoparticles and their combination (Au + AG) by using a continuous-wave (CW) laser at 637 nm via Z-scan method. The Au and Ag nanoparticles were synthesized through Au and Ag targets in distilled water by palsed laser ablation method and combined together to achieve (Au + AG) bimetallic nanoparticle. The structural and linear optical properties were also studied by X-Ray Diffraction (XRD) pattern, and double beam Ultraviolet visible (UV-vis) spectrophotometer respectively. The Z-scan results show that, the combined (Au + Ag) bimetallic nanoparticle solution exhibits the largest nonlinear absorption coefficient, $\beta = 7.54936 \times 10^{-4}\ cm/W$. However, the laser-deposited Au nanoparticle demonstrates the largest nonlinear refractive index, $n_2 = 2.0407 \times 10^{-14}\ cm^2/W$. To that end, it implies that the bimetallic nanoparticle (Au + Ag) is a promising candidate for the development of high-performance nonlinear photonic applications.

Keywords: Nonlinear optics; Z-scan, pulsed laser deposition, Au and Ag nanoparticles.

2B2

OBSERVATION OF 3RD ORDER OPTICAL NONLINEARITY IN LONG-CHAIN ALKYLAMMONIUM BISMUTH IODIDE QUANTUM DOTS

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ABSTRACT- Lead-free halide perovskites are proposed as potential candidates for nonlinear optical materials, replacing the widely studied hybrid organic lead halide perovskites (e.g., $CH_3NH_3PbI_3$). In this study, we report the observation of third-order optical nonlinear behavior in an organic-inorganic bismuth halide perovskite compound with butylammonium (BA: $C_4H_{11}N^+$) as the cation and compared with the published $PhABiI_4$ QDs. as the cation, comparing it with the published PhA_4BiI_6 QDs. Transmission electron microscopy (TEM) reveals that the compound consists of nanosized perovskite QDs. Under continuous beam 637 nm laser excitation, both compounds exhibit similar nonlinear optical susceptibility $\chi^{(3)}$ (10^{-6} esu) , which is characteristic of many common third-order nonlinear materials. The nonlinearity in the halide perovskite QDs is primarily excitonic, as evidenced by its strong enhancement near the exciton resonance. With its simple and inexpensive synthesis, we have demonstrated that $(BA)_2BiI_5$ comparable with $PhABiI_4$ QDs carries huge potential in a various application in nonlinear regime.

Keywords: Lead-free, bismuth halide perovskite, quantum dots, nonlinear optic, z-scan.

2B3

STRUCTURAL PROPERTIES AND HARDNESS OF ERBIUM-DOPED CALCIUM SODIUM FLUOROPHOSPHATE GLASS EMBEDDED WITH SILVER NANOPARTICLES

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ABSTRACT- The structural properties and hardness of phosphate-based glasses were investigated. These glass samples were synthesized via the melt-quenching technique, where the concentrations of silver nanoparticles embedded into the glass varied from 0.0 to 5.0 mol %. The structural properties were analyzed using an X-ray diffractometer (XRD) to determine the amorphous nature of all the glass samples and Fourier Transform Infrared spectroscopy (FTIR) to reveal modifications in the glass network structures. The properties of phosphate glasses were found to be strongly related to the structure, which may be modified by various glass constituents. The hardness of the glasses was measured in terms of Vickers Hardness. No sharp peaks can be observed in the XRD spectra to indicate that the glass is amorphous. FTIR spectroscopy reveals the presence of various phosphorus-oxygen vibrations in the glass samples, and the position of vibration bands of the basic phosphate tetrahedral network remains unaffected by silver nanocluster formation. The Vickers Hardness was found to increase from 3.532 GPa to 4.115 GPa with the silver nanoparticle content.

Keywords: Structural, hardness, phosphate glass, silver nanoparticles.

ORAL SESSION 3

3A2

CHARACTERIZATION OF THE HEAT AFFECTED ZONE OF GOLD WIRE BOND

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ABSTRACT- Experimentally determines the HAZ (heat affected zone) material properties and improve the accuracy on wire bond model. Recrystallization and grain size of annealed gold wire have been investigated and they affected the microstructures, which mechanical tests of annealed wires have been experimentally evaluated. Measured grain sizes dependent material properties of gold wire to describe the heat affected zone (HAZ) was considered into finite element model (FEM). The simulation results were verified against the experimental destructive wire pull test. Both experiment and simulation exhibiting very close agreement. This analysis is expected to be useful for understanding HAZ formation relate to wire bond lifetime.

Keywords: Wire bond, heat affected-zone (HAZ), grain size, mechanical properties, finite element model (FEM).

3A3

ELECTRICAL CHARACTERIZATION OF HYBRID P3HT: CdS AND PRISTINE P3HT

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ABSTRACT- Organic polymers possess intriguing qualities that make them suitable for constructing electrically conductive devices and there has been a growing utilization of organic polymers in electronic devices. This research study selects P3HT which is an organic semiconductor as the material of choice due to its excellent absorption coefficient within the visible range of the solar spectrum. In order to create solar cells with ITO/PEDOT: PSS/P3HT: CdS/Ag structures, the process began with the cleaning of substrates. To deposit the desired materials onto the substrate, a solution of P3HT and a cadmium chloride solution were spin-coated onto the cleaned substrate at a fixed rotational speed. To embed CdS nanoparticles between polymer layers, the films were exposed to hydrogen sulphide (H2S) gas and then the resulting films were annealed at various temperatures. A Keithley 2636A system source meter was employed as the four-point probe instrument to measure the electrical properties of the device. The I-V curves of the P3HT: CdS nanocomposite device were assessed with a four-point probe in order to study the relationship between current and applied voltage. The findings emphasize that subjecting the polymer films to high-temperature thermal treatment prior to metal contact enhances their radiation absorption. This, in turn, promotes the generation of excitons and ultimately improves the performance of the solar cells.

Keywords: P3HT: CdS hybrid, organic semiconductors, J-V characteristics, annealing temperature.

3A4

EFFECT OF RAPID THERMAL ANNEALING PROCESS ON $Ga_xCe_yO_z$ PASSIVATION LAYER

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ABSTRACT- The formation of a ternary $Ga_xCe_yO_z$ passivation layer spin coated on a silicon (Si) substrate was reported in this work. The as-deposited $Ga_xCe_yO_z$ passivation layer was subjected to rapid thermal processing (RTP) at different temperatures of 700, 800, and 900°C for 3 minutes in nitrogen ambient. The grazing incidence X-ray diffraction (GIXRD) characterization confirms the successful formation of a ternary $Ga_xCe_yO_z$ passivation layer, and the elemental analysis of the investigated passivation layers was carried out using energy-dispersive X-ray (EDX) spectroscopy. The thickness of the $Ga_xCe_yO_z$ layer and silicon dioxide (SiO_2) interfacial layer were estimated using the X-ray reflectivity (XRR) measurements. A further investigation on the surface topographies was carried out using atomic force microscopy (AFM). The capacitance-voltage (*C-V*) and current-voltage (*I-V*) analyses were performed to determine the metal-oxide-semiconductor characteristics of the investigated $Ga_xCe_yO_z$ passivation layers.

Keywords: $Ga_xCe_yO_z$, RTP, cerium, gallium, passivation layer.

3A5

OPTIMIZATION OF MODIFIED ACTIVATED CARBON COCONUT SHELL WITH TETRAETHYLENEPENTAMINE (TEPA) AND IMIDAZOLE (Ims) FOR CARBON CAPTURE USING RESPONSE SURFACE METHODOLOGY APPROACH

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ABSTRACT- Carbon dioxide (CO_2) is a significant greenhouse gas produced by human activities such as combustion of fossil fuels, industrial operations, and transportation. This has led to a global effort to reduce the release of greenhouse gases into the environment. Using effective and environmentally-friendly adsorbents made from biomass waste, such as coconut shell, is an attractive alternative to conventional adsorbents due to its cost-effectiveness and potential for carbon capture. Therefore, the aims of this study to investigate the optimal conditions for modifying activated coconut shell (AC-CS) with Tetraethylenepentamine (TEPA) and Imidazole (Ims) with different loadings using Response Surface Methodology (RSM). RSM is used as a tool to rapidly optimize the ratios of TEPA and Ims for impregnating AC-CS in order to obtain the highest iodine value as an indicator for the CO_2 capture capacity of the adsorbents. RSM based on Central Composite Design (CCD) was implemented to analyze and optimize the influence of TEPA and IMS loading as independent variables on iodine value as the response function. The predicted optimum condition by RSM gives the TEPA loading value of 60.4% and Ims loading of 9.09% with an iodine value of 1200.56 mg/g. This optimum condition was then compared with the experimental value, which resulted in an iodine value of 1201.40 mg/g with a small error of 0.84%. The modified adsorbent at the optimum conditions was further characterized using TGA, FTIR and SEM to observe its physicochemical properties. The characterizations show that this adsorbent has the potential to capture CO_2 due to its porous structure that can increase surface area and further studies on adsorption studies will be done to evaluate the performance of the adsorbent.

Keywords: Optimization, tetraethylenepentamine, imidazole, response surface methodology, carbon capture.

3A6

INNOVATIVE ACID TREATMENT STRATEGIES FOR ENHANCED MULTIWALLED CARBON NANOTUBE FUNCTIONALITY

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ABSTRACT- The viability of multi-walled carbon nanotube dispersion limits their potential despite extensive research on carbon nanotube applications. In an effort to create experimental conditions that effectively modify the external walls of multiwalled carbon nanotubes while curtailing nanotube structural destruction, this study examines the surface modification process (functionalization) of MWCNTs treated with several chemical compositions of concentrated strong acid, dilute strong, concentrated weak acid, and dilute weak acid (nitric acid, sulfuric acid, and hydrogen peroxide). Eleven (11) samples were prepared from different acid combinations. Fourier Transform Infrared spectroscopy and Carbon, Hydrogen, Nitrogen, Sulphur, and Oxygen analyzer were used to estimate the functional groups in the samples (pristine and functionalized). The dispersion and solubility test was carried out to observe the solubility of the functionalized-MWCNTs in deionized water and Ethanol. All samples were soluble in Ethanol, whereas the solubility of the *functionalized*-MWCNTs in distilled water was in the order of sample F > K > E > B > H > C > D > G > A > I > J. Samples B, E, F, and K have more excellent solubility and diffusion than the *pristine*-MWCNTs, although Sample F showed a well-dispersed MWCNT colloid. The FTIR spectrum demonstrates that the acid-treated MWCNTs is well fortified with carboxyl groups and other carboxyl groups. The CHNSO analysis shows that the sample contained a significant amount of oxygen, with sample F having the highest number of functional groups. Therefore, the result suggests that the combination of two acids can effectively modify the exterior walls of the MWCNT.

Keywords: Acid treatment, functional groups, carbon nanotubes, surface modification, multiwalled carbon nanotubes.

3A7

INVESTIGATE THE BEHAVIOUR OF FIELD PLATE ON E-MODE AlGaN/GaN MISHEMT DEVICES FOR POWER DEVICES APPLICATION

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ABSTRACT- GaN, as a wide-bandgap material, has become one of the preferred materials for high-temperature, high-frequency, and high-power devices, with the demand of social production. This is because of its excellent characteristics and the advantage of producing 2DEG without doping. In this study, field plate impact on E-mode Gallium Nitride (GaN)-based metal insulation-semiconductor high electron mobility transistors (MISHEMTs) have been investigated by using Silvaco Tcad Software. It is noticed that the breakdown voltage of the E-mode GaN MISHEMT device without a field plate around 600V and higher electric field at the gate edge and drain edge, which effects on GaN MISHEMT device's reliability issue. Therefore, different types of field plates have been implemented (gate field plate, source field plate, drain field plate and dual field plate) and analysis of the suitable field plate for the MISHEMT devices. Thus, it is observed that the breakdown voltage of the gate field plate, source field plate, and drain field plate showed around 730V, 760V, and 940V where the electric field at the gate edge and drain edge still revealed. So, to solve those issues, a dual field plate (gate + drain) has been proposed, which illustrates a breakdown voltage approximately 1050V with less electric field at the gate edge and drain edge. Eventually, it is sighted that the field plate does not influence the characteristics curve of the devices.

Keywords: GaN MISHEMT, semiconductor devices, wide bandgap, breakdown voltage, field plate.

3B2

DEVELOPMENT OF AMINE-MODIFIED SILICA GEL FROM RICE HUSK FOR EFFICIENT CARBON DIOXIDE CAPTURE

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ABSTRACT- The increasing level of atmospheric carbon dioxide emissions has become a significant concern due to its potential impact on the environment. Adsorption technology using solid-based sorbents is an effective method for mitigating greenhouse gas emissions. Rice husk is a promising source to produce silica gel due to its high silica content and sustainable use of agricultural waste. In this study, silica gel was synthesized using rice husk ash (RHA) via sol-gel processing and ambient pressure drying. The synthesized silica gel was then modified with tetratetraethylenepentamine (TEPA) and imidazole (Ims) in order to enhance its selectivity towards CO_2 adsorption. The resulting material was characterized using various techniques such as EA, FTIR, and SEM analysis to evaluate its physicochemical properties. Afterwards, the performance and effectiveness of the amine-modified silica gel as a sorbent material for carbon capture applications were evaluated by applying it in pressure swing adsorption (PSA) for CO_2 adsorption capacity. The results indicated that the amine-modified silica gel demonstrated a significantly higher CO_2 adsorption capacity (36.71 mol/kg abs) in comparison to unmodified silica gel (22.71 mol/kg abs). This is due to the functional groups of TEPA and Ims on the surface of the amine-modified silica gel provide more adsorption sites for CO_2 molecules, allowing for increased selectivity and capacity for CO_2 adsorption. As a conclusion, the utilization of RHA as a raw material for synthesizing silica gel provides an economically and environmentally sustainable approach for producing such materials. Furthermore, the modification of silica gel with amine groups, as demonstrated in this study, has the potential to greatly enhance its effectiveness as a sorbent material for carbon capture applications.

Keywords: Adsorption CO_2, amine, rice husk, silica gel.

3B3

STUDY ON ANODIC GROWTH TUNGSTEN OXIDE NANOPARTICLE ON ITO GLASS : STRUCTURAL, MORPHOLOGY AND OPTICAL PROPERTIES

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ABSTRACT- Tungsten oxide (WO_3) is an n- type semiconductor with indirect bandgap of (2.60-3.25 eV). WO_3 can be prepared by the anodization of tungsten on indium tin oxide (ITO) glass. The anodization of tungsten film grown on ITO glass is an area of research that involves the formation and characterization of an oxide layer on tungsten coated ITO substrates. This process holds significance due to its potential applications in various fields, including microelectronics, optoelectronics, and energy storage. This application is strongly related to the material study such as structural, morphological, electrical, optical, etc. Because of the importance of understanding the material properties before it can generalize to application, investigation of the structural, morphological, and optical characteristics of WO_3 grown on film via anodization is the main goal of this work. In this experiment, two sets of samples were grown under various conditions. The first parameter involves anodizing W for various growth times of 15, and 20 minutes, while the second parameter involves varying the voltage of 15, 20, 25, and 30 V. Field Emission Scanning Electron Microscopy (FESEM), X-Ray diffraction (XRD), and UV-Visible (UV-Vis) techniques were used to analyze the surface morphology, crystal structure, and optical property of WO_3. From the results, the bandgap energy increase from 3.85 eV to 3.99 eV upon increase of voltage during anodization for 15 min. Whereas, the bandgap energy decrease from 4.06 eV to 3.83 eV during anodization for 20 min.

Keywords: Tungsten oxide thin film, Anodization, RF magnetron sputtering, UV-Vis properties.

3B4

ENHANCING SOLID-STATE LASER PERFORMANCE: THE IMPACT OF PLASMONIC NANOPARTICLES ON PHOTOLUMINESCENCE IN Er^{3+}-DOPED SODIUM ZINC TELLURITE GLASS

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ABSTRACT- Present work examine the effects of silver (Ag), gold (Au), and titanium (Ti) nanoparticles (NPs) inclusion on the absorption, photoluminescence, and Judd Ofelt properties of erbium doped sodium zinc tellurite glass (TNZE); a candidate for solid-state laser host. Ten absorption bands of Er^{3+} ion in range 400–1600 nm was evidenced which corresponds to their *4f* transitions. Three prominent photoluminescence (PL) bands of Er^{3+} ion were observed around 525, 545 and 630 nm, corresponding to transitions $^2H_{11/2}\rightarrow{}^4I_{15/2}$, $^4S_{3/2}\rightarrow{}^4I_{15/2}$ and $^4F_{9/2}\rightarrow{}^4I_{15/2}$, respectively. The based glass with 0.15 mol% of Ti NPs inclusion shows the utmost PL enhancement (η_E) (14–21 times) compared to glasses incorporated with Ag (9–10 times) and Au NPs (3–8 times), accordingly. The enhanced PL may be due to the strong local field induced by surface plasmon resonance of metal NPs (490–630 nm) that assist Er^{3+} ions' transitions. Judd Ofelt parameter $(\Omega_2,\Omega_4,\Omega_6)$ is calculated and glass with 0.15 mol% of Ti NPs inclusion shows highest spectroscopic quality, χ (1.19) compare to glass with Au (0.59) and Ag NPs (0.90) embedment. This research revealed a few potential glass compositions with plasmonic nanoparticles that are attractive for solid-state laser materials developments.

Keywords: Gold nanoparticles, silver nanoparticles, titanium nanoparticles, plasmon, luminescence.

3B5

ENHANCING SELECTIVE WAVELENGTH SENSING IN PANI-ZnO COMPOSITES-BASED PHOTODETECTORS THROUGH LSPR EFFECTS OF GOLD AND SILVER NANOPARTICLES

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ABSTRACT- This research investigates the potential of using gold and silver nanoparticles to enhance the performance of polyaniline-zinc oxide (PANI-ZnO) composite photodetectors through the localized surface plasmon resonance (LSPR) effect. By incorporating different types of gold and silver nanoparticles within the PANI-ZnO composite structure, the LSPR properties are tailored to selectively enhance the device's sensitivity to specific wavelengths. The optical and electrical characteristics of the photodetectors, including responsivity, spectral response, and dark current, are examined to evaluate the performance enhancement. Experimental results demonstrate that the inclusion of distinct types of gold and silver nanoparticles leads to a significant improvement in light absorption and photocurrent generation, allowing for a tunable wavelength sensitivity in the photodetectors. These findings provide valuable insights into the design and optimization of PANI-ZnO composite photodetectors, offering a promising approach to develop highly efficient and wavelength-selective optoelectronic devices. The ability to selectively enhance specific wavelength ranges holds significant potential for applications in sensing, imaging, and other optoelectronic systems. The results of this study contribute to the understanding and advancement of LSPR-based enhancements in composite photodetectors, opening new avenues for the development of high-performance optoelectronic devices.

Keywords: Photodetectors, PANI-ZnO composite, Localized Surface Plasmonic Resonance (LSPR), Gold nanoparticles, Silver nanoparticle.

3B6

AN EFFICIENT METHOD OF HIGH TEMPERATURE REVERSE BIAS (HTRB) USING FLUORINERT ISOLATION IN DISCRETE TECHNOLOGY

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ABSTRACT- For High Temperature Reverse Bias (HTRB) testing of 1200V and 1700V IGBTs and diodes, Silicone gel was typically used at the chip edge to prevent arcing during high voltage stress. However, it was discovered that the gel posed challenges for small chips as it impeded with proper contact between the needle and the chip. This study aimed to identify an efficient technique for conducting HTRB testing on small chips using electronic liquids known as "Fluorinert." Fluorinert possessed desirable characteristics such as high dielectric strength and transparency. It evaporated completely without leaving any residue and proved its suitability for achieving high blocking voltages when used as electrical isolation. Various sizes and voltage class of IGBTs and diodes were prepared and subjected to both Silicone gel and Fluorinert. While Silicone gel was applied solely at the chip edge using paint brushes, the low-viscosity Fluorinert was applied with a syringe, ensuring complete coverage of the samples in a Fluorinert bath. The setup using Fluorinert offered effective electrical isolation and enabled precise control of biasing conditions and temperature. The electrical behavior and performance of the devices during HTRB test were accurately captured using monitoring and measurement equipment. The results indicated that the breakdown voltage achieved with the Fluorinert setup was comparable with Silicone gel. No abnormal leakage behavior was observed at critical voltage levels for both IGBTs and diode. The notable advantage of using Fluorinert was a significant reduction in sample preparation time, reducing it from 30 minutes to 1 minute. In conclusion, this study presents an efficient method for HTRB testing in discrete technology using Fluorinert isolation. By leveraging the exceptional thermal properties and electrical insulation characteristics of Fluorinert, this technique offers improved accuracy, reliability, and device longevity under high-temperature reverse bias conditions. The proposed method opens up possibilities for advanced testing and evaluation of discrete components in high voltage applications, enabling the development of robust and reliable electronic devices for a wide range of applications.

Keywords: Fluorinert isolation, HTRB, discrete technology.

3B7

STUDY OF BIO-ORGANIC BASED NATURAL RUBBER THIN FILM AS A RESISTIVE SWITCHING MATERIAL

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ABSTRACT- Green materials are now being used extensively in various electronic applications as a result of increasing environmental consciousness. Among them, bio-organic materials are attractive alternatives due to their natural biocompatibility, biodegradability and environmental friendliness. Bio-organic material is defined as material extracted from plant, virus, living, and/or once living thing that subsequently processed through a simple and environmentally friendly procedures to make it into a functional device. Here, a non-volatile memory device based on resistive switching in a bio-organic natural rubber thin film is demonstrated. Commercially purchased natural rubber latex was formulated and processed. A simple structure in which the natural rubber film is sandwiched between silver (Ag) and indium tin oxide (ITO) as top and bottom electrodes, respectively, is used. From the current-voltage measurements, the device could demonstrate reproducible bipolar switching characteristics. Surface roughness, morphology and chemical functional groups were investigated via atomic force microscopy, scanning electron microscopy and fourier transform infrared microscopy, respectively. Current-voltage characteristics show that filamentary conduction is the primary conduction process in thin films made of natural rubber. The device can give competitive performance and has a high ON/OFF ratio at relatively low read voltage and wide read memory window, making it a promising candidate for next-generation non-volatile memory.

Keywords: Resistive switching, bio-organic, non-volatile memory, natural rubber, metal-insulator-metal.

ORAL SESSION 4

4A2

INFLUENCE OF ANNEALING TREATMENT DURATION ON THE FORMATION OF Tb_4O_7 PASSIVATION LAYER ON SI SUBSTRATE IN ARGON AMBIENT

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ABSTRACT- In this study the influence of annealing duration on the formation of a Tb_4O_7 passivation layer deposited on n-type Si(100) substrate by radio frequency (RF) sputtering within a argon (Ar) ambient was investigated. The passivation layers characteristics, such as crystal structure, thickness, composition, surface roughness and optical analysis by X-ray diffraction (XRD), scanning electron microscopy (SEM) equipped with energy dispersive X-ray analysis (EDX), Atomic force microscopy (AFM) as well as Ultraviolet-visible spectrophotometer (Uv-vis) were studied respectively. The formation of the Tb_4O_7 passivation layers was observed as a function of fixed annealing temperature and duration for (15 and 45 min) in a controlled Ar ambient.

Keywords: Passivation layer; Tb_4O_7, annealing duration, argon ambient, surface analysis.

4A3

EFFECT OF FORMING GAS-OXYGEN-FORMING GAS ANNEALING ON THULIUM OXIDE PASSIVATION LAYER ON SILICON

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ABSTRACT- Thulium oxide (Tm_2O_3) was deposited on silicon (Si) substrate as a high dielectric constant (κ) passivation for Si-based metal-oxide-semiconductor (MOS) capacitor. The as-deposited Tm_2O_3 passivation layer was subjected to different post-deposition annealing temperatures of 500, 600, 700, and 800°C in forming gas-oxygen-forming gas ambient. The grazing incidence X-ray diffraction characterization has revealed that polycrystalline Tm_2O_3 passivation layers were formed after the post-deposition annealing process. The energy-dispersive X-ray (EDX) spectroscopy was employed to investigate elemental composition of annealed Tm_2O_3 passivation layers, where the nitrogen ions were proved be incorporated into Tm_2O_3 passivation layer. The thickness of the Tm_2O_3 passivation layers and SiO_2 interfacial layers that was obtained from fitting the X-ray reflectance (XRR) measurements. The surface morphologies and three-dimensional topographies of the investigated passivation layers were characterized using field emission scanning electron microscopy and atomic force microscopy, respectively. The energy band gap of the investigated Tm_2O_3 passivation layers was obtained from diffused reflectance spectra. The electrical characteristics of the investigated Tm_2O_3 passivation layers were also reported in this work.

Keywords: high-κ, Tm_2O_3, MOS capacitor, post-deposition annealing, surface passivation.

4A4

EFFECT OF PVA-G-GMA/PAA SOLUTION CONCENTRATION ON THE POROUS FIBER STRUCTURE

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ABSTRACT- The research focuses on the fabrication of porous fiber using a method called non-solvent induced phase separation (NIPS) as an alternative to electrospinning. The process involves preparing a polymer solution of PVA-g-GMA/PAA with water as the solvent and inducing precipitation by exchanging the solvent with IPA, a non-solvent solution that has an affinity to water. The resulting porous fiber is then dried at room temperature. The study explores various factors affecting the porous structure of the fiber, including the type of crosslinking (chemical, ionic, or covalent), solution concentration (ranging from 10% to 16% by weight), and precipitation time (ranging from 15 minutes to 24 hours). Different concentrations of GMA (0.05, 0.15, and 0.25) were used in the PVA polymer solution, and the effect of the PVA-g-GMA to PAA ratio was studied with ratios of 7:3, 6:4, 5:5, and 4:6.The results indicate that the best pore structure was achieved with a PVA-g-GMA to PAA ratio of 6:4 and a solution concentration of 10% by weight. A precipitation time of 24 hours was found to be sufficient for obtaining a complete porous fiber structure. The pore size of the fibers was classified as micro-porous, ranging from 500 nm to 1 um. In conclusion, the study successfully produced a porous structure in PVAGMA fiber under the selected conditions, suggesting potential applications in fiber fabrication.

Keywords: Polyvinyl alcohol, poly acrylic acid, multiple crosslinked, non-solvent induced phase separation, porous fiber.

4A5

IMPROVEMENT OF UV PHOTODETECTOR PERFORMANCE THROUGH COATING SI NANOWIRES WITH AU NANOPARTICLE-DECORATED ZnO THIN FILM

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ABSTRACT- This study explores the enhancement of ultraviolet (UV) photodetector performance through the application of Au NPs, achieved by coating ZnO nanostructures onto silicon nanowires (SiNWs) using the Vibration-Assisted Drop-Cast Method (VADCM). The results of the Field Emission Scanning Electron Microscope (FESEM) display a noticeable transformation in the surface morphology of ZnO NCs after photo deposition, offering evidence to support the existence of Au NPs. The electrical behaviour of Au NPs/ZnO NRs photodetector, represented by the current-voltage (I-V) characteristics illustrates a marked elevation in conductivity in comparison to the photodetector lacking Au NPs. The plasmonic effect boosts electromagnetic fields, intensifying light-matter interactions and improving charge carrier separation, particularly in the UV range. This hybrid structure enhances UV photodetection sensitivity and efficiency, showcasing the potential of this method for advanced photodetectors with applications in various fields.

Keywords: UV photodetection, plasmonic effect, silicon nanowires, ZnO nanorods, gold nanoparticles , plasmonic effect, photo-deposition techniqu.

4B2

CHARACTERIZATION OF MECHANICAL PROPERTIES OF PMMA REINFORCED NANO-SiO_2 FOR DENTURE BASE APPLICATION

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ABSTRACT- Poly methyl methacrylate (PMMA) is a polymer that usually used in a manufacturing of a temporary and permanent denture base. However, PMMA has high possibility to get eroded and liable to fracture within time. Therefore, the addition of nanoparticle elements has been extensively studied recently to improve its mechanical properties. In this study, different samples of nanocomposite were prepared by mixing PMMA with nano-SiO_2 (ranged from 0-2.5% wt.) in order to select the best ratio for temporary denture base by using cold curing with hand lay-up moulding method. The samples were tested for several mechanical tests included hardness, impact, flexural and compressive strength as well as surface roughness. Based on our findings, the addition of 2% nano-SiO_2 to PMMA has the maximum improvement on majority of the tests. Hardness was improved around 8% compared to the control sample and compressive strength test improved 67% from the control sample when 2000 N of load was applied. In addition, there is an increment of 48% in flexural strength. However, there was slight decreased in impact strength and surface roughness about 11% and 21% respectively as compared to the control sample it can be concluded that the addition of SiO_2nanoparticles at the concentration of 2% wt. has potential in improving the properties as the temporal denture base.

Keywords: Poly Methyl Methacrylate (PMMA), SiO_2 nanoparticles, denture base, mechanical properties.

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THE INFLUENCE OF DIFFERENT GRAPHENE NANOPLATELETS (GNPS) LOADINGS ON MECHANICAL AND THERMAL BEHAVIOR OF EPOXIDIZED PALM OIL-EPOXY RESIN NANOCOMPOSITES

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ABSTRACT- This study investigated the effects of incorporating graphene nanoplatelets (GNP) with different loadings (0.5, 0.75, and 1.0 wt%) into epoxidized palm oil-epoxy (EP-EPO) resin blend. The mechanical properties were evaluated through flexural and Izod impact tests, while the thermal properties were analyzed using Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA). X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) were employed to assess nanofiller dispersion and fracture behavior, respectively. Results indicated that 0.5 and 0.75 wt% GNP loadings improved mechanical properties, while 1.0 wt% loading decreased them. Similar trends were observed in the thermal properties. This study provided valuable insights into the mechanical and thermal behaviors of EP-EPO resin blend when GNP is incorporated.

Keywords: Graphene nanoplatelets (GNP), epoxidized palm oil (EPO), epoxy resin, mechanical properties, thermal properties.

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FEASIBILITY STUDY OF GOLD NANOISLANDS ON AlGaN/GaN HEMT FOR PH SENSING

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ABSTRACT- In this work, a novel aluminum gallium nitride/gallium nitride (AlGaN/GaN) high electron mobility transistor (HEMT) pH sensor with gold nanoislands (AuNis) as a sensing area is developed. The fabrication includes 3 nm of gold-thin film on AlGaN/GaN, followed by the formation of an AuNis with rapid thermal processing (RTP) at 400 °C. Field emission scanning electron microscopy (FESEM) showed uniform AuNi deposition with a diameter range of approximately 7–30 nm. The AlGaN/GaN pH sensor exhibits Nernstian behaviour of 46.05 mV/pH and a linear response in a wide pH sensing range from 2 to 12. Furthermore, the hysteresis of this prepared sensor displayed good reversibility in a wide range of pH 2 to 12 and pH 12 to 2 loop cycles. Therefore, the proposed AuNi on AlGaN/GaN HEMT has a high potential for developing a future stable biosensor with a wide range of detection.

Keywords: HEMT, AlGaN/GaN, pH sensor, gold nanoislands.

4B5

COMPARATIVE STUDY BETWEEN CEO_2 AND BORON DOPED CEO_2 FOR SI BASED METAL OXIDE SEMICONDUCTOR DEVICE

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ABSTRACT- $B_xCe_{1-x}O_y$ films were successfully grown on n-type Si (100) substrates by co-sputtering method with Boron and CeO_2 power at 30 W, and 160 W, respectively. The as-deposited $B_xCe_{1-x}O_y$ films were subjected to post-sputter oxidation in nitrogen/ oxygen/ nitrogen ambient at 800ºC for 30 min. In this work, the influence of boron during a co-sputtering of $B_xCe_{1-x}O_y$ was explored on the structural, morphological, optical, and electrical characteristics of the $B_xCe_{1-x}O_y$ films. The growth of $B_xCe_{1-x}O_y$ films was accomplished where the grazing incidence X-ray diffraction (GIXRD) characterization was disclosed that the CeO_2 peaks orientation was obtained from the $B_xCe_{1-x}O_y$ films. The surface morphology of the $B_xCe_{1-x}O_y$ films was attained by field emission scanning electron microscope (SEM) analysis. The $B_xCe_{1-x}O_y$ films divulged a higher root-mean-square (RMS) roughness by atomic force microscopy (AFM) analysis as compared to CeO_2 films. The inclusion of boron atoms into the CeO_2 lattice has narrowed the direct energy bandgap of the $B_xCe_{1-x}O_y$ in comparison with the CeO_2 film.

Keywords: Sputtering method, post-sputter oxidation, ambient, atomic force microscopy, GIXRD.

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