ISPE 2022

NOV. 11-13, 2022

INTERNATIONAL SYMPOSIUM

ON PRECISION ENGINEERING

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General Information

2022 3rd International Symposium on Precision Engineering 2022 (ISPE 2022) will be held in the Huisun Experimental Forest (HEF), Nantou County, during November 11 ~ 13, 2022. The main objective of the ISPE 2022 symposium is to provide a major international platform for knowledge exchange and an interactive forum in integrated technologies, mechanical engineering, optics, electronics, electrical engineering and material engineering into precision manufacturing, precision measurement, precision inspection, MEMS, semiconductor and precision environmental control, etc. These are all fascinating topics related to future needs. On behalf of the ISPE 2022 organizing committee, we sincerely welcome you for participating this symposium to share your experience and research results. ISPE 2022 welcomes authors to submit papers on any branch of precision engineering and its applications, and other subjects.

Plenary Speakers

- Chair Prof. Yu-Lin Shen
  Department of Mechanical Engineering
  University of New Mexico, U.S.A

- Prof. Kahar Bin Osman
  Faculty of Engineering
  Universiti Teknologi Malaysia, Malaysia

Keynote Speakers

- Prof. Vòng Bính Long
  School of Biomedical Engineering
  International University, Vietnam National University Ho Chi Minh, Vietnam

- Distinguished Prof. Ying-Hao Chu
  Department of Materials Science and Engineering,
  National Tsing Hua University, Taiwan
  Department of Materials Science and Engineering,
  National Yang Ming Chiao Tung University, Taiwan
  Department of Electrophysics,
  National Yang Ming Chiao Tung University, Taiwan
  Institute of Physics, Academia Sinica, Taiwan
  Center for Nanotechnology, Materials Science, and Microsystems,
  National Tsing Hua University, Taiwan

Invited Speakers

- Prof. Chengkuo Lee
  Department of Electrical and Computer Engineering
  National University of Singapore, Singapore
- Prof. Bhaskar Kanseri
  Department of Physics
  Indian Institute of Technology Delhi, India
- Assoc Prof. Dr. Jun Hieng Kiat
  Department of Mechanical and Material Engineering
  University Tunku Abdul Rahman, Malaysia
- Prof. Ngoc Dang Khoa Tran
  Faculty of Mechanical Engineering
  Industrial University of Ho Chi Minh City, Vietnam
- Dr. Nabila A. Karim
  Fuel Cell Institute
  University Kebangsaan Malaysia, Malaysia

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  President of National Chung Hsing University, Taiwan
- Distinguished Prof. Ming-Der Yang
  Dean of College of Engineering
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Symposium Chair

- Prof. Po-Liang Liu
  Head of Graduate Institute of Precision Engineering
  National Chung Hsing University, Taiwan
- Prof. Chengkuo Lee
  Department of Electrical and Computer Engineering
  National University of Singapore, Singapore

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  Science Institute, University of Iceland, Reykjavik, Iceland

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- Chair Prof. Yu-Lin Shen
  Department of Mechanical Engineering
  University of New Mexico, U.S.A.

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  Center for Emergent Functional Materials Science, Department of Applied Chemistry, National Yang Ming Chiao Tung University, Hsinchu, Taiwan

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  National Yang Ming Chiao Tung University, Taiwan
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  Fuel Cell Institute, Universiti Kebangsaan Malaysia, Malaysia
- Prof. Vidar Gudmundsson
  Science Institute, University of Iceland, Iceland
- Ts. Dr. Kean Long Lim
  Fuel Cell Institute, Universiti Kebangsaan Malaysia, Malaysia
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  Department of Physics
  Indian Institute of Technology Delhi, New Delhi, India
- Prof. Ho Thanh Huy
  Department of Physics and Electronic Engineering
  VNU-Ho Chi Minh University of Science, Vietnam
- Prof. Ratchatin Chancharoen
  Department of Mechanical Engineering
  Chulalongkorn University, Thailand

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  National Chung Hsing University, Taiwan
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  Graduate Institute of Precision Engineering
  National Chung Hsing University, Taiwan
- Distinguished Prof. Dung-An Wang
  Graduate Institute of Precision Engineering
  National Chung Hsing University, Taiwan
- Prof. Chia-Feng Lin
  Department of Materials Engineering
  National Chung Hsing University, Taiwan
- Prof. and Head Po-Liang Liu
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  National Chung Hsing University, Taiwan
- Prof. Hui-Min David Wang
  Graduate Institute of Biomedical Engineering

National Chung Hsing University, Taiwan

- Assoc Prof. Fu-Yuan Hsu
  Department of Materials Science and Engineering
  National United University, Taiwan
- Assoc Prof. Sheng-Fang Huang
  Mechanical Engineering Department
  China University of Science and Technology, Taiwan
- Assoc Prof. Kuo-Chih Liao
  Graduate Institute of Biomedical Engineering
  National Chung Hsing University, Taiwan
- Assoc Prof. Shu-Ping Lin
  Graduate Institute of Biomedical Engineering
  National Chung Hsing University, Taiwan
- Assist Prof. Jen-Chuan Tung
  Center for General Education
  Chang Gung University, Taiwan
- Assoc Prof. Chih-Liang Wang
  Graduate Institute of Precision Engineering
  National Chung Hsing University, Taiwan
- Assoc Prof. Chian-Hui Lai
  Graduate Institute of Biomedical Engineering
  National Chung Hsing University, Taiwan
- Assist Prof. Bill Cheng
  Graduate Institute of Biomedical Engineering
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Symposium Secretary

Yi-Che Chen

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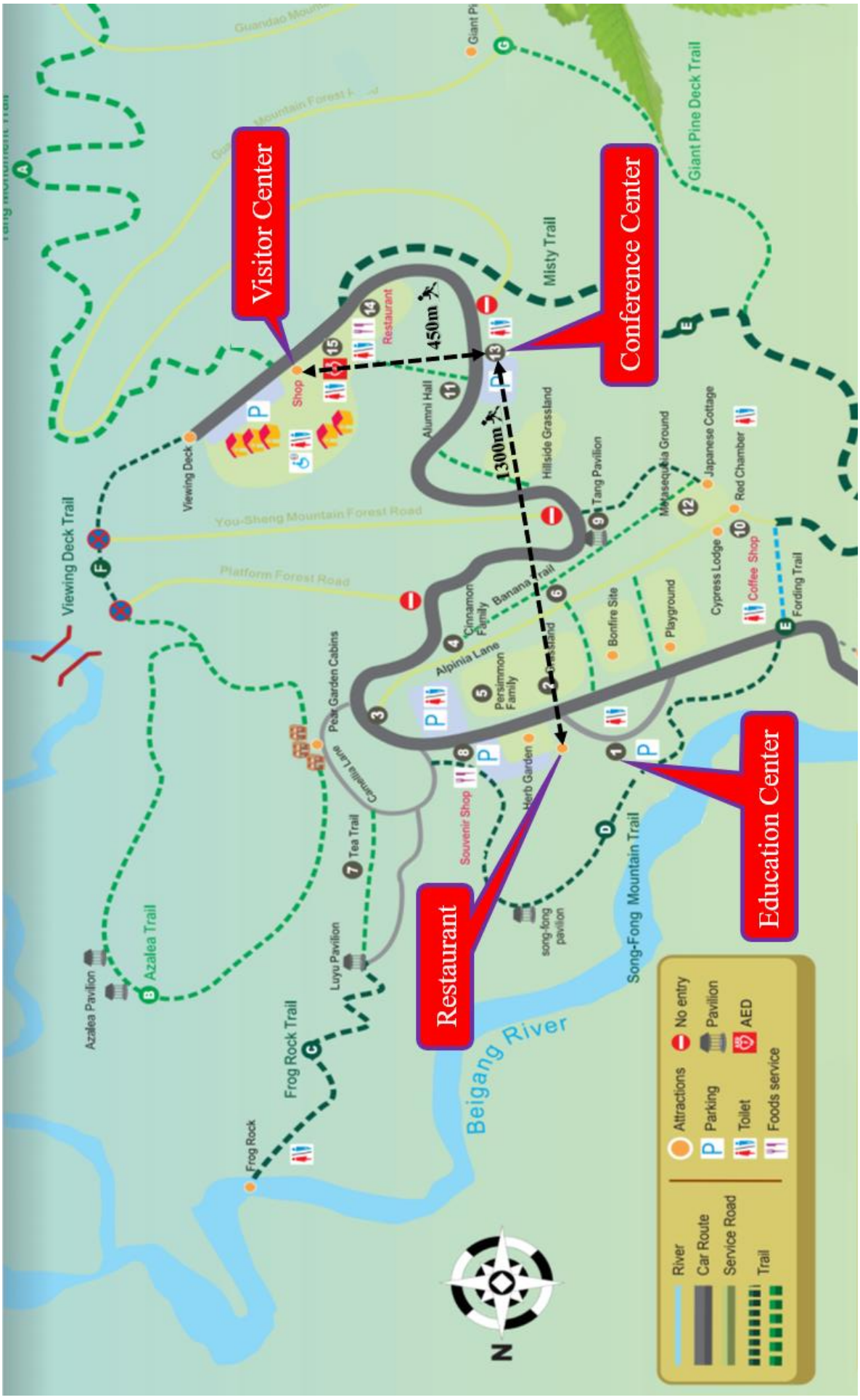
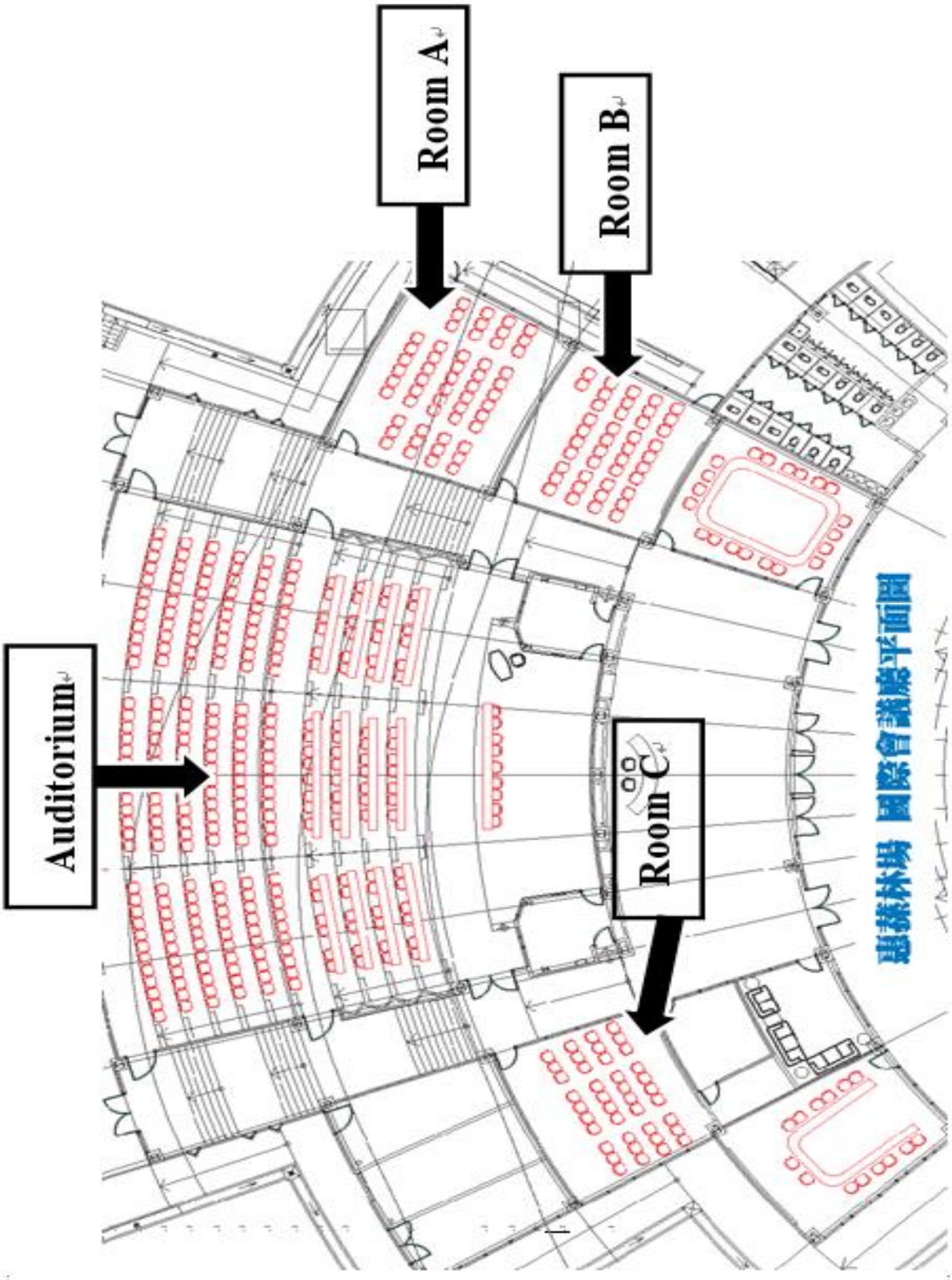
Hui-Sun Experimental Forest Map (1/2)

Hui-Sun Experimental Forest Map (2/2)



Floor Map of Conference Center



Symposium Agenda

All academic events will be held at Conference Center of Huisun Experimental Forest Station, Taiwan

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<tr><td>08:15~08:45</td><td colspan="3">Registration</td></tr>
<tr><td rowspan="2">08:45~10:00</td><td colspan="2">Invited Talk & Oral Session (1)</td><td rowspan="17">Poster Session</td></tr>
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<tr><td>10:30~11:15</td><td colspan="2">Plenary Speech (1)</td></tr>
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<tr><td rowspan="2">16:55~18:00</td><td colspan="2">Oral Session & Invited Talk (4)</td></tr>
<tr><td>Session 4A</td><td>Session 4B</td></tr>
<tr><td>18:30</td><td colspan="3">Symposium Banquet</td></tr>
<tr><td colspan="4">13 November, 2022 - Academic Visit</td></tr>
<tr><td>09:00~10:30</td><td colspan="3">Academic Visit or Huisun Experimental Forest Hiking Tour</td></tr>
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Plenary Speaker 1

Chair Prof. Yu-Lin Shen

Department of Mechanical Engineering
University of New Mexico, U.S.A.

Title of Plenary Speech

Predicting Effective Thermal Conduction and Mechanical Behavior of Porous Structures

Abstract of Plenary Speech

Materials containing internal pores are ubiquitous in structural components and functional devices. Metamaterials and lattice structures, fabricated by additive technologies, also incorporate regular empty space into their design. Understanding how the geometric configuration of the pores affects the overall material properties calls for systematic analyses. In this presentation we highlight our recent developments of numerical models to predict the effective thermal conductivity and mechanical behavior of porous structures, with attention devoted to various shapes (aspect ratios), sizes, and periodic spatial distributions of the existing voids. Starting with the simplest case with one pore per unit cell, we gradually increase the level of complexity of the geometric model. When the aspect ratio of the pores deviates from unity, anisotropy becomes important and the underlying geometry plays an increasing role in dictating the overall material behavior. The internal pores become embedded cracks in the limiting case, which can be analyzed using the same methodology. Insights gained from the theoretical consideration have direct implications in the design and performance evaluation of pore-containing structures.

Plenary Speaker 2

Professor Kahar Bin Osman

Faculty of Engineering
Universiti Teknologi Malaysia, Malaysia

Title of Keynote Speech

Stents and Additive Manufacturing

Abstract of Keynote Speech

Medical practitioners have been using stents to overcome the constriction of arteries or to maintain certain lumens in our body. Stents themselves have been around for more than 40 years and have seen significant developments in their fabrication techniques. Moving from metal based stents, currently, polymers have also been used to produce stents. After bare metal stents, drug eluting stents and bioresorbable stents are also being implanted. Fabrication techniques have also been improved to produce better and cost effective stents. Currently, efforts have been expanded to use 3D printing as one of the alternatives in stents fabrications. Reports have shown that additive manufacturing have been used to attempt to fabricate cardiovascular stents but issues related to their reduced qualities were mentioned. This talk will compare two products of Direct Metal Laser Sintering for tracheal stents. The final products show that, with improvement in the design, better and stronger stents can be produced. However, other qualities of the stents need more investigation.

Keynote Speaker 1

Prof. Vòng Bính Long

School of Biomedical Engineering
International University, Vietnam National University Ho Chi Minh, Vietnam

Title of Keynote Speech

Design of antioxidant self-assembled nanomedicine for oral drug delivery system

Abstract of Keynote Speech

Since oral administration is preferable for patients to improve their quality of life, it is very essential if drugs, which are only approved by injection, can be extended to oral medication. This is the reason that many reports have been published using nanoparticle-assisted oral drug delivery system (DDS); however, they have remained many challenges. In order to overcome the drawbacks of oral DDS, we designed an original silica-containing antioxidant nanocarrier (siRNP), which was prepared by the self-assembly of an amphiphilic block copolymer (PEG-b-siPMNT) possessing a poly(ethylene glycol) (PEG) shell as a hydrophilic segment and ROS-scavenging nitroxide radical and silica moieties in the hydrophobic core. There are several points to improve the effectiveness of oral DDS by siRNP as follows: i) Polymer micelle-based design: Since the hydrophobic segment of the amphiphilic block copolymer is composed of PEG, the densely packed brushes on the nanoparticle surface improve its dispersion even under the harsh GI tract conditions, preventing nanoparticle aggregation and keeping its small sizes, and improving accumulation in the intestinal mucosa. we have previously confirmed that the core-shell type polymer micelles improved the accumulation tendency in the intestinal mucosa by almost two orders of magnitude than that of commercially available polystyrene nanoparticles although they are initially the same size before the oral administration; ii) Silica installation in the core of RNP: Several nanometer-sized silica in the core of RNP increased the stability of the self-assembling polymer micelles (RNP) by the crosslinking of the block copolymer chain

to each other, which prevents disintegration and/or coagulation of the nanoparticle and further improve accumulation in the intestinal mucosa; iii) Another effect of the silica crosslinking: The installation of silica in the core of RNP also improves the drug loading capacity by drug adsorption on the porous silica surface in the core, preventing the leakage of the drug from the carrier; iv) Installation of nitroxide radicals in the core of nanocarrier: The installation of nitroxide radicals in the core via the covalent conjugation increases antioxidant character of nanocarrier. The covalent linkage prevents leakage of the antioxidants and ensures its safety. Recently, we have investigated that siRNP significantly improved the bioavailability of conventional hydrophobic drugs. The orally administered drug@siRNP effectively suppressed the intestinal inflammation and cancer, liver fibrosis, and minimized the adverse effects of conventional drugs.

Keynote Speaker 2

Distinguished Prof. Ying-Hao Chu

Department of Materials Science and Engineering,
National Tsing Hua University, Taiwan
Department of Materials Science and Engineering,
National Yang Ming Chiao Tung University, Taiwan
Department of Electrophysics,
National Yang Ming Chiao Tung University, Taiwan
Institute of Physics, Academia Sinica, Taiwan
Center for Nanotechnology, Materials Science, and Microsystems,
National Tsing Hua University, Taiwan

Title of Plenary Speech

Functional Atomic Composite: A New Prospect of MICAtronics

Abstract of Plenary Speech

The use of new materials opens up new ages for human beings. For example, silicon-based semiconductor technology creates a revolution of our daily life into the era of electronics. Thus, the exploration of new materials is crucial for developing next-generation electronics. Pioneered by graphene, new 2D materials exhibit abundant unusual physical phenomena that were undiscovered in bulk forms due to its unique electronic structure. The confinement of charge and heat transport at such ultrathin planes offers possibilities to overcome the bottleneck of present devices in thickness limitation and push the technologies into the next generation. While most researchers are struggling for large-scale manufacturing of these intriguing materials and device fabrication, less attention is paid to revisit existing 2D layered systems. Muscovite mica, a 2D layered oxide, is the largest available natural and synthetic 2D layered single crystal. In 2016, Chu's group was the pioneer proposing to use muscovite mica as substrates to build up flexible electronics using inorganic materials, forming a research

playground named “MICAtronics”. Due to its 2D feature, an atomically smooth surface can be obtained for van der Waals heteroepitaxy and superior mechanical flexibility can be utilized for bending conditions. Owing to its naturally thermal and chemical stabilities, the heterostructures made on mica show excellent environmental stability, standing out as an alternative solution to soft technology. Various heteroepitaxies, including metal/muscovite, oxide/muscovite, and conventional semiconductor/muscovite were shown with lots of device demonstrations, delivering new material solutions for flexible devices and presenting a promising future for muscovite based flexible electronics. Currently, Chu’s group is the most active research group along this research direction. However, in these studies, muscovite simply serves as a flexible substrate, no critical functionality of muscovite is revealed. Thus, the key question we would like to address in this talk is: can we create new properties of muscovite by structural modification? Taking the nature of 2D layered structure of muscovite, a van der Waals gap of 0.3 nm exists in muscovite between layers, which can be viewed as a 2D cavity. The idea of this study is to use this 2D cavity to create new material form by insertion of chemical species, especially focusing on transition metal ions. Then, a heat treatment is implemented to transfer transition metal ions into crystalline form. During this process, the atmosphere will be controlled, expecting to deliver materials in metal, oxide, nitride, and carbide forms. The existence of these new formed systems with muscovite can be viewed as an atomic composite due the atomic layer stacking of the heterostructure. By a proper design, this atomic composite can show properties different from bare muscovite, delivering new substrate selection for flexible electronics.

Invited Speaker 1

Prof. Chengkuo Lee

Department of Electrical and Computer Engineering
National University of Singapore, Singapore

Title of Invited Talk

AI-Enhanced Nanosensors for Environmental Monitoring, Smart Home and Metaverse

Abstract of Invited Talk

In the Internet of Things (IoT) era, various devices (e.g., sensors, actuators, energy harvesters, etc.) and systems have been developed toward the realization of self-sustained IoT sensor nodes for smart homes/ buildings and environmental. The surface-enhanced infrared absorption (SEIRA) spectroscopy provides lattice and molecular vibrational fingerprint information which is directly linked to the molecular constituents, chemical bonds, and configuration. The nanosensors using Infrared (IR) plasmonic nanoantennas (PNAs) are powerful tools to identify molecules by the IR fingerprint absorption from plasmon-molecules interaction based on the SEIRA spectroscopy technology. Secondly, the nanophotonic waveguides that implement long optical pathlengths on silicon photonics chips have been investigated as promising gas sensors for the weak interactions with gas molecules in the infrared absorption (SEIRA) spectroscopy as well. By leveraging large longitudinal electric field discontinuity at periodic high-index-contrast interfaces in subwavelength grating metamaterial and its unique features in refractive index engineering, a nanophotonic waveguide sensor achieves acetone absorption spectroscopy at 7.33 μm, showing a detection limit of 2.5 ppm with a waveguide length of only 10 mm. The artificial intelligence (AI) technologies push forward the development of diversified smart nanosensors in order to realize the advanced artificial intelligence of things (AIoT) technology. Furthermore, the recent advances in the combination of AIOT based nanosensors in the human machine interfaces (HMI) and innovative micro-haptic technology will provide the excellent immersive user experience in the future metaverse.

Invited Speaker 2

Prof. Bhaskar Kanseri

Experimental Quantum Interferometry and Polarization (EQUIP)
Department of Physics, Indian Institute of Technology Delhi, India

Title of Invited Talk

Quantum Secure Communication: Activities and prospects

Abstract of Invited Talk

Quantum optics offers a framework to test fundamental aspects of quantum mechanics such as coherence, entanglement, and non-classical properties of light. More recently, it has led to the development of quantum technologies which aim to harness quantum principles for promising applications in computing, communication and precision metrology. This area has evolved significantly in recent years, and this year Physics Nobel prize has also been awarded for ground breaking experiments in these domains. Quantum key distribution (QKD) is a method of quantum cryptography, which has become a new generation security solution and does not rely on the computation assumptions of problems presumed difficult. This talk will begin with several key aspects of fibre and free-space quantum secure communication and would further highlight efforts being made by our group at IIT Delhi for both research and development in these areas. One of our studies also focuses for exploring the effects of partial coherence on spatial profile, polarization entanglement and squeezing features of biphotons. These non-classical photon beams having partially spatially coherent features can be more robust against atmospheric losses and turbulence compared to their fully coherent counterparts, offering a way to achieve higher key rates in quantum communication applications. Some implementations of QKD in lab scale and in field would also be discussed. The prospects of photonic quantum technologies would also be highlighted emphasising on field deployable devices for QKD and hybrid quantum networks for future quantum internet.

Invited Speaker 3

Assoc. Prof. Dr. Jun Hieng Kiat

Department of Mechanical and Material Engineering
University Tunku Abdul Rahman, Malaysia

Title of Invited Talk

All-Weather Solar Cell Incorporating Long Persistent Phosphors and Carbon

Abstract of Invited Talk

Solar energy has gained much research interest due to its attractive feature and low fabrication cost. It also does not produce CO_2 emission during the energy conversion. However, the main issue of solar energy is its inability to generate electricity when there's no light irradiation. Therefore, development of all-weather solar cell is proposed. The device is designed to generate electricity during day and nighttime. In this work, a simple methodology to fabricate all-weather dye-sensitized solar cell (DSSC) is presented. The electrode of the DSSC was doped with green-emitting long persistent phosphors (LPP) and carbon quantum dots (CQD) in order to provide the photoenergy conversion functionality under dark condition. The fabricated DSSC was able produce a power conversion efficiency of 3.22% under dark along with consistent power output for at least 30 minutes. The light emission under dark is made possible by the LPP where the absorbed light during light irradiation is released as green photo fluorescence when the light source is removed. This work represents a step forward for the improvement of versatile DSSC.

Invited Speaker 4

Prof. Ngoc Dang Khoa Tran

Faculty of Mechanical Engineering
Industrial University of Ho Chi Minh City, Vietnam

Title of Invited Talk

Design the Compliant Tristable Mechanism with Two Different Bistable Mechanisms

Abstract of Invited Talk

This study presents a new method to design a compliant mechanism with three distinct motion positions. The connection of a frame mass constructs the mechanism, and two bistable mechanisms have two stable positions. Each of the two stable mechanisms worked based on the tension and compression of the flexible element. The combination of the two bistable mechanisms with different behavior accurately predicts the tristable mechanism's characteristics. The finite element method is employed to analyze the compliant bistable mechanisms and tristable mechanisms. The results show the maximum forces of the tristable mechanism close to the maximum force of the bistable mechanism and easily predict the stable position of the tristable mechanism based on the stable position of each bistable mechanism. The frame mass's stiffness causes the maximum force error. This method is investigated against several tristable mechanism designs to demonstrate its effectiveness.

Invited Speaker 5

Dr. Nabila A. Karim

Fuel Cell Institute
University Kebangsaan Malaysia, Malaysia

Title of Invited Talk

Calcium Carbonate from Chicken Eggshells as Filler in Composite Nafion Membrane for Direct Ethanol Fuel Cell: A Molecular Dynamics Studied

Abstract of Invited Talk

The problem of ethanol cross-over from anode to cathode reduces the overall performance in the Direct Ethanol Fuel Cell (DEFC). Therefore fillers are used to reduce the problem of ethanol cross-over. Therefore, this study developed calcium carbonate ($CaCO_3$) from Chicken Eggshells as Filler in Nafion Membrane Composite for Direct Ethanol Fuel cells. Three clusters of $CaCO_3$ are formed as filler in the Nafion membrane, namely as $(CaCO_3)_2$, $(CaCO_3)_3$ and $(CaCO_3)_4$ and conducted using the Molecular Dynamics method to determine properties of the composite membrane, namely ion conductivity, ethanol permeability and selectivity. Three main factors influencing the three composite membranes were tested in this study: cluster size of $CaCO_3$, filler loading in wt% and ethanol concentration. The presence of filler has reduced ethanol permeability in DEFC application compared to the Nafion membrane. Selectivity is used to balance the properties of ion conductivity, and ethanol permeability as these two properties are very important to improve the overall performance of DEFC. A3%-1M, B3%-1M and C3%-1M have lower ion conductivity than the Nafion membrane, but all three composite membranes have higher selectivity than the Nafion membrane. All three composite membranes are suitable for use at low ethanol concentrations. Composite membrane C ($(CaCO_3)_4$) is required to restrict ethanol permeability at a high ethanol concentration of 5 M. Large structure size in cluster $(CaCO_3)_3$ can reduce ethanol permeability but requires loading $(CaCO_3)_3$ by 5wt%. ANOVA analysis showed significant values for the three responses of ion conductivity, ethanol permeability and selectivity.

Oral Sessions

Nov. 12, 2022

Session 1

Precision manufacturing machines and technologies

Session Chair: Prof. Chil-Chyuan Kuo
Department of Mechanical Engineering
Ming Chi University of Technology

08:45~10:00	I-4	Design the Compliant Tristable Mechanism with Two Different Bistable Mechanisms *Ngoc Dang Khoa Tran* Faculty of Mechanical Engineering, Industrial University of Ho Chi Minh City, Vietnam
	I-5	Calcium Carbonate from Chicken Eggshells as Filler in Composite Nafion Membrane for Direct Ethanol Fuel Cell: A Molecular Dynamics Studied *Nabila A. Karim* Fuel Cell Institute, University Kebangsaan Malaysia, Malaysia
	O-1	A First-Principles Study on the Effect of Cr, Mn, and Co Substitution on Fe-Based Normal- and Inverse-Heusler Compounds: $Fe_{3-x}Y_xZ$ (X= 0, 1, 2, 3; Y=Cr, Mn, Fe, Co; Z=Al, Ga, Si) *Hung-Lung Huang*[1], *Jen-Chuan Tung*[2,†], *and Horng-Tay Jeng*[1,*] [1] Department of Physics, National Tsing Hua University, Taiwan [2] Center for General Education, Chang Gung University, Taiwan
	O-5	A New Sequential Convolutional Neural Network for Smart Manufacturing with Action recognition *Shi-Cheng Chang*[†], *and Chih-Hsiung Shen* Department of Mechatronics Engineering, National Changhua University of Education, Taiwan
	O-6	Research on Deep Learning and Machine Vision for Object Positioning of Robotic Arms *Bo-Ru Lin*[†], *and Chih-Hsiung Shen* Department of Mechatronics Engineering, National Changhua University of Education, Taiwan

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Session 2

Micro-manufacturing and assembly technologies

Session Chair: Assis Prof. Jen-Chuan Tung

Center for General Education

Chang Gung University, Taiwan

14:30~15:35	I-1	AI-Enhanced Nanosensors for Environmental Monitoring, Smart Home and Metaverse *Chengkuo Lee* Department of Electrical and Computer Engineering, National University of Singapore, Singapore
	O-3	Development Prospects of ALD Technology in Energy Applications *Chih-Liang Wang* Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
	O-4	3D Printing Monitoring of Rapid Tool Manufacturing Process Based on Machine Vision and Deep Learning *Chil-Chyuan Kuo*[1,2,*], *and Chi-Che Hung*[1,†] [1] Department of Mechanical Engineering, Ming Chi University of Technology, Taiwan [2] Research Center for Intelligent Medical Devices, Ming Chi University of Technology, Taiwan
	O-2	Fabrication of the Concave Micro Pillar Array Using the Masked Stereolithography *Tsung-Hung Lin* Department of Mechanical and Electro Mechanical Engineering, National Ilan University, Taiwan

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Session 3

Green manufacturing and smart technologies

Session Chair: Assoc. Prof. Chih-Liang Wang
Graduate Institute of Precision Engineering
National Chung Hsing University, Taiwan

15:50~16:55	I-3	All-Weather Solar Cell Incorporating Long Persistent Phosphors and Carbon *Jun Hieng Kiat* Department of Mechanical and Material Engineering, University Tunku Abdul Rahman, Malaysia
	O-7	Thin-film thickness assessments with the use of a common-path interferometer *Hoang-Quy Le[*,†], Shyh-Tsong Lin, You-Yi Chen, and Zhe-Wei Lin* Department of Electro-optical Engineering, National Taipei University of Technology, Taiwan
	O-8	Using Numerical Methods to Design Lens with Specific Irradiance and High Collimation *Tzu-Chen Yu[†], and Cheng-Mu Tsai[*]* Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
	O-11	Investigate the effect of copper interlayer thickness ratio on the microstructure and mechanical properties of copper/tungsten and copper/chromium bilayers using high power impulse magnetron sputtering *Yu Huang[†], Wei-Chieh Chen, and Ming-Tzer Lin[*]* Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan

Nov. 12, 2022

Session 4

Applied science, engineering and technologies

Session Chair: Assoc Prof. Chi-Jung Su
Department of Medical Applied Chemistry
Chung Shan Medical University

16:55~18:00	I-2	Quantum Secure Communication: Activities and Prospects *Bhaskar Kanseri* [1] Experimental Quantum Interferometry and Polarization (EQUIP) Department of Physics [2] Indian Institute of Technology Delhi, India
	O-9	Design and Characterization of A Microhotplate for Gas Sensing *Nguyen-Vu-Binh Lai†, and Dung-An Wang** Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
	O-10	Design and Fabrication of A Torque Sensor with Applications in Robot Skin and Joint *Tri-Hieu Nguyen†, and Dung-An Wang** Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan

Poster Session

Poster No.	Paper Title
P-1	*Ab initio* Studies of Work Function Changes of O_3 Adsorption on $ZnGa_2O_4$(111) Surface for Gas Sensors *Jen-Chuan Tung*[1] *,Shih-Wei Huang*[2]*, Dun-Ru Hung*[3]*, Po-Liang Liu*[3,*,†]*, Ray-Hua Horng*[4]*, and Cheng-Chung Chang*[5] [1] Center for General Education, Chang Gung University, Taiwan [2] Department of Surgery, Show Chwan Memorial Hospital, Taiwan [3] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan [4] Institute of Electronics, National Yang Ming Chiao Tung University, Taiwan [5] Graduate Institute of Biomedical Engineering, National Chung Hsing University, Taiwan
P-2	Development of a Rapid Mold with Conformal Heating Channel and Conformal Cooling Channel for Liquid Silicone Rubber Injection Molding *Chil-Chyuan Kuo*[1,2,*,†]*, and Qing-Zhou Tasi*[1] [1] Department of Mechanical Engineering, Ming Chi University of Technology, Taiwan [2] Research Center for Intelligent Medical Devices, Ming Chi University of Technology, Taiwan
P-3	*Ab* initio Studies of Work Function Changes of H_2O Adsorption on $ZnGa_2O_4$(111) Surface for Gas Sensors *Yu-Cheng Lin*[†]*, and Po-Liang Liu*[*] Graduate Institute of Precision Engineering National Chung Hsing University, Taiwan
P-4	*Ab initio* Calculations of Epitaxial Softening of NiO(111) and SnO_2(100) Crystal Structures *Yi-Cheng Tang*[†]*, and Po-Liang Liu*[*] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan

P-5	An *Ab initio* Heterojunctions Database for GaN/Muscovit *Jia-Wei Dai†, and Po-Liang Liu** Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-6	Deep Learning-Based Gas Molecule Adsorption Prediction of NO, NO_2, CO, CO_2, H_2S and O_3 Vacuum Energy: Optimization, Analysis, and Explanation *Yi-Che Chen†, and Po-Liang Liu** Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-7	*Ab initio* Studies of Work Function Changes of NO Adsorption on $ZnGa_2O_4$(111) Surface for Gas Sensors *Jhih-Hong Shao†, and Po-Liang Liu** Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-8	First-Principles Calculations of Spin Spirals in Co-based Heusler Alloys Co_2XY (*X*=Cr, Mn, Fe; *Y*=Al, Ga, In, Si, Ge, Sn) *Chia-Jung Yang[1,†], Jen-Chuan Tung[2], and Po-Liang Liu[3,*]* [1] Master Program for Digital Health Innovation, China Medical University, Taiwan [2] Center for General Education, Chang Gung University, Taiwan [3] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan

P-9	Large Band Gap Topological Insulators Sn_2BiBrO_6 and Sn_2SeTeO_6 Double Perovskites: A First-Principle Theoretical Calculation *Jen-Chuan Tung*[1,†], *Yin-kuo Wang*[2], *and Po-Liang Liu*[3,*] [1] Center for General Education, Chang Gung University, Taiwan [2] Center for General Education, National Taiwan Normal University, Taiwan [3] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-10	Preparation of Green Emissive Carbon Nanodots by Microwave Method *Yu-Xiu Lu*[1,†], *Chi-Jung Su*[2,3,*], *and Wei-Li Yuan*[4] [1] Department of Photonics, Feng Chia University, Taiwan [2] Department of Medical Applied Chemistry, Chung Shan Medical University, Taiwan [3] Department of Medical Education, Chung Shan Medical University Hospital, Taiwan [4] Department of Chemical Engineering, Feng Chia University, Taiwan
P-11	Preparation/Analysis of Fluorescent Carbon Nanopoints and Their Detection with 2-Aminoethanol and Citric Acid/Octonic Acid *Yun-En Chen*[1,*,†], *Yu-Ru Wu*[1], *Jhih-Peng Zhang*[1], *Chi-Jung Su*[1], *and Wei-Li Yuan*[2] [1] Department of Medical Applied Chemistry, Chung Shan Medical University, Taiwan [2] Department of Chemical Engineering, Feng Chia University, Taiwan
P-12	Synthesis of Green-Light Fluorescent Carbon Nanodots with 2-Aminoethanol and Citric Acid *Yu-Ru Wu*[1,*,†], *Chi-Jung Su*[1], *and Wei-Li Yuan*[2] [1] Department of Medical Applied Chemistry, Chung Shan Medical University, Taiwan [2] Department of Chemical Engineering, Feng Chia University, Taiwan

P-13	Prediction of Local Optimization Algorithm in Lens Design by Using Deep Learning *Yu-Cheung Chen, Hsin-Hung Lee†, and Cheng-Mu Tsai** Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-14	Cryptanalysis of Ye et al.'s Semi-quantum Summation Against the Collective-dephasing Noise *Chun-Wei Yang[1,*], Chi-An Chen[1,†], Jason Lin[2], and Chia-Wei Tsai[3]* [1] Master Program for Digital Health Innovation, College of Humanities and Sciences, China Medical University, Taiwan [2] Department of Computer Science and Engineering, National Chung Hsing University, Taiwan [3] Department of Computer Science and Information Engineering, National Taichung University of Science and Technology, Taiwan
P-15	Intercept-and-resend Attack on Zeng and Long's Controlled Quantum Secure Direct Communication and Authentication Protocol *Chun-Wei Yang[1,*], Kai-Lin Wang[1,†], Chia-Wei Tsai[2], and Jason Lin[3]* [1] Master Program for Digital Health Innovation, College of Humanities and Sciences, China Medical University, Taiwan [2] Department of Computer Science and Information Engineering, National Taichung University of Science and Technology, Taiwan [3] Department of Computer Science and Engineering, National Chung Hsing University, Taiwan
P-16	Quantum Conference Key Distribution Protocol on Quantum Repeater based Quantum Network *Chia-Wei Tsai[1,*], Jason Lin[2], Chun-Wei Yang[3], and Chun-Hsiang Wang[1,†]* [1] Department of Computer Science and Information Engineering, National Taichung University of Science and Technology, Taiwan [2] Department of Computer Science and Engineering, National Chung Hsing University, Taiwan [3] Master Program for Digital Health Innovation, College of Humanities and Sciences, China Medical University, Taiwan

P-17	Rice Yield Prediction Using Deep Learning Hybrid Model with Multiple-Sensors Remote Sensing *Che-Hao Chang*[1,†], *Jason Lin*[1,*], *Chia-Wei Tsai*[2], *and Chun-Wei Yang*[3] [1] Department of Computer Science and Engineering, National Chung Hsing University, Taiwan [2] Department of Computer Science and Information Engineering, National Taichung University of Science and Technology, Taiwan [3] Master Program for Digital Health Innovation, College of Humanities and Sciences, China Medical University, Taiwan
P-18	Combustion Characteristics of Densified Refuse Derived Fuel Produced from Rice Straw *Jia-Xian Liao*[†], *Yu-Hsuan Cheng, Yo-ping Greg Wu*[*], *and Ya-Fen Lin* Department of Chemical and Materials Engineering, National Ilan University, Taiwan
P-19	Effects of the TiN Hetero-buffer Layer in Radio Frequency Magnetron Sputtered β-Ga_2O_3 Films on Si Substrate *Chao-Chun Yen*[1,†], *Hsin-Yu Chou*[1,†], *Anoop Kumar Singh*[1], *Po-Wei Wu*[1], *and Dong-Sing Wuu*[1,2,*] [1] Department of Materials Science and Engineering, National Chung Hsing University, Taiwan [2] Department of Applied Materials and Optoelectronic Engineering, National Chi Nan University, Taiwan
P-20	Synthesis of SiO_2-coated Perovskite Quantum Dots for Micro-LED Display Applications *Hsin-Yu Chou*[1,†], *Chih-Wei Lo*[1], *Kai-Ping Chang*[1], *Chao-Chun Yen*[1], *and Dong-Sing Wuu*[1,2,3,*] [1] Department of Materials Science and Engineering, National Chung Hsing University, Taiwan [2] The Innovation and Development Center of Sustainable Agriculture, National Chung Hsing University, Taiwan [3] Department of Applied Materials and Optoelectronic Engineering, National Chi Nan University, Taiwan

P-21	Applying Multi-level Information to Steady-state Visual Evoked Potential-based Brain Computer Interfaces *Yeou-Jiunn Chen*[1,†], *Zheng-Han Lin*[1], *Yin-Yu Su*[1], *Xing-Ying Wu*[1], *Shih-Chung Chen*[1], *and Chung-Min Wu*[2,*] [1] Department of Electrical Engineering, Southern Taiwan of Science and Technology, Taiwan [2] Department of Intelligent Robotics Engineering, Kun Shan University, Taiwan
P-22	Metal Oxide Electrode Formation for Anion Exchange Membrane Hydrogen Production Module *Hsiharng Yang*[1,2,*], *Kun-Hong Tseng*[1], *Facheng Su*[1,†], *and Nabila A. Karim*[3] [1] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan [2] Innovation and Development Center of Sustainable Agriculture (IDCSA), National Chung Hsing University, Taiwan [3] Fuel Cell Institute, Universiti Kebangsaan Malaysia, Malaysia
P-23	Nickel Copper Mixed Metal Oxide Electrode for Anion Exchange Membrane Electrolyzer *Hsiharng Yang*[1,2,*], *Shang-Fu Wang*[1], *Facheng Su*[1,†], *and Kean Long Lim*[3] [1] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan [2] Innovation and Development Center of Sustainable Agriculture (IDCSA), National Chung Hsing University, Taiwan [3] Fuel Cell Institute, Universiti Kebangsaan Malaysia, Malaysia
P-24	Deep UV PD performance improvement by UV-ozone surface treatment *Chih-Yang Huang*[1,†], *Yun-Sheng Li*[2], *Tarntair*[2], *and Ray-Hua Horng*[2,*] [1] Institute of Pioneer Semiconductor Innovation, National Yang Ming Chiao Tung University, Taiwan [2] Institute of Electronics, National Yang Ming Chiao Tung University, Taiwan

P-25	Using kernel density estimation algorithm in knowledge distillation to construct a classification model for bipolar disorder patients *Yu-Shiang Tseng, and Meng-Han Yang*[*,†] Department of Computer Science and Information Engineering, National Kaohsiung University of Science and Technology, Taiwan
P-26	The effect of oxide-based nanocomposite fillers on gel-state dye-sensitized solar cells *Yi-Hong Liao*[†]*, Hong-En Tsai, and Chih-Liang Wang*[*] Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-27	Investigation of non-contact surface topography measurement system for transparent polymer materials *Yu-Jung Lee*[*,†] Department of Mechanical Engineering, Southern Taiwan University of Science and Technology, Taiwan
P-28	Study of ZGO epilayer-based hard X-ray photodetector under different intensities from synchrotron irradiation *Siddharth Rana*[1,2,†]*, Jitendra Pratap Singh*[1]*, and Ray-Hua Horng*[2,*] [1] Department of Physics, Indian Institute of Technology Delhi, India [2] Institute of Electronics, National Yang Ming Chiao Tung University, Taiwan

P-29	Heat Dissipation Improvement of AlGaInp-based LED with Cu/Invar/Cu Substrate *Hung-Yu Chen†, Ray-Hua Horng*, and Shreekant Sinha* Institute of Electronics, National Yang Ming Chiao Tung University, Taiwan
P-30	Design of A Current Mirror by Ltspice *Kumail Hussain Mir†, and Dung-An Wang** Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan
P-31	Design of A Current Mirror for A Pressure Sensor *Qaiser Abbas†, and Dung-An Wang** Department of Graduate Institute of Precision Engineering, National Chung Hsing University, Taiwan

Abstract Collections

No. O-1

TITLE: A first-principles study on the effect of Cr, Mn, and Co substitution on Fe-based normal- and inverse-Heusler compounds: $Fe_{3-x}Y_xZ$ (x= 0, 1,2 ,3; Y=Cr, Mn, Fe, Co; Z=Al, Ga, Si)

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ABSTRACT

First-principles calculation has become one of the most reliable approaches in predicting structural, electronic, and magnetic properties for material applications. Alloys in Heusler structures have also attracted much attention recently since they can be easily synthesized and provide interesting properties for future spintronic applications. In this work, we investigate a series of Fe-based Heusler compounds $Fe_{3-x}Y_xZ$ (x = 0, 1, 2, 3; Y= Cr, Mn, Co; Z= Al, Ga, Si) with $L2_1$- and XA-type structures using first-principles calculations based on density functional theory[1]. According to formation energy calculations and mechanical property analysis, most of the studied Heusler compounds are thermodynamically stable and could be synthesized experimentally. The Co substitution leads $Fe_{3-x}Co_xZ$ to a ferromagnetic ground state like Fe_3Z with a strong magnetization ranging from 4 to 6 μB/f. u. While replacing Fe with Cr or Mn, the exchange coupling between Cr (Mn) and its neighboring atoms generally tend to be anti-parallel. Among the antiferromagnetic compounds, Mn_3Al and Mn_3Ga are antiferromagnetic half metal while Mn_3Si is ferrimagnetic half metal. These rarely found type of half metals with low magnetic moment and high spin polarization at the Fermi level are important for low energy consumption spintronic applications. The estimated Curie temperatures for Mn_3Al, and Mn_3Si and Co_2FeSi (XA) are in good agreement with previously theoretical values, while for Fe_3Al and Fe3Si, they are in good agreement with previous experimental results. The good consistency in Curie temperature demonstrates high reliability of our predictions based on first-principles calculations. As for the topological property aspect, we predict Fe_2CrAl and Fe_2MnAl as the 3-dimensional Weyl semimetal. Furthermore, Fe_2CrSi is predicted to be the magnetic nodal-line semimetal. Interestingly, our mechanical property analysis demonstrates that Co_3Si and Fe_2CoSi ($L2_1$) exhibit ultraelastic metal behavior, which is of high potential in advanced mechanical industry. This work suggests that Heusler compounds are excellent candidates for future spintronics as well as for high-performance ultraelastic metals.

Keyword: Fe-based Heusler alloys, Curie temperature, Half metal

REFERENCES

[1] Huang, H.L.; Tung, J.C.; Jeng, H.T. A first-principles study on the effect of Cr, Mn, and Co substitution on Fe-based normal- and inverse-Heusler compounds: Fe3-xYxZ (x= 0, 1,2 ,3; Y=Cr, Mn, Fe, Co; Z=Al, Ga, Si). Front. Phys. 2022, 10, 975780.

No. O-2
TITLE: Fabrication of the Concave Micro Pillar Array Using the Masked Stereolithography

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ABSTRACT

This study presents a simple method to fabricate the concave micro pillar array using the masked stereo-lithography. The vat polymerization technology produces three dimension objects by selectively curing photopolymer liquid resin using UV light-activated polymerization. The vat polymerization technology comes in three main methods: stereo-lithography (SLA), Digital light processing (DLP), and liquid-crystal display (LCD). The concave micro-pillar array was made using the masked stereo-lithography, which utilizes the LED array as the UV light source, the LCD screen as a mask to create an image of each layer and to hardens the layer gradually [1]. The process of the masked stereo-lithography comprises the 3D model, the slicing software for 3D printing, and 3D printer. This method can precisely control the geometric profile of concave micro-pillar array. The experimental results showed that the concave micro-pillar array in resin could be formed. The concave micro-pillar array printed successfully with 20 μm layer thickness. The micro pillar array has been widely used in the fields of biomedicine and microfluidics [2][3].

Keyword: micro pillar array, stereolithography

REFERENCES

[1] Excell, Jon. "The rise of additive manufacturing". The Engineer. 2013.
[2] Yu He, Zefan Lu, Hongliang Fan and Tao Zhang, "A photofabricated honeycomb micropillar array for loss-free trapping of microfluidic droplets and application to digital PCR" Lab on a Chip 2021.
[3] Chaozhan Chen, Bin Ran, Zhenxing Wang, Hongli Zhao, Minbo Lan, Huaying Chen and Yonggang Zhu, "development of micropillar array electrodes for highly sensitive detection of biomarkers", RSC Adv., 2020.

No. O-3
TITLE: Development Prospects of ALD Technology in Energy Applications

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ABSTRACT

The atomic layer deposition (ALD) has been regarded as a promising deposition technique due to its gas phase deposition processes based on self-limiting and saturated surface reactions, which enable to achieve a required film-based material conformally on the high aspect ratio geometry with precise composition and thickness control. The ALD technique is recently employed to develop the functional thin film with low cost and high performance in energy applications. In this presentation, the growth mechanism of ALD is explained firstly and followed by a brief overview of its potential applications in energy fields. The applications in dye-sensitized solar cells (DSCs) and lithium ion batteries (LIBs) are particularly introduced. In DSCs, a new approach to make a low-cost, high-conductivity carbon-based counter electrode with tunable catalytic activity via ALD is developed to tackle the problem in the typical Pt counter electrode, which suffers from the noble and rare nature as well as the poor stability in the electrolyte. In LIBs, a three-dimensional flexible binder-free core-dual shell electrodes via atomic layer deposition of nanocomposite metal oxides is developed for LIBs. More details and results related to the influence of ALD cycles on the performances of DSC and LIB, which can further inspire new insights into potential energy applications, will be mentioned in the presentation.

Keyword: atomic layer deposition, solar cells

No. O-4

TITLE: 3D Printing Monitoring of Rapid Tool Manufacturing Process Based on Machine Vision and Deep learning

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ABSTRACT

Usually human monitor task to avoid failure or inferior in common 3D printing during whole printing process, also save both material and time dissipation. Pause printing job to perform essential action, for example dimension measurement, then determine to re-start new printing job, or fix up malfunction caused by printer before continue original printing job. However 3D printing is to build the desired shape layer by layer to create finished product, knows as additive manufacturing (AM) technology. Compared with traditional molding technology, 3D printing takes serval times of the time.

To develop an effective method to improve printing efficiency is significant mission. In this study, smart phone or single-board computer is designed as a basic hardware platform, and connects with external digital camera or utilizes internal camera of phone set to capture images in specified stage through whole printing process. By appropriate algorithm from machine vision system to calculate 3D (L*W*H) dimensions, and coordinate with deep-learning network to check the various geometric shape of printed object from the designed drawing, meanwhile evaluate the printing quality and record to data base. Once the defect is detected of real printed object, the platform will issue alters to user to take imperative response. This diminish unnecessary labor and enables production automatically.

Additive manufacturing (AM) becomes a feasible approach in currently manufacturing industry. Besides the advantages of producing all complex geometric objects, to fabricate rapid mold tooling by 3D printing is to reduce cost of investment and decrease risk of failure. By means of the excellent characteristics of 3D printing, application for several areas of the industry, such as automobile, medical, mold, appliances, aerospace, aviation and so on. With the continuous popularization and development of 3D printing technology, broaden application of 3D printing technology is penetration in the future.

None additional monitoring functions are provided for normal 3D printer, hence to monitor whole printing process is required by operator. Just in case, if ran out of filament or encounter potential undesirable phenomena, the 3D printer is keep moving machinery till all data file output finish. Operator should terminate printing job to perform essential action, for example dimension measurement, and judge to restart printing jog or not. Compared with traditional molding technology, 3D printing takes serval times of the time on account of building the desired shape layer by layer. For single print job is a affordable by one operator, but it is not practical in mass-production factory. Lots amount of printer perform printing job simultaneously in realistic plant, team of members must to be assigned to monitor printing job. To develop an automatic and effective approach is a significant mission to improve printing efficiency and ensure quality.

According literature review, there are many successful exploitations of new applications. Yet due to new industry for current industry, rare discussions relate to 3D printing monitoring and quality. Vaezi and Chua [1] studied the effects of two parameters of layer thickness and binder saturation level on the mechanical strength, surface quality and dimensional accuracy in the 3D printing process. Experimental results show that under the same layer thickness, increasing the binder saturation level from 90% to 125% would result in an increase of tensile and flexural strengths of the specimens and decrease of dimensional accuracy and surface uniformity of the specimens.

Straub [2] proposed a method to detect completion failure defects during the 3D printing process. The quality of the parts produced is assessing by a multi-camera system (composed of five camera units, consisted a Raspberry Pi and a Raspberry Pi camera per unit) with C# and Dot Net framework as an image processing

software. Wuest et al. [3] proposed a method to deal with the large amounts of complex and high-dimensional data in conventional manufacturing. Other work related to 3D printing quality can be found in [4] and [5]. Utilizing smart phone efficiently and using its internal camera serves as image source for machine vision system and exploiting the advantage of deep-learning network to monitor quality in 3D printing, which is the first in its class. Besides our research develops a convenient solution and facilitates an easy installation in 3D printing, that replaces unnecessary labor and enables production automation.

Keyword: 3D printing, Additive Manufacture, Single-Board Computer, Machine Vision, Deep-Learning

REFERENCES

[1] M. Vaezi, C. K. Chua, Effects of layer thickness and binder saturation level parameters on 3D printing process. International Journal of Advanced Manufacturing Technology, 53 (2011) 275-284.
[2] J. Straub, Initial work on the characterization of additive manufacturing (3D printing) using software image analysis. Journal of Machines, 3 (2015) 55-71.
[3] T. Wuest, C. Irgens, K. D. Thoben, An approach to monitoring quality in manufacturing using supervised machine learning on product state data. Journal of Intelligent Manufacturing, 25 (2014) 1167-1180.
[4] D.A. Roberson, D. Espalin, R.B. Wicker, 3D printer selection: A decision-making evaluation and ranking model. Virtual and Physical Prototyping, 2015, 8:3, 201-212.
[5] W. M. Wang, C. Zanni, L. Kobbelt, Improved surface quality in 3D printing by optimizing the printing direction.Eurographics, 2016

No. O-5

TITLE: A New Sequential Convolutional Neural Network for Smart Manufacturing with Action recognition

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ABSTRACT

In the past, the work progress of traditional industrial computing workers, the raw materials consumed and the number of completed pieces, need to be calculated manually. With the advancement of technology, Now, with faster internet speed and more powerful computing power, the era of Industry 4.0 is coming, Factories will become smarter, more efficient, and less wasteful. In the future, traditional industries will import the era of big data, The way we're going to be handled human calculations in the past, change to the machine to compute, Make the data more accurate and save labor costs. How do we quantify the values produced by traditional industrial workers and store them on the network, Therefore, this study intends to use the deep learning LSTM (Long Short-Term Memory) neural network output, Action recognition of the continuous body movements of the staff, combined with TCP/IP, the collected data were sent to the cloud.

To quickly and accurately identify the body movements of the staff, we will use MediaPipe, an open-source project published by Google in 2019, MediaPipe can process data as array functions, and collect action data, These data are processed through a deep learning LSTM (Long Short-Term Memory) neural network, Identify the coordinates of the staff's body movements. Finally, the TCP/IP connection is used to send the collected data to the server through LabView.

To record the actions of personnel, make quantitative data, 1. We use the body node recognition provided by MediaPipe. We take the welding worker as an example to make the following action recognition: (1) Get: take the circuit board, (2) Soldering: Take a soldering iron and solder to fix the parts on the circuit board, (3) Put: Place the soldered circuit boards in the collecting box for quantitative storage. 2. Use deep learning LSTM (Long Short-Term Memory) for training analysis of actions, and predict the result of worker action output recognition. 3. To make the recognition action more accurate, we will use neural network training under different conditions, such as light and dark, the speed of performing actions, and different people to achieve better recognition rates. 4. Send the identification result data to the server for storage or analysis using TCP/IP through LabView.

The research focus of this paper, Real-time connection monitoring and storage of data through a neural network and network connection between machines and workers, accurately calculating the number of times the workers take, and unload materials and the time required for welding storage, and quickly digitization of the data through human-machine collaboration. In the future, the stored data can also be imported into big data computing, providing more in-depth analysis, improving efficiency, and reducing waste.

Keyword: Convolutional neural network, MediaPipe, Human-Robot Collaboration, Gesture Recognition

REFERENCES

[1] Zhang, Fan, et al. "Mediapipe hands: On-device real-time hand tracking." arXiv preprint arXiv:2006.10214 ,2020.

No. O-6
TITLE: Research on Deep Learning and Machine Vision for Object Positioning of Robotic Arms

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ABSTRACT

In the main operation of the factory, many robotic arms are used for automated processes, and the application of robotic arms is gradually moving from a single repetitive level to a more diverse and rich field. Robotic arms can gradually achieve more precise and complex movements while ensuring personal safety. Robotic arms play a very important role in improving the working environment and fabricating efficiency, so the identification and precise positioning of objects will become more important. In the whole system, machine vision plays a role like human eyes, as a guide to guide the robot arm to locate the target. Therefore, this study intends to simplify the complexity through the multivariate regression analysis of deep learning, use the object position in machine vision, and then convert the coordinates of the object in machine vision into the coordinates of the robot arm.

Because more than two webcams are required, objects can be located in three-dimensional space through machine vision. This paper proposes the object space locating of machine vision in the robotic arm, which is briefly described as follows: First, the object model of YOLOv4 is established, and YOLOv4 is used for object identification. Then, the coordinate of the objects in the vision is used to establish a multivariate regression analysis model using deep learning, and the coordinates of the objects in the machine vision are used as condition parameters. The coordinates of the objects in the machine vision are used to predict the coordinates of the object grasped by the robotic arm. The YOLOv4 object recognition and multivariate regression analysis models are stored as two models, which can be used in different object and arm placement methods.

The research method of this paper is divided into the following stages: (1) Establish the YOLOv4 model: collect the pictures of the objects to be identified, select the objects in the photo through LabelImg, and complete the establishment of the picture files and annotate files, and then carry out the training of YOLOv4. (2) Establish multivariate regression analysis data: collect the coordinates of the object in the two screens, use the coordinates of the object in the screen as the input, and the coordinates of the object captured by the robotic arm are the output, and the input and output stored as a piece of data. (3) Establish a multivariate regression model: Through the Python programming language, using Tensorflow-GPU as the training framework, the stored training data is used for the MLP neural network model. (4) Result verification and error measurement: import YOLOv4 and multivariate regression analysis model into the Python program, place the object on the fixed nine marker points, and test the model to predict the coordinates of the object grasped by the robotic arm and the actual grasping of the robotic arm. The error of the coordinates of the object, and do the difference analysis.

This paper aims to use machine vision to combine object recognition with multivariate regression analysis to predict the position in which the robot arm needs to grasp the object. To help human beings to operate the object more conveniently and accurately. It is expected to locate objects through machine vision combined with deep learning, so that the robotic arm can reach the position accuracy of the object. Through deep learning, the forecast of results can be repeatedly debugged and tested to compensate for errors so that the position of objects in machine vision can be more accurate so the robotic arm can be used in today's smart manufacturing.

Keyword: Machine vision, Robot arm, Multivariate regression analysis, Deep learning

REFERENCES

[1] B. M. Wilamowski, "Neural network architectures and learning algorithms," in IEEE Industrial Electronics Magazine, vol. 3, no. 4, pp. 56-63, Dec. 2009, doi: 10.1109/MIE.2009.934790.
[2] R. Girshick, J. Donahue, T. Darrell and J. Malik, "Rich Feature Hierarchies for Accurate Object Detection and Semantic Segmentation," 2014 IEEE Conference on Computer Vision and Pattern Recognition, 2014, pp. 580-587, doi: 10.1109/CVPR.2014.81.
[3] P. -Y. Chen, W. -L. Chen, N. -S. Pai, M. -H. Chou, G. -S. Huang and C. -Y. Chang, "Implement of a 6-DOF manipulator with machine vision and machine learning algorithms," 2017 International Conference on Applied Electronics (AE), 2017, pp. 1-5, doi: 10.23919/AE.2017.8053583.
[4] Z. Pan, Z. Jia, K. Jing, Y. Ding and Q. Liang, "Manipulator Package Sorting and Placing System Based on Computer Vision," 2020 Chinese Control And Decision Conference (CCDC), 2020, pp. 409-414, doi: 10.1109/CCDC49329.2020.9164071.
[5] S. -L. Chen, S. -C. Lin, Y. Huang, C. -W. Jen, Z. -L. Lin and S. -F. Su, "A Vision-based Dual-axis Positioning System with YOLOv4 and Improved Genetic Algorithms," 2020 Fourth IEEE International Conference on Robotic Computing (IRC), 2020, pp. 127-134, doi: 10.1109/IRC.2020.00027.

No. O-7
TITLE: Thin-film thickness assessments with the use of a common-path interferometer

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ABSTRACT

Conventional interferometers for thickness measurements can achieve non-contact, high-resolution, and full-field measurements but are highly sensitive to environmental perturbations. This research proposed a common-path tandem interferometer possessing the advantages over conventional optical interferometers of high measurement repeatability and high resistance to environmental perturbations. This paper presents the apparatus and measurement theory of the interferometer, the experimental setup for implementing the interferometer, and the experiments conducting the setup to examine the air-film thickness of empty liquid-crystal cells. The experimental results agree with the validity and high measurement repeatability of the interferometer. The interferometer's tolerance of noise was also examined experimentally, the result confirms the interferometer's high resistance to environmental disturbances.

Keyword: common-path tandem interferometer, thin-film thickness measurement, full-field measurement, non-contact measurement, measurement repeatability, environmental perturbation

REFERENCES

[1] C.-F. Kao , S.-K. Tsai, and S.-H. Lu, "Measuring cell gap of liquid crystal displays by scanning white-light tandem interferometry," JJAP 48, 106508 (2009).
[2] N. Borgetto, C. Galizzi, F. André, and D. Escudié, "A thickness measurement technique based on low-coherence interferometry applied to a liquid film with thermal gradient," Exp. Therm. Fluid Sci. 34, 1242–1246(2010).
[3] F. Gao, H. Muhamedsalih, and X. Jiang, "Surface and thickness measurement of a transparent film using wavelength scanning interferometry," Opt. Express 20, 21450-21456(2012)
[4] N. Borgetto, F. André, C. Galizzi, and D. Escudié, "Simultaneous film thickness measurement and wall temperature assessment by Low-Coherence Interferometry," Exp. Therm. Fluid Sci. 44, 512–519(2013).
[5] S. C. Zilio, "Simultaneous thickness and group index measurement with a single arm low-coherence interferometer," Opt. Express 22, 27392-29397 (2014).
[6] J.-A. Kim, C.-S. Kang, T. B. Eom, J. Jin, H. S. Suh, and J. W. Kim, "Quadrature laser interferometer for in-line thickness measurement of glass panels using a current modulation technique," Appl. Opt. 53, 4604-4610(2014).
[7] Y. Kim, K. Hibino, N. Sugita, and M. Mitsuishi, "Absolute optical thickness measurement of transparent plate using excess fraction method and wavelength-tuning Fizeau interferometer," Opt. Express 23, 4065-4073 (2015).
[8] Y. Kim, K. Hibino, N. Sugita, and M. Mitsuishi, "Measurement of optical thickness variation of BK7 plate by wavelength tuning interferometry," Opt. Express 23, 22928-22938(2015).
[9] J. E. Park, J. Kim, and M. Cha, "Measurement of thickness profiles of glass plates by analyzing Haidinger fringes," Appl. Opt. 56, 1855-1860 (2017).
[10] J. -A. Kim, J. W. Kim, C.-S. Kang, J. Jin, and J. Y. Lee, "An interferometric system for measuring thickness of parallel glass plates without 2π ambuiguity using phase analysis of quadrature Haidinger fringes. Rev. Sci. Instrum. 88, 055108(2017).
[11] Y. Kim, K. Hibino, T. Kizaki, N. Sugita, and M. Mitsuishi, "Simultaneous interferometric measurement of the absolute thickness and surface shape of a transparent plate using wavelength tuning Fourier analysis and phase shifting," Precis. Eng. 48, 347–35 (2017).
[12] J. Wang , Y. Lu , X. Sun , and L. Yu, "Spectrally-resolved interferometry to measure thickness and refractive index of transparent material," Proc. of SPIE 12059, 1205910 (2021).

No. O-8

TITLE: Using Numerical Methods to Design Lens with Specific Irradiance and High Collimation

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ABSTRACT

A design of a freeform lens that can convert the Gaussian distributed beam into a specific irradiance distribution while maintaining high collimation.To achieve specific irradiance patterns and high collimation, we propose a numerical method for constructing freeform lenses.The surface of the lens is constructed segment by segment, with a refractive surface based on Snell's law.To validate the numerical method, we design a lens that produces a light spot with a triangular irradiance distribution and a hollow center, and simulated it in Zemax

Keyword: Freeform, Irradiance, Collimation, Segments

REFERENCES

[1] C. M. Tsai, Y. C. Fang, and C.T.e Lin, *Application of genetic algorithm on optimization of laser beam shaping*, Opt. Express, vol. 23, no. 12, pp. 15877-15887, 2015.
[2] P. Han, H. -C Hsu, and C. -M Tsai, *Beam Shaping Freeform Lens Design with Modified Optical Flux Partition*, IEEE Photonics J., vol. 10, no. 1, Art. ID 8200113, 2018.

No. O-9
TITLE: Design and Characterization of a Microhotplate for Gas Sensing

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ABSTRACT

This study implements a CMOS MEMS microhotplate for gas sensing using the UMC 0.18 μm process. The proposed sensor is used to measure the gas concentration based on the changes in resistance. A non-salicide N+ poly layer is used for heating and a non-salicide HR poly is used for resistive sensing. An aluminum conductor layer is utilized for spreading heat. Simulation of the microhotplate is performed in order to achieve high sensitivity. Finite element analyses were employed to analyse the microhotplate. Fabrication of the microhotplate is also described.

Keyword: Microhotplate, Gas sensing, CMOS-MEMS, ABAQUS

REFERENCES

[1] Liu, H.; Zhang, L.; Li, K.H.H.; Tan, O.K. Microhotplates for Metal Oxide Semiconductor Gas Sensor Applications – Towards the CMOS-MEMS Monolithic. Micromachines 2018, 9, 557. https://doi.org/10.3390/mi9110557
[2] Lee, Y.-C.; Yang, P.-L.; Chang, C.-I.; Fang, W. Design and Fabrication of MOS Type Gas Sensor with Vertically Integrated Heater Using CMOS MEMS Technology. In Proceedings of the Eurosensors 2018 Conference, Graz, Austria, 9–12 September 2018. https://doi.org/10.3390/proceedings2130772
[3] Kumar, H.; Singh, K. K.; Sood, N.; Kumar, A.; Mittal, R. K. Design and simulation of a Micro Hotplate for MEMS based integrated gas sensing system. In Proceedings of the 2014 IEEE Sensors Applications Symposium (SAS), Queenstown, New Zealand, 18-20 Feburary 2014. https://doi.org/10.1109/SAS.2014.6798942
[4] Asri, I.A.A.; Fuaad, M.R.A.; Ali, M.S.M. MEMS Gas Sensors: A Review. IEEE Sens. J. 2021, 21, 18381-18397. https://doi.org/10.1109/JSEN.2021.3091854
[5] Prasad, M.; Yadav, R.P.; Sahula, V.; Khanna, V.K. FEM Simulation of platinum-based microhotplate using diffrerent dielectric membranes for gas sensing applications. Sens. Rev. 2012, 32, 59-65. https://doi.org/10.1108/02602281211197152
[6] Tang, B.; Shi, Y.; Li, J.; Tang, J.; Feng, Q. Design, Simulation, and Fabrication of Multilayer Al2O3 Ceramic Micro-Hotplates for High Temperature Gas Sensors. Sensors 2022, 22, 6778. https://doi.org/10.3390/s22186778
[7] Wei, G.; Wang, P.; Li, M.; Lin, Z.; Nai, C. Simulation and Optimization of a Planar-Type Micro-Hotplate with Si3N4-SiO2 Transverse Composite Dielectric Layer and Annular Heater. Micromachines 2022, 13, 601. https://doi.org/10.3390/mi13040601
[8] Zhao, W.-J.; Xu, D.; Chen, Y.-S.; Wang, X.; Shi, Y.-B. A Low-Temperature Micro Hotplate Gas Sensor Based on AlN Ceramic for Effective Detection of Low Concentration NO2. Sensors 2019, 19, 3719. https://doi.org/10.3390/s19173719
[9] Yuan, Z.; Yang, F.; Meng, F. Research Progress on Coating of Sensitive Materials for Micro-Hotplate Gas Sensor. Micromachines 2022, 13, 491. https://doi.org/10.3390/mi13030491
[10] Nikolic, M.V.; Milovanovic, V.; Vasiljevic, Z.Z.; Stamenkovic, Z. Semiconductor Gas Sensors: Materials, Technology, Design, and Application. Sensors 2020, 20, 6694. https://doi.org/10.3390/s20226694

No. O-10
TITLE: Design and Fabrication of a Torque Sensor with Applications in Robot Skin and Joint

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ABSTRACT

A MEMS 6-axis force-torque sensor using piezoresistive sensing is described. The sensor is 1500 μm × 1500 μm × 11.16 μm in size. A .18 m CMOS MEMS process is employed for fabrication of the sensor. Sensing beam's size is 250 μm × 15 μm × 11.16 μm (length × width × thickness), respectively. There are 7 polysilicon strips in each beam. The sensing beam structure of this design is simple, which is adaptable with semiconductor device fabrication process. The intended sensing range is 0-10 kPa. Wheatstone bridge is utilized to amplify the output signal.

Keyword: 6-axis force-torque sensor, Piezoresistive beams, Wheatstone Bridge, Robot skin and joint

REFERENCES

[1] Takahashi, H.; Nakai, A.; Nguyen, T.V.; Matsumoto, K.; Shimoyama, I. A triaxial tactile sensor without crosstalk using pairs of piezoresistive beams with sidewall doping. Sens Actuators A Phys 2013, 199, 43 – 48.
[2] Nakai, A.; Morishita, Y.; Matsumoto, K.; Shimoyama, I. 6-axis force-torque sensor chip composed of 16 piezoresistive beams. In Proceedings of the MEMS 2015 – 28th IEEE International Conference on Micro Electro Mechanical Systems, Estoril, Portugal, 18 – 22 January 2015.
[3] Nakai, A.; Morishita, Y.; Matsumoto, K.; Shimoyama, I. 6-axis force-torque sensor chip composed of 16 piezoresistive beams. In Proceedings of the 2017 IEEE 30th International Conference on Micro Electro Mechanical Systems (MEMS), NV, USA, 22 – 26 January 2017. [4] Dao, D.V.; Toriyama, T.; Wells, J.C.; Sugiyama, S. Silicon piezoresistive six-degree of freedom force-moment micro sensor. Sens. Mater. 2003, 15, 113 – 135.
[5] Jacq, C.; Lüthi, B.; Maeder, Th.; Lambercy, O.; Gassert, R.; Ryser, P. Thick-film multi-DOF force/torque sensor for wrist rehabilitation. Sens. Actuator A Phys 2010, 162, 361 – 366.
[6] Beyeler, F.; Muntwyler, S.; Nelson, B.J. A Six-Axis MEMS Force –Torque Sensor With Micro-Newton and Nano-Newtonmeter Resolution. J Microelectromech Syst 2009, 18, 433 – 441. [7] Qin, Y.; Zhao, Y.; Li, Y.; Zhao, Y.; Wang, P. A High Performance Torque Sensor for Milling Based on a Piezoresistive MEMS Strain Gauge. Sens 2016, 16, 513. [8] Mei, T.; Li, W.J.; Ge, Y.; Chen, Y.; Ni, L.; Chan, M.H. An integrated MEMS three-dimensional tactile sensor with large force range. Sens. Actuator A Phys 2000, 80, 155 – 162.
[9] Estevez, P.; Bank, J.M.; Porta, M.; Wei, J.; Sarro, P.M.; Tichem, M.; Staufer, U. 6 DOF force and torque sensor for micro-manipulation applications. Sens. Actuator A Phys 2012, 186, 86 – 93.
[10] Handwerker, J.; Gieschke, P.; Baumann, M.; Paul, O. CMOS integrated silicon/glass-bonded 3D force/torque sensor. In Proceedings of the 2012 IEEE 25th International Conference on Micro Electro Mechanical Systems (MEMS), Paris, France, 29 January 2012 - 02 February 2012.

No. O-11

TITLE: Investigate the Effect of Copper Interlayer Thickness Ratio on the Microstructure and Mechanical Properties of Copper/Tungsten and Copper/Chromium Bilayers Using High Power Impulse Magnetron Sputtering

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ABSTRACT

In this study, the deposition of copper/tungsten and copper/chromium bilayers by high power impulse magnetron sputtering (HiPIMS) was compared with the previous DC magnetron sputtering (DCMS), because the thickness design has no quantitative basis. In this study, the parameters of the deposited films were investigated by changing the power output and thickness ratio, the surface, microstructure, and texture of sputtered films were measured by scanning electron microscopy (SEM), atomic force microscope (AFM), and X-ray diffraction spectroscopy (XRD). The hardness and resistivity were measured by nanoindentation and a four-point probe measurement. The results reveal that the HiPIMS sputtered copper/tungsten and copper/chromium bilayers exhibit higher hardness, lower electrical resistance, and lower surface roughness than films deposited under the same deposition conditions as DCMS. These excellent properties are attributed to the increased peak power density of the target during the HiPIMS deposition process, which increases the ion energy and enables the deposition of highly dense grain structures and changes in texture transformation. Through the results of different thickness ratios, this novel process technology deposition parameter database can be used for future high power impulse magnetron sputtering copper/ tungsten and copper/chromium multilayer deposition.

Keyword: High Power impulse Magnetron Sputtering(HiPIMS), Copper/Tungsten Thin Films, Copper/Chromium Thin Films, Duty Cycle, Mechanical Properties

REFERENCES

[1] L.R. Brandt, E. Salvati, C. Papadaki, H. Zhang, S. Ying, E. Le Bourhis, I. Dolbnya, T. Sui, A.M. Korsunsky, "Probing the deformation and fracture properties of Cu/W nano-multilayers by in situ SEM and synchrotron XRD strain microscopy", Surf. Coat. Technol., 320 (2017), pp. 158-167.
[2] Louis E. Toth, Transition metal carbides and nitrides 1st edition, New York and London: Academic Press (1971).

No. P-1

TITLE: *Ab* initio Studies of Work Function Changes of O_3 Adsorption on $ZnGa_2O_4$ (111) Surface for Gas Sensors

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ABSTRACT

We performed first-principles calculations to study the adsorption of the O_3 molecules on clean, Pd-, Pt-, and Au-doped $ZnGa_2O_4$(111) surfaces. The adsorption reactions and work function changes of the O_3 adsorption models were examined. The O_3 molecules on the clean, Pd-, Pt- , and Au-doped $ZnGa_2O_4$(111) surface exhibit maximum work function changes of 1.22 eV, 1.67 eV, 1.27 eV, and 1.49 eV, respectively. We also found that the monodentate and bidentate adsorption of the O_3 molecule on the clean $ZnGa_2O_4$(111) surfaces are -0.08 eV and -2.94 eV, respectively. The results show that the monodentate adsorption of the O_3 molecule on the clean $ZnGa_2O_4$(111) surfaces has the largest work function change (1.22 eV). The possible reason is that the surface passivation of oxygen formed by the bidentate adsorption of the O_3 molecule reduces the work function change from 1.22 eV to 0.76 eV. The adsorption energies of the catalyzed $ZnGa_2O_4$(111) surfaces are twice as much as -0.18 eV ~ -0.26 eV compared to the clean one. The results demonstrate that $ZnGa_2O_4$-based gas sensors doped by palladium, platinum, and gold can improve the sensitivity of detecting O_3 molecules.

Keywords: first-principles calculations, $ZnGa_2O_4$, work function, adsorption energy

No. P-2

TITLE: Development of a Rapid Mold with Conformal Heating Channel and Conformal Cooling Channel for Liquid Silicone Rubber Injection Molding

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ABSTRACT

Liquid silicone rubber (LSR) possesses some distinct properties, such as chemical stability, high temperature resistance, flame resistance, corrosion resistance, and electrical insulation. However, the uniformity of the vulcanization temperature of LSR was limited because the layout of the cartridge heater does not follow the profile of the mold cavity. Metal three-dimensional printing technique can be used to make LSR injection mold with conformal heating channels and conformal cooling channel simultaneously. However, this method is not suitable for a mold required to develop a new LSR product. In this study, an innovative approach was demonstrated to make an LSR injection mold for the pilot run of a new fish eye lens. The equation of $y = -0.006x^3 + 1.2114x^2 - 83.221x + 1998.2$ with the correlation coefficient of 0.9883 seems to be an optimum trend equation for predicting solidification time of a fish eye lens (y) using vulcanizing hot water temperature (x). The equation of $y = -0.002x^3 + 0.1329x^2 - 1.0857x + 25.4$ with the correlation coefficient of 0.9997 seems to be an optimum prediction equation for the solidification time of a fish eye lens (y) using LSR weight (x) since it has a highest correlation coefficient. The saving in solidification time of a fish eye lens about 28% can be obtained when an LSR injection mold with CHC for vulcanizing hot water temperature of 70 ℃.

Liquid silicone rubber (LSR) injection molding is a promising method for mass production of parts with sophisticated geometries because of its ease of processability [1]. Injection molding of LSR is ideal for rubber parts in specific demands, such as medical, automotive, aerospace, electrical, and consumer industries since it provides better end-product performance [2]. Conformal cooing channel (CCC) is employed in the plastic injection molding to enhance productivity and molded part quality [3]. In addition, hitherto little has been reported on the use of conformal heating channel (CHC) and CCC simultaneously in the LSR injection mold. In this study, numerical simulation is used as an effective way for designing both CHC [4] and CCC [5]. The feasibility of LSR injection mold with dual channels was fabricated with aluminum-filled epoxy resin. To validate the simulation results and evaluate the effectiveness of LSR injection mold, LSR injection molding is carried out. Thermal imaging technology can help characterize changes in vulcanization process. Thus, an infrared thermal imager is also employed to record temperature history during LSR injection molding [6].

Fabrication of CHC using conventional machining technique is difficult. Thanks to the features of three-dimensional printing technology, both CHC and CCC were printed using polyvinyl butyral filament because these materials can be removed thoroughly by industrial alcohol solution easily. The viscosity is the index of the resistance of an LSR to flow, which depends on temperature, shear rate and pressure. In general, LSR undergoes a significant volumetric change over pressure and temperature. To calculate shrinkage or warpage of a convex lens after vulcanization, characterization of pressure-volume-temperature relationship is required.

Keywords: Liquid silicone rubber, Conformal heating channel, Conformal cooling channel

REFERENCES

[1] Guo, J.; Wang, X.; Wang, J.; Chen, C.; Liu, Y.; Fan, W.; Jia, Z. Study on the Anticondensation Characteristics of Liquid Silicone Rubber Temperature-Control Coatings. Polymers 2019, 11, 1282.

[2] Woitschach, F.; Kloss, M.; Schlodder, K.; Borck, A.; Grabow, N.; Reisinger, E.C.; Sombetzki, M. In Vitro Study of the Interaction of Innate Immune Cells with Liquid Silicone Rubber Coated with Zwitterionic Methyl Methacrylate and Thermoplastic Polyurethanes. Materials 2021, 14, 5972.
[3] Mohd Hanid, M.H.; Abd Rahim, S.Z.; Gondro, J.; Sharif, S.; Al Bakri Abdullah, M.M.; Zain, A.M.; El-hadj Abdellah, A.; Mat Saad, M.N.; Wysłocki, J.J.; Nabiałek, M. Warpage Optimisation on the Moulded Part with Straight Drilled and Conformal Cooling Channels Using Response Surface Methodology (RSM), Glowworm Swarm Optimisation (GSO) and Genetic Algorithm (GA) Optimisation Approaches. Materials 2021, 14, 1326.
[4] Houssat, M.; Villeneuve-Faure, C.; Lahoud Dignat, N.; Locatelli, M.-L.; Cambronne, J.-P. Temperature Influence on PI/Si3N4 Nanocomposite Dielectric Properties: A Multiscale Approach. Polymers 2021, 13, 1936.
[5] Sahu, M.; Narasimhan, L.; Raichur, A.M.; Sover, A.; Ciobanu, R.C.; Lucanu, N.; Aradoaei, M. Improving Fracture Toughness of Tetrafunctional Epoxy with Functionalized 2D Molybdenum Disulfide Nanosheets. Polymers 2021, 13, 4440.
[6] E. Haberstroh, W. Michaeli, E. Henze," Simulation of the Filling and Curing Phase in Injection Molding of Liquid Silicone Rubber (LSR)," Journal of Reinforced Plastics and Composites, Volume: 21 issue: 5, 2002, Pages 461-471.

No. P-3

TITLE: *Ab* initio Studies of Work Function Changes of H_2O Adsorption on $ZnGa_2O_4$(111) Surface for Gas Sensors

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ABSTRACT

In this study, an open data database of gas sensors was established based on density functional theory (DFT). The Gas Sensor Database (SOD) is a crystal structure model that predicts optimal adsorption. SOD by entering the substrate type, substrate space group, substrate Miller index, gas type, whether the substrate is doped, whether the substrate is defective, whether the substrate has water molecules. Model. We obtained a crystal structure model of water molecules (H_2O) adsorbed on $ZnGa_2O_4$ (111) by SOD binding. After SOD binding, we show the crystal structure model of the adsorption of water molecules (H_2O) on zinc gallium oxide $ZnGa_2O_4$(111) hydrogen (H), and the bonded gallium (Ga) surface is the most stable model for the adsorption effect.

Keywords: *Ab* initio, $ZnGa_2O_4$, Adsorption, Sensor Open Database

No. P-4

TITLE: *Ab* initio Calculations of Epitaxial Softening of NiO(111) and SnO_2(100) Crystal Structures

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ABSTRACT

In this study, the atomic structures of NiO(111) and SnO_2(100) were calculated based on first principles and density functional theory, and several sets of models were established based on the crystal structures of NiO(111) and SnO_2(100). .) to calculate and analyze the epitaxial softening properties of the two materials by biaxial deformation and triaxial deformation methods, respectively. The three-axis calculation total energy of NiO(111) structure optimization is -136.1947 to -137.3964(eV), the two-axis calculation total energy is -137.0694 to -137.3964(eV), and the three-axis total energy calculation of SnO_2(100) structure optimization is From -37.6227 to -37.6784 (eV), the biaxially calculated total energy is -37.8146 to -37.8276 (eV), and the trend lines for the two compounds SnO_2(100) are stiffer and anharmonic elastic. In addition, applying the calculated results to the least squares formula, the calculated lattice constant and total energy (*q*, NiO<111>) were deduced to be 0.22~0.25, (*q*, SnO_2<100>) were 0.28~0.33, and the trend line It can be inferred that the epitaxial softening of NiO(111) and SnO_2(100) are both compressive strains.

Keyword: *Ab* Initio, NiO, SnO_2, Epitaxial softening

No. P-5
TITLE: An *Ab* initio Heterojunctions Database for GaN/Muscovite

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ABSTRACT

This research is based on the material gene machine learning method to construct and predict the heterojunction model open database of the crystal structure of the heterojunction between semiconductor materials. The open database of the heterojunction model is based on the user input of the crystal structure and crystal structure plane of the thin film and substrate Orientation and through the heterojunction model open database contains atom type and height search module, surface element replacement module, angle conversion module and crystal structure combination module to construct the heterojunction crystal structure model, open through the heterojunction model The database is based on density functional theory simulation to study the heterojunction structure of GaN (001) thin film crystal grown on muscovite (001) substrate crystal, and analyzed by interface bond enthalpy. There are 8 O-Ga bonds and 2 Al-Ga bonds. The interface model of the bond and 4 Si-Ga bonds is the optimal interface configuration.

Keyword: Muscovite, GaN, *Ab* initio, Database

No. P-6

TITLE: Deep Learning-Based Gas Molecule Adsorption Prediction of NO, NO_2, CO, CO_2, H_2S and O_3 Vacuum Energy: Optimization, Analysis, and Explanation

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ABSTRACT

In this research the $ZnGa_2O_4$ model was established as a substrate for gas sensor structure through the first principle and based on the density general function theory, the substrate surface adsorbed NO, NO_2, CO, CO_2, H_2S and O_3 sensing gas molecules, the six gas sensing molecules adsorption model by quantum calculation tool (Vienna *Ab* initio Simulation Package, VASP) to simulate the Fermi energy and vacuum energy values, and then the simulated values to establish a gas adsorption material gene database. The six gas sensing molecule adsorption models were simulated by the quantum calculation tool (Vienna *Ab* initio Simulation Package, VASP) to calculate the Fermi energy and vacuum energy values, and then the simulated values were used to build a gas adsorption material gene database, which contains the six sensing gas molecules, gas adsorption points and Fermi energy, the gas adsorption material gene database with machine learning predicted NO, NO_2, CO, CO_2, H_2S and O_3 six sensing gas adsorption of The vacuum energy and the best model weight value (w) after training is 0.085 and the learning accuracy is 66.71%.

Keyword: *Ab* initio, Vacuum energy, Genetic algorithm, Machine learning

No. P-7

TITLE: *Ab* initio Studies of Work Function Changes of NO Adsorption on $ZnGa_2O_4$(111) Surface for Gas Sensors

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ABSTRACT

In this study, based on density functional theory (DFT), first-principles calculations were used to study the effect of nitric oxide (NO) gas molecules on the Ga-Zn-O of gallium zinc oxide ($ZnGa_2O_4$) (111) surface The work function and adsorption energy change of the cut surface. In the study of the adsorption of NO gas molecules on the Ga-Zn-O section of pure $ZnGa_2O_4$(111), NO gas molecules were adsorbed on Ga_{3c}, Zn_{3c}, O_{3c}, O_{4c} sites on the surface of $ZnGa_2O_4$(111) by nitrogen atoms or oxygen atoms, respectively. , the highest work function change of -0.35 eV is obtained when nitrogen atoms are adsorbed on Ga_{3c} sites, and the second highest work function change of -0.27 eV is obtained when oxygen atoms are adsorbed on Ga_{3c} sites. The highest sensitivity is achieved when the site adsorbs NO gas molecules.

Keyword: *Ab* initio, $ZnGa_2O_4$, NO, Metal oxide, Work function

No. P-8

TITLE: First-Principles Calculations of Spin Spirals in Co-based Heusler Alloys Co_2XY (*X*=Cr, Mn, Fe; *Y*=Al, Ga, In, Si, Ge, Sn)

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ABSTRACT

The electronic and magnetic properties of the Co-base Heusler alloys Co_2XY (*X*= Cr, Mn, Fe; *Y*= Al, Ga, In, Si, Ge, Sn) are studied under the framework of density functional theory. Further, the total energy of the transverse spin-spiral wave as a function of the wave vector q for all Co-based Heusler alloys has been calculated by using *ab initio* density functional theory. The electronic correlation functionals were described using generalized gradient approximation (GGA) with the Perdew–Wang (PW91) correction. Following our previous studies[1,2], we further calculate the exchange parameters *J* by using the calculated energy dispersion relations of the spin-spiral waves. Furthermore, the Curie temperature is obtained by using the mean field approximation (MFA). It is found that all these Co-based Heusler alloys are energetically stable in ferromagnetic state. The Co_2CrAl, Co_2CrSi, Co_2CrGe, Co_2MnSi, and Co_2MnGe are theoretically predicted half metals and their spin magnetization follows the Slater-Pauling rules. The calculated spin magnetic moment of Co_2MnAl, Co_2MnSi, Co_2MnGe, and Co_2MnSn are in good agreement with experiments. Nonetheless, the calculated spin magnetic moment of Co_2CrAl are twice as experimental results. The spin-wave stiffness constant *D* of these Co-based Heusler alloys is also evaluated using the formula $D = \frac{2\mu_B}{m_s}\frac{d^2E(q)}{dq^2}$ [3], where m_s is the saturated spin magnetic moment and $E(q)$ is the calculated total energy as a function of the wave vector q. We found that these Co-based are strongly ferromagnetic materials.

Keyword: Spin-wave stiffness, Co-based Heusler alloys, Exchange parameters

REFERENCES

[1] Tung, J.C.; Guo, G.Y. High spin polarization of the anomalous Hall current in Co-based Heusler compounds. *New J. of Physics* 2013, 15, 033014.
[2] Huang, H.L.; Tung, J.C.; Guo, G.Y. Anomalous Hall effect and current spin polarization in Co_2FeX Heusler compounds (X = Al, Ga, In, Si, Ge, and Sn): A systematic ab initio study. *Phys. Rev. B*, 2015, 91, 134409.
[3] Tung, J.C.; Guo, G.Y. Ab initio studies of spin-spiral waves and exchange interactions in 3d transition metal atomic chains. *Phys. Rev. B*, 2011, 83, 144403.

No. P-9

TITLE: Large Band Gap Topological Insulators Sn_2BiBrO_6 and Sn_2SeTeO_6 Double Perovskites: A First-principle Theoretical Calculation

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ABSTRACT

Following our previous study[1] and under the frameworks of density functional theory, we find a new class of three-dimensional (3D) topological insulators (TIs) Sn_2BiBrO_6 and Sn_2SeTeO_6 double perovskites out of Ge_2SeTeO_6, Sn_2SeTeO_6, Ge_2XYO_6, and Sn_2XYO_6 (X=As, Sb, Bi; Y= Br, I). Our *ab initio* theoretical calculations show that Sn_2BiBrO_6 and Sn_2SeTeO_6 are Z2 nontrivial and their bandgaps are large, being 0.396 eV and 0.133 eV, respectively. The mechanism for the band topology is quite different from the conventional topological insulators where the band inversion is due to the spin orbit coupling. Unlike the conventional topological insulators, the band inversion occurs at Γ point in the absence of spin-orbit interactions. The bandgap of Sn_2BiBrO_6 and Sn_2SeTeO_6 double perovskite is caused by the spin-orbit coupling therefore, the bandgap is larger than conventional topological insulators. In this study, we calculate the mechanical properties, i. e. the elastic constants, and the results show that these double perovskites are mechanically stable. Nonetheless, further phonon dispersions investigation reveals that these structures are unstable. We also present mechanical properties such as bulk, shear, Young's moduli, Poisson's and Pugh's ratio, longitudinal, transverse, average sound velocity, and Debye temperature. We found that the topology comes from the $BiBrO_4$ and $SeTeO_4$ surface, and very interesting, the shift of Sn or Ge atom can produce a significant nonzero electric polarization leaving the coexisting of topology and electric polarization in these double perovskits. The coexisting of topology and electric polarization make Sn_2BiBrO_6 and Sn_2SeTeO_6 double perovskites a ferroelectric material that definitely be useful in future spintronic applications.

Keyword: Double perovskites, Topological insulator, Density functional theory

REFERENCES

[1] Tung, J.C.; Lee, C.H.; Liu, P.L.; Wang, Y.G. Electronic Band Structures of the Possible Topological Insulator Pb_2BiBrO_6 and Pb_2SeTeO_6 Double Perovskite: An Ab Initio Study. *Appl. Sci.* 2022, 12, 5913.

No. P-10

TITLE: Preparation of Green Emissive Carbon Nanodots by Microwave Method

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ABSTRACT

Green synthesis of carbon nanodots (Carbon Nano-Dots，CNDs) has been receiving wide attention in recent years. Numerous carbon containing chemicals and methods of carbonization have been carried out. In this study, acids such as trans-aconitic acid and amines such as ethylenediamine dihydrochloride were selected as the reactants. In addition to hydrothermal method, microwave heating was also used to pyrolyze the chemical resulting in fluorescent CNDs. The process is more environmentally friendly, and deionized water is used in the reaction process. Meanwhile, several experimental parameters such as the heating duration, heating rate, and ratio of acid to amine were adjusted to determine the optimal recipe.

Keyword: carbon nanodots, Green emissive, microwave heating

REFERENCES

[1] Azami T, Kasuya D, Yuge R, Yudasaka M, Iijima S, Yoshitake T, Kubo Y. Large-scale production of single-wall carbon nanohorns with high purity. J. Phys. Chem. C 2008;112:1330–1334.
[2] Tagmatarchis N, Maigné A, Yudasaka M, Iijima S. Functionalization of carbon nanohorns with azomethine ylides: towards solubility enhancement and electron-transfer processes. Small 2006;2(4):490–494.

No. P-11

TITLE: Preparation/Analysis of Fluorescent Carbon Nanopoints and Their Detection with 2-Aminoethanol and Citric Acid/Octonic Acid

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ABSTRACT

Syntheses of carbon nanodots (Carbon Nano-Dots，CNDs) have been explored a lot in all aspects. Numerous carbon containing chemicals and methods of carbonization have been carried out. In current research, acids such as citric acid and amines such as 2-aminoethanol were selected as the reactants. In addition to the reflux method, microwave radiation was used to pyrolyze the chemicals and give fluorescent CNDs. Meanwhile, several experimental parameters such as the heating duration, heating rate, and ratio of acid to amine were adjusted to determine the optimal recipe. So far, the as prepared CNDs show a quantum yield (QY) about 0.3% using quinine sulfate as the reference of fluorescence.

Keyword: carbon nanodots, green-light fluorescent, microwave radiation

REFERENCES

[1] Tung, J.C.; Lee, C.H.; Liu, P.L.; Wang, Y.G. Electronic Band Structures of the Possible Topological Insulator Pb_2BiBrO_6 and Pb_2SeTeO_6 Double Perovskite: An Ab Initio Study. *Appl. Sci.* 2022, 12, 5913.
[2] Athinarayanan, J., Almaiman, S. A., Al-Harbi, L. N., Periasamy, V. S., & Alshatwi, A. A. (2021). Fabrication of fluorescent carbon nanodots from laboratory paper waste for Fe3+ ions detection. Journal of King Saud University-Science, 33(7), 101584.
[3] Kim, K. W., Kwon, Y. M., Kim, S. Y., & Kim, J. Y. H. (2022). One-pot synthesis of UV-protective carbon nanodots from sea cauliflower (Leathesia difformis). Electronic Journal of Biotechnology, 56, 22-30.
[4] Meiling, T. T., Cywiński, P. J., & Bald, I. (2016). White carbon: Fluorescent carbon nanoparticles with tunable quantum yield in a reproducible green synthesis. Scientific reports, 6(1), 1-9.
[5] Zhao, Y., He, B., Liu, E., Li, J., Wang, L., Chen, S., ... & Qu, S. (2021). Aluminum-based surface polymerization on carbon dots with aggregation-enhanced luminescence. The Journal of Physical Chemistry Letters, 12(19), 4530-4536.

No. P-12

TITLE: Synthesis of Green-Light Fluorescent Carbon Nanodots with 2-Aminoethanol and Ocitric Acid

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ABSTRACT

Green synthesis of carbon nanodots (Carbon Nano-Dots，CNDs) has been receiving wide attention in recent years. Various carbon sources and ways of carbonization have been attempted. In this study, acids such as aconitic acid and amines such as urea were selected as the reactants. In addition to hydrothermal method, microwave heating was also used to pyrolyze the chemical resulting in fluorescent CNDs. Besides, several reaction parameters such as the heating time, heating power, and composition were tuned to help find out the optimal conditions. It was found that CNDs with a green fluoresce could be prepared rapidly.

Keyword: carbon nanodots, green-light fluorescent, microwave heating

REFERENCES

[1] Abbas, F., Kumar, S., Pal, S. K., & Panda, D. (2022). Carbon nanodot doped in polymer film: Plasmophore enhancement, catalytic amination and white-light generation. Journal of Molecular Liquids, 347, 118001.
[2] Athinarayanan, J., Almaiman, S. A., Al-Harbi, L. N., Periasamy, V. S., & Alshatwi, A. A. (2021). Fabrication of fluorescent carbon nanodots from laboratory paper waste for Fe3+ ions detection. Journal of King Saud University-Science, 33(7), 101584.
[3] Kim, K. W., Kwon, Y. M., Kim, S. Y., & Kim, J. Y. H. (2022). One-pot synthesis of UV-protective carbon nanodots from sea cauliflower (Leathesia difformis). Electronic Journal of Biotechnology, 56, 22-30.
[4] Meiling, T. T., Cywiński, P. J., & Bald, I. (2016). White carbon: Fluorescent carbon nanoparticles with tunable quantum yield in a reproducible green synthesis. Scientific reports, 6(1), 1-9.
[5] Nawara, K., & Waluk, J. (2019). Goodbye to quinine in sulfuric acid solutions as a fluorescence quantum yield standard. Analytical chemistry, 91(8), 5389-5394.
[6] Sutanto, H., Alkian, I., Romanda, N., Lewa, I. W. L., Marhaendrajaya, I., & Triadyaksa, P. (2020). High green-emission carbon dots and its optical properties: Microwave power effect. AIP Advances, 10(5), 055008.
[7] Zhu, H., Wang, X., Li, Y., Wang, Z., Yang, F., & Yang, X. (2009). Microwave synthesis of fluorescent carbon nanoparticles with electrochemiluminescence properties. Chemical Communications, (34), 5118-5120.

No. P-13
TITLE: Prediction of Local Optimization Algorithm in Lens Design by Using Deep Learning

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ABSTRACT

A deep leaning is applied to predict a lens design rule that is based on local optimization algorithm in this paper. Three separate lens design rules are made for the optimization in two lens elements optical systems whose structure parameters are created randomly. These random lens structures are optimized by using three separate lens design rules that are developed by Zemax OpticStudio API to create a big optimization data set. All the optimization results are collected in further deep learning process to determine which optimization rule could be the best choice for lens optimization when given a lens parameters. The model developed by deep learning shows that the prediction has 91% accuracy to determine an appropriate optimization rule.

Keyword: Deep learning, Lens design, Optical

REFERENCES

[1] J. Meiron, *Damped Least-Squares Method for Automatic Lens Design*, 1965, pp.1105-1109
[2] K. Levenberg, *A method for the solution of CERTAIN problems in least squares*, Quart. Appl. Math. 2, 1994, pp. 164–168.

No. P-14

TITLE: Cryptanalysis of Ye et al.'s Semi-quantum Summation Against the Collective-dephasing Noise

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ABSTRACT

In 2021, Zhang et al. [1] proposed a three-party semi-quantum summation protocol with an almost-dishonest third party (TP) using single photons. In Zhang et al.'s protocol, the measurement in a GHZ-type basis is utilized to detect the honesty of an almost-dishonest TP as well as to compute the summation of participants' private messages. TP is almost-dishonest, which means that the TP can start all sorts of attacks within quantum boundaries except collusion with other dishonest users. In 2022, Pan [2] shows that by launching a participant attack, the TP can obtain three participants' measurement results on the particle groups except for checking the existence of the eavesdropper and the honesty of the TP without being detected. However, Zhang et al.'s and Pan's protocols do not consider the negative effect of noise and are only applicable to ideal noise-free quantum channels. In practical applications, photons are inevitably affected by birefringent wave motion in optical fibers. Therefore, the negative effect of noise cannot be ignored. Channel noise can be considered as collective noise because the photons propagate in a shorter time window than the noise variance and are affected by the same noise. Thus, the design of a feasible semi-quantum summation protocol for the collective noise quantum channel is an urgent problem. In 2022, Ye et al. [3] proposed a two-party semi-quantum summation protocol, where two classical participants can accomplish the summation of their private binary sequences with the assistance of a quantum almost-dishonest TP. Ye et al. concentrate on designing a semi-quantum summation protocol immune to the collective-dephasing noise. The security analysis turns out that this protocol can effectively prevent outside attacks from the eavesdropper and the participant attacks from TP. In this study, we analyze the security of Ye et al.'s semi-quantum summation protocol. In Ye et al.'s protocol, in order to check the existence of eavesdroppers and the honesty of the TP, it is designed that the TP first measures all the received quantum states and publishes the measurement results. As a result of this design, when Alice and Bob announce the results of their respective calculations, Alice who announces the results first will be at a disadvantage because Bob who announces the results later can obtain the results of TP and Alice first, and he can deduce whether Alice's results are the same as his own. Therefore, Ye et al.'s protocol cannot achieve the purpose of safe computation.

Keyword: Quantum cryptography, Semi-quantum summation, Collective-dephasing noise

REFERENCES

[1] Zhang, C., Huang, Q., Long, Y., Sun, Z.: Secure Three-Party Semi-quantum Summation Using Single Photons. Int. J. Theor. Phys. 60(9), 3478-3487 (2021)
[2] Pan, H.-M.: Cryptanalysis and Improvement of Three-Party Semi-Quantum Summation Using Single Photons. Int. J. Theor. Phys. 61(4), 103 (2022)
[3] Ye, T.-Y., Xu, T.-J., Geng, M.-J., Chen, Y.: Two-party secure semiquantum summation against the collective-dephasing noise. Quantum Inf. Process. 21(3), 118 (2022)

No. P-15

TITLE: Intercept-and-Resend Attack on Zeng and Long's Controlled Quantum Secure Direct Communication and Authentication Protocol

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ABSTRACT

In the controlled quantum secure direct communication and authentication (CQSDCA) protocols, only under the permission of the controller, the sender and the receiver can implement secure direct communication successfully. In 2017, Nanvakenari and Houshmand [1] proposed a three-party CQSDCA protocol by using four-particle cluster states via a quantum one-time pad and local unitary operations. In 2018, Zhong et al. [2] found that there are some security problems with Nanvakenari and Houshmand's CQSDCA protocol. Some information about the receiver's and the controller's identity messages can be stolen without being detected by the selective-CNOT-operation (SCNO) attack from an eavesdropper. This means that the requirements of the CQSDCA protocol are not satisfied. In 2019, Zeng and Long [3] proposed a CQSDCA protocol based on the five-particle cluster state and the classical XOR operation. The security analysis revealed that the protocol could effectively prevent eavesdroppers from acquiring useful information and was able to detect eavesdropping behavior. However, this study found that there is an intercept-and-resend attack on Zeng and Long's CQSDCA protocol, which is described as follows. First, the receiver intercepts the photon sequence sent by the sender to the controller. Since the sequence of photons is arranged in a fixed order, the receiver can measure the results of the controller's control photons and authentication photons. Based on the measurement result, the receiver generates the same quantum sequence and sends it to the controller. then, the receiver can calculate the control message and decode the secret message. In addition, this attack mode is not detected by the controller.

Keyword: Quantum cryptography, Cluster state, Controlled quantum secure direct communication, Authentication, Intercept-and-resend attack

REFERENCES

[1] Nanvakenari, M., Houshmand, M.: An efficient controlled quantum secure direct communication and authentication by using four particle cluster states. Int. J. Quant. Infor. 15(01), 1750002 (2017)
[2] Zhong, J., Liu, Z., Xu, J.: Analysis and Improvement of an Efficient Controlled Quantum Secure Direct Communication and Authentication Protocol. Computers, Materials & Continua 57(3), 621--633 (2018)
[3] Zheng, X.-y., Long, Y.-x.: Controlled quantum secure direct communication with authentication protocol based on five-particle cluster state and classical XOR operation. Quantum Inf. Process. 18(5), 129 (2019)

No. P-16

TITLE: Quantum Conference Key Distribution Protocol on Quantum Repeater based Quantum Network

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ABSTRACT

Quantum key distribution (QKD) protocol [1], which lets the two remote users share the unconditional security key by using the properties of quantum mechanics, is a crucial research issue in quantum cryptography. To overcome the quantum transmission distance, the QKD network architecture [2-8] was proposed to provide QKD service for any end-user in the wide area. Although the existing QKD networks can give the two end users the end-to-end key distribution service, they do not consider the conference key distribution service, which lets an end user (e.g., Alice) distribute a secret key to multiple end users (e.g., Bob_1, Bob_2, …, Bob_n). In light of this, this study summarizes the property of measuring Graph state [9] and then uses this property to propose a quantum conference key distribution (QCKD) protocol in the QKD network. By the proposed QCKD protocol, Alice can securely share her secret key with n end users by assisting with the quantum repeaters, the quantum nodes of the QKD network. In the proposed QCKD protocol, Alice only equips the Hadamard operation, σ_z operation, and Z-basis measurement device, and the other end users also only prepare the Hadamard operation and Z-basis measurement device. Furthermore, each repeater only needs to create single photons, perform control-Z operation to create the entanglement relation of the Graph state, and measure the single photons with Z- or X-bases to build the suitable routing path, rather than it needs to perform any complex multiple entanglement state measurement (e.g., Bell measurement). Therefore, the proposed QCKD is practical due to the lightweight quantum equipment of end users and quantum nodes. Finally, this study gives a security analysis to explain that the proposed QCKD protocol is robust under collective attack.

Keyword: quantum key distribution protocol, trusted repeater, quantum conference key distribution protocol, quantum network.

REFERENCES

[1] C. H. Bennett and G. Brassard., "Quantum cryptography: Public key distribution and coin tossing," In Proceedings of IEEE International Conference on Computers, Systems and Signal Processing, volume 175, page 8. New York, 1984.
[2] Hughes, R. J., Morgan, G. L., & Peterson, C. G. (2000). Quantum key distribution over a 48 km optical fibre network. Journal of Modern Optics, 47(2-3), 533-547.
[3] Chia-Wei Tsai, Chun-Wei Yang, Jason Lin, Yao-Chung Chang*, and Ruay-Shiung Chang, "Quantum Key Distribution Networks: Challenges and Future Research Issues in Security" (2021), Appl. Sci. 2021, 11(9), 3767.
[4] Hughes, R. J., Nordholt, J. E., Derkacs, D., & Peterson, C. G. (2002). Practical free-space quantum key distribution over 10 km in daylight and at night. New journal of physics, 4(1), 43.
[5] Gobby, C., Yuan, Z. L., & Shields, A. J. (2004). Quantum key distribution over 122 km of standard telecom fiber. Applied Physics Letters, 84(19), 3762-3764.
[6] Lodewyck, J., Bloch, M., García-Patrón, R., Fossier, S., Karpov, E., Diamanti, E., ... & Grangier, P. (2007). Quantum key distribution over 25 km with an all-fiber continuous-variable system. Physical Review A, 76(4), 042305.
[7] Fürst, M., Weier, H., Schmitt-Manderbach, T., Ursin, R., Tiefenbacher, F., Scheidl, T., ... & Perdigues, J. M. (2006, October). Free-space quantum key distribution over 144 km. In Advanced Free-Space Optical Communication Techniques/Applications II and Photonic Components/Architectures for Microwave Systems and Displays (Vol. 6399, p. 63990G). International Society for Optics and Photonics.
[8] Shimizu, K., Honjo, T., Fujiwara, M., Ito, T., Tamaki, K., Miki, S., ... & Sasaki, M. (2013). Performance of long-distance quantum key distribution over 90-km optical links installed in a field environment of Tokyo metropolitan area. Journal of Lightwave Technology, 32(1), 141-151.
[9] M. Hein; J. Eisert; H. J. Briegel (2004). "Multiparty entanglement in graph states". Physical Review A. 69: 062311.

No. P-17

TITLE: Rice Yield Prediction Using Deep Learning Hybrid Model with Multiple-Sensors Remote Sensing

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ABSTRACT

UAVs and remote sensing have become more popular worldwide for smart farming in nowadays. The prediction of crop yield is one of the major research topics in agricultural industries. However, the use of machine learning techniques to automate the prediction of crop yield are still at its early stage of developments. This study presents an efficient hybrid model that integrate a Multi-Kernel Convolutional Neural Networks (MKCNNs) and a Bidirectional Long Short-Term Memory (Bi-LSTM) to predict the rice yield [1,2]. Three different algorithms – Pearson Correlation Coefficients (PCCs), SHapley Additive exPlanations (SHAP) and Recursive Feature Elimination with Cross-Validation (RFECV) are used to analyze the data to filter out irrelevant data to reduce the training time of predictive model [3–5]. The digital data is first reformatted into a two-dimensional matrix and then sent to the proposed hybrid model with architectural setups such as the training algorithms, the depth of the network, and the hyperparameters. The hybrid model has applied early stopping and multi-tasking techniques to increase the prediction performance in ablation experiment [6]. As a result, the Root-Mean-Square Error (RMSE) of the proposed model in yield prediction has achieved 359.35 and $R^2 = 0.68$ [7,8], which is better than the other state-of-the-art models such as ANNs (RMSE = 546.51, $R^2 = 0.10$) and DNNs (RMSE = 395.14, $R^2 = 0.54$) [9]. Moreover, the proposed model has shown significant performance in determining the prediction is a high yield or low yield with 90% accuracy, 92% precision, 96% recall, and 94% F1 score [10].

Keyword: crop yield prediction, remote sensing, deep learning, multi-tasking learning, CNNs, Bi-LSTM

REFERENCES

[1] LeCun, Y.; Bottou, L.; Bengio, Y.; Haffner, P. "Gradient-based learning applied to document recognition." *Proceedings of the IEEE* 86.11 1998: 2278-2324.
[2] Graves, A.; Schmidhuber, J. "Framewise phoneme classification with bidirectional LSTM and other neural network architectures." *Neural Networks* 18.5-6 2005: 602-610.
[3] Benesty, J.; Chen, J.; Huang, Y.; Cohen, I. "Pearson correlation coefficient." *Noise Reduction in Speech Processing* 2009: 1-4.
[4] Winter, E. "The shapley value." *Handbook of Game Theory with Economic Applications* 3 2002: 2025-2054.
[5] Guyon, I.; Weston, J.; Barnhill, S.; Vapnik, V. "Gene selection for cancer classification using support vector machines." *Machine Learning* 46.1 2002: 389-422.
[6] Caruana, R. "Multitask learning." *Machine Learning* 28.1 1997: 41-75.
[7] Hyndman, R. J.; Koehler A.B. "Another look at measures of forecast accuracy." *International Journal of Forecasting* 22.4 2006: 679-688.
[8] Draper, N. R.; Smith, H. The Geometry of R^2. In Applied regression analysis, 3rd ed.; John Wiley & Sons, Canada, 1998; volume 326, 452-453.
[9] Khaki, S.; Wang L. "Crop yield prediction using deep neural networks." *Frontiers in Plant Science* 10 2019: 621.
[10] Powers, D. M. "Evaluation: from precision, recall and F-measure to ROC, informedness, markedness and correlation." *International Journal of Machine Learning Technology* 2:1 2011: 37-63.

No. P-18

TITLE: Combustion Characteristics of Densified Refuse Derived Fuel Produced from Rice Straw

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ABSTRACT

Rice straw was used to produce densified refuse-derived fuel (RDF-5) in this study. Rice straw was pretreated by drying, cutting, and milling. It was then mixed with water in a ratio of 2:1, and fed into a screw extrusion machine to produce RDF-5. Physical and chemical analyses were performed on RDF-5. These analyses included ultimate analysis, proximate analysis, thermogravimetric analysis (TGA), and the assessment of calorific value, durability, and compressive strength. Additionally, an RDF-5 combustion test was performed using a stationary furnace.

The proximate analysis showed that the moisture content and volatile content of RDF-5 reduced by 4.02% and 3.46%, respectively, compared with rice straw. Gross calorific values for rice straw and RDF-5 were 3502.98 kcal/kg and 3637.35 kcal/kg, respectively, while the fixed carbon in rice straw and RDF-5 were 1.28% and 6.92%, respectively. The durability of RDF-5 exceeded 99.9%, indicating its suitability for transportation and storage.

In the experimental results of TGA, rice straw and RDF-5 both showed a two-stage thermal degradation curve pyrolysis under nitrogen, while there were three stages of thermal degradation for rice and RDF-5 combustion under air environment. the ignition temperature (Tig) of straw was lower than that of RDF-5 in both nitrogen and air environments and the Tig of straw and RDF-5 in the air environment was as expected lower than the Tig in the N_2 environment. The maximum thermal decomposition rate (Rmax) of RDF-5 in N_2 and air environment was similar, while the average thermal decomposition rate (Ravg) in air environment was higher than that in N_2. Coupled with the three-stage decomposition, the RDF-5 had a higher burnout temperature when operating in the air.

Results of the combustion test showed that RDF-5 can reduce pollutant emissions, compared with rice straw. Results from the stationary furnace showed that the type of fuel influences pollutant emissions. When maximum emission concentrations are considered, the continuous feed combustion mode emits significantly fewer pollutants than batch combustion. The emissions of CO, CO_2, and NOX from RDF batch combustion were lower than those from the continuous feed combustion when analyzed based on total emission concentration. Continuous feeding leads to lower emissions than batch feeding.

Keyword: Biomass application, Densified refuse derived fuel, Rice straw, Renewable energy, Air pollution reduction.

No. P-19

TITLE: Effects of the TiN Hetero-buffer Layer in Radio Frequency Magnetron Sputtered β-Ga_2O_3 Films on Si Substrate

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ABSTRACT

The β-phase gallium oxide (β-Ga_2O_3) semiconductor material has excellent chemical, thermal stability, and its breakdown voltage is better than that of silicon carbide (SiC) and gallium nitride (GaN). For high power device applications, the native substrate of GaN, SiC, and Ga_2O_3 wafers are expensive and difficult to enlarge size. The β-Ga_2O_3/Si substrate has a high potential for power device applications due to the high stability, low cost, and good heat dissipation. However, the interface of β-Ga_2O_3/Si substrate has lattice mismatch and diffusion issues [1]. Besides, the native amorphous-nano-oxide film formed on Si substrate, resulting in the growth of Ga_2O_3 no longer affected by the substrate crystallinity during epitaxy [2]. The nano amorphous silicon oxide (SiO_2) dominates the (100) preferred orientation of β-Ga_2O_3 in prepared films, which is the driving force for the twin boundaries and stacking faults [3, 4]. Therefore, the titanium nitride (TiN) films were developed as a hetero-buffer layer in the interface of the β-Ga_2O_3/Si substrate by radio frequency magnetron sputtering. This work highlights the effects of the hetero-buffer layer, the thickness of the buffer layer, the process atmosphere, and annealing temperatures on the microstructural and surface morphology of β-Ga_2O_3 films under optimized growth conditions. As a result, the hetero-buffer layer can block the diffusion of Si elements, improve the crystallinity of the active layer, and avoid the amount of (100) preferred orientation for β-Ga_2O_3, thereby improving the carrier mobility and electrical characteristics.
Keyword: micro pillar array, stereolithography

Keywords: Si substrate, β-phase Ga_2O_3, Interfacial oxide, Preferred orientation, TiN hetero-buffer layer, Radio-frequency magnetron sputtering

REFERENCES

[1] M. K. Yadav, A. Mondal, S. Das, S.K. Sharma, A. Bag, Impact of annealing temperature on band-alignment of PLD grown Ga_2O_3/Si (100) heterointerface, J. Alloys Compd., 819 (2020) 153052.
[2] C. C. Yen, T.M. Huang, P.W. Chen, K.P. Chang, W.Y. Wu, D.S. Wuu, Role of Interfacial Oxide in the Preferred Orientation of Ga_2O_3 on Si for Deep Ultraviolet Photodetectors, ACS Omega, 6 (2021) 29149-29156.
[3] B. Choi, B. Allabergenov, H.-K. Lyu, S.E. Lee, Twin-induced phase transition from β-Ga_2O_3 to α-Ga_2O_3 in Ga_2O_3 thin films, Appl. Phys. Express, 11 (2018) 061105.
[4] G. Wagner, M. Baldini, D. Gogova, M. Schmidbauer, R. Schewski, M. Albrecht, Z. Galazka, D. Klimm, R. Fornari, Homoepitaxial growth of β-Ga_2O_3 layers by metal-organic vapor phase epitaxy, Phys. Status Solidi A 211 (2014) 27-33.

No. P-20

TITLE: Synthesis of SiO_2-coated perovskite quantum dots for micro-LED display applications

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ABSTRACT

The cadmium quantum dots (QDs) have good luminous properties, but cadmium is toxic and not acceptable to the environment, therefore, in this work, the cadmium-free perovskite QDs have been demonstrated by chemical solution methods. The new structure of the green $CsPbBr_3/Cs_4P_bBr_6$ perovskite QDs have been realized. To ensure that luminous properties of the synthesized perovskite QDs are not affected by moisture and oxygen, the SiO_2 passivation layer was coated on the perovskite QDs by sol-gel method and hydrolysis of tetramethoxysilane (TMOS), and then dispersed in a polar solvent to facilitate mixing with negative photoresist (SU8-3010). Afterward, perovskite QDs were exposed and developed on the glass substrate by a photolithography process, and the pixels were spaced apart through the black matrix to reduce the crosstalk between each other. Then, when the pixelated perovskite QDs are applied to the blue light micro-LED display as the color conversion layer, it was found that the excessive blue light will penetrate through the green pixels and resulting in a decrease in color purity. Therefore, we use a 23-layer distributed Bragg reflector (DBR) to reflect excess blue light on pixels back to perovskite QDs. The green light is not filtered by DBR and the actual luminous intensity of green light will increase by 118%, respectively, and the transmittance of blue light is only 0.5%. Finally, the graph pixelated perovskite QDs on glass substrate were attached to the blue light display by the alignment and realized monochrome/area color and full-color micro-LED display.

Keyword: Perovskite Quantum Dot, Micro-LED display Sol-gel method, Photolithography process, Distributed Bragg Reflector, SiO_2

No. P-21

TITLE: Applying Multi-level Information to Steady-state Visual Evoked Potential-based Brain Computer Interfaces

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ABSTRACT

The disease of amyotrophic lateral sclerosis (ALS) hinders the normal functioning of the motor neurons and then people with ALS have difficulty communicating with others. People with ALS still have normal thinking abilities, thus they will feel pain in daily lives. Recently, many researchers have proposed brain-computer interfaces (BCIs) to help people communicate with others [1, 2]. Compared with other BCIs, the steady-state visual evoked potentials-based (SSVEP-based) BCI has a high signal-to-noise rate, thus it is very suitable for practical applications. Therefore, developing an SSVEP-based BCI can help people communicate with others. Recently, multi-level information has been used to increase the accuracy of intelligent systems [3-5]. Song et. al. proposed the multi-scale feature learning scheme, which focuses on the fusion of concrete features and abstract features. Li et. al. and Chuang et al. used spatial features and temporal features to develop intelligent systems. The experimental results showed that multi-level information is able to improve the accuracy of intelligent systems. Therefore, integrating with multi-level information is able to increase the performance of the SSVEP-based BCIs. In this study, a deep neural network with an input layer, a sequence of convolutional layers and dropout layers, a group convolutional layer, a softmax layer, and an output layer is proposed to develop an SSVEP-based BCI, which integrates with multi-level information. The multi-level information used in this study includes temporal SSVEP signal and spatial SSVEP signal. First, the spatial and temporal signals are adopted to find the embedding features by using three convolutional layers. Second, the embedding features for spatial signals and temporal signals are concatenated. Third, a convolutional layer is used to find the fused embedding features. Finally, a group convolutional layer and a softmax layer are applied to find the final decisions. To compare the proposed approaches, only spatial and temporal signals are selected as the inputs of the neural networks (denoted as baseline_time and baseline_frequency). The accuracy of baseline_time, baseline_frequency, and neural networks with multi-level information are 92.00%, 92.90%, and 95.10%, respectively. It is clear that the performance of baseline_frequency is lower than that of baseline_time. The results showed that the feature in the frequency domain can increase the discriminative information, and then the multi-level information can achieve the best performance. Moreover, the performance by using canonical correlation analysis, filter bank canonical correlation analysis, and task-related component analysis were 59%, 72%, and 88%, respectively. Therefore, the proposed approach outperforms other approaches and multi-level information including spatial and temporal features can effectively improve the performance of SSVEP-BCIs.

Keyword: steady-state visual evoked potential, brain-computer interface, deep learning, multi-level information

REFERENCES

[1] Chen, S.C.; Chen, Y.J.; Zaeni, I.A.E.; Wu, C.M. A Single Channel SSVEP based BCI with a Fuzzy Feature Threshold Algorithm in a Maze Game. Int. J. Fuzzy Syst. 2017, 19(2), 553–565.
[2] Graves, A.; Schmidhuber, J. "Framewise phoneme classification with bidirectional LSTM and other neural network architectures." *Neural Networks* 18.5-6 2005: 602-610.
[3] Song, Z.; Zhang, Y.; Liu, Y.; Yang K.; Sun, M. MSFYOLO: Feature fusion-based detection for small objects. IEEE Latin America Transactions, 2022, 20(5), 823–830.
[4] Li, Y.; Wang, X.; He, Y.; Wang, Y.; Wang, Y.; Wang, S. Deep Spatial-Temporal Feature Extraction and Lightweight Feature Fusion for Tool Condition Monitoring. IEEE Transactions on Industrial Electronics, 2022, 69(7), 7349-7359.
[5] Chuang, C.C.; Lee, C.C.; Yeng, C.H.; So, E.C.; Chen, Y.J. Attention Mechanism-Based Convolutional Long Short-Term Memory Neural Networks to Electrocardiogram-Based Blood Pressure Estimation. Appl. Sci. 2021, 11, 12019.
[6] Wang, Y.; Chen, X.; Gao, X.; Gao, S. A benchmark dataset for ssvep-based brain–computer interfaces. IEEE Transactions on Neural Systems and Rehabilitation Engineering, 2016, 25(10):1746–1752.

No. P-22

TITLE: Metal Oxide Electrode Formation for Anion Exchange Membrane Hydrogen Production Module

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ABSTRACT

The research target is to explore a hydrogen production module using metal oxide as an active and stable oxygen evolution reaction (OER) electrode. Metal oxide (NiFeO) was formed onto nickel foam by immersed a corrosive solution $Fe(NO_3)_3 \cdot 9H_2O$ as anode electrode. Pt/C was used as cathode electrode. Two electrodes were combined with anion exchange membrane for a single cell of membrane electrode assembly(MEA). This MEA then be placed into the hydrogen production module to measure the hydrogen evolution by electrolysis. Nano-particles NiFeO on the electrode surface enhances the OER activity. It's measured that the single cell of anion exchange membrane (AEM) module can reach 15.9 A at 2 V in the 1 M KOH solution. It's also found that the corrosive time has different effects on NiFeO formation. The optimum result was taken for 12 hours corrosion to reach the best electrolysis performance. Also, the current density can be operated up to 304 mA/ cm^2 at temperature 70°C. Such experiments showed the feasibility of metal oxide formed onto nickel foam as anode electrode can be practiced in AEM electrolyzer for hydrogen production.

Keyword: hydrogen production, anion exchange membrane, metal oxide, electrolyzer, clean energy

REFERENCES

[1] D. Barsuk, A. Zadick, M. Chatenet, K. Georgarakis, N. T. Panagiotopoulos, Y. Champion, A. M. Jorge Jr,"Nanoporous silver for electrocatalysis application in alkaline fuel cells," Materials & Design, 2016, vol. 111, pp. 528536, 2016.
[2] X. Loh, O. Li, F. Taiwo, N.P. Tariq, P. Brandon, K. Wang, B. Xu, B. Wang, "Development of Ni–Fe based ternary metal hydroxides as highly efficient oxygen evolution catalysts in AEM water electrolysis for hydrogen production," Int. J. Hydrogen Energy, 2020, pp. 24232-24247

No. P-23

TITLE: Nickel Copper Mixed Metal Oxide Eelectrode for Anion Exchange Membrane Electrolyzer

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ABSTRACT

The high-efficiency hydrogen production module with non-precious metal catalyst for water electrolyzer was developed. The nickel-copper mixed metal oxide (MMO) synthesized by chemical reduction and carbon black (Vulcan XC72R) was used as the support to make a nickel-copper catalyst (40wt% NiCu/C MMO) as the cathode. In the anode part, the cobalt iron oxide catalyst (CoFe) was used, combined with an anion exchange membrane (X37-50RT), and based on this ion exchange membrane, the manufacturing process of the membrane electrode assembly (MEA) is changed. and compare. In the experiment, the proportion of ionic polymer, the excitation time of the gas diffusion electrode (GDE), the comparison of the gas diffusion layer, the optimal loading amount, etc. were changed to discuss its influence on the electrolytic performance, and finally the best results were integrated for testing. In the comparison of different ionic polymer ratios, it is shown that the ionic polymer ratio has a great influence on the electrolytic performance, and the optimal ratio is 80:20. In the comparison of excitation time of GDE, it is found that when more time is given to soak 1M KOH solution, when the excitation time is increased to 48 hours, the electrolytic performance can be greatly improved, and 3 mg/cm^2 of NiCu/C MMO is loaded through GDL280 with a harder texture. And highefficiency electrolyzers can be made at an electrolyte temperature of 55°C. In summary, the highest current density obtained in this experiment is 364 mA/cm^2 at input 2V.

Keyword: hydrogen production, anion exchange membrane, metal oxide, electrolyzer, membrane electrode Assembly

REFERENCES

[1] C. Bonneuil, P. Choquet, B. Franta, "Early warnings and emerging accountability: Total's responses to global warming, 1971–2021," Global Environmental Change, 2021.
[2] I. Vincent, A. Kruger, D. Bessarabov, "Development of efficient membrane electrode assembly for low cost hydrogen production by anion exchange membrane electrolysis," International Journal of Hydrogen Energy, 2017, vol. 42, pp. 10752-10761, 2017.

No. P-24

TITLE: Deep UV PD Performance Improvement by UV-ozone Surface Treatment

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ABSTRACT

In recent years, a new coronavirus (COVID-19) has appeared in our living world, human beings begin to increase their awareness in medical care and personal safety issues. Because of the damage caused by COVID-19, the public's requirements for sterilization have increased a lot. As we known, using UVC light (< 280 nm) to kill the virus is an effective way. However, the optical wavelength under 280 nm is invisible, we will not aware if the UVC light source is broken or not, besides, the energy of UVC light is to strong that will harm our eyes [1], so it is necessary to combine a DUV photodetector with UVC light source.

There are plenty of wide bandgap material, $ZnGa_2O_4$ (ZGO) is one of them. ZGO has a ultra wide bandgap with 5.2 eV [2], making ZGO a suitable material for DUV photodetector.

In this study, metal-semiconductor-metal (MSM) deep ultraviolet photodetectors (DUV PDs) based on ZGO is fabricated, ZGO thin film is prepared by metal organic chemical vapor deposition (MOCVD).The effect of UV-ozone treatment on the characteristic of DUV PDs is reported. It shows a better photoelectric characteristic than the device without UV-ozone treatment.

Keyword: PD, $ZnGa_2O_4$, DUV, Wide Bandgap Semiconductor

REFERENCES

[1] L.-C. Cheng, C.-Y. Huang, and R.-H. Horng, "Thickness Effect on Operational Modes of $ZnGa_2O_4$ MOSFETs," IEEE Journal of the Electron Devices Society, vol. 6, pp. 432-437, 2018.
[2] Omata, Takahisa, et al. "New ultraviolet-transport electroconductive oxide, $ZnGa_2O_4$ spinel." Applied physics letters 64.9 (1994): 1077-1078.

No. P-25

TITLE: Using Kernel Density Estimation Algorithm in Knowledge Distillation to Construct a Classification Model for Bipolar Disorder Patients

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ABSTRACT

Bipolar disorder is a severe mood disorder characterized with alternating episodes of depression and mania [1, 2]. According to statistics, people with bipolar disorder account for about 1% of the global population [3]. About one-quarter to one-third of people with bipolar disorder experience economic, social, or professional problems [2]. According to the survey provided by WHO, bipolar disorder is one of the top 20 causes of disability in the world, and causes a huge burden on society [4]. Many patients with bipolar disorder also suffer from other mental illnesses [2], and they have twice the risk of dying from cardiovascular/cerebrovascular diseases [1]. Therefore, proposing physiological/pathological explanations for the co-morbid associations of bipolar disorder with a variety of illnesses poses a clinical challenge. In addition, although the side effects of antipsychotic drugs may increase the risk of cardiovascular/cerebrovascular diseases, they are not always taken seriously. Consequently, this paper addresses these challenges by constructing a multivariate classification model in order to popularize knowledge in primary care about the various co-morbidities associated with bipolar disorder. A novel application of "knowledge distillation" would be used to improve the classification performance.

This paper uses the publicly shared database MIMIC (Medical Information Mart for Intensive Care) as the source, which contains de-identified data of electronic medical records, and the information comes from thousands adult patients of medical/surgical intensive care units as well as emergency wards[5, 6]. The development of MIMIC is approved respectively by the IRBs of the teaching hospital for Harvard Medical School and MIT. It has been widely used by academic researchers around the world. This paper selects bipolar disorder patients and control samples from MIMIC, and then reads the diagnostic data from all their medical records as characteristic features. Since ICD (International Classification of Diseases) codes are used in these diagnostic records, they are converted into numerical vectors using the word embedding algorithms. Based on the concept of knowledge distillation [7, 8], we used the KDE (Kernel Density Estimation) algorithm to examine the data distribution of these characteristic features. To the best of our knowledge, this paper is the first attempt to apply KDE in knowledge distillation. Finally, we use machine learning algorithms such as SVM (Support Vector Machine), decision tree, artificial neural network, etc., to construct the classification model for "bipolar disorder patients vs. control samples".

Compared with the classification models constructed only by using the diagnostic data, if the information of data distribution provided by KDE is added, the classification accuracy can be improved by 9%~13%. Moreover, the recall values can be significantly improved by 13% to 25% without affecting the classification precision much. In addition, structures of the decision trees after training are analyzed, and it is found that the diagnostic features for the bipolar disorder patients from the control samples, such various kinds of mental conditions, are repeatedly identified. In conclusion, the results of this paper preliminarily verify the effectiveness of the KDE algorithm for knowledge distillation, which improves the performance of the classification model. In addition, various co-morbidities associated with bipolar disorder could be observed in these multivariate classification models. The work to be carried out can be summarized into three directions. 1. Improve the calculation formula of KDE to provide more accurate estimates for data distribution. 2. Introduce prescription information and more broadly validate co-morbid associations with other illnesses for severe mental illness and/or side effects of antipsychotics. 3. Expand the method of applying KDE for knowledge distillation to the analysis of more kinds of medical and/or public health problems.

Keyword: bipolar disorder, Medical Information Mart for Intensive Care (MIMIC), knowledge distillation, kernel density estimation (KDE), machine learning

REFERENCES

[1] A. P. Association, Diagnostic and Statistical Manual of Mental Disorders: DSM-5, 5th ed. Arlington, VA: American Psychiatric Publishing, 2013.
[2] I. M. Anderson, P. M. Haddad, and J. Scott, "Bipolar disorder," BMJ, vol. 345, p. e8508, Dec 27 2012.
[3] I. Grande, M. Berk, B. Birmaher, and E. Vieta, "Bipolar disorder," Lancet, vol. 387, pp. 1561-1572, Apr 9 2016.
[4] A. J. Ferrari, E. Stockings, J. P. Khoo, H. E. Erskine, L. Degenhardt, T. Vos, et al., "The prevalence and burden of bipolar disorder: findings from the Global Burden of Disease Study 2013," Bipolar Disord, vol. 18, pp. 440-50, Aug 2016.
[5] A. L. Goldberger, L. A. Amaral, L. Glass, J. M. Hausdorff, P. C. Ivanov, R. G. Mark, et al., "PhysioBank, PhysioToolkit, and PhysioNet: components of a new research resource for complex physiologic signals," Circulation, vol. 101, pp. E215-20, Jun 13 2000.
[6] A. Johnson, L. Bulgarelli, T. Pollard, S. Horng, L. A. Celi, and R. Mark. (2021, March 16). MIMIC-IV (1.0 ed.). Available: https://doi.org/10.13026/s6n6-xd98
[7] G. Hinton, O. Vinyals, and J. Dean, "Distilling the Knowledge in a Neural Network," presented at the Conference on Neural Information Processing Systems; Deep Learning and Representation Learning Workshop, Montreal, Canada, 2015.
[8] A. Korattikara Balan, V. Rathod, K. P. Murphy, and M. Welling, "Bayesian dark knowledge," in Conference on Neural Information Processing Systems, Montreal, Canada, 2015, pp. 3438-3446

No. P-26

TITLE: The Effect of Oxide-based Nanocomposite Fillers on Gel-state Dye-sensitized Solar Cells

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ABSTRACT

Dye-sensitized solar cell (DSSC) has attracted great interest due to the low cost, simple fabrication, and better low light performance. However, the DSSCs of using liquid electrolytes result in the poor stability and thereby limit its commercial potential. In this regard, the nanocomposite fillers for gel electrolytes in DSSCs are developed to improve the DSSC stability. The nanocomposite fillers based on SnO_2 are developed by the microwave synthesis. The results show that the addition of SnO_2 nanofillers in the polyethylene glycol (PEG) can effectively improve the ionic conductivity and diffusion coefficient of gel electrolyte. A series of SnO_2 nanofillers after different heat treatments are systemically investigated in the gel-state DSSC. The gel-state DSSC using SnO_2 nanofillers after vacuum heat treatment can display a conversion efficiency of 7.2%. The sulfurization of SnO_2 can further help the improved stability of gel-state DSSC, which can maintain an initial efficiency of 92% after 100 h. More details related to the characterization of SnO_2 such XRD, TEM, UV-Vis will be discussed in the presentation.

Keyword: Dye-sensitized solar cells, SnO_2, nanofillers, microwave-assisted synthesis

No. P-27

TITLE: Investigation of Non-contact Surface Topography Measurement System for Transparent Polymer Materials

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ABSTRACT

For satisfying the characteristic requirements for liquid crystal displays, the liquid optical clear adhesive must be able to retain high transmittance and meet the specification of various optical characteristics (including haze, transparency, yellowing resistance, etc.)[1-2]. Since the display has very strict standards for transmittance, general optical measurement method are difficult to obtain focal length for multi-layer structured transparent materials. In this research, with the aid of Chromatic confocal microscopy [3], a measurement system has been built to obtain the three-dimensional surface topography of a multi-layer structure by taking advantage of its optical slicing capability. The result shows that the system can overcome the cross-sectional error encounter when the adhesive is not dispensed uniformly, and the result is compared with the reflection moiré method. In addition, with the proposed system, shrinkage rate of optical clear adhesive is analyzed for finding the best curing condition for display bonding. For the manufacture process of panel display, optical clear adhesive is not only play the role of lamination, but also be able to increase the sensitivity of touch by optimizing the surface topography.

Keyword: Optical clear adhesive, Surface topography, Non-contact measurement systems

REFERENCES

[1] Rosen, S. L.; Fundamental principles of polymeric material, 2nd ed.; Wiley Interscience, New York, 1993.
[2] Satas, D.; Handbook of Pressure Sensitive Adhesive Technology, 2nd ed.; Springer, New York, 1989.
[3] Weng, C.J., Lu, B.R., Cheng, P.Y., Hwang, C.H., and Chen, C.Y., Measuring the thickness of transparent objects using a confocal displacement sensor, 2017 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), Italy, 2017, pp. 1-5.

No. P-28

TITLE: Study of ZGO epilayer-based hard X-ray photodetector under different intensities from synchrotron irradiation

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ABSTRACT

Application of X-ray detector is multidimensional and vast especially in the field of the medical imaging, security screening, scientific research ,quality inspection in food industry and environment monitoring[1],[2]. Conventionally, indirect X-ray detectors are utilized which uses scintillators or phosphors to convert the X-ray into the visible light[3]. Another method is to convert the X-ray directly to the electrical current that account for the direct X-ray detectors (DXD). DXD shows the capability of a linear response, high resolution and fast pulse rise time[4]. DXD suffers from the limited from limited detection sensitivity, high leakage current, toxicity and small stopping power[5]. Zinc Gallium oxide (ZGO) is a promising candidate for DXD due to its wide band gap (> 4.8 eV), high chemical and thermal stability. We have demonstrated here the use of ZGO to make a hard X-ray photodetector with a superior sensitivity. A metal-semiconductor-metal (MSM) based ZGO photodetector (PD) is fabricated by the use of metalorganic chemical vapour deposition (MOCVD) on c-plane (0001) sapphire substrate and it is tested under the different illumination intensities coming from a synchrotron radiation source (TLS 17B1) of X-ray corresponding to 1.239 Å (10 KeV). X-ray diffraction patterns of the ZGO showed the high epitaxial growth on the sapphire. Raman spectroscopy of samples are performed in order to confirm the composition. The linearity in I-V curve of ZGO and the microampere value of the dark current at 5 V, 10 V and 15 V confirms a high signal/noise (S/N) ratio. Further measurements of the photocurrent have been done at bias voltages of 5 V, 10 V and 15 V with three flux intensities of 5.7×10^7, 6.2×10^9 and 4.6×10^{11} counts/sec. The time response tests of the samples at fixed intensity are done by changing the bias voltages. The results of the PD measurements show the sensitivity of ZGO even at the low X-ray flux intensity of 5.7×10^7 counts/sec. Further the sensitivity for the medium flux (i.e., 6.2×10^9 counts/sec) is found to be 7.78×10^5 μAGy-1cm^{-2}. ZGO is found to show high sensitivity as compared to the traditionally used gallium oxide which is almost 100 times. Our Photodetector was found to show a stable behavior upto a radiation intensity of 4.6×10^{11} counts/sec giving a sensitivity of about 5.41×10^5 μAGy-1cm^{-2} at bias voltage of 5V. Hence, the fabricated PD is found to be highly sensitive and stable for direct hard X-ray detection.

Keyword: DXD- Direct X-ray detector, ZGO- Zinc gallium oxide, PD-Photodetector.

REFERENCES

[1] J. R. Rouxel, M. Kowalewski, K. Bennett, and S. Mukamel, "X-Ray Sum Frequency Diffraction for Direct Imaging of Ultrafast Electron Dynamics," Phys. Rev. Lett., vol. 120, no. 24, pp. 1–5, 2018, doi: 10.1103/PhysRevLett.120.243902.
[2] M. Tegze and G. Faigel, "X-ray holography with atomic resolution," Nature, vol. 380, no. 6569, pp. 49–51, 1996, doi: 10.1038/380049a0.
[3] Q. Xu et al., "High-sensitivity X-ray imaging of a lead halide perovskite single-crystal scintillator," Opt. Lett., vol. 45, no. 2, p. 355, 2020, doi: 10.1364/ol.45.000355.
[4] A. Datta, Z. Zhong, and S. Motakef, "A new generation of direct X-ray detectors for medical and synchrotron imaging applications," Sci. Rep., vol. 10, no. 1, pp. 1–10, 2020, doi: 10.1038/s41598-020-76647-5.
[5] S. Kasap et al., "Amorphous and polycrystalline photoconductors for direct conversion flat panel x-ray image sensors," Sensors, vol. 11, no. 5, pp. 5112–5157, 2011, doi: 10.3390/s110505112.

No. P-29

TITLE: Heat Dissipation Improvement of AlGaInp-based LED with Cu/Invar/Cu Substrate

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ABSTRACT

In this study, the n-side up vertical light emitting diodes(LEDs) with AlGaInP epilayer were fabricated. The size of LED is 1000 um× 1000 um. We use bonding technique to transfer GaAs substrate to copper invar copper (CIC) substrate. In previous research, Mr. Lee compare CIC substate with CuW and silicon. In the result, the coefficient of thermal expansion(CTE) of CIC substrate is very similar to the CTE of GaAs. In addition, CIC substrate has high thermal conductivity and low cost. Nevertheless, the thickness of CIC substrate in that study is 100 um only. We will compare different thickness of CIC substrate in this study. Two type of CIC substrates which are 100 um and 50 um are selected. With wet etching process, we can remove Cu and invar layer. After experiment, we found that 20 um substrate has the lowest surface temperature and thermal resistance. It shows that thinner substrate has better heat dissipation performance. However, the thermal resistance of 10 um substrate is very large. Because 10 um substrate is too weak, it is easy to bend or be broken. The 10 um LED is hard to be fixed on Metal Core PCB (MCPCB), and there would be lots of gap between LED and MCPCB, which cause LED's thermal resistance to be very large. For 10 um and 20 um samples, most of them have leakage problem after semiconductor process. We use InGaAs EMMI to detect the place where leak current occurs. The microscope image shows that leak current is concentrate in a corner. We thought that it is the scratched when using tweezer to pick them, and the weak substrate is also a reason to cause that. In conclusion, reducing the thickness of substrate to 20 um could improve heat dissipation performance, but the thermal resistance becomes large when reducing to 10 um. The main problem is because that 10 um substrate is easy to bend so that it is hard to contact with paste uniformly.

Keyword: red light emitting diode, copper invar copper(CIC), wafer bonding

REFERENCES

[1] Cheng-Po Li; Ray-Hua Horng. Performance Improvement of N-side up AlGaInP-based LED by Composite Metal Substrate. Institute of Electronics, Nationl Chiao Tung University, Fab 2019.
[2] Shreek ant Sinha; Fu-Gow Tarntair; Cheng-Han Ho; Yuh-Renn Wu; Ray-Hua Horng. Investigation of Electrical and Optical Properties of AlGaInP Red Vertical Micro-Light-Emitting Diodes With Cu/Invar/Cu Metal Substrates. IEEE Transactions on Electron Devices, vol. 68, pp. 2818–2822, 2021
[3] R. H. Horng; H. Y. Chien; K. Y. Chen; W. Y. Tseng; Y. T. Tsai; F. G. Tarn Tair. Development and Fabrication of AlGaInP-Based Flip-Chip Micro-LEDs, IEEE Journal of the Electron Devices Society, Vol. 6, 475–479, 2018.
[4] F. L. Wu; S. L. Ou; Y. C. Kao; C. L. Chen; M. C. Tseng; F. C. Lu; M. T. Lin; R. H. Horng. Thin-film vertical-type AlGaInP LEDs fabricated by epitaxial lift-off process via the patterned design of Cu substrate, Opt. Express 23(14), 18156–18165, 2015
[5] M. R. Krames; O. B. Shchekin; R. Mueller-Mach; L. Zhou; G. Harbers; M. G. Craford. Status and future of high-power light-emitting diodes for solid-state lighting, J. Display Technol., vol. 3, pp. 160–175, 2007
[6] G. Harbers; S. Bierhuizen; M. R. Krames. Performance of high power light-emitting diodes in display applications, Journal of Display Technology, vol. 3, pp. 98–109, 2007.
[7] K. Streubel; N. Linder, R. Wirth; A. Jaeger; High brightness AlGaInP light-emitting diodes, IEEE Journal of Selected Topics in Quantum Electronics, vol. 8, no. 2, pp. 321–332, 2002.

No. P-30
TITLE: Design of a Current Mirror for a Sensor

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ABSTRACT

Design and implementation of a current mirror MOSFET for piezoresistive sensor applications is described. The current mirror circuit has an output current of 1mA and a MEMS resistive. This MOSFET is designed using a 0.18µm CMOS MEMS technology. The channel region of the piezoelectric sensing MOSFET forms the flexible surface as well as the sensing element. The piezoresistive effect in MOSFET has been utilized for the calculations of strain induced carrier mobility variation under applied external pressure [1]. The channel region of the active MOSFET is a part of the flexible surface. The output transistor of the current mirror circuit results in the change of its drain current. Finite element analyses is used for simulation of the sensor. Spice is used to evaluate the features of the current mirror sensor circuit. Simulation results show that the MOSFET embedded sensor has an acceptable sensitivity.

Keyword: CMOS, MOSFET, Sensors

REFERENCES

[1] Rathore, P. K., & Panwar, B. S. (2013). CMOS-MEMS Based Current Mirror MOSFET Embedded Pressure Sensor for Healthcare and Biomedical Applications. In Advanced Materials Research (Vol. 647, pp. 315–320). Trans Tech Publications, Ltd.

No. P-31
TITLE: Design of a Current Mirror by Ltspice

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ABSTRACT

The design and of a current mirror MOSFET for piezoresistive sensor applications is described. Utilizing the piezoresistive effect in MOSFETs and a 0.18 m CMOS technology, a pressure sensing structure was created. Two square silicon diaphragms and six p- and n-channel MOSFETs make up the proposed structure. The reference transistors are placed on the substrate. Pressure sensing MOSFETs are incorporated in the middle of the fixed edge and in the center, respectively, to sense the maximum compressive and tensile stress. The design and simulation of the suggested Current mirror are carried out using the Spice and finite element analyses.

Keyword: MEMS CMOS, Piezoresistors, Diaphragam, Ltspice, MOSFET Channels.

REFERENCES

[1] Rathore, P.K.; Panwar, B.S. A novel CMOS-MEMS integrated pressure sensing structure based on current mirror sensing technique. Microelectron. Int 2015 ,32, 81–95.

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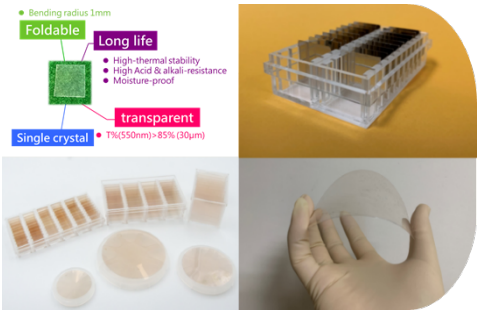

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