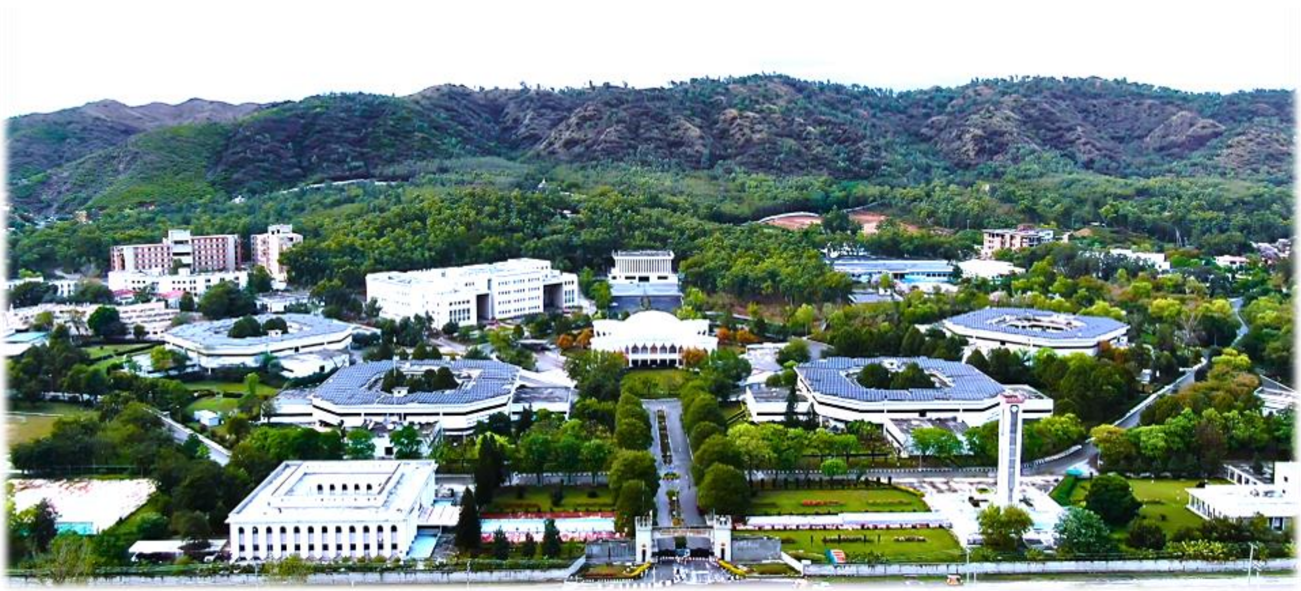
Book of Abstracts

3rd International Conference on Modern Technologies in Mechanical & Material Engineering MTME 2025



16th and 17th April 2025

Created by: Dr. Hamza Mohsin

Edited by: Dr. Ali Turab Jafry

MTME-2025

Preface

The 3rd International Conference on Modern Technologies in Mechanical and Materials Engineering (MTME-2025) was held on April 16–17, 2025, at the Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, Pakistan. MTME-2025 focused on four core thematic areas: thermo-fluids, design and manufacturing, drives and control, and materials science and engineering. The conference brought together participants from diverse academic and professional backgrounds—including mechanical, materials, and chemical sciences—to exchange cutting-edge ideas.

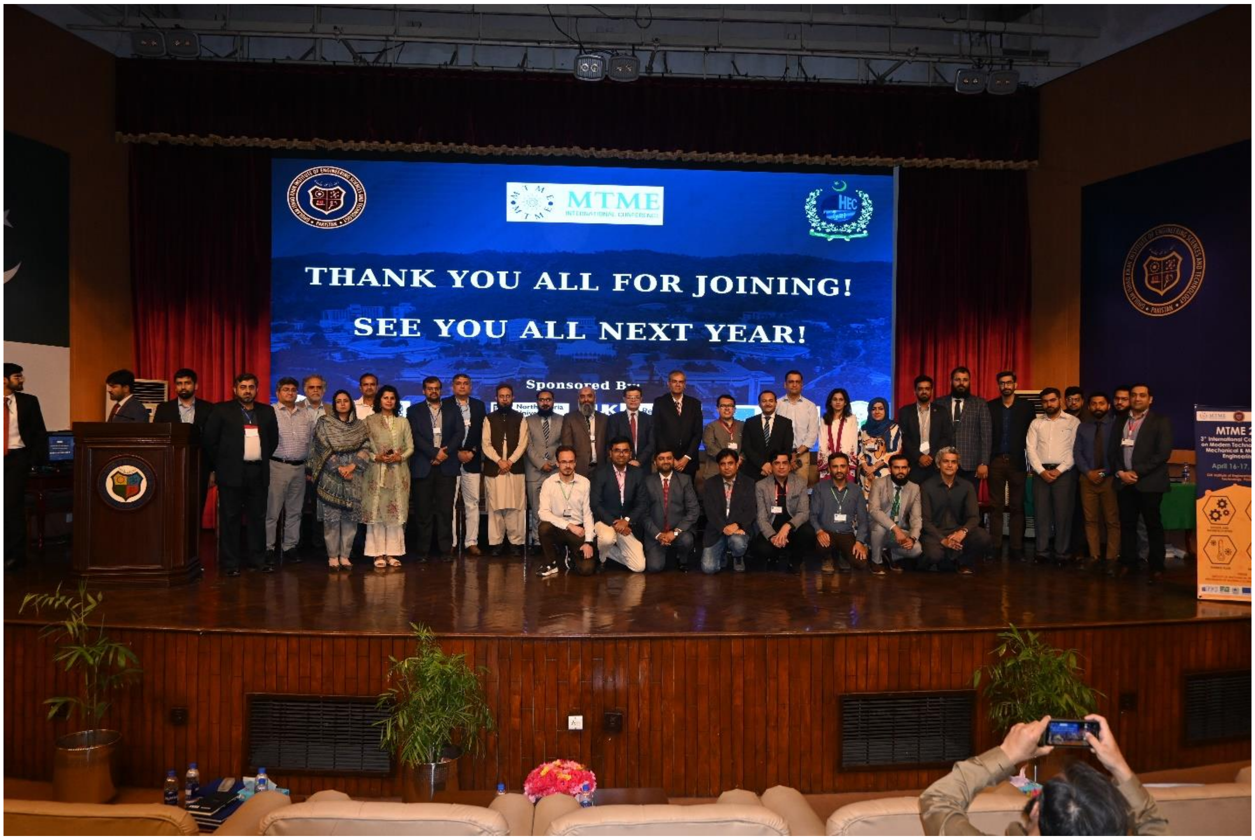
The primary objective of MTME-2025 was to provide a platform for interdisciplinary collaboration, nurturing innovation and critical thinking, especially among young researchers and students. The conference received an encouraging response, with presenters from across the globe attending in person in Pakistan, fostering the exchange of technological insights, cultural perspectives, and collaborative problem-solving approaches.

This year, we received 80 submissions (papers/abstracts), of which 27 full length papers were selected through a rigorous peer-review process for publication in Materials Proceedings Journal. The accepted abstracts are published in this issue. The topics span a wide range of emerging areas, including advanced materials, nanotechnology, thermal and fluid systems, structural analysis, digital twin technologies, robotics, sustainable engineering, and energy and environmental materials.

A highlight of MTME-2025 was the industry-academia panel discussion held on April 17, focusing on the theme: “Academia-Industry Preparedness in the Era of AI.” Key representatives from leading organizations such as Fauji Fertilizer Company, Fatima Group, KSB Pumps, OGDCL, Dawlance, and Fauji Cement Company, joined academic leaders from notable institutions including IIUI, UET Taxila, COMSATS, PAFIAST, and GIK Institute. The panel addressed critical themes such as future skill requirements, institutional roles in shaping the AI transition, the impact of digital transformation, and strategies for lifelong learning.

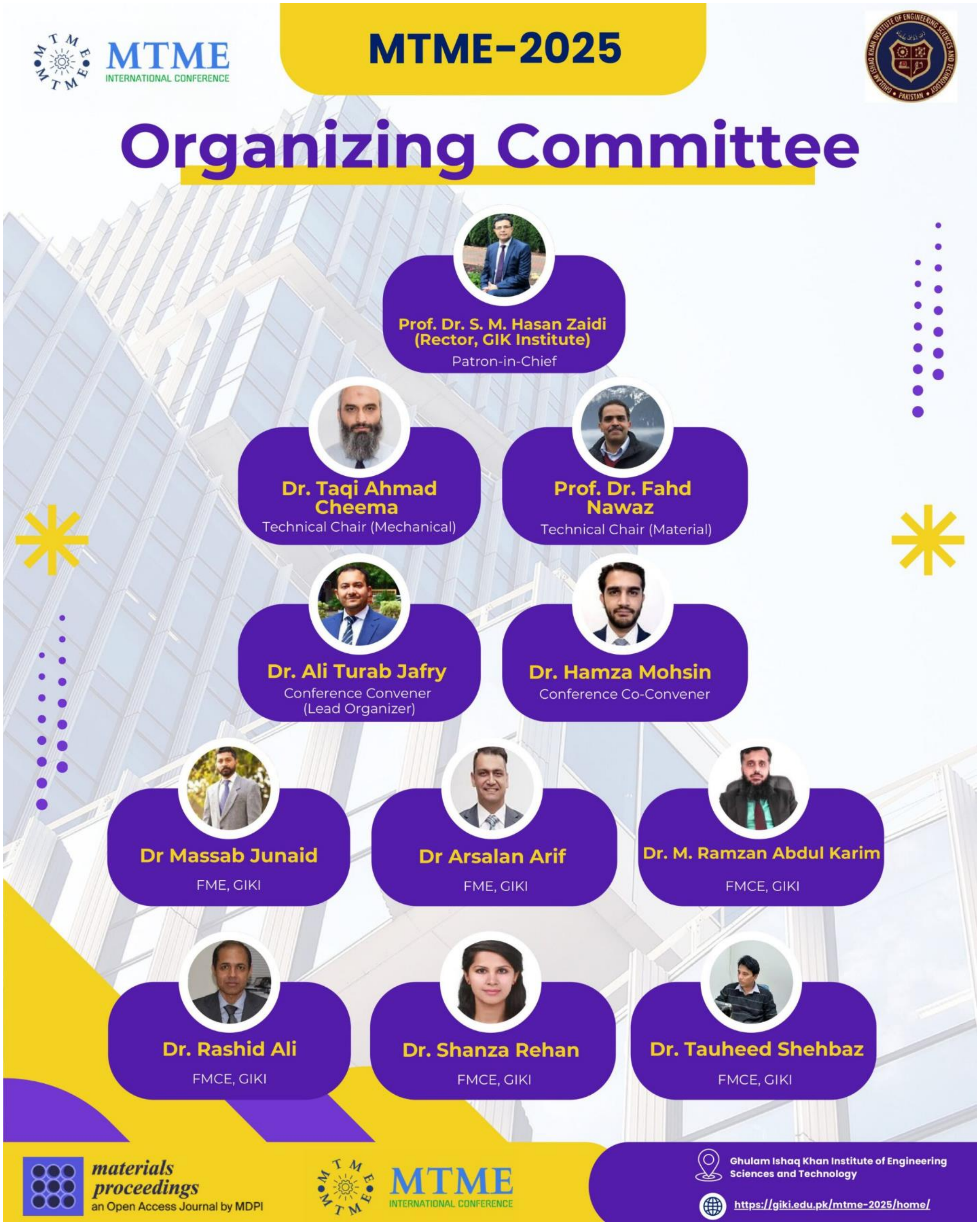
We extend our heartfelt thanks to all contributors, reviewers, panelists, participants, sponsors, and organizers for making MTME-2025 a successful and intellectually stimulating event.


MTME
MTME 25
3rd International Conference on Modern Technologies in Mechanical & Materials Engineering
April 16-17, 2025
GIK INSTITUTE OF ENGINEERING SCIENCES & TECHNOLOGY, PAKISTAN


MTME
THANK YOU ALL FOR JOINING!
SEE YOU ALL NEXT YEAR!

Contents

Organizing Committee



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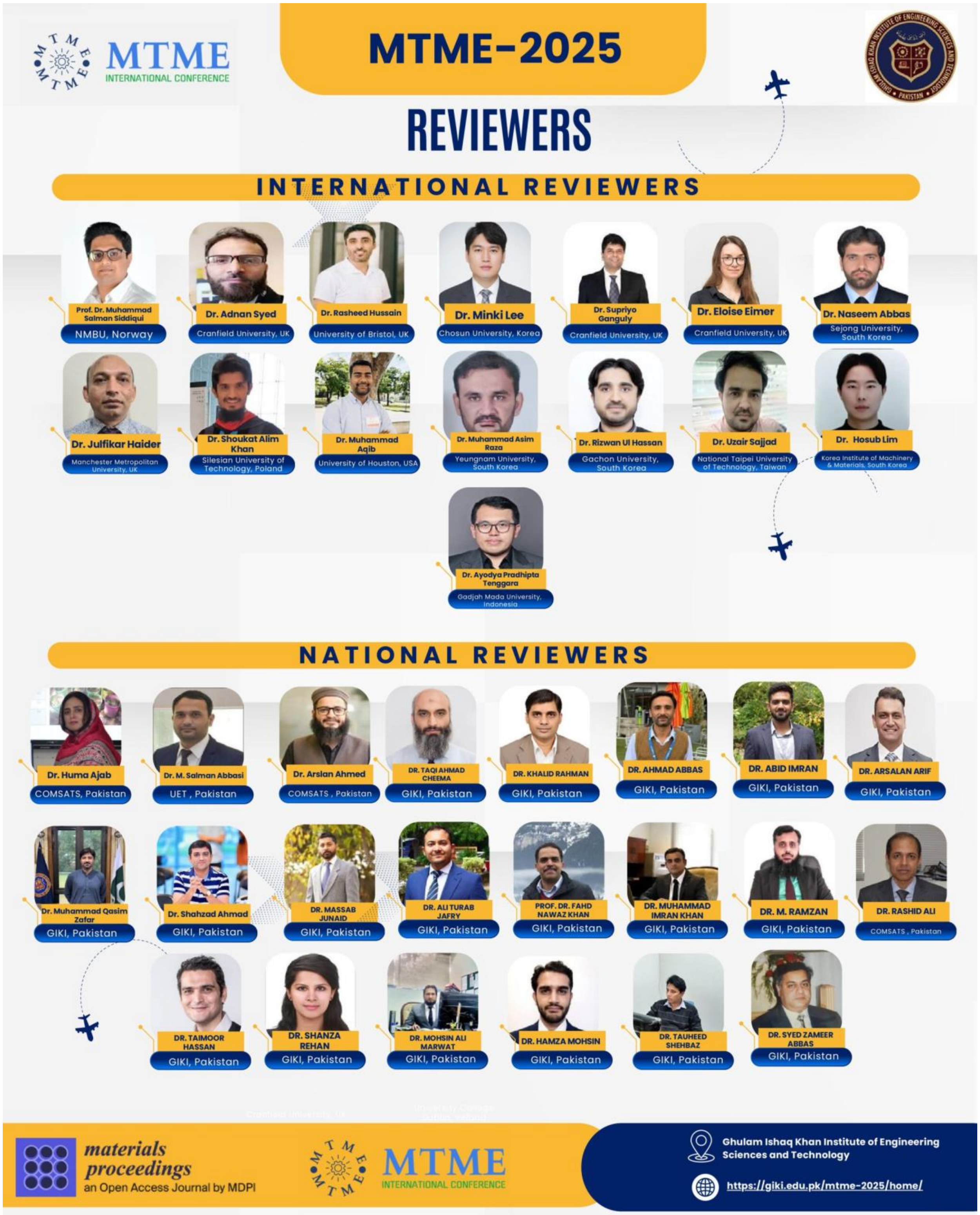
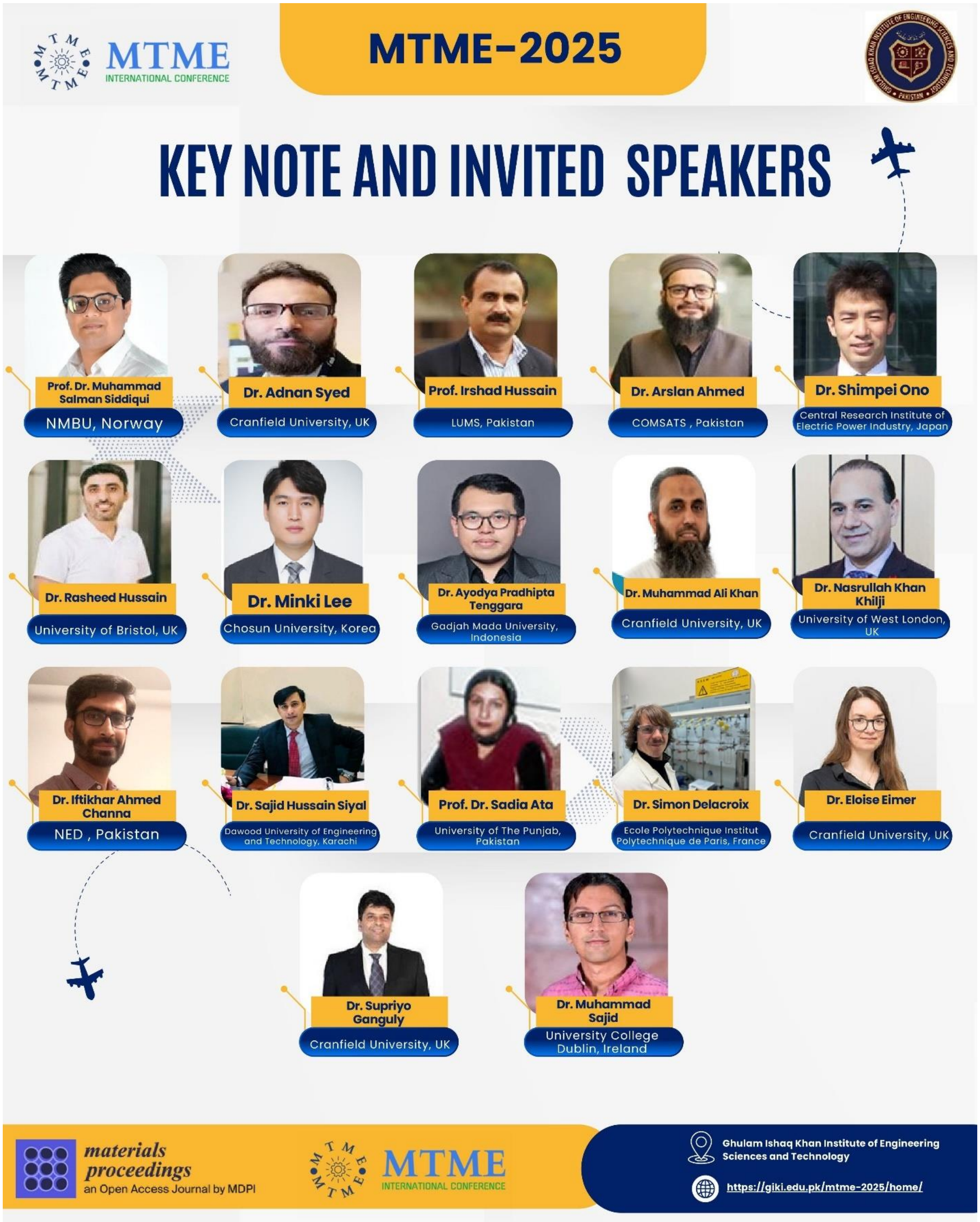


Keynote and Invited Speakers



Conference program

MTME-2025

3rd International Conference on Modern Technologies in Mechanical & Materials Engineering

Venue: Ghulam Ishaq Khan Institute, Topi, Pakistan

Day 1-Wednesday, 16th April 2025

08:00 – 09:00 — On-Desk Registration *(Faculty of Mechanical Engineering)*
09:00 – 10:30 — Parallel Technical Sessions – 1 *(FME & FMCE)*
10:35 – 10:50 — Tea / Refreshments *(FME & FMCE)*
11:00 – 12:50 — Inauguration Ceremony *(AHA Auditorium)*

- Recitation from the Holy Qur'an
- National Anthem
- Welcome Address by Patron in Chief (Pro-Rector GIK Institute)
- Address by Conference Chair (Dean FMCE)
- Keynote Speakers
    - Adnan Syed (Cranfield University, UK)
    - Ayodya Pradhipta Tenggara (Gadjah Mada University, Indonesia)
    - Shimpei Ono (Central Research Institute of Electric Power Industry, Japan)
    - Mehreen Taufiq (Fatima Group, Pakistan)
- Address by Chief Guest
- Presentation of Shields to the guests
- Group Photo

13:00 – 14:00 — Lunch & Prayer Break *(Faculty Club)*
14:20 – 16:20 — Parallel Technical Sessions – 2 *(FME & FMCE)*
16:25 – 16:40 — Tea / Refreshments *(FME & FMCE)*
16:30 – 18:00 — Hiking

Day 2-Thursday, 17th April 2025

09:00 – 11:00 — Parallel Technical Sessions – 3 *(FME & FMCE)*
09:00 – 13:00 — Training Workshops

- Robot Control with ROS *(Robotics Lab, New Academic Block)*
- Materials Characterization: Scanning Electron Microscope (SEM) and X-ray diffraction (XRD) *(SEM Lab, FMCE)*

11:00 – 11:30 — Tea / Refreshments *(FME & FMCE)*
13:00 – 14:00 — Lunch & Prayer Break *(Faculty Club)*
14:10 – 15:15 — Poster Sessions *(AHA Auditorium)*
15:00 – 15:20 — Tea / Refreshments *(AHA Auditorium)*
15:30 – 16:30 — Industry–Academia Panel Discussion *(AHA Auditorium)*

- Panelists from: Pakistan Welding Institute, NESCOM, Pak Army, Fauji Fertilizer Company Limited, Fatima Group, KSB Pumps, OGDCL, UET Taxila, COMSATS University Islamabad, PAFIAST and others

16:45 – 18:00 — Closing Ceremony *(AHA Auditorium)*

- Closing Remarks by Rector, GIK Institute
- Address by Chief Guest
- Best Paper & Poster Awards
- Shields to Panelists, Sponsors, Session Chairs, Guests of Honor
- Vote of Thanks
- Group Photo

FULL LENGTH PAPERS FOR ORAL PRESENTATIONS

Assessment of Condition-Based Maintenance Readiness Framework in the Perspective of Industry 4.0: A Case Study of Developing Countries

Muhammad Nauman[1], Uzair Khaleeq Uz Zaman [2], Aamer Ahmed Baqai[3], and Ahmad Sajjad[4]*

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Affiliation 2: HoD Department of Mechanical Engineering, College of Electrical and Mechanical Engineering, National University of Sciences and Technology, Rawalpindi, Pakistan

Affiliation 3: Professor Department of Mechanical Engineering, College of Electrical and Mechanical Engineering, National University of Sciences and Technology, Rawalpindi, Pakistan

Affiliation 4: Department of Industrial Engineering, College of Aeronautical Engineering, National University of Sciences and Technology, Islamabad, Pakistan

Abstract.

This research proposes a framework for Condition-Based Maintenance (CBM) to enhance the estimation of Remaining Useful Life (RUL) in industrial equipment, focusing on minimizing unplanned downtime and optimizing maintenance strategies. Developing countries are facing a great challenge in adopting the Condition Based Maintenance. One of the reasons is the non-availability of a solid framework for checking the current state of maturity and readiness level for Condition-Based Maintenance. This empirical research has presented a maturity framework based on the IMPULS models developed by the German Association of Mechanical Engineers for Industry 4.0. The framework has been modified for Condition Based Maintenance (Maintenance 4.0) using the Delphi method. Assessing the maturity and readiness for Condition-Based

Maintenance (CBM) involves structuring various factors. The developed framework for Condition Based Maintenance Maturity (CMI4.0) in the perspective of Industry 4.0, has been validated in the maintenance of the diversified industrial sector of developing countries. It will, therefore, provide a direction to formulate the enterprise transformation strategies in the Industry 4.0 paradigm. The framework leverages machine learning (ML) and deep learning techniques, to process complex real-world sensor data for condition-based maintenance. The research emphasizes anomaly detection, predictive analytics, and proactive maintenance scheduling to reduce costs and improve operational efficiency. This work aligns with Sustainable Development Goals (SDG 9) by promoting innovative maintenance practices and sustainable industrial operations, offering significant contributions to smart and intelligent maintenance systems.

Few-Shot Learning for Thermal Image-Based Fault Detection in Induction Motors

Mohammad Fazail Bangash[1], Arsalan Arif[1], Syed Salman Shah[1], [1]Muhammad Arsalan and [2]Faisal Khan*

Affiliation 1: Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Faculty of Mechanical Engineering, 23460, Swabi, Topi, Pakistan

Affiliation 2: COMSATS University Islamabad - Abbottabad Campus

Abstract:

Induction motor (IM) faults can lead to severe downtime and maintenance costs, making early fault detection critically important. Thermal imaging offers a non-contact means to monitor motor health by capturing temperature distributions that reflect underlying faults. However, developing robust fault classifiers from thermal images is challenging due to the limited data typically available for faulty conditions. This paper proposes a few-shot learning approach using SqueezeNet, a compact 2D Convolutional Neural Network (CNN) architecture, to detect IM faults from thermal images, even with only 30 samples per fault category. Four motor conditions are considered: Healthy, Bearing Fault, Stator Single Phasing Fault, and Rotor Fault, with a total of 120 thermal images (30 per class) and no preprocessing applied. The SqueezeNet model was trained on an 80/20 train-test split and evaluated using accuracy as the performance metric. Despite the small dataset, the model achieved 100% accuracy in classifying the motor condition on the test set. These results demonstrate the effectiveness of deep learning-based few-shot classification for thermal image fault diagnosis. The paper also addresses the implications of achieving perfect accuracy on a limited dataset and outlines future directions for improving generalization and deploying this technique in industrial motor monitoring.

Design and Control of 3 DOF Bionic Leg

Abdullah Wali, Ashar Tanveer, Hasham Ahmed Khawaja, Dr. Abid Imran, and Dr. Taimoor Hassan

Affiliation: Faculty of Mechanical Engineering, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Swabi, Topi, Pakistan

Abstract:

This study gives the design and development of a 3-degree-of-freedom (3-DOF) bionic leg prosthesis aimed at enhancing agility and stability on uneven terrain. The prosthesis joins biomechanical principles, eco-friendly materials, and cost-effective solutions to improve mobility for amputees. Lightweight, still durable materials ensure flexibility and structural integrity, while joint motion, torque distribution, and energy efficiency is optimized by complete kinematic and dynamic simulations . Multi-body dynamics, evaluating load distribution and gait adaptability is clarified by ADAMS simulation. Experimental gait testing further validates real-world performance. A advanced control system, utilizing sensor feedback and real-time adjustments, enables dynamic adjustment to varying terrains, prevents falls, and enhances user comfort. This research advances biomechanical engineering by addressing mobility challenges, offering an innovative, affordable, and efficient prosthetic solution for improved quality of life.

Digital Twin Enabled Control of a 4DOF Robotic Arm

Maiza Matloob [1], Zulkifal [1], M. Aizaz Khan[1], Khadija Asim[1], and Abid Imran [1]

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Abstract:

In the new era of industrial automation and smart manufacturing, systems integration of physical and virtual has become essential. Digital Twin technology facilitates remote monitoring, prediction, and control of robotic systems, thereby improving efficiency, adaptability and real time decision making. This paper describes the development of a Digital Twin of the DOBOT Magician robotic arm on ROS 1 Noetic on Ubuntu 20.04 for precise synchronization and real time control. The system successfully mirrored the physical robot's movements, sensor feedback, and joint states, and so could be used to automate pick and place operations in industry. Stable and low latency data exchange was achieved through a wired communication interface. The potential of Digital Twins in Industry 4.0 can, therefore, be realised. This work is significant to the field of intelligent robotics and digital manufacturing and thus demonstrates the potential of Digital Twin technology for transforming automation in industry.

Computational Fluid Dynamics (CFD) Analysis of a Centrifugal Left Ventricular Assist Device (LVAD) Using ANSYS

Ali Akbar [1], Muhammad Awais [1], Muhammad Kamil Ayub [1] and Ali Turab Jafry [2]

Affiliation 1: Faculty of Mechanical Engineering, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, Swabi, Pakistan 23460
Affiliation 2: Associate Professor, Faculty of Mechanical Engineering, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi Swabi, Pakistan 23460

Abstract:
In this study a blood pumped centrifugal LVAD model is predicted using a Computational Fluid Dynamics (CFD) analysis. The flow behavior, shear stress distribution and pressure characteristics in the pump are evaluated as primary objectives to determine optimum performance parameters, which undergo minimal shear induced damage and pressure variations and which are of critical importance for further LVAD design refinement.
The CF Turbo was used to design the impeller and volute, and the meshing was first conducted in ANSYS TurboGrid and Mesh to achieve blood flow effectively. Shear Stress Transport (SST) turbulence model in ANSYS CFX was used to simulate the flow. The study centered on flow characteristics, pressure distribution, wall shear stress and efficiency. Finally, results demonstrate that the pump can obtain a physiological flow rate of 5 L/min, a pressure head of 100 mmHg, and predicted efficiency of 87%. Blood damage is minimized with wall shear stress lesser than 300 N/m ^{2}. These findings show the promise of CFD in the design optimization of LVADs prior to experimental testing.

Gas assisted jetting of the non-Newtonian shear thinning fluids

Zahra[1], Kuldeep Baghel[2], Jinkee Lee[131]

Affiliation 1: School of Mechanical Engineering, Sungkyunkwan University, 16417, Suwon, South Korea
Affiliation 2: School of Mechanical Engineering, Hanyang University, 15588, Ansan, South Korea
Affiliation 3: Institute of Quantum Biophysics, Sungkyunkwan University, , 16417, Suwon, South Korea

Abstract :
Gas Dynamic Virtual Nozzles (GDVNs) are widely used for producing microjets, but their behaviour with non-Newtonian fluids remains less understood. This study investigates how shear thinning and viscoelasticity influence jetting behaviour in GDVNs, aiming to optimize flow parameters for controlled jet formation. A 3D-printed nozzle was used to study aqueous alginate solutions at varying concentrations (0.5%, 1.0%, and 1.5%), with air as the continuous phase. Jetting was visualized using a high-speed camera and analysed for jet diameter and length using ImageJ. Analytical solutions and scaling laws were derived and compared with experimental data and literature. For Newtonian and laminar flow, we demonstrated the linear dependency of jet diameter on the Reynolds number through the derived scaling law. The measured jet diameter for non-Newtonian fluids significantly deviates from water due to their viscoelastic nature. We developed correlations to predict jet diameter across a wide range of viscosities, relaxation times, and operating conditions. Results revealed multiple jetting regimes dependent on air pressure and flow rate, including Rayleigh jetting, beads-on-string, stable jet, and atomization. These findings highlight the role of rheological properties in jet formation and offer guidelines for tuning GDVN performance in applications such as bioprinting.

Open ended Grass Free powdered Titanium dioxide nanotubes: Synthesis Characterization and Photocatalytic study.

Muniba Yaseen*[1], *Tayyaba* Ghani[2], *Suleman* Ahmed[1], *Khadim* Hussain[2], *Ahmed* bin waqas[2].

Affiliation 1: Department of Physics and Applied Sciences, Pakistan Institute of Engineering and Applied Sciences, Islamabad, Pakistan.
Affiliation 2: Department of Metallurgy and Materials Engineering, Pakistan Institute of Engineering and Applied Sciences, Islamabad, Pakistan.

Abstract:

Titanium dioxide based semiconductors have been used as catalyst for various environmental remediation applications. Due to versatile band gap modification, it has been widely used in degradation of organic dyes. The current study focuses on the synthesis of powdered Titanium dioxide nanotubes (p-Tints) through anodization method. The three step anodization approach with ethylene based electrolyte is used to grow grass free, powdered and open ended Tints at a specified voltage and temperature. The synthesized nanotubes have been characterized using Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), X-ray Diffraction (XRD), Ultravoilet (Uv)-visible Spectroscopy. SEM has confirmed the open ended grass free morphology, while XRD proved the crystalline nature of the anatase p-Tints. The optical properties from Uv-visible Spectroscopy also assisted in the band gap estimation through tauc's plot. For examining the charge recombination during degradation process, Photoluminescence is also performed . Additionally, anodized p-Tints are utilized for the photocatalysis of an azo dye bromothymol blue (BTB) resulting in 85% degradation within 120 minutes. Unlike previous conventional studies for closed bottom Tints [1, 2], the porous open ended tubes enabled more dye molecules to adsorb onto the p-Tints surface resulting in better photodegradation. This research has explored the potential of nanotubes as an environmental friendly nanocatalyst for the enhanced dye degradation.

Highly Efficient Visible-Light-Driven α-Bi_2O_3/Mn_2O_3 Heterojunction Photocatalysts for Ciprofloxacin HCl Degradation

Abdul Hannan Zahid, Saiqa Sana, Sophia Nawaz Gishkori, Muhammad Ahsan Waseem, Fahid Nisar

Affiliation: Department of Chemical Engineering, University of Gujrat, Gujrat, 50700, Pakistan

Abstract:

Water pollution from persistent antibiotics poses serious environmental and health risks. This study explores the synthesis and photocatalytic performance of α-Bi_2O_3/Mn_2O_3 and $Mn^{2+}O$/Mn_3O_4 heterojunction photocatalysts for degrading Ciprofloxacin HCl (C-HCl), a widely used antibiotic contributing to antibiotic resistance in wastewater. The objective is to develop stable, efficient, and visible-light-driven photocatalysts for sustainable pollutant degradation while overcoming the limitations of conventional wastewater treatment. MnO- and Bi_2O_3-based photocatalysts often suffer from agglomeration, phase instability, and rapid charge recombination, limiting their photocatalytic efficiency. Traditional synthesis methods, such as hydrothermal, solvothermal, and sol-gel, require multi-step processing and high-energy input. This study employs single-step calcination at 450°C to prepare highly stable α-Bi_2O_3/Mn_2O_3 and $Mn^{2+}O$/Mn_3O_4 photocatalysts, ensuring high crystallinity and stability while simplifying synthesis. The structural, morphological, optical, and electronic properties were characterized using XRD, SEM, UV-Vis DRS, and PL spectroscopy. Photocatalytic degradation of C-HCl under visible-light irradiation was evaluated, with kinetics analyzed using the Langmuir-Hinshelwood model. Photoelectrochemical (PEC) analysis assessed charge separation and transfer efficiency. α-Bi_2O_3/Mn_2O_3 demonstrated superior performance, achieving 99.4% C-HCl degradation within 90 min, compared to 70.6% for $Mn^{2+}O$/Mn_3O_4 and 56.2% for α-Bi_2O_3. This enhancement was attributed to efficient heterojunction formation, facilitating rapid charge separation and reducing recombination. Morphological modifications further improved light absorption and reactive site availability, accelerating pollutant degradation. Scavenger experiments revealed that superoxide (•O_2^-) radicals and holes

(h^+) were the primary active species, validating an effective charge transfer mechanism. Despite the photocorrosion susceptibility of Bi_2O_3-based materials, α-Bi_2O_3/Mn_2O_3 exhibited high photostability over five cycles, with minimal efficiency loss (about 10%) due to strong interfacial interactions. Neverteless, MnO and α-Bi_2O_3-based photocatalysts have promising applications in wastewater treatment and environmental remediation, yet charge recombination and low visible-light absorption remain key challenges. This study presents α-Bi_2O_3/Mn_2O_3 as a highly efficient, stable, and scalable photocatalyst, offering a sustainable solution for antibiotic-contaminated wastewater treatment.

Keywords: α-Bi_2O_3, MnO, Heterojunction Photocatalyst, Visible-Light Photocatalysis, Ciprofloxacin HCl Degradation, Photocatalytic Efficiency, Wastewater Treatment

Microstructural study and magnetic properties of LaCe -co-dopped M-Type ferrites synthesized by co-precipitation method

Mozaffar Hussain[1,], Amna Azhar[1] and Ayesha Iqbal[1]

Affiliation 1: Advance Materials Processing Lab, Department of Physics, Air University, Islamabad, Pakistan, 44400.

Abstract:

We report the microstructural analysis and magnetic behavior of La-Ce co-doped ferrites with a wide range of compositions, including strontium ferrite [$SrFe_{12-x}(La_{0.5}Ce_{0.5})_xO_4$] and cobalt ferrite [$CoFe_{2-x}(La_{0.5}Ce_{0.5})_xO_4$] with varying La-Ce contents (x= 0.0 - 0.4) using a modified co-precipitation method at room temperature. The structural and morphological properties were studied using X-ray diffraction (XRD) and scanning electron microscopy (SEM) respectively. The synthesized nanoparticles were found to confirm the hexagonal and cubic structure for La-Ce co-doped strontium and cobalt ferrite magnets respectively. The lattice parameters a and c for strontium ferrite decrease from 5.84 to 5.20 Å and 23.01 to 21.92 Å, respectively while for cobalt ferrite an increase from 8.29 to 8.38 Å. The optimum room temperature magnetic properties include saturation magnetization (M_s), remanent magnetization (M_r), and coercivity (H_c) up to 71.6 emu/g, 30 emu/g, 1284 Oe, and 39 emu/g, 16 emu/g, 349 Oe with 10% La-Ce substitution for Fe in strontium and cobalt ferrite respectively. The gradual decrease of coercivity (H_c) in both magnets is ascribed to the less magnetocrystalline anisotropy of La and Ce as well as the occupation of La-Ce ions at 12k and 2a sites which have negative influence on anisotropy. The M_r/M_s ratio decreases with the increase of LaCe contents in both alloys, which is attributed to the reduced exchange interaction between magnetic particles.

Advancing Sustainable Hydrogen Production: Computational Insights into 2D $CrSi_2N_4$ as a High-Performance Catalyst for the Hydrogen Evolution Reaction

Rao Uzair Ahmad[1], *Nasir* Javed[1], and *Fahd Sikandar* Khan[1]

Affiliation 1: Faculty of Engineering Sciences, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi 23640, Pakistan

Abstract:

Recent advancements in 2D materials, particularly nitride-based systems, have emerged as promising alternatives to the scarce, costly, and degradable platinum-group metals (PGMs) as hydrogen evolution reaction (HER) catalysts. This study investigates 2D chromium silicon nitride (CrSi2N4) as a PGM-free catalyst for the HER.Density functional theory (DFT) calculations confirm its stability with a cohesive energy of −6.01 eV/atom, which is closer in magnitude to that of experimentally available MoSi2P4 (-6.21 eV). The optimized hexagonal lattice features strong Cr–N bonds, ensuring mechanical resilience..

HER activity, assessed via the computational hydrogen electrode method shows near-optimal hydrogen adsorption ($\Delta G_h^* = -0.12$ eV), significantly outperforming $MoSi_2N_4$ ($\Delta G_h^* \approx 2.15$ eV) and approaching Pt(111). Nitrogen vacancies introduced moderate ΔG_h^* values (0.64 eV), comparable to vacancy-engineered $MoSi_2N$. With a ~1.8 eV bandgap, high carrier mobility, and corrosion resistance in acidic/alkaline media, CrSi2N4 exhibits excellent electrochemical stability.

Vacancy engineering, biaxial strain, and external E-field tuning are known to optimize ΔG_h^*, which can be explored for more enhanced catalytic performance. This study positions CrSi2N4 as an earth-abundant, efficient HER catalyst, demonstrating the potential of computationally guided defect engineering for sustainable hydrogen production and scalable electrolyzers.

Design and development of a magnetically coupled marine thruster capable of thrust vectoring for UUVs

Aliyan Ahmed[1], Sanaullah Shah[1], Shahroz Ahmad[1], Sarmad Ishfaq[1] and Muhammad Abdul Ahad[1]*

Affiliation 1 : Department of Mechanical Engineering, Air University, Aerospace and Aviation Campus, Kamra, Pakistan.

Abstract :

This study focuses on the design and development of a magnetically coupled, vectoral thruster for Unmanned Underwater Vehicles (UUVs), addressing the propulsion and control limitations present in conventional UUV systems. Traditional control surfaces rely on mechanical linkages, which result in frictional losses; furthermore, direct mechanical contact combined with dynamic seals introduces risks of wear and water ingress. This research explores the use of permanent magnetic coupling in conjunction with a novel electromagnetic actuator, yielding a watertight propulsion system capable of thrust vectoring. Dynamic seals, commonly employed to prevent fluid ingress, are replaced with static seals in this design, thereby eliminating wear and the possibility of leakage. This is achieved through a face-to-face magnetic coupling utilizing four sets of high-strength N52 neodymium magnets, enabling contactless torque transmission while maintaining the integrity of the electronic compartment. The conventional control mechanism is substituted with a system of four precisely controlled electromagnets, which exert magnetic forces on ferromagnetic material mounted on the shaft. This configuration allows interaction with the electromagnets to produce a 10-degree angular displacement about the pivot. This mechanism, supported by the magnetic coupling, permits the shaft to move freely in two perpendicular planes, achieving two degrees of freedom (2-DOF) essential for enhanced maneuverability. Furthermore, by eliminating mechanical linkages, the system significantly reduces acoustic signatures, which is critical for stealth operations. These advancements in non-contact propulsion and control represent a significant step toward the next generation of UUVs—engineered for stealth, efficiency, and superior maneuverability, with promising applications in military, marine research, and offshore

engineering. At an advance velocity of 1 m/s and a rotational speed of 1200 rpm, the thruster generates 10 N of thrust in the forward direction. This integrated propulsion system, which combines a magnetic actuator with structural flexibility, enhances the UUV's hydrodynamic performance while reducing mechanical complexity.

Design and development of a novel hybrid magnetic coupling for marine propulsion systems

*Aliyan Ahmed1, Sanaullah Shah1, Shahroz Ahmad1, Sarmad Ishfaq1 and Muhammad Abdul Ahad1**

Affiliation 1 : Department of Mechanical Engineering, Air University, Aerospace and Aviation Campus, Kamra, Pakistan.

Abstract:

This study presents the development of an advanced Hybrid Magnetic Coupling (HMC) for the propulsion system of Unmanned Underwater Vehicles (UUVs). Conventional UUV thrusters rely on dynamic seals, which are susceptible to wear, water leakage, and high maintenance requirements, ultimately limiting operational efficiency and service life. The proposed HMC integrates electromagnets and permanent magnets to facilitate non-contact mechanical power transmission, thereby eliminating dynamic seals and significantly reducing friction, mitigating water ingress, and enhancing slippage control. A high-precision computational model is developed to optimize the structural integrity and performance of the system. Additionally, a feedback control algorithm is designed, simulated, and tested to enhance the stability and responsiveness of the propulsion system integrated with the HMC. Unlike traditional permanent magnetic couplings, which suffer from slippage under varying load conditions, the proposed HMC, coupled with a control system, effectively mitigates slippage and ensures enhanced torque stability. To validate the system's performance, a dedicated test rig is constructed to conduct trials under simulated underwater conditions, assessing load-bearing capacity, response time, and long-term operational reliability. Upon successful validation, the HMC-enabled thruster will be integrated into a torpedo-shaped UUV propulsion system. This innovative approach offers a highly efficient and reliable alternative to conventional thrusters, contributing to the advancement of underwater propulsion technology and improving the resilience, performance, and sustainability of UUVs operating in demanding marine environments.

An electrochemical sensor based on composite of dichalcogenide and perovskite for ultra-sensitive detection of dopamine.

*Muhammad Hassan Lakhesar[1], Sadia Muhammad Khuidad[1], Sibgha Safdar[1], Rida Riaz[1], Muhammad Umar Draz[1], Huma Ajab[*1], Asim Yaqub[2], Ali Turab Jafry[3]*

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Abstract:

Dopamine (DA) is a neurotransmitter that executes a significant role in the central nervous system working, reward, motivation and mood regulation. Detecting dopamine levels is crucial for identifying and treating neurological, psychiatric, and addiction. In this study, an electrochemical sensor platform was successfully developed utilizing a hydrothermal approach based on MoS_2@$SrTiO_3$ nanocomposite for detection of DA. The nanocomposite was characterized by different analytical techniques. The SEM reflected the morphology of nanocomposite which showed characteristics of both MoS_2 and $SrTiO_3$. The FTIR spectrum indicated interaction between MoS_2 and $SrTiO_3$, which contributed to the formation of a composite with better catalytic capabilities. XRD diffractogram was used to analyze the crystal structures of MoS_2, $SrTiO_3$, and MoS_2@$SrTiO_3$ nanocomposite. MoS_2@$SrTiO_3$ nanocomposite-modified electrode showed enhanced catalytic activity for DA electrochemical oxidation compared to the unmodified electrode, as analyzed by cyclic voltammetry. For better sensitivity and selectivity, the following conditions like incubation time (10 min), pH (7) and concentration of nanocomposite (5mM) were optimized. A good sensitivity was obtained with a lower limit of detection (LOD) of 0.05 µM. This study leads the way for new electrochemical analysis approaches and demonstrates the

versatility of $MoS_2@SrTiO_3$ nanocomposites in a variety of electroanalytical applications for disease diagnosis.

Metal-doped Fe_2O_3 nanoparticles for sensitive and selective detection of levofloxacin

*Muhammad Jawad[1], Muhammad Umar Draz[1], Huma Ajab[*1], Asim Yaqub[2], Ali Turab Jafry[3]*

Affiliation 1: Department of Chemistry, COMSATS University Islamabad, Abbottabad Campus, Abbottabad 22020, Pakistan.
Affiliation 2: Department of Environmental Sciences, COMSATS University Islamabad, Abbottabad Campus, Abbottabad 22020, Pakistan.
Affiliation 3: Faculty of Mechanical Engineering, Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi, District Swabi, Khyber Pakhtunkhwa, 23640, Pakistan

Abstract:
Levofloxacin is a highly bioavailable, broad-spectrum fluoroquinolone. It delivers convenient single-daily administration and fast antibacterial activity. Though, it can cause severe side effects such as rupture of tendons, QT prolongation, and antibiotic resistance. Environmental monitoring detects residues that facilitate antimicrobial resistance necessitating its monitoring. The electrochemical sensors offer sensitivity with high selectivity, cost-effectiveness, small size, and a fast response. Therefore, the current study explored the electrochemical properties of Zn-doped α-Fe_2O_3 nanoparticles for the detection of levofloxacin. The co-precipitation method was applied for the synthesis of Zn-doped-Fe nanoparticles and characterization was scrutinized by fourier transform infrared and scanning electron microscopy After characterization, the optimization study was carried out for antibiotic levofloxacin detection through electrochemical techniques such as cyclic voltammetry and differential pulse voltammetry. Different parameters, like pH, time (25 min), and concentration (25 mM), were optimized. It was found that the voltametric behavior of levofloxacin was pH-dependent, with the maximum response found at pH 6.0 PBS. The successful calibration was carried out with the linear response with better sensitivity. In the basis of the results, it can be said that an effective sensing platform with high selectivity was achieved through an economical approach for pharmaceutical screening tests and medical diagnostics.

Removal of Iodine from Nuclear Power Plant Effluents Using Advanced metal-TEDA Impregnated Activated Carbon for Environmental Protection

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Abstract:

With the increasing demand of energy, nuclear power is a major source to produce electricity. All around the world, nuclear power plants generate 11% of electricity. Nuclear power has been a significant source of clean and reliable electricity and when combined with other renewable energy sources like hydro, solar and wind power, nuclear power can be considered the backbone of clean energy systems. But after the Fukushima Daiichi accident in 2011, numerous questions were raised about safe operation of nuclear power plants. Nuclear power plants (NPPs) may produce radioactive isotopes of iodine as a by-product of uranium fission, which has the potential to be dangerous for environment. Large amounts of gaseous radioactive iodine may be present in the exhaust gas that is released from a nuclear power plant. An important factor in the assessment of efficient radioactive waste treatment system is the effective trapping of radioactive iodine isotopes, that were released as gaseous effluents from nuclear power plants. Due to their high surface area and porosity, activated carbons (ACs) are widely utilized in nuclear facility air filtration systems to facilitate the efficient adsorption of volatile iodine species. This study investigates the adsorptive removal of iodine species using metal-triethylenediamine (TEDA) modified activated carbons for applications in nuclear safety. The modification of activated carbon with metal species and TEDA was performed to enhance both physical and chemical adsorption mechanisms, allowing for efficient iodine capture even at elevated temperatures. The main purpose of this work was to capture toxic gas (such as I_2), for which surface of activated carbon (AC) was modified by impregnating it with combination of four metals i.e. Ag, Ni, Zn, Cu. After the impregnation of

metals, triethylenediamine (TEDA) was doped on metal impregnated activated carbon (IAC) surface. Characterization techniques, including SEM-EDX, XRD, FTIR, AAS, BET and UV Visible spectroscopy were employed to analyze the structural and chemical properties of modified adsorbents. Adsorption experiments were conducted under controlled conditions, simulating relevant nuclear power plant environments, to evaluate the adsorption capacity and kinetic behavior of the materials by breakthrough experiment. Results demonstrate that the metal-TEDA modification significantly improves the adsorption efficiency (1030 mg/g) of iodine species compared to raw activated carbon. The characteristics of raw and impregnated activated carbons have been studied by ASTM standard test methods and Boehm titrations. Adsorption of I_2 onto metal-TEDA was best described by Langmuir isotherm and pseudo-second-order kinetic models which suggested the spontaneity of adsorption. Thermodynamic parameters demonstrate that the adsorption of I_2 is exothermic, spontaneous and chemisorption in nature. The findings of this study highlight the potential of metal-TEDA-modified activated carbon as an effective adsorbent for iodine removal in nuclear safety applications, contributing to improved air purification and radionuclide mitigation strategies. The adsorptive removal of iodine compounds, particularly radio-iodide, is crucial for ensuring nuclear safety and mitigating environmental risks.

Exploring the electrochemical performance of NiCuCo based metal organic framework in energy storage application.

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Abstract:
Metal-organic frameworks (MOFs) have gained significant attention as electrode materials for energy storage applications due to their high surface area and tunable porosity. This study focuses on the Hydrothermal synthesis and electrochemical evaluation of four MOF-based electrode compositions: Ni-TPA, Co-TPA, Cu-TPA, and NiCoCu-TPA. The objective is to optimize electrochemical performance for energy storage applications. Hydrothermal synthesis was carried out by dissolving metal precursors and terapthalic acid in deionized water separately, and then the solutions were mixed and were poured into the autoclave, which was then put into the oven for reaction at required conditions. All the prepared samples characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) to confirm phase purity, morphology, and elemental composition. Electrochemical performance was accessed by cyclic voltammetry (CV), Galvanostatic charge-discharge (GCD) and Electrochemical Impedance Spectroscopy (EIS) using Gamry electrochemical workstation by using our samples as working electrode, platinum disc as counter electrode and Hg/HgO electrode as reference electrode in three electrode system. Electrochemical testing demonstrated that the NiCoCu-TPA electrode exhibited superior performance compared to individual Ni, Co, and Cu electrodes, leading to its selection as the positive electrode for a hybrid supercapacitor device. Supercapacitors excel for fast energy storage and release because they have both the properties of battery energy density and capacitor power density together in one system. The synthesis of MOFs

enables their potential use in supercapacitor electrodes which combine efficient power output with effective energy storage. Next-generation supercapacitors benefit from ternary MOFs according to the device measurements in which NiCoCu-TPA served as the positive electrode and activated carbon served as the negative electrode. The fabricated device showed promising power and energy storage capabilities.

Development of therapeutic ions loaded bi-polymeric 3D printed biomimetic scaffolds investigated in-vitro and in-vivo for burn wound repair

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Abstract

Skin is vital for protecting internal organs from external contaminants and infectious pathogens. Burn is among the frequent traumas leading to skin deformation and necrosis, and existing treatments like fluid therapy and the use of wet dressings seem ineffective. A novel, potentially effective, and precise 3D-printed scaffold was proposed for presumable burn injuries. A natural polysaccharide guar gum (GG) was chemically modified (oxidized) to guar gum dialdehyde (OGG) to enhance its reactivity towards the other biopolymer, i.e., sodium alginate (ALG). The copper and silver doped mesoporous bioactive glass nanoparticles (Cu-Ag MBGNs) were also loaded to OGG/ALG ink (before 3D printing) to build a biologically active scaffold holding therapeutic potential. A custom-made 3D extrusion printer was employed to fabricate the scaffold , followed by its freeze gelation. Post fabrication, the scaffold was characterized both *in-vitro* and *in-vivo* in terms of its healing potential and material properties. Scanning electron microscopy revealed the microporous interlinked network (also validated by Fourier Transform Infrared Spectroscopy) and uniform distribution of Cu-Ag MBGNs. The microporous nature of the scaffold promoted moisture retention capabilities. In contrast, Cu-Ag MBGNs promoted cellular growth, bactericidal potency, and release of proteins involved in skin rejuvenation, as portrayed in WST-8 assay, antimicrobial, and biomarker studies. The OGG/ALG/Cu-Ag MBGNs scaffold significantly enhanced the release of vascular endothelial growth factor (VEGF) from co-cultured primary dermal fibroblast (HDFa) cells to 284 ± 16 ng/mL in comparison to 203 ± 15 ng/mL release from bare HDFa cells. The developed OGG/ALG/Cu-Ag MBGNs scaffold was further investigated *in-vivo*, and poses its potential to heal the burnt site effectively. The scaffold was seen to promote the re-epithelialization process and minimize the risk of inflammation, as validated by histological analysis and the release of inflammatory cytokines. Conclusively, the study features OGG/ALG/Cu-Ag MBGNs scaffold as a potential next generation post burn treatment by offering multifaceted approach of healing by yielding bactericidal efficacy, angiogenic potency and healing proficiency from single 3D printed scaffold.

Keywords: Biomimetic 3D scaffolds, Healing, ECM remodeling, Biochemical analysis, Angiogenesis

Poster presentation

Multilayer adsorption of reactive orange16 dye onto Fe_2O_3-ZnO hybrid Nano adsorbent: Mechanistic insights from kinetics, isotherms and dynamic light scattering studies

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Abstract:

Fe_2O_3/ZnO hybrid nanoadsorbent was synthesized via coprecipitation method and characterized. Hydrodynamic size and stability of the nanoadsorbent were investigated in batch adsorption of Reactive orange (RO)16 dye at increasing concentrations. The mechanism of monolayer and multilayer dye adsorption was elucidated for the first time together through dynamic light scattering (DLS), isotherm, kinetic studies. The nanoadsorbent exhibited 85% RO16 dye removal. Nonlinear fitting of isotherm and suggest the chemisorption (monolayer) and physisorption (multilayer) of dye over the heterogeneous surface of the nanoadsorbent, respectively, at lower and higher dye concentration. PFO provided better fit then PSO model. DLS studies demonstrate that monolayer adsorption increased hydrodynamic size up to 100 mg L^{-1} by face-off binding of dye molecules, whereas multilayer adsorption was in the 100–500 mg L−1 concentration range; besides increase in adsorption capacity, didn't magnify hydrodynamic size owing to face-on binding with multiple dye molecule stacking. Zeta potential data confirmed greater stability of the nanoadsorbent at solution pH (6) with large hydrodynamic size. Thermodynamic studies confirmed an endothermic (ΔH = 44.83 kJ mol^{-1}) spontaneous (ΔG = −1.68 to −4.80 kJ mol^{-1})

and entropy ($\Delta S = 0.157$ J mol^{-1} K^{-1}) driven adsorption process. A toxicity assay proved that the nanoadsorbent and treated water are environmentally safe.

Detection of nitro-aromatics using C_5N_2 as an electrochemical sensor: an DFT approach

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Abstract:

Nitroaromatics impose severe health problems and threats to the environment. Therefore, the detection of such hazardous substances is essential to save the whole ecosystem. Herein, the C_5N_2 sheet is used as an electrochemical sensor for the detection of 1,3-dinitrobenzene (1,3-DNB), trinitrotoluene (TNT), and picric acid (PA) using the PBE0/def2SVP level of theory as implemented in Gaussian 16. The highest interaction energy was observed for the picric acid@C_5N_2 complex. The trend in interaction energies for the studied system is PA@C_5N_2 >TNT@C_5N_2 >1,3-DNB@C_5N_2. The studied systems were further analysed by qualitative and quantitative analyses to determine the interactions between the nitroaromatic analytes and the C_5N_2 sheet. Electronic properties of all analytes@C_5N_2 complexes have been examined by NBO, EDD, FMO and DOS analysis. QTAIM analysis depicts the stronger non-covalent interactions for the PA@C_5N_2, which shows consistency with interaction energy and NCI analysis. Furthermore, NBO and FMO analyses show that the C_5N_2 substrate exhibits high sensitivity and selectivity towards the picric acid compared to TNT and 1,3-DNB nitroaromatics. EDD and DOS analyses are in agreement with NBO and FMO analyses. Furthermore, the recovery time of the studied system has been computed to determine the efficiency of C_5N_2 material as an electrochemical sensor. Overall, the results show that carbon nitride can be a good sensor for the detection of nitroaromatics.

Metal Phosphate/MOF-based Composites as Efficient and Durable Electrocatalysts for Enhanced Water Splitting

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Abstract:

Developing cost-effective and stable electrocatalysts for water splitting is crucial for sustainable hydrogen production. Metal-organic frameworks (MOFs) offer significant potential due to their high surface area and tunable composition. Incorporating Co-phosphate into MOFs enhances their catalytic activity, offering alternatives to noble-metal-based catalysts. This study investigates Co-phosphate/Co-pyridine dicarboxylic acid (Co-PDC) MOF composites with varying Co-phosphate content (15%, 30%, and 45%). The composites are synthesized via a hydrothermal approach and evaluated electrochemically using linear sweep voltammetry (LSV), cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS). Compared to pristine Co-MOF, which required an overpotential of 258 mV to reach 10 mA cm^{-2} in the oxygen evolution reaction (OER), the Co-PDC/Co-phosphate MOF composites exhibited lower overpotentials: 112 mV (15%), 117 mV (30%), and 143 mV (45%). For the hydrogen evolution reaction (HER), the Co-PDC MOF required 228 mV, while the composites showed 136 mV (15%), 158 mV (30%), and 4 mV (45%). These results highlight the enhanced electrocatalytic activity of Co-phosphate-incorporated MOFs, demonstrating lower overpotentials, improved stability, and reduced resistance. This study provides insights into designing efficient MOF-based electrocatalysts for sustainable hydrogen production.

Low-Cost Magnetic Biochar Composite: Eco-friendly Synthesis, Characterization, and Application for heavy metal removal

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Abstract:

In this study, we present a simple and cost-effective method for synthesizing magnetic biochar composite (MBC) using low-cost pine bark waste and cobalt ferrite ($CoFe_2O_4$). Using batch method MCB was used for the removal study of the contaminated wastewater having lead copper, and cadmium, The morphological and chemical structure of the magnetic biochar composite was characterized using Fourier transform Infra-Red spectroscopy (FTIR), Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD). The influence of pH, initial metal ion concentration, and contact time on the adsorption efficiency of Pb (II), Cu (II) and Cd (II) onto magnetic biochar (MBC) was systematically examined. The magnetic biochar (MBC) demonstrated effective adsorption of lead, copper, and cadmium over the initial range of 6.04 µg/L to 8.04 µg/L. The integration of several remarkable characteristics, including easy magnetic separation, cost-effectiveness, environmentally friendly properties, and strong sorption performance, makes magnetic biochar (MBC) a highly suitable material for industrial applications. Its potential is significant in the field of wastewater treatment, where it can be utilized for the efficient removal of heavy metal contaminants, contributing to sustainable and effective wastewater management.

Towards Sustainable Development and Applying 3R Concept in Marble Processing Industry

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Abstract:
This paper presents a sustainable approach to managing marble slurry waste produced by the marble industry by incorporating it into the production of durable tiles. The rapid growth of the marble industry has led to significant waste management challenges. This study explores using the 3R concept—reduce, reuse, and recycle—to evaluate the feasibility of utilizing marble slurry in tile production. Through literature review, data collection, and experimentation, the research identifies effective strategies for sustainable waste management. The study found that replacing a portion of the conventional tile blend (sand, fine gravel, cement, and water) with marble slurry produced tiles comparable to traditional ones, with mixing ratios of 10% and 20% showing similar strength. However, increasing the slurry content to 50% resulted in a decrease in tile strength. This highlights the importance of balancing waste utilization with product quality. By recycling marble slurry into tiles, the industry can reduce its environmental impact while producing high-quality, sustainable products. This shift towards eco-friendly practices not only benefits the environment but also sets a precedent for future industry trends, contributing to a greener future.

Machine Learning-Based Prediction of Young's Modulus of Biocompatible Alloys Using HEAPS-Derived Features

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Abstract:

Purpose: The discovery of new materials has often posed challenges to the advancement of society. Traditional alloy design methods rely on empirical calculations and computational simulations, both of which are resource-intensive. Therefore, there is a need to develop an approach that overcomes these limitations.

Method: This study proposes the development of a machine learning (ML) model to predict the Young's Modulus (YM) of biocompatible alloys. The model's performance was enhanced by calculating features from the HEAPS method and incorporating them into the ML model. Finally, the model's accuracy was evaluated by comparing its predictions with the properties of newly synthesized biocompatible alloys.

Results: The developed ML model predicted the Young's Modulus (YM) of biocompatible alloys with an accuracy of 0.76 using r^2, enhanced by features from the HEAPS method. Efforts are ongoing to improve this accuracy by refining the feature set and comparing predictions with the properties of newly synthesized alloys.

Conclusions: The study demonstrates the potential of machine learning in predicting the Young's Modulus (YM) of biocompatible alloys, addressing the limitations of traditional alloy design methods. With an initial accuracy of 0.76, the model shows promise, though ongoing efforts to refine features aim to further enhance its performance. These findings highlight the efficiency of data-driven approaches in accelerating materials discovery and optimization.

Comparative Analysis of Back Surface Field (BSF) Layer in InGaP/GaAs Solar Cells

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Abstract :

This study attempts to analyze the significance of the back surface field (BSF) layer and its impact on the efficiency and other factors of the InGaP/GaAs device. The selection of a perfect BSF layer is necessary as it helps to reduce recombination losses and enhance the carrier collection mechanism across the device. The dual-junction InGaP/GaAs solar cell is simulated to optimize efficiency via Silvaco ATLAS. Optimization is performed with one sun at 300K and the solar spectrum utilized here is AM1.5. The top cell of the device is InGaP and the bottom cell is GaAs-based. The BSF layer of the bottom cell is replaced by InAlGaP and InAlP with a thickness of 0.1 µm and doping concentration of 5×10^{18}. The AlGaAs-based BSF layer of the bottom cell (GaAs) is replaced by InAlGaP and InAlP and the efficiency increases from 22.08 % to 25.10 % and 27.33 %. The current density shows an enhancement from 14.21 mA/cm^2 to 15.72 mA/cm^2 and 17.23 mA/cm^2. The power density for the reference device is 30.33 mW/cm^2 and for the proposed devices, we have values of 34.65 mW/cm^2 and 37.73 mW/cm^2. The selection of a perfect BSF layer is necessary as it helps to reduce recombination losses and enhance the carrier collection mechanism across the device. The variation in the BSF layer helps to collect charge carriers efficiently and optimize the cell by enhancing the efficiency of the proposed devices.

Enhancing Mechanical Properties of FeCrMnCoNi High-Entropy Alloy through Titanium and Boron Addition

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Abstract:

Purpose: This study investigates the enhancement of mechanical properties in FeCrMnCoNi High-Entropy Alloys (HEAs) by adding titanium and boron to form in situ TiB^2 particles. The aim is to significantly improve the hardness and strength of the base alloy by achieving a dispersion of these hard ceramic particles, leveraging the HEA's inherent strength and ductility.

Method: High-purity elements were arc-melted and cast to create Equi atomic FeCrMnCoNi HEA and HEA composite through Ti and B additions. The resulting microstructures were characterized using optical microscopy, Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and Energy Dispersive Spectroscopy (EDS). Mechanical properties were evaluated through Vickers hardness testing.

Results: The formation of TiB_2 particles led to a substantial increase in hardness, rising from 175 HV in the base alloy to 800 HV in the composite. Microstructural observations and EDS analysis revealed the presence of polygonal and irregular shaped TiB_2 particles in a HEA matrix. The presence of hard particles raised the hardness significantly.

Conclusions: The formation of TiB_2 particles significantly enhanced the hardness of FeCrMnCoNi HEAs. This improvement underscores the potential of TiB_2 as a reinforcement phase for high-strength applications. The study confirms that strategic alloying and particle dispersion can effectively tailor the mechanical properties of HEAs, opening avenues for advanced materials design.

Fabrication of Graphene-metal oxides electrochemical filter: A novel hybrid system for onsite treatment of wastewater containing emerging contaminants

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Abstract:

Water contamination by emerging pollutants—particularly dyes, pharmaceuticals, and pesticides—poses a significant challenge to public health and environmental sustainability. Innovative techniques are required for the efficient and effective treatment of such effluents. The present work explores the onsite treatment of contaminated wastewater through new $GOSnO_2$ and $GOZnO_2$ composite electrodes by electrochemical oxidation (EO) in batch and once-through continuous systems. The novel electrode GOSnO2 exhibited excellent oxidation capabilities. Process optimization was achieved using a response surface methodology (RSM) with a Box-Behnken design (BBD), wherein the effects of key operating parameters—pH (3–9), current (0.1–0.9 A), and treatment time (30–180 minutes)—were systematically evaluated. The effects of operating conditions, i.e., pH, current, and treatment time, on the efficiency of the process were systematically investigated. Under optimum conditions, removal efficiencies of 95% for congored and 90% for methylene blue were achieved. A once-through continuous setup operating at an optimal flow rate was also performed, with the electrodes demonstrating durability over multiple cycles. The contribution of several reactive species to the EO process was examined in the presence of scavengers, and toxicity studies confirmed that the EO process effectively detoxifies contaminated wastewater. Hence, this EO process, which is low-cost and highly efficient, can be applied to the treatment of wastewater contaminated with emerging pollutants.

An octahedral metal oxide nanoparticle-based dual-signal sensing platform for simultaneous detection of histidine and lysine in human blood plasma and urine

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Abstract:

Histidine and lysine are essential amino acids involved in physiological processes and serve as biomarkers for various diseases, necessitating accurate detection methods. This study introduces a cost-effective, single colorimetric probe using nickel oxide nanoparticles (NiONPs) as an artificial enzyme for their detection. NiONPs were characterized using SEM-EDX, FE-SEM, FTIR, and XRD. Their peroxidase-like activity catalyzed the oxidation of TMB in the presence of H_2O_2, optimized at pH 3, 10 mM TMB, 60 mM H_2O_2, and 18 min incubation. The interaction between NiONPs and these amino acids temporarily inhibited TMB oxidation, enabling selective detection. The method achieved a limit of detection of 0.07 µM for histidine and 1.1 µM for lysine with high stability. Validation in biological samples showed strong recoveries: 93.6–98.2% in urine and 90.5–96.0% in plasma for histidine, and 91.2–94.8% in urine and 88.4–93.3% in plasma for lysine. The NiONP-based probe is selective, feasible, and reliable for real-world applications, with future work focusing on integration into microfluidic systems for on-site amino acid detection.

Enhancing the electrochemical properties of Co-MOF by using mixed ligands for water splitting application

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Abstract:
With increasing energy demands and environmental concerns, electrochemical water splitting is becoming a prospective path for green hydrogen production. Yet, poor HER and OER kinetics continue to be a limiting factor. Metal-organic frameworks (MOFs), because of their large porosity, tunable framework, and plentiful active sites, have the capability to accelerate ion transport, facilitate charge transfer, and enhance catalytic surface area. This study reports the sonochemical fabrication of a mixed-ligand cobalt MOF (Co-MOF) from pyromellitic acid (PMA) and terephthalic acid (TPA) with three products: S1 (Co-MOF-PMA), S2 (Co-MOF-TPA), and S3 (Co-MOF-PMA,TPA). XRD and SEM revealed successful crystallinity and porous, flake-like morphology. S3 showed better electrocatalytic performance, having HER and OER overpotentials of 150 mV and 50 mV at 10 mA cm^{-2}, respectively—substantially lower than S1 and S2. Electrochemically active surface area (ECSA) was calculated to be 190 cm^2 (HER) and 651 cm^2 (OER), showing increased availability of active sites. These enhancements result from the cooperative effects of two ligands, which increase structural stability and charge transfer. The results show the promise of mixed-ligand Co-MOFs as efficient, stable electrocatalysts for future water-splitting applications.