17 - 19 November 2023

LORD CHARLES HOTEL, SOMERSET WEST, CAPE TOWN, SOUTH AFRICA.

ABSTRACTS - ICARAE2023

3rd International Conference on APPLIED RESEARCH AND ENGINEERING

Cape Peninsula University of Technology, Cape Town, South Africa.

Organized By

The Department of Mechanical and Mechatronic Engineering.

In Partnership with

The Institute of Aeronautical Engineering Dundigal, Hyderabad, India.

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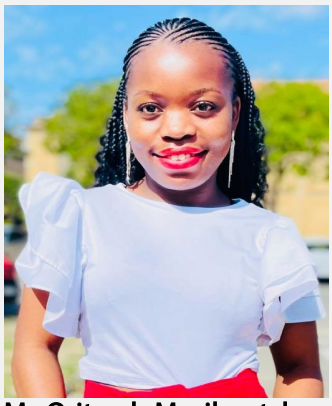

Ms Oritonda Muribwatoho
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Foreword from the Organizing Committee

Dear Esteemed Participants,

It is with great pleasure and anticipation that we extend our warmest welcome to the International Conference on Applied Research and Engineering (ICARAE 2023). As members of the organizing committee, we are thrilled to facilitate this gathering of brilliant minds from diverse corners of the globe.

The challenges that confront our world today are often universal, transcending geographical boundaries. While some regions have made strides in addressing these issues, others are still navigating the path towards solutions. Recognizing the imperative for a collaborative platform, ICARAE 2023 endeavours to serve as the nexus for the exchange of insights and innovations.

This conference aspires to be a melting pot of ideas, where researchers, engineers, technologists, academics, and postgraduate students converge to share their research findings and advancements across various scientific and engineering domains. The collective knowledge and expertise of the participants will contribute to a dynamic discourse, fostering a collaborative spirit that transcends borders.

Lord Charles Hotel in Cape Town, South Africa, has been chosen as the venue for this momentous occasion, offering a vibrant backdrop for the exchange of ideas and the forging of new connections. From November 17 to 19, 2023, we invite you to join us in this intellectual journey, where the latest breakthroughs in science and engineering will be unveiled, and the seeds of future collaborations will be sown.

As we embark on this shared endeavour, we are confident that ICARAE 2023 will be not only a platform for the dissemination of knowledge but also a catalyst for transformative ideas and solutions. We extend our deepest gratitude to all participants, sponsors, and supporters who make this conference a reality.

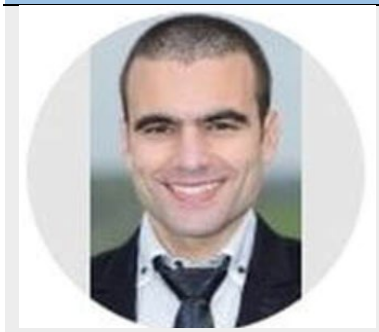
Together, let us pave the way for a future where global challenges are met with collective wisdom and innovation.

Warm regards,

Organizing Committee - ICARAE 2023

KEYNOTE SPEAKERS

KEYNOTE SPEAKER 1



Professor João Pedro Oliveira

Affiliation: Professor, Materials Science Department of FCT/NOVA, Portugal.

Research interests: welding and fusion-based additive manufacturing of advanced engineering materials, with a special scientific interest in less conventional engineering alloys such as shape memory and high entropy alloys.

Biography: Professor João Pedro Oliveira is currently an assistant professor at the Materials Science Department of FCT/NOVA, Portugal.

Prior to his current appointment at FCT/NOVA, he was a postdoctoral researcher at the Welding Engineering program of Ohio State University, United States. He did his PhD in laser welding of shape memory alloys at FCT/NOVA while being a visiting researcher at the Center of Advanced Materials Joining of the University of Waterloo, Canada. His research group is heavily invested in the use of high-energy synchrotron X-ray diffraction for fine probing of the material microstructure ex-situ or in-situ. He currently supervises 10 PhD students in the areas of welding and additive manufacturing. He is also an Associate Editor of Additive Manufacturing (Elsevier).

Title of the lecture: Development WAAM Variants for Improvement on Microstructure and Mechanical Response in Engineering Alloys.

KEYNOTE SPEAKER 2

Professor Ashish Kumar Srivastava

Affiliation: Associate Professor, Muzaffarpur Institute of Technology (MIT) Muzaffarpur, Department of Science, Technology and Technical Education, Government of Bihar, India

Research interests: 3D Printing (Metal and fibre), Friction Stir Additive Manufacturing (Through Robotic Milling, CNC Milling and Conventional VMC), Wire-Arc Additive Manufacturing (Through Robotic Welding), Friction Stir welding, Friction Stir Processing, Mechanical and Electromagnetic stir casting, Abrasive Waterjet cutting and turning, and Wire electric discharge cutting and turning.

Biography: Prof. Ashish Kumar Srivastava completed his Ph.D. at the Indian Institute of Technology (ISM) Dhanbad, Jharkhand, India, in February 2018.

He is currently working as an Associate Professor in the Department of Mechanical Engineering, MIT Muzaffarpur, Department of Science, Technology and Technical Education, Government of Bihar, India. He is a good learner, and listener and contributed a lot to society through his academics, administration and research work. As a researcher, he has published more than 120 research papers in various journals of repute, indexed in SCI/SCIE/SCOPUS. He has also presented more than 20 research papers at various international and national conferences in India and Abroad. Dr. Srivastava is among the Top 2% of scientists in the world listed by Stanford University USA and Elsevier B.V. in

2022 and 2023. He has successfully completed 2 research-funded projects under the collaborative research scheme of TEQIP-III. Presently received a grant of Rs 10.19 Lacs from the Council of Science and Technology, Uttar Pradesh (CST-UP). Recently he has published 9 Indian patents, which are likely to be granted in the upcoming years. Dr. Srivastava has also worked with the Institute of the Geonics of the CAS, Ostrava-Poruba, Czech Republic and Slovak Research and Development Agency (Slovak Republic) under contract No. APVV-207-12 to carry out his Ph.D. research work related to abrasive waterjet cutting and turning.

Title of the lecture: Artificial Intelligence Application in Friction Stir Additive Manufacturing

KEYNOTE SPEAKER 3

Professor Ajay Kumar

Affiliation: Associate Professor in School of Engineering and Technology, JECRC University, Jaipur, Rajasthan, India.

Research interest: Incremental Sheet Forming, Artificial Intelligence, Sustainable Materials, Additive Manufacturing, Mechatronics, Smart Manufacturing, Industry 4.0, Waste Management, and Optimization Techniques.

Biography: He received his Ph.D. in the field of Advanced Manufacturing from Guru Jambheshwar University of Science & Technology, Hisar, India after B.Tech. (Hons.) in mechanical engineering and M.Tech. (Distinction) in manufacturing and automation.

He has over 60 publications in international journals of repute, including SCOPUS, Web of Science and SCI indexed database and refereed international conferences. He has organized various national and international events, including an international conference on Mechatronics and Artificial Intelligence (ICMAI-2021) as conference chair. He is currently organising an international conference on Artificial Intelligence, Advanced Materials, and Mechatronics Systems (AIAMMS-2023) as conference chair. He has more than 20 national and international patents to his credit. He has supervised more than 8 M.Tech, Ph.D scholars and numerous undergraduate projects/ thesis. He has a total of 15 years of experience in teaching and research. He is a Guest Editors and Review Editor of reputed journals, including Frontiers in Sustainability. He has contributed to many international conferences/ symposiums as a session chair, expert speaker, and member of the editorial board. He has won several proficiency awards during the course of his career, including merit awards, best teacher awards, and so on. He is an adviser of QCFI, Delhi Chapter student cell at JECRC University and has also authored many in-house course notes, lab manuals, monographs and invited chapters in books. He has organized a series of Faculty Development Programs, International Conferences, workshops, and seminars for researchers, PhD, UG and PG-level students. He is associated with many research, academic, and professional societies in various capacities.

Title of the lecture: Dieless Sheet-Forming Techniques.

ABSTRACTS FOR DELEGATES

TECHNICAL SESSION 1

COMPARATIVE FLEXURAL ANALYSIS OF CANTILEVER BEAM AT VARIOUS LOADS USING ANALYTICAL, COMPUTATIONAL AND EXPERIMENTAL TECHNIQUES

Ashenafi Abuye[1,3,a*], Fasikaw Kibrete[1,2,b], Getaw Ayay[1,c], Ermias Gebrekidan[1,d]

[1]Department of Mechanical Engineering, College of Engineering, Addis Ababa Science and Technology University, P.O. Box 16417, Addis Ababa, Ethiopia

[2]Department of Mechanical Engineering, University of Gondar, P.O. Box 196, Gondar, Ethiopia

[3]Department of Mechanical Engineering, Debre Berhan University, P.O. Box 445, Debre Berhan, Ethiopia

Abstract: Measurement of strain and stress plays a crucial role in advancing research in mechanical engineering. in this paper, the bending strain and stress of the steel cantilever beam subjected to concentrated loads at the free end are investigated using analytical, experimental, and numerical approaches. The experimental investigation was carried out through the use of a strain gauge sensor connected with a Wheatstone quarter-bridge configuration. The strain gauge used in this experiment is interfaced with the NI SignalExpress software in conjunction with the NI modules to ensure accurate data acquisition. The experimental measurements provide essential benchmark values for comparison with the numerical results. The numerical simulation is developed using ANSYS Workbench. The comparison results show that the experimental values have good agreement with the simulated FEM and analytical values. The findings of this study provide valuable insights into the bending strain characteristics of steel cantilever beams and contribute to the advancement of mechanical engineering research.

STUDY THE WEAR BEHAVIOUR OF AL7075/SIC COMPOSITE UTILIZING THE GREY-BASED TAGUCHI TECHNIQUE

Abhijit Bhowmik[1], Indradeep Kumar[2], VSS Venkatesh[3], Sarbjeet Kaushal[4], Rahman S. Zabibah[5], Manish Gupta[6]

[1]Department of Mechanical Engineering, Dream Institute of Technology, Kolkata, India

[2]Department of Aeronautical Engineering, Institute of Aeronautical Engineering, Hyderabad, Telangana

[3]Department of Mechanical Engineering, G.M.R Institute of Technology, Rajam, India

[4]Department of Mechanical Engineering, Gulzar Group of Institutions, Punjab, India

[5]College of Medical Technology, The Islamic University, Najaf, Iraq.

[6]Division of Research and Development, Lovely Professional University, Phagwara, India

Abstract: Composites are replacing more conventional materials due to their advantageous properties, such as high strength, hardness, low weight, and wear resistance. In this study, the stir casting method is used to create

an Al7075/SiC aluminium matrix composite, and its dry sliding wear behaviour is examined. The EDX and SEM results both show that the silicon carbide is evenly distributed throughout the matrix. The dry sliding wear behaviour of the composites is investigated using the Taguchi L16 orthogonal array to reduce the number of experimental runs. Four key process parameters—reinforcement quantity (0%, 3%, 6%, and 9%), load (15N, 30N, 45N, and 60N), sliding velocity (0.75m/s), sliding distance (1.5m/s), and sliding distance (3m/s)—are evaluated across four levels to determine the best parameter combination for reducing wear rate. S/N ratios are best when the following conditions are met: 3 wt.% SiC reinforcement, 15 N load, 3 m/s sliding velocity, and 800 m sliding distance (as shown in the main effect graphic). Wear rate, frictional force, and coefficient of friction are all affected by the four process parameters, and their effects are often studied using analysis of variance (ANOVA).

MATHEMATICAL MODEL OF UNSTEADY MHD COUETTE FLOW OF MAXWELL VISCOELASTIC MATERIAL AND HEAT TRANSFER WITH RAMPED WALL TEMPERATURE

Karema Mundell-Thomas[1], and Victor M. Job[2,b]*

[1,2]Department of Mathematics, The University of the West Indies, Mona Campus, Jamaica

Abstract: The time-dependent magnetohydrodynamic (MHD) Couette flow of Maxwell material in a rotating system with ramped wall temperature has been examined under Ohmic (Joule) heating. The Continuity equation, Cauchy's equation of motion, the constitutive equation for the Maxwell model, and the energy equation with Ohmic heating with relevant initial and boundary conditions are all considered in obtaining a mathematical model for the investigation. The finite element technique is applied to numerically solve the non-dimensionalized governing equations using the mathematical software MATLAB. The values of Weissenberg number, Hartmann number, Eckert number, and angular velocity of the rotating system are varied, and their effects on the fluid temperature and velocity are shown graphically and discussed.

OLEFIN DIHYDROXYLATION MEDIATED BY OS-ZN-AL HYDROTALCITE-LIKE CATALYST: THE SCOPE AND REACTIVITY USING VARIOUS CO-OXIDANTS

Philani Perfect Mpungose[1,2]*, Ntokozo Malaza[3], Bhekumuzi Gumbi[2], Holger Friedrich[2]

[1]Department of Chemistry, Cape Peninsula University of Technology, Cape Town, 7530, South Africa

[2]School of Chemistry and Physics, University of KwaZulu-Natal, Durban 4001, South Africa

[3]Department of Environmental and Occupational Studies, Cape Peninsula University of Technology, Cape Town, 7925, South Africa

Abstract: The heterogeneous oxidation of olefins to vicinal diols was investigated using an Os-Zn-Al hydrotalcite-like catalyst (HTlc). The Os-Zn-Al HTlc was synthesised by the co-precipitation method and characterised fully using XRD, FT-IR, TEM, SEM, ICP-OES and BET surface area measurements. The ability

of the synthesised Os-Zn-Al HTlc to catalytically dihydroxylate olefins to vicinal diols using various co-oxidants (air, NMO, K3Fe(CN)6, H2O2 and *t*-BuOOH) was investigated. The focus was mostly on N-methylmorpholine N-oxide (NMO) and K3Fe(CN)6 since they are well-established co-oxidants for osmium catalysed dihydroxylation. When NMO was used, 100 % olefin conversion was achieved for all olefins tested. While 100% conversion was only achieved with electron-rich olefins when K3Fe(CN)6 was used as a co-oxidant. Recyclability and leaching tests were done, and it was found that the catalyst could be recycled at least 3 times in the NMO system, and the K3Fe(CN)6-K2CO3 system was found to be truly heterogeneous.

TECHNICAL SESSION 2

PREPARING AND STUDYING OF AU NANOCOMPOSITES SYNTHESIZED WITH DIFFERENT POLYMER MATRIX

Amer N. Jarad[1] , Ahmed S. Abed[2] , Kahtan A. Mohammed[2*], Ali K. Alhussainy[3] , Rahman S. Zabibah[4] , Mohammed Al-khafaji[5] , Shubham Sharma[6,7]

[1]Department of Material Science, Polymer Research Centre, University of Basrah, Iraq
[2]Faculty of Pharmacy, Jabir Ibn Hayyan Medical University, Najaf, Iraq
[3]Department of Medical Physics, Hilla University College, Babylon, Iraq
[4]Medical Laboratory Technology Department, College of Medical Technology, the Islamic University, Najaf, Iraq.
[5]National University of Science and Technology, Dhi Qar, Iraq
[6]Mechanical Engineering Department, University Center for Research and Development, Chandigarh University, Mohali, Punjab, 140413, India
[7]School of Mechanical and Automotive Engineering, Qingdao University of Technology, 266520, Qingdao, China

Abstract: In this paper, the effect of polymer matrix type that is used as a capping material around the gold particles on the optical properties was investigated. Nanocomposite materials of gold with polyethene oxide, poly venal alcohol and polyvinyl pyrrolidone were synthesized by chemical reduction method using trisodium citrate as a reduction agent. gold-based nanocomposites deposited as a film by drop casting technique on glass substrates. The effect of polymer matrix type on the optical properties (surface plasmon resonance, direct and indirect band gap) were investigated. It was observed from the absorption spectra of the various synthesized materials that the type of polymer used in the preparation process has a very important influence on the location of the plasmonic absorption peak as well as the amount of the energy gap. The band gaps were found in the range 1.9 to 2.3 eV.

DEVELOPMENT AND IMPLEMENTATION OF AN ARTIFICIAL NEURAL NETWORK FOR THE SIMULATION OF FLOOD PHENOMENA IN A NATURAL AREA

Evangelos Keramaris[1, a] *, Ioannis Petikas[2, b]

[1]*International Hellenic University, Department of Environmental Engineering, Thessaloniki, Greece*

[2]*University of Thessaly, Department of Civil Engineering, Volos, Greece*

Abstract: In this study an Artificial Neural Network for the simulation of flood phenomena in a natural area was developed. Then this network was implemented in the urban area of a Greek city (Amyntaio, Florina). The neural networks have many advantages: non-linearity, adaptability, input-output mapping, indicative response, damage resistance, the possibility of implementation with VLSI (Very Large-Scale Integration) technology, content-related information and analysis and design uniformity. With neural networks, mathematical simulation of the considered phenomenon is not attempted, but the extraction of quantitative conclusions for specific data, based on similar cases. With the development and implementation of this network, all the points that are in risk for flood are identified. The results showed that the help of an Artificial Neural Network in these cases is crucial for the future decisions in cases of flood phenomena.

ELECTRON MICROSCOPY FOR MATERIALS CHARACTERIZATION: ADVANCES AND APPLICATIONS

Manoj Agrawal[1,a] * , VVSH Prasad[2,b], Ginni Nijhawan[3,c] and Sarah Salah Jalal[4,d]

[1]*Department of Mechanical Engineering, GLA University, Mathura, UP, India*

[2]*Department of Mechanical Engineering, Institute of Aeronautical Engineering, Hyderabad, Telangana*

[3]*Lovely Professional University, Phagwara, India*

[4]*National University of Science and Technology, Dhi Qar, Iraq*

Abstract: Electron microscopy techniques, such as Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), Energy-dispersive X-ray spectroscopy (EDS), Scanning transmission electron microscopy (STEM), Electron diffraction, Operando electron microscopy, and Aberration-corrected electron microscopy, have revolutionized the field of materials science. These techniques allow researchers to investigate the structure and properties of materials at the nanoscale level, enabling the study of the microstructural evolution of nanomaterials. This research paper presents a comprehensive review of the different electron microscopy techniques used in the study of nanomaterials and their microstructural evolution. The paper discusses the principles, advantages, and limitations of each technique, as well as their applications in materials science. The paper also discusses the contributions of electron microscopy techniques to the understanding of the microstructural evolution of nanomaterials, including the study of defects, phase transformations, and growth mechanisms. The paper highlights the potential of Operando electron microscopy and Aberration-corrected electron microscopy to provide real-time observations of materials under working conditions, enabling the study of dynamic processes at the nanoscale level. This research paper provides a comprehensive overview of the electron microscopy techniques used in the study of nanomaterials and their microstructural evolution.

EMERGING APPLICATIONS OF ADVANCED MATERIALS PROCESSING IN HEALTHCARE AND BIOTECHNOLOGY SHASHANK

Srivastava[1, a]* ,A Somaiah[2,b],Vishal Sharma [3,c] and Hawraa K. Judi[4,d]

[1]*Department of Mechanical Engineering, GLA University, Mathura, UP, India*

[2]*Department of Mechanical Engineering, Institute of Aeronautical Engineering, Hyderabad, Telangana*

[3]*Lovely Professional University, Phagwara, India*

[4]*Hilla University College, Babylon, Iraq*

Abstract: Advanced materials processing techniques have opened up new opportunities in the field of healthcare and biotechnology. In particular, chemical vapor deposition (CVD) and sol-gel processing have shown great potential for the synthesis of novel biomaterials with unique optical, mechanical, and biological properties. These materials can be used for a variety of applications in tissue engineering, drug delivery, and bio sensing, among others. In this experimental research paper, we investigate the use of CVD and sol-gel processing for the fabrication of biomaterials with tailored properties for biomedical applications. Specifically, we focus on the synthesis and characterization of graphene-based coatings, bioactive glass nanoparticles, and mesoporous silica nanoparticles. These materials were chosen due to their potential for use in a wide range of biomedical applications, including wound healing, drug delivery, and imaging.

TOPOLOGICAL OPTIMIZATION OF MINING VEHICLE TYRE

Peter Müller[1a] , L Mthembu[1b]*

[1]*28 Pioneer Avenue, Florida, Roodepoort, 1709, Gauteng, RSA*

Abstract: Commercial tyres that are specifically designed for higher speed and on-highway tarred road conditions are currently being used on lightweight underground mining utility vehicles. This is due to there being no alternative tyres that are readily available and better suited for the application and mining environment. This research calls attention to the side effects and risks of using commercial tyres in mining environments. In this research, a topologically optimised tyre that better conforms with the design parameters of the mining vehicle is proposed and analysed using a model-based systems engineering approach.

FABRICATION OF FUNCTIONALLY GRADED MATERIALS THROUGH SEVERE PLASTIC DEFORMATION OF POWDERS: PROCESS, SIGNIFICANCE, AND FUTURE DEVELOPMENT

Obara Cleophas[1, a], Abiodun Bayode[2, b], Fredrick Mwema[3, 4, c*], Tien Chien Jen[3, d]

[1] *Department of Mechanical Engineering, Dedan Kimathi University of Technology, Nyeri, Kenya,*

[2] *School of Mechanical and Nuclear Engineering, North-West University, Potchefstroom, South Africa*

[3] *Department of Mechanical & Construction Engineering, Northumbria University, Newcastle, UK*

[4] *Department of Mechanical Engineering Science, University of Johannesburg, South Africa*

Abstract: Functionally graded materials (FGMs) are a spectacular invention in materials science and engineering, offering unique features useful in various applications. Having the capability to gradually alter features, like composition, microstructure, or mechanical qualities of materials, gives FGMs unparalleled adaptability, making them suited for a wide range of high-impact applications. One of the novel methods of creating FGMs is to use severe plastic deformation (SPD) techniques on powdered materials. The SPD of powders involves a few crucial steps. The process begins with selecting materials of varied compositions or phases and progresses to powder mixing, cold compaction, SPD methods, and, if necessary, heat treatment. The process is subsequently completed with characterization and testing, which evaluate the microstructure and characteristics of the final FGM formed. FGMs are set to continue transforming materials engineering and pushing the boundaries of their applications in many engineering fields and industries since they exhibit attractive capabilities like improved efficiency, durability, and performance. FGMs are primed to continue changing materials engineering and expanding their reach into innovations as research in this field continues. Therefore, this article explores the process of fabricating FGMs by SPD and emphasizes its significance, numerous applications in various industries, and future trends in FGM production.

INVESTIGATION OF AERODYNAMIC PERFORMANCE OF NACA 4412 WING WITH SURFACE ROUGHNESS

Yagya Dutta Dwivedi [1, a], Abdul Wahab[1, b], P Aditi Deekshita [1, c], and Akhil Shesham[1, d], Lovi Raj Gupta[2,e], Mohammed Ayad Alkhafaji[3,f]

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[3]National University of Science and Technology, Dhi Qar, Iraq

Abstract: Aircraft aerodynamic performance is predominantly reliant on wing flow, and several flow control techniques are employed in the aerospace industry to improve lift characteristics, drag reduction, and increased stall angle of attack. Present study aims to investigate the impact of surface roughness on wing aerodynamic performance through experimental method. By analyzing pressure and velocity changes across different angles of attack and two Reynolds numbers, the study provides a thorough understanding of flow behavior. Additionally, the research compares the aerodynamic characteristics of a NACA 4412 airfoil with both rough and smooth surfaces. Results demonstrate that the rough surface increases lift coefficient by 22%, reduces drag by 19%, and improves aerodynamic performance by 18%. The introduction of roughness augments turbulence, which helps maintain boundary layer attachment, delay stall and prevents flow separation, resulting in enhanced performance of the wing. The study suggests that this approach can improve the take-off and landing efficiency of low Reynolds number flights such as micro air vehicles, and ultimately increases fuel economy.

FABRICATION AND CHARACTERIZATION OF ALCRFECUNI HIGH ENTROPY ALLOY DOPED WITH (YX) VIA ARC MELTING TECHNOLOGY FOR ENGINEERING APPLICATION

P Mpofu[a]*, N Malatji[a], M.B Shongwe[a] and L.R Kanyane[a]

[a]Department of Chemical, Metallurgical and Materials Engineering, Tshwane University of Technology, P.M.B. X680, Pretoria, South Africa

Abstract: AlCrFeCuNi-(Yx) high entropy alloy (HEA) was fabricated using an arc-melting and casting process. The effect of Yttrium (Y) at varied atomic ratios on the microstructural evolution and Nano-mechanical behaviour of the synthesized HEAs was investigated. The HEA being studied proved to possess superior mechanical properties as compared to Ti64, Ni-based alloys and stainless-steel materials. The results show that Y incorporation in the AlCrFeCuN HEA matrix resulted in grain refinement. The results also show that Y addition resulted in increased microhardness from 550HV to a maximum of 772HV at 3at% Y.

MECHANICAL CHARACTERISTICS AND CRYSTALLOGRAPHIC TEXTURE OF AA5083 DURING EQUAL CHANNEL ANGULAR PRESSING TECHNIQUE.

Nagendra Singh[1,2], Manoj Kumar Agrawal[1]

[1]Department of Mechanical Engineering, GLA University, Mathura, UP, India- 281406

[2]Department of Mechanical Engineering, Institute of Engineering and Technology, Khandari Campus, Agra, UP, India- 282002

Abstract: AA5083 bars processed by four-pass ambient Equal Channel Angular Pressing were subjected to intersection annealing, where time and temperature were varied after each pass. The microstructures, texturing, and compressive characteristics of the samples were meticulously examined. Due to the high annealing temperatures, both ultimate tensile strength and compressive stresses decreased with increasing grain size. However, intersection annealing at room temperature resulted in the best compressive yield strength. The deformation behavior of AA5083 billets was investigated using finite element analysis. Electron backscatter diffraction was employed to examine the texture of the Equal Channel Angular Pressed billet crystals. Extensive research was conducted on the tensile properties and Vickers microhardness. The finite element simulations revealed that the 90^0 die exhibited a significantly more uniform dispersion of plastic strain compared to the 120^0 die. The renewal of additional slip mechanisms during the four-pass process was attributed to the grain refining that occurred after the 1-pass and 2-pass stages. Equal Channel Angular Pressing successfully produced a homogeneously ultra-fine-grained microstructure. The increase in strength was attributed to grain refining and dislocation strengthening. Molecular dynamics simulations were employed to study the ECAPed approach of AA5083, providing insights into the deformation behavior and polycrystal formation.

TECHNICAL SESSION 3

OPTIMIZATION OF WIRE-EDM PROCESS PARAMETER FOR MACHINING OF EN-24 STEEL IN TERMS OF SURFACE INTEGRITY AND MATERIAL REMOVAL RATE

Ajay Pal[1,a], Bipin Kumar Singh[2,b], P. Venkata Mahesh[3,c], Amit Kumar[2,d], Rakesh Kumar[4,e], Ashish Goyal[5,f*], Manish Gupta[6,g], Mohammed Ayad Alkhafaji[7,h]

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[6]Division of Research and Developments, Lovely Professional University, Phagwara, India
[7]National University of Science and Technology, Dhi Qar, Iraq

Abstract: Due to the increase in the application of super alloys, the machining of such materials is tedious task for the manufacturing industries. The machining of such materials requires huge cost that directly affects the cost of product. Furthermore, the optimized conditions that provide high material removal rate (MRR) as well as better surface integrity is indeed requirement. To postulate the optimized condition for EN-24 steel as work piece during machining on wire EDM are revealed in this study. The investigating parameter selected are peak current (Ip), pulse on time (Ton) and pulse off time (Toff) for maximum MRR and surface roughness. The investigation suggested peak current as highest contribution on the MRR and surface roughness. The optimal levels of parameters for MRR is Ip as 5 A, Ton as 20 µ sec, Toff as 15 µ sec, whereas, for surface roughness the optimum condition observed as i.e. Ip as 1 A, Ton as 10 µ sec and Toff 5 µ sec. The result also suggested that the contribution of current on surface integrity is high and minimum value i.e. 6.39 micron is observed at 1A, whereas, maximum MRR i.e. 7.701 mm3/min is obtained for pulse on time as 20 µ sec.

INFLUENCE OF ANNEALING TEMPERATURE ON THE CHEMICAL COMPOSITION OF COMPOSITE AL-SI COATING DEPOSITED VIA MAGNETRON SPUTTERING ON ZK60A

Ashish Kumar Singh[1,a], Nikolajs Glizde[2,b] and Konstantin Savkovs [3,c]

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[2] Faculty of Mechanical Engineering, Transport and Aeronautics, Institute of Aeronautics, Kipsalas street 6B
[3]Riga Technical University, Riga, Latvia, LV-1048

Abstract: In this paper, the effect of heat treatment temperature on the resultant composition of composite Al-Si coatings on ZK60A alloy investigated. The coatings were developed using magnetron sputtering deposition. These coatings can serve as an effective anti-corrosion barrier for Mg alloys in aqueous mediums. The magnetron target composition was 80% Al and 20% Si, while in the deposited coating, it was 78% Al and 18% Si, with the rest being atoms from the substrate. The as-deposited coatings had pores, and the Al-Si composite was deposited

in the form of globules. The sputtered coatings were subjected to heat treatment for 1.5 hours at 420 °C (HT1) and 350 °C (HT2). The ratio of elements in the heat-treated coatings changed significantly due to diffusion between the substrate-coating interface and migration through the pores that exist in the coating. It was found that Mg migrates into the coating and Si into the substrate. Al/Mg ratio was reduced by 81.2 and 60.6 %, respectively, in the coating after the HT1 and HT2.

SMART MATERIALS FOR SENSING AND ACTUATION: STATE-OF-THE-ART AND PROSPECTS

Toshit jain[1, a]*, B D Y Sunil[2,b], Mustafa Asaad Hasan [3,c] and Alok Jain[4,d]
[1]*Department of Mechanical Engineering, GLA University, Mathura, UP, India*
[2] *Department of Physics, Institute of Aeronautical Engineering, Hyderabad, Telangana*
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Abstract: This research paper provides a comprehensive review of the current state-of-the-art and prospects of smart materials for sensing and actuation applications. Smart materials, with their unique ability to respond to external stimuli, have been the subject of extensive research and development in recent years. The paper begins by discussing the various types of smart materials, including piezoelectric materials, shape memory alloys, and electroactive polymers, and their properties and applications in sensing and actuation. The paper then delves into the mechanisms and principles of sensing and actuation using smart materials, including how they can be utilized in various fields, such as robotics, healthcare, and energy harvesting. The challenges and limitations of these materials are also highlighted, and potential solutions and future directions for research are discussed. Furthermore, the paper covers the advancements in the design and fabrication of smart materials and devices, including the use of nanotechnology and 3D printing. The potential for integration with emerging technologies, such as artificial intelligence and the internet of things, is also explored. Overall, this paper provides a comprehensive and in-depth analysis of the state-of-the-art and prospects of smart materials for sensing and actuation applications. The research presented has significant implications for the development of next-generation smart materials and devices, with the potential to revolutionize various industries and improve our quality of life.

IN SITU TESTING OF MATERIALS: ADVANCEMENTS AND OPPORTUNITIES

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Abstract: In situ testing has witnessed a remarkable surge in popularity, reflecting the growing recognition of its significance in materials science and engineering. The ability to study materials in real-time under operational conditions has become a driving force in the field. From aerospace to energy and defense applications, in situ testing has emerged as a key tool for understanding materials behavior in extreme environments. Advancements in various in situ testing methods have opened new avenues for research. Strain measurement, deformation behavior, mechanical properties, microstructure, spectroscopy, electrochemistry, corrosion resistance, thermal stability, high temperature testing, fatigue testing, nanomechanics, non-destructive testing, and in situ microscopy are among the domains that have seen notable progress. These advancements provide opportunities to probe materials at the atomic scale and under realistic environmental conditions, enabling a deeper understanding of their behavior. The integration of advanced characterization techniques, including synchrotron radiation, X-ray diffraction, neutron scattering, scanning probe microscopy, and acoustic emission, has significantly enhanced the capabilities of in situ testing. These techniques allow researchers to explore the underlying mechanisms governing materials behavior and develop novel materials with tailored properties. In situ testing represents a powerful tool for comprehending materials behavior under extreme conditions and advancing the development of high-performance materials. By bridging the gap between laboratory experiments and real-world applications, in situ testing enables a more accurate understanding of material responses and facilitates the design and optimization of materials across various industries.

BIOINSPIRED COMPOSITES: LESSONS FROM NATURE FOR MATERIALS DESIGN AND PERFORMANCE

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Abstract: Bioinspired composites have become an increasingly popular area of research in materials science, as they offer a promising approach to developing high-performance materials. By drawing inspiration from the structures and properties of natural materials, researchers can design composites with enhanced mechanical, thermal, and other properties. This review article discusses the lessons that can be learned from nature for materials design and performance, with a focus on the structures and properties of biological materials such as bone, spider silk, and nacre. We explore the key mechanisms that give these materials their unique properties, including hierarchical structures, nanoscale building blocks, and interfacial interactions. By understanding these mechanisms, researchers can develop new materials with improved strength, toughness, and other desirable properties. We also discuss the potential applications of bioinspired composites in fields such as aerospace, engineering, and biomedical science. Overall, this review highlights the importance of nature as a source of inspiration for materials design and provides insights into the development of high-performance composites.

PROCESSING OF ADVANCED MATERIALS FOR NEXT-GENERATION ELECTRONICS AND PHOTONICS

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Abstract: Advanced materials play a crucial role in the development of next-generation electronics and photonics due to their unique physical and chemical properties. This review highlights recent advances in the processing of advanced materials, including two-dimensional materials, organic semiconductors, and perovskites, for their integration into electronic and photonic devices. Specifically, we discuss the methods of material synthesis, characterization, and device fabrication, as well as their applications in transistors, photovoltaics, light-emitting diodes, and sensors. We also address the challenges and opportunities associated with the development of advanced materials for the future of electronics and photonics.

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE FOR ADVANCED MATERIALS PROCESSING: OPPORTUNITIES AND CHALLENGES

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Abstract: This research paper explores the opportunities and challenges associated with the use of machine learning and artificial intelligence in advanced materials processing. With the exponential growth of data, advanced analytical techniques and powerful computational tools, machine learning and artificial intelligence can be leveraged to develop novel materials with tailored properties, enhance process optimization, and improve manufacturing efficiencies. However, the integration of these technologies into materials processing systems is not without challenges, including data acquisition and pre-processing, algorithm selection and optimization, and the interpretation of results. This paper provides an overview of the state-of-the-art in machine learning and artificial intelligence for advanced materials processing, highlighting case studies and examples of successful applications, and identifying potential future research directions. The goal of this research is to provide insights and recommendations to accelerate the adoption of these technologies and their impact on the development of advanced materials.

HIGH-SPEED MACHINING OF DIFFICULT-TO-MACHINE MATERIALS: STRATEGIES AND TOOLS

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Abstract: The research on high-speed machining (HSM) of challenging-to-machine materials has gained significant importance in the manufacturing industry, owing to the surging need for high-performance components. The processing of these materials poses considerable difficulties owing to their elevated strength, hardness, and thermal conductivity, frequently resulting in reduced material elimination rates, abbreviated tool longevity, and substandard surface texture. This paper provides an overview of the strategies and tools employed in HSM of challenging-to-machine materials, as well as the most recent advancements in this area. The significance of selecting suitable cutting parameters, such as cutting speed, feed rate, and depth of cut, is 18ynthesize due to their substantial influence on the machining process. The utilisation of sophisticated machining methods, including high-pressure coolant and cryogenic cooling, is also deliberated to augment the efficacy of machining. Furthermore, an examination is conducted on the diverse categories of cutting instruments employed in HSM of challenging-to-process substances, encompassing coated carbide, ceramic, and polycrystalline diamond (PCD) tools. The study examines the efficacy of various tool types and offers suggestions regarding their suitable application in diverse machining situations. In addition; it provides empirical evidence to showcase the efficacy of HSM techniques and equipment in processing challenging-to-work-with materials. The findings indicate that the utilisation of HSM can yield a notable enhancement in both the productivity and precision of the processing of challenging-to-cut materials. In general, the present study offers significant perspectives on the methodologies and instruments employed in HSM of challenging-to-process materials. This can aid manufacturing professionals and scholars in enhancing the machining procedure and devising novel machining approaches for high-performance constituents.

TECHNICAL SESSION 4

THE IMPACT OF POLYMER MATRIX TYPE ON THE OPTICAL PROPERTIES OF SILVER NANOCOMPOSITES

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Abstract: Nanocomposites materials of silver (Ag) with polyethene oxide, venal polyalcohol and polyvinyl pyrrolidone were synthesized by chemical reduction method using trisodium citrate (TSC) as a reduction agent. Silver based nanocomposites deposited as a film by drop-casting technique on (2x2 cm2) glass substrates. The effect of polymer matrix type on the optical properties (surface plasmon resonance, transmission and direct and indirect bandgap) were investigated. It was observed from the absorption spectra of the various synthesized materials that the type of polymer used in the preparation process significantly influences the location of the plasmonic absorption peak and the amount of the energy gap.

ENHANCED STABILITY OF A THREE-DIMENSIONAL GRAPHITE NANOSHEETS NETWORKS MODIFIED ASPHALT MIXTURE

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Abstract: To date, several concepts have been developed to enhance the mechanical and service life of asphalt pavements. Additives such as graphene, carbon nanotubes, carbon fibers and carbon black are used in the hot mix asphalt (HMA) or the asphalt binder (i.e., bitumen) for higher resistance to permanent deformations such as rutting, and transverse thermal cracking due to increased traffic volumes, vehicle mass and axle loads. In this study, graphite nanosheets (GNs) were used as potential modifier of bitumen binder in the HMA. The goal of this study is to use laboratory-compacted samples to examine how GNs modified bitumen affects the Marshall stability and flow of the asphalt mixture. The X-ray diffraction (XRD) study revealed a diffraction peak of GNs (002) at 2θ =26.5° along the bitumen's γ-band and 10-band, which confirm a successful dispersion of GNs into bitumen binder. Furthermore, morphological analysis showed formation of three dimensional (3d) interconnected networks of GNs between the bitumen micro-structures which could act as bridges for increased flexural strength of the binder. The results of the Marshall stability and flow tests show that the addition of GNs to the bitumen binder had an impact on the mechanical properties of the asphalt mixture. At 5% by weight of GNs modified bitumen (GNs-B), the compacted hot-mix Asphalt sample showed a higher Marshall stability of

11.7 kN recording 13.6% enhancement in comparison with the asphalt mixture with pure bitumen (P-B). In addition, when GNs-B was used, a lower flow of 1.4 mm was recorded which is desirable to prevent rutting and other forms of failure in asphalt pavements. This study underlines that adding GNs into asphalt binders such as bitumen could play a key role in enhancing the performance of asphalt pavements, which in turn extends their service life and saves maintenance expenses.

ECO-DESIGN OF PRODUCTS AND PROCESSES: PRINCIPLES AND TOOLS FOR SUSTAINABLE MANUFACTURING

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Abstract: Eco-design is a crucial approach in achieving sustainable manufacturing, which seeks to reduce the environmental impact of products and processes throughout their lifecycle. This paper explores the principles and tools that are used in eco-design, providing an overview of the key concepts and methods for sustainable manufacturing. The principles of eco-design are centered on minimizing the environmental impact of products and processes through the use of renewable resources, reducing waste and emissions, and improving energy and material efficiency. The paper discusses these principles in detail and highlights the benefits that can be achieved by implementing eco-design in manufacturing. The tools and methods of eco-design include life cycle assessment (LCA), design for environment (DfE), and environmental management systems (EMS) whereas DfE involves designing products and processes to minimize their environmental impact. EMS provides a framework for managing environmental performance across an organization. The paper also discusses the challenges of implementing eco-design in manufacturing, including the need for collaboration across different functions within an organization, the availability of data and resources, and the complexity of the supply chain.

SELF-HEALING MATERIALS: MECHANISMS, CHARACTERIZATION, AND APPLICATIONS

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Abstract: There is a category of materials known as self-healing materials, which are distinguished by their inherent capacity to mend themselves in the event of internal damage or fractures. Because it possesses a built-in healing mechanism, it possesses this one-of-a-kind power. This system can react to injury in methods that range encompassing chemical reactions, physical alterations, and biological processes. The need to extend the endurance and longevity of materials used in a variety of industries, such as building, transportation, and electronics, has been a driving force behind the creation of self-healing materials. The mechanisms that are used to research self-healing materials as well as the approaches that are used to 21ynthesized21 them, are discussed in this article. The many methods of self-healing, such as microcapsule-based healing, intrinsic healing, and extrinsic healing, are explored in this article. Intrinsic healing is also covered. In addition, the characterization methods that were utilised in order to evaluate the efficacy of the healing process, such as mechanical assessment, thermal evaluation, and microscopy, are discussed here. In addition, the prospective usage of self-healing materials in several industries, such as coatings, adhesives and related products composites, and biomedical devices, are addressed in this article. In this article, the advantages of using self-healing materials in certain applications are described such as an improvement in the materials' longevity, reliability, and sustainability.

ENERGY-EFFICIENT MANUFACTURING: OPPORTUNITIES AND CHALLENGES

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Abstract: The industrial manufacturing sector is the biggest final usage sector when speaking of both final energy consumption and emission of greenhouse gases (accounting for over 30% of the total); the industry's expansion is fast modifying the climate of the whole globe. Energy conservation is one of the key components of success for sustainable production because of the pressing need to reduce the negative effects that industrial operations have on the surrounding environment. As a direct consequence of this, the scientific community's involvement in energy management has significantly increased, which has resulted in a number of literature evaluations being conducted on methodologies. However, there is a dearth of both a detailed study of the techniques and tools that attempt to improve energy awareness as well as an assessment of the impact that these methods and tools have on energy efficiency. To try to fill this void, the author of this work conducts an extensive literature study on the various energy assessment methodologies and tools. After examining the databases of scientific literature, a total of 1366 publications were retrieved; however, it might be of use to industry practitioners in the field of energy management. In accordance with the guidelines provided by ISO 50001, the procedures and instruments were 21ynthesized into three primary areas (namely, AAM which means analysis, assessment, and saving measures),

and the particular results important to each category were then 22ynthesized. In its concluding section, the article discusses problems and topics that still need to be addressed and offers proposals for new lines of inquiry.

GREEN MACHINING: ENVIRONMENTAL AND ECONOMIC IMPACTS OF CUTTING FLUID

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Abstract: Green machining is an emerging field that focuses on reducing the environmental impact of machining processes while maintaining or improving their economic efficiency. Cutting fluids are commonly used in machining operations to reduce friction and heat generated during cutting, but they can also cause negative environmental and health impacts. This paper reviews the environmental and economic impacts of cutting fluids in machining processes and presents various green machining techniques that can be used as alternatives to traditional cutting fluids. The paper also discusses the challenges associated with implementing green machining techniques and the potential benefits for both the environment and the economy.

COMPUTATIONAL ANALYSIS OF A CRUCIFORM TAIL CONFIGURATION ON A FIXED WING UNMANNED AERIAL VEHICLES

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Abstract: In the cruciform tail configuration design, the horizontal stabilizer (tail plane) is moved part of the way up on the vertical stabilizer (fin) to ensure that the tail should not be in the influence of downwash of the wing and the engine. The present work was undertaken to have an understanding of the flow pattern on both the elevators while having a good stall angle and adequate structural stiffness. The cruciform tail configuration was modelled, simulated and analysed. The design was simulated computationally using ANSYS and XFLR5 software and experimented using a low-speed wind tunnel. This configuration was used for an aircraft design to test the flight. The cruciform tail configuration had significantly good static and dynamic stability characteristics at low speeds when compared to the conventional configurations. The static longitudinal stability was found

good as the slope of coefficient of moment (Cm) and Angle of attack was negative. The dynamic stability in longitudinal and lateral found to be dampened in 10 to 12 seconds which was significantly good. This configuration has a 9% higher aerodynamic performance Cl/Cd ratio, and the coefficient of lift (Cl) found 0.6 and coefficient of drag (Cd) found significantly low 0.01. The airplane model with cruciform was found laterally and longitudinally stable in static as well as in dynamic conditions with full damping obtained within 12 seconds.

RAPID SOLIDIFICATION TECHNIQUES FOR METAL PROCESSING: MICROSTRUCTURE AND PROPERTIES

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Abstract: Rapid solidification techniques have gained significant attention in recent years due to their ability to produce metals with unique microstructures and properties that are not achievable through conventional processing methods. Rapid solidification techniques involve cooling the metal at very high rates, which leads to the formation of a fine-grained microstructure. This is in contrast to traditional processing methods, which typically result in coarse-grained microstructures. In this paper, we provide an overview of the various rapid solidification techniques that have been developed, including melt spinning, spray forming, and gas atomization. These techniques involve the rapid cooling of a molten metal by quenching it onto a rapidly rotating wheel or by spraying it onto a substrate. The cooling rate achieved through these techniques is typically in the range of 104 to 107 K/s, which is orders of magnitude higher than that achieved through conventional casting methods. The unique microstructure resulting from rapid solidification techniques has several advantages over conventional processing methods. The fine-grained microstructure leads to improved homogeneity, increased strength, and improved ductility. Additionally, the unique microstructure also leads to improved thermal stability and increased corrosion resistance. These properties make rapid solidification techniques particularly attractive for applications in aerospace, automotive, and medical industries. In this review, we also highlight recent developments in rapid solidification techniques and their potential applications. These include the production of high strength and wear-resistant materials for cutting tools, the development of lightweight alloys for aerospace applications, and the production of biocompatible alloys for medical implants. Overall, this review provides a comprehensive overview of the recent advances in rapid solidification techniques for metal processing and their potential applications in various industries.

ADVANCES IN DENTAL MATERIALS: BIOACTIVE GLASS AND CERAMIC COMPOSITES

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Abstract: In recent times, there have been notable advancements in dental materials, with particular emphasis on the progress made in the development of bioactive glass and ceramic composites. The unique capacity of bioactive glass to promote bone regeneration and repair has garnered significant attention. This has led to its widespread use in the field. The utilisation of ceramic composites as dental materials has exhibited favourable outcomes owing to their superior strength, biocompatibility, and aesthetic allure. The present review article provides an overview of the latest developments in bioactive glass and ceramic composites, encompassing their characteristics, manufacturing techniques, and employment in the field of dentistry. The present study will concentrate on the application of bioactive glass in the fields of restorative dentistry, bone augmentation interventions, and endodontic treatment. The utilisation of ceramic composites in implant dentistry will be examined, along with their prospective implementation in other dental contexts. This review aims to elucidate the difficulties that are linked with the utilisation of said materials, including their fragility and the requirement for meticulous handling, in addition to plausible remedies for mitigating these difficulties. The advancements in bioactive glass and ceramic composites possess the capacity to considerably enhance the results of diverse dental procedures, thereby furnishing patients with restorations that are more enduring, visually appealing, and biocompatible.

SMART MATERIALS IN BIOMEDICAL APPLICATIONS: CURRENT TRENDS AND FUTURE CHALLENGES

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Abstract: Smart materials have been revolutionizing the field of biomedical engineering due to their unique properties and capabilities. They are able to respond to various external stimuli such as temperature, pH, light, and magnetic fields, among others. In this review, we will discuss the current trends and future challenges in the use of smart materials in biomedical applications. We will focus on the different types of smart materials and their properties, as well as their potential applications in drug delivery, tissue engineering, biosensors, and medical devices. We will also discuss the challenges and limitations associated with the use of smart materials,

such as biocompatibility, stability, and scalability. Finally, we will provide an outlook on the future of smart materials in biomedical applications and the potential impact on healthcare.

TECHNICAL SESSION 5

EXPLORING THE FUTURE OF ADVANCED MATERIALS PROCESSING: INNOVATIONS AND CHALLENGES AHEAD

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Abstract: This research paper investigates the future of advanced materials processing, with a focus on the innovations and challenges that lie ahead. The study begins by exploring the current state of advanced materials processing and the latest trends in the field, including the use of advanced manufacturing technologies, such as additive manufacturing, to create complex geometries and novel materials. The paper then examines the challenges facing the field, including the need to develop new processing techniques that can handle a wider range of materials and produce materials with specific properties. The study also analyses the potential impact of emerging technologies, such as artificial intelligence and machine learning, on the future of materials processing. Finally, the paper concludes with a discussion of the key innovations and trends that are likely to shape the future of materials processing, including the use of sustainable materials, the development of new nanomaterials, and the integration of advanced sensors and data analytics into the manufacturing process. Overall, this research paper provides a comprehensive analysis of the future of advanced materials processing and highlights the critical role that innovation will play in shaping the field in the coming years.

SEMI-CLOSED-FORM SOLUTIONS OF THE VAN DER POL OSCILLATOR SYSTEM

Modify A. E. Kaunda

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Abstract: Second-order vector-valued nonlinear differential equations occurring in science and engineering have been considered, which generally do not have closed-form solutions. Explicit incremental semi-analytical numerical solution procedures for nonlinear multiple-degree-of-freedom systems have been developed. Higher-order equivalent differential equations were formulated, and then subsequent values of vectors were updated using explicit Taylor series expansions. As the time step tends to zero, the values of displacement and velocity

are exact in the Taylor series expansions involving as many higher-order derivatives as necessary. A typical second-order differential equation considered was the van der Pol oscillator. Further developments consisted of closed-form solutions of the van der Pol equation. What remains to be determined is the closed-form solution of displacement, which is being addressed. Further applications of the semi-analytical procedures to time-dependent systems should also include time-independent equations that are differentiable in terms of other independent variables, such as partial differential equations that have many independent variables.

BIOMIMETIC MATERIALS FOR REGENERATIVE MEDICINE: DESIGN AND APPLICATIONS

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Abstract: Bio mimetic materials have shown great potential for tissue engineering and regenerative medicine as they can mimic the natural extracellular matrix (ECM) of tissues and organs. The ECM is a complex network of proteins, glycosaminoglycans, and other bio molecules that provide structural support to cells and regulate their behaviour. Bio mimetic materials can be designed to replicate the biochemical and biophysical properties of the ECM, creating an environment that promotes cell adhesion, proliferation, differentiation, and tissue regeneration. There are different classes of bio mimetic materials, including natural and synthetic polymers, as well as inorganic materials such as Hydroxyapatite and ceramics. Polymers made from nature that assist with with cell growth and differentiation, like collagen, which is fibrin, and hyaluronic acid, for instance, have been utilised extensively in tissue engineering. Both the physical and chemical characteristics of synthetic polymers, which include polyethylene glycol, also known as PEG, and poly lactic acid (PLA), can be modified to satisfy the needs of different tissues. Inorganic materials such as hydroxyapatite and ceramics can mimic the mineralized ECM of bone and tooth tissues, providing a scaffold for cell attachment and mineral deposition. Recent advances in the field of bio mimetic materials include the use of nanotechnology and 3D printing to create complex structures with precise control over their size, shape, and mechanical properties. Nanoparticles and nano fibers can be incorporated into bio mimetic materials to enhance their mechanical strength, surface area, and bioactivity. 3D printing can be used to create customized scaffolds that match the shape of the target tissue, allowing for more effective tissue regeneration.

HYBRID WELDING TECHNIQUES FOR IMPROVED JOINT PERFORMANCE

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Abstract: The process of welding is extensively employed in diverse industrial sectors for the purpose of material joining. The integrity of components or structures is significantly dependent on the quality and performance of welded joints. Nevertheless, conventional welding techniques present certain restrictions, including reduced welding velocity, substandard joint characteristics, and deformation. Hybrid welding techniques have surfaced as a viable solution in recent times to address the limitations and enhance the joint performance. The present study provides a thorough examination of diverse hybrid welding methodologies, encompassing laser-arc hybrid welding, friction stir welding, and hybrid laser welding. The manuscript examines the operational mechanisms, benefits, and constraints of every method. Moreover, the paper presents findings from recent research studies that have examined the collective efficacy of these methodologies across various materials and contexts. The findings indicate that the utilization of hybrid welding methods has the potential to enhance joint performance through the improvement of mechanical properties, reduction of defects, and minimization of distortion. The manuscript additionally examines the obstacles and prospective avenues in the realm of hybrid welding. The research presented herein offers significant insights for both researchers and practitioners operating within the welding industry. Specifically, it provides guidance on the selection of optimal welding techniques for applications, as well as the optimization of welding parameters to enhance joint performance.

ADVANCEMENTS IN GAS TUNGSTEN ARC WELDING FOR AEROSPACE APPLICATIONS

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Abstract: Gas Tungsten Arc Welding (GTAW) is a widely used welding process in the aerospace industry due to its ability to produce high-quality welds. Recent advancements in GTAW technology have enabled the welding of new materials and increased efficiency in the welding process. These advancements include the use of advanced GTAW processes such as pulsed current and AC square wave welding, which have improved control of the welding arc, resulting in better penetration, reduced heat input, and minimized distortion. The development of new filler materials with improved properties has also enabled the welding of advanced aerospace materials such as titanium alloys and high-strength aluminium alloys. The use of robotic GTAW systems has increased productivity and reduced labour costs while maintaining high-quality welds. Advances in GTAW inspection methods, such as real-time monitoring and nondestructive testing, have improved quality control and reduced the need for destructive testing. These technological advancements have significant

implications for the aerospace industry. Improved weld quality has led to increased safety, improved durability, and reduced weight of aerospace structures. Increased efficiency and productivity have reduced manufacturing costs and increased the speed of aircraft production. The ability to weld advanced materials has expanded the design possibilities for aerospace engineers, allowing for lighter and stronger aircraft. In conclusion, the advancements in GTAW for aerospace applications have improved weld quality, increased productivity, and expanded capabilities for welding advanced materials, making it a crucial process for the aerospace industry.

MICROWAVE-ASSISTED SYNTHESIS OF TRIAZINE COVALENT ORGANIC FRAMEWORKS VIA FRIEDEL-CRAFTS REACTION FOR USE IN TREATING BRACKISH WATER

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Abstract: Water scarcity is becoming an ever-growing problem in society. This is all due to the rapid increase in human population, harsh changes in the weather climate. New approaches for treating and recycling brine water into freshwater instead of discharging are needed, significantly large reduction in energy usage and decreasing harmful impact to the environment must be achieved in brine recovery. This study aims to introduce green technology into the reclamation of brine water by use of covalent organic framework (COFs) materials which will be used as part of a novel triazine-based COFs material which can be used as a nanomembrane for desalination of brine water from water treatment plants at Umgeni Water. Current technological approaches used are inefficient and unsuitable in 3rd world, developing countries including the Republic of South Africa. This work focuses on a microwave-assisted synthesis involving Friedel Crafts reaction between monomers to yield a product of triazine-based covalent organic frameworks (COFs) membranes. To confirm the products high-resolution transmission electron microscopy (HRTEM), and carbon NMR (13C NMR) with peaks at chemical shifts of 131, 143 and 172 ppm, respectively. Fourier-transform infrared spectroscopy (FTIR) was employed and showed N-H stretches at a region of 3396 to 3050 cm^{-1} . The COFs that were successfully 28ynthesized are going to be incorporated on a polymeric substrate to fabricate a nanofiltration membrane and applied for nanofiltration or ultrafiltration purposes.

THE UTILISATION OF RICE HUSK ASH LEACHATES FOR THE SYNTHESIS OF ECOFRIENDLY GEOPOLYMERS

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Abstract: Geopolymers are inorganic polymers that are projected as feasible alternatives to Portland cement due to their lower CO2 emissions and high mechanical properties. In recent times however, their impact on other environmental indices such as abiotic depletion, fresh water toxicity, marine ecotoxicity, terrestrial ecotoxicity, acidification and human toxicity has become questionable, thus the need to investigate alternative ecofriendly precursors and activators. This work is aimed at manufacturing an eco-efficient geopolymer by utilizing biomass ash leachate as an alternative to the conventional alkali silicate solution. The leachate was obtained by soaking the rice husk ash (RHA) in a 10M concentration of NaOH solution and filtering to obtain a clear solution. The effects of the calcination temperature of the kaolin and the RHA content in the alkaline solution were investigated and a factorial design of experiments was developed considering three levels of calcination temperature (700oC, 800oC and 900oC) and five levels of RHA content (0g, 5g, 10g, 15g and 20g). Physical and mechanical tests were performed on the synthesized geopolymer pastes as well as chemical and analysis using x-ray diffraction and x-ray spectroscopy. The impacts of replacing the synthetic alkali silicates with rice husk ash-based activators were compared. The results showed that the calcination temperature of the kaolin and the content of the RHA both contributed significantly to the flexural and compressive strength at the 0.01 level of significance. A compressive strength of 10.4Mpa was obtained for the MK915 binders which are a 100% increase from samples without RHA content. The results of this research prove that utilizing RHA-based activators in metakaolin-based geopolymers can be feasible for less critical applications where a very high compressive strength will not be required.

FEM ANALYSIS ON THERMO-MECHANICAL BEHAVIOR AND EXPERIMENTAL VALIDATION OF AL20CR20FE25NI25MN10 HIGH ENTROPY ALLOY DURING SPARK PLASMA SINTERING

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Abstract: A fully thermal-electrical-mechanical coupled and dynamic finite element model (FEM) is applied to analyse of the temperature and stress distribution in spark plasma sintering (SPS) process of Al20Cr20Fe25Ni25Mn10 high entropy alloy (HEA) via COMSOL Multiphysics 5.3a. The FEM focused on the effect of holding times while keeping temperature, pressure and sintering rate constant. The microstructural evolution and densification validation experiments are implemented to validate the simulation results. The detailed microstructure analysis showed that the computational temperature and stress distribution attained in the present FEM are related. The results showed good particle to particle necking at 12min holding time.

However, a further improvement on the developed model is still needed for more precise prediction of microstructural evolution in different SPS conditions.

TECHNICAL SESSION 6

OPTIMIZATION OF BAR SOAP EXTRUSION PROCESS PARAMETERS THROUGH NUMERICAL MODELLING

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Abstract: Soap plodder is a mechanical device used in the soap production process to refine, homogenize, and compact the soap. The mesh size of the refining screen, processing pressure, and length-to-diameter ratio (L/D) influence the plodder's refining capabilities and the resultant soap quality. The use of waste cooking oil is on the increase by most small-scale enterprises. However, the production is hampered by common quality problems such as grittiness, trapped air bubbles, and poor surface finish. The primary purpose of this research was to optimize the operating parameters of a soap plodder machine, notably screw length, screw speed, and density, to obtain maximum screw pressure while maintaining a low temperature. To achieve this, a finite element model (FEM) of soap plodder was developed using ANSYS Polyflow software. First, the rheological and thermal properties of the soap paste were determined using a rotational viscometer and transient hot wire method respectively. The obtained values for viscosity, thermal conductivity, and heat capacity were 900 cps, 0.0449 W/mK, and 17.29 J/Kg-K, respectively. An L9 Taguchi design of experiment (DOE) was then adopted for the FEM simulation for three distinct levels of screw speed (20, 35, and 50 RPM), screw lengths (300, 550, and 800 mm), and density of the soap products (200, 550, and 900 kg/m^3). The analysis of variance (ANOVA) and Taguchi optimization modelling was then adopted for analysis. The ANOVA indicated a positive correlation between the pressure of the extrudate and the three parameters under investigation: screw length, screw speed, and density. Specifically, an increase in these parameters leads to an increase in extrudate pressure. The density parameter was shown to have the most significant impact on temperature. The optimum conditions were attained as follows: a screw length of 800 mm, a screw speed of 50 RPM, and a material density of 900 kg/m^3. The resulting response consisted of a pressure of 4.3604 bar and a temperature of 315 K. The observed responses would guarantee an optimal pressure within the soap plodder, hence enhancing the refining, homogenization, and utilization of a small mesh-size screen to facilitate improved soap processing. The low temperature will eliminate the necessity of utilizing a cooling jacket, hence resulting in a decrease in both the expenses associated with construction and operation.

CERTAIN INVESTIGATION ON FEASIBILITY OF DEVELOPING RISER LESS DUCTILE IRON CASTINGS

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Abstract: The solidification mechanism of ductile iron is a bit complex due to the precipitation of graphite and silicon. These elements change the solidification pattern of cast iron. The density of these elements is less than iron leads to occupying more volume, consequently increasing the overall metal volume. There are two aspects on this increase in metal volume. One is, reducing this volume increase to reduce the creation of porosities at the earlier stage of solidification and second is, using this volume increase to remove porosity at the later stage of solidification. Proper understanding of this graphite expansion in cast iron solidification will bring insights on reducing or removing of the risers. The current study focus on correlating the net contraction and austenitic liquidus point with shrinkage. The average contraction found through this study is 1.36 % which is more than the net expansion of 0.25 % (without riser) reported in literature.

MICROSTRUCTURAL CHARACTERISTICS, HARDNESS AND TRIBOLOGICAL BEHAVIOR OF ADDITIVE MANUFACTURED CM247LC NICKEL SUPER ALLOY

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Abstract: Nickel superalloys are being used in applications subjected due to its excellent creep and oxidation behavior. The CM247LC nickel-based super alloy is considered due to its exceptional combination of high-temperature strength, creep resistance, oxidation/corrosion resistance, and mechanical properties suitable for applications, particularly in the aerospace industry. Though, unfavorable tribological behavior is the primary challenge in gas turbine applications. Nickel-based superalloy CM-247LC was manufactured through laser powder bed fusion process under two different conditions. X-ray diffraction analysis (XRD) was carried out to study phases present in as-built CM247LC alloy. Microhardness and tribological characteristics were investigated on the as-built alloy. XRD spectrum was predominantly observed with γ and γ′ peaks. The presence of γ′ and MC carbides offered strengthening to the as built CM247LC alloy, which enhanced the hardness and tribological properties. The wear rate of samples gets increased with an increase in load applied during the wear test. Worn-out surfaces were examined and it was observed that the predominant types of wear mechanisms as adhesion and abrasion.

DESIGN OF THERMAL ENERGY STORAGE SYSTEM

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Abstract. The paper concentrates on the design of a sensible thermal energy storage system. In a process plant, steam is used to create vacuum in a pressure vessel. Thereafter, steam is exhausted to the environment in a carbon steel pipe. A thermal energy storage system is designed to partially absorb the wasted energy and to store the energy in a tank. Dowtherm, a popular heat transfer fluid is chosen as the energy storage medium. A bolt-on heat exchanger is used to transfer heat from the steam pipe. The heating mechanism and thermal energy storage is modelled using MATLAB. The basic energy storage system is designed by employing engineering standards, alternatives, and constraints.

STUDY ON SEISMIC PERFORMANCE OF REINFORCED CONCRETE HIGH-RISE BUILDING WITH BUCKLING RESTRAINED BRACES DISSIPATION DEVICES

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Abstract: Performance-based Seismic Engineering is the modem approach to Earthquake Resistant Design to control lateral deflection and inter-story drifts. It is a significant challenge to overcome in the execution of high-rise buildings. Since structures are subjected to lateral loads, the Utilization of dissipation devices such as the bracing, shear wall, and dampers are a possible method to enhance the structural performance of the high-rise building under load cases. These cases are varying to static and dynamic ones as Response Spectrum. Properly designed and detailed structures with dissipation devices have exhibited excellent performance during a severe earthquake. Lateral forces due to will be resisted in its plane. In continuation studies of reinforced concrete structure compared to the absorbing devices, three essential reinforced concrete buildings were taken for analysis G+ 30 floors to cover the broader spectrum of high-rise building construction. Software ETABS carried out seismic analysis through Response Spectrum Analysis. The result highlights how structural damper systems perform much better than other systems with accuracy and exactness through the parameters of Displacement, Drift, Base shear, and Stiffness. Damper structures are more suitable for high-rise buildings and earthquake zones due to this study's results; maximum height of systems could be possible, which must be economically less expensive than steel structure of the same height.

INVESTIGATE THE EFFECT OF PROCESS PARAMETERS FOR WELD BEAD DURING ARC WELDING PROCESS

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Abstract: This investigation focused to analyze the effect of welding parameter like groove angle, current and thickness on the Rockwell hardness at weld bead after welding of mild steel plate using Arc welding process. An attempt has also been made to optimize the input parameter in order to achieve highest Rockwell hardness. The analysis revealed that the maximum Rockwell hardness was observed for low thickness plate. The result was dedicated to development of fine particles at the weld bead high rate of cooling. The research also revealed that the hardness value at the weald bead was high for larger value of groove angle compared to low groove angle. This happened due to formation of fine particles at the weld bead during welding of high groove angle alongside effective cooling rate. The hardness also increases regardless of the current value so, to control the hardness at weld bead the impact of groove angle may be considered as a significant parameter.

MICRO-MILLING OF MICRO-STRUCTURED SURFACES: CHALLENGES AND OPPORTUNITIES

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Abstract: The fabrication of micro-structured surfaces is becoming increasingly important in many industrial sectors, including microelectronics, aerospace, and biomedical engineering. Micro-milling is one of the most widely used techniques for the production of such surfaces. However, the process of micro-milling poses significant challenges due to the small feature sizes involved, leading to difficulties in achieving the desired surface quality, accuracy, and productivity. This research paper explores the challenges and opportunities associated with micro-milling of micro-structured surfaces. It highlights the fundamental aspects of the process, such as the selection of cutting tools, machining parameters, and surface characterization techniques. The paper also discusses the challenges that arise during the process, including tool wear, tool deflection, and surface roughness. Furthermore, the paper presents various approaches that have been developed to overcome these

challenges, such as tool path optimization, tool compensation, and hybrid machining techniques. The paper also discusses the opportunities presented by micro-milling, such as the ability to produce complex and functional micro-structured surfaces. This paper provides a comprehensive overview of the challenges and opportunities associated with micro-milling of micro-structured surfaces.

IMPACT OF STACK LENGTH ON PERFORMANCE OF STANDING WAVE THERMOACOUSTIC REFRIGERATOR

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Abstract: The low coefficient of performance of thermoacoustic refrigerators has limited their development. The goal of this paper is to investigate the effect of different stack lengths on standing wave thermoacoustic refrigerator (TAR) performance. The stack is essential in the TAR because it expands the gas-solid interface, allowing for a greater temperature difference between the warm and cold regions. Hence literature studies on stack length, geometry, plate spacing, and material have been investigated. Three numerical modelling geometries were simulated using COMSOL Multiphysics 6.0 to determine an effective TAR design. A quarter wavelength resonator tube was built using a 2D axisymmetric model. The acoustic wave and energy fields in solids were studied using conjugate heat transfer, with the flow type considered laminar and helium as the working gas. The optimal TAR design was chosen based on the lowest temperature difference between the three simulated geometries. Seven numerical models were simulated for stack lengths ranging from 15 mm to 45 mm, revealing that COP increased as stack length decreased, while the temperature difference decreased.

*****END *****

THE DEPARTMENT OF MECHANICAL AND MECHATRONIC ENGINEERING POST GRADUATE STUDIES

The department of Mechanical and Mechatronic Engineering is divided into the fields of Mechanical Engineering and Mechatronics. The Mechanical Engineering qualification concentrates on the areas of mechanics, fluid mechanics, strength of materials and thermodynamics, while mechatronics is an inter-disciplinary field that combines traditional disciplines of electrical, electronic, mechanical, control and computer engineering skills to solve problems that bridge the boundaries between these disciplines, which requires multi-skilled students.

Mechanical Engineering as a career

In Mechanical Engineering the technician or technologist works closely with the Engineer to ensure that the engineer's design is realised in practical terms. The main duties of the Mechanical Engineering technician will be to liaise with management and the workshop. The Mechanical Engineering course produces Technicians with knowledge of economic design, planning and production.

Mechanical Engineering technicians form a vital link in industry where designs are to be successfully implemented. They are employed by consultants, contractors and in the public sector. Due to the versatility of the Mechanical Engineering syllabus students have been placed in:

- mining companies
- automotive factories
- engineering and production workshops
- building service contractors
- consulting engineers.

The technician could be involved in a combination of any of the following functions:

- setting out of work on site.
- designing and detailing of mechanical equipment
- contract planning and supervision
- quality control of material testing and non-destructive testing
- drawing up of contract documents
- drawing office supervision.

Mechatronics as a career

A mechatronic engineer is a

- broadly skilled individual
- willing to seek and apply knowledge from many fields
- to design, specify, manufacture, commission, operate and maintain
- intelligent electro-mechanical systems that perform a specified task.

Where do our graduates find employment?

- home to farm automation
- from marine to aviation
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