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Numerical Modeling and Simulation of Rocket Trajectories with Atmospheric and Orbital Considerations Using MATLAB and Simulink

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ABSTRACT

This paper presents a comprehensive approach to simulating rocket flight trajectories using MATLAB and Simulink, focusing on the modeling of forces such as atmospheric drag, thrust, and gravity, which influence the rocket's motion. The primary objective is to compute the rocket's position, velocity, and key orbital parameters over time, while considering factors like atmospheric density variations and Earth's curvature. The simulation results, including time histories of position, velocity, and orbital elements, are analyzed to evaluate the rocket's ascent, burnout, and orbital insertion. The findings highlight the evolution of the rocket's trajectory and orbital parameters, demonstrating the effectiveness of the integrated MATLAB and Simulink simulation model for trajectory prediction in space missions.

Supersonic Flow: Advanced CFD Analysis of Convergent-Divergent Nozzles

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ABSTRACT

This study investigates the intricate dynamics of supersonic flow through a convergent-divergent (CD) nozzle using Computational Fluid Dynamics (CFD). CD nozzles, fundamental to jet propulsion systems, facilitate the acceleration of fluid from subsonic to supersonic velocities by converting pressure and thermal energy into kinetic energy. The research explores the nozzle's geometric optimization and its impact on flow parameters such as pressure, velocity, temperature, and density. Employing advanced CFD simulations, the study provides a detailed analysis of the nozzle's performance, including shockwave effects and energy transformations. The findings highlight the critical role of CD nozzles in aerospace applications, offering valuable insights for improving thrust efficiency and supersonic flow stability.

Leveraging Graph Theory for Efficient Neural Network Optimisation in Image and Video Processing Tasks

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Graph theory has emerged as a powerful tool for optimizing neural networks, offering structured approaches to enhance efficiency in image and video processing tasks. By representing neural networks as graphs, it becomes possible to analyze connectivity patterns, prune redundant connections, and optimize resource allocation. In this paper, various graph-based techniques have been explored, including graph convolutional networks (GCNs), spectral clustering, and graph-based regularization, to improve feature extraction and reduce computational complexity. Shortest path algorithms have been utilized for efficient data flow, spectral graph theory for dimensionality reduction, and modularity-based clustering for layer optimization. Experimental evaluations on benchmark datasets such as ImageNet and UCF-101 have demonstrated that graph-based optimization significantly reduces model complexity while maintaining or improving classification accuracy. The results highlight the effectiveness of these techniques in enhancing the efficiency of deep convolutional architectures, particularly in real-time image and video processing applications. By integrating graph-theoretic principles into neural network design, this paper contributes to the development of more interpretable, scalable, and computationally efficient AI models. These findings underscore the potential of graph-based frameworks in deep learning optimization, paving the way for more adaptive and resource-efficient neural networks.

A Systematic Review on Role of Artificial Intelligence for the Prediction of Construction Work

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ABSTRACT

India is an emerging nation with rapid development and ongoing projects where there is a growing demand for advanced technology to efficiently manage and optimize. Artificial Intelligence (AI), is therefore the most suitable form for its current use in developed country and developing country. In different construction areas, machine learning (ML) techniques have been used to characterise materials using image processing techniques, design concrete mixes using historical data, forecast labour behaviour, and forecast the properties of fresh concrete, hardening, and hardened concrete. Based on this study, a review of machine learning applications for concrete was conducted using to assess the key features of the literature. The ability of typical review studies to clearly and methodically

connect disparate parts of the literature is constrained. Among the most difficult elements of creative research are knowledge mapping, co-citation, and co-occurrence. The data needed to accomplish the study's objectives was found and retrieved using the Scopus database. Based on this review, a brief analysis of the research area's perspectives is given. The findings indicate that more machine learning applications can be expanded by using historical data from industry and scientific laboratory experiments to provide a comprehensive platform for predicting and evaluating concrete properties. It was discovered that using machine learning to model yields adequate accuracy while saving time and money for acquiring concrete properties.

Keywords: Artificial Intelligence, Machine learning, Concrete Technology, Construction work.

Dynamics and Stability Analysis of Wall-Septum Structures Inspired by Under Water Animal

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ABSTRACT

Nature has long provided novel solutions to engineering problems, resulting in designs that maximize durability, effectiveness, and flexibility. Cuttle bone due to its unique "wall-septum" microarchitecture, which offers remarkable strength and light weight distinguishes out among these. Because of this structure, the cuttle bone can withstand substantial amounts of hydrostatic pressure in deep-sea conditions. The engineering use of aquatic animal microstructures, such as cuttle bones, remains unexplored despite its potential. This study aims to fill this gap by examining the effects of additional horizontal planes on mechanical performance in wall-septum designs. In the current study modal analysis of wall septum has been carried out under various edge constraints to assess its dynamic behavior. In order to bring insight into energy absorption and structural stability, the study additionally examines at deformation patterns across modal modes. One of the other objective is to modify the structure by the inclusion of dfferent horizontal plane to improve natural frequencies, and decrease deformation. Epoxy carbon composites were used to create the structures because of their excellent strength-to-weight ratio and suitability for bioinspired designs. The results showed that mechanical performance was significantly enhanced by the addition of horizontal planes. Stiffness and natural frequencies were higher in structures with planes, indicating better dynamic stability. With more planes, deformation under compressive stresses decreased, but with higher modal modes, it gradually rose. These results demonstrate how bioinspired designs have the ability to improve performance without sacrificing light weight. In conclusion, this study demonstrates the transformative potential of mimicking the cuttle bone’s “wall-septum” architecture. Horizontal

planes are incorporated into these constructions to increase frequency responsiveness, decrease deformation, and improve stiffness. For sectors like aerospace and automotive, where lightweight, high-performance materials are essential, these developments offer insightful information. This work opens the door for further advancements in bioinspired engineering by filling the research gap in underwater animal-inspired designs.

DESIGN AND SIMULATION OF THERMAL ENERGY STORAGE SYSTEM WITH PHASE CHANGE MATERIAL

ABSTRACT:-

Inthecurrenttime,duetotheneedoftheenergyfortheworldandrestrictedquantityofthefossil fuels,itisnecessarytoutilizethealternateenergy.Fortheothersourcesofenergy,TheThermalEnergy Storage (TES) units are playingvery importantrole inmakingenergysystems efficient andeco-friendly, particularly when using renewable sources like wind and solar power. With integrated Thermal Energy StoragePhaseChangeMaterials(PCM),theresearchdiscussedintendstodesignandsimulateaThermal Energy Storage System (TES) that can absorb andrelease thermalenergy during phase transitions ofthe PCM,thusallowingthestorageoflargeamountsofenergywithsmalltemperaturedifferences.Thework focuses on the identification of suitable PCMs based on their thermophysical properties like the heat of fusion and the melting point. In this research Methylsilylidine(SiH3) is selected as a PCM because of its High Latent Heat of Fusion, Narrow melting temperature range and chemical stability. In this research work, an intensive numerical and simulation study is performed inside the cylindrical type heat exchangerwhichconsistoneinnertubefromwhichthewaterasfluidistransferredandonthewallof thistubeBranch-curvedshapedfinsaredesignedforenhancingtheheattransfer.Thevariousboundary conditions were applied on themodeled the structure of the cylinder where the heat transfer fluid (water)movesfromtheinlettotheoutlet.Thecomputationalanalysisisdoneonthe optimizedsizeof the mesh geometry and the complete model is divided into nodes and miniature elements. After completion of simulation the value of the volumetric fraction is 0.90341399. The investigation results suggest that the thermochemical systemsas well as heating and cooling energy storage systems based onPCMcanhaveimprovedenergystoragecapabilitiesandefficiencyinenergyapplicationswithregard to waste heat recovery, renewable energy sources use, and stabilization of the electric grid.

Design and Analysis of Cold Plates for Wafer Fabrication Equipment using Nanofluids

ABSTRACT

Cold plates are highly effective heat sinks used in electronic systems, particularly in semiconductor wafer fabrication, where precise temperature control is crucial for processes like ion implantation, deposition, etching, and lithography. By using liquid cooling, they can transfer heat four times faster than air cooling, ensuring the reliability and quality of semiconductor devices. Nanofluids, a blend of nanoparticles and base fluids like water and ethylene glycol, significantly enhance cooling performance due to their superior thermal properties. Despite their potential, the use of nanofluids as coolants in cold plates remains largely unexplored. A literature review on cold plates highlights the importance of design features such as ribs, fins, and dimples in the flow channels, which boost heat transfer efficiency. Building on previous studies, a serpentine channel cold plate with a rectangular cross-section was analysed, with a focus on a 6-channel Y-axis configuration. This design was validated numerically and showed excellent temperature uniformity. Further numerical studies explored how changing the channel's cross-sectional shape could improve performance, keeping the 6-channel Y-axis configuration as a reference. Nanofluids is numerically studied using the best performing cold plate out of the varied cross-sections for the flow path.

A review of surface modifications on metallic substrates performed by Colmonoy powders

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ABSTRACT

The present article concentrates on the review of the surface modification of metallic substrates through Colmonoy-based powders performed by utilising various surface engineering techniques. Colmonoy (a Ni-based alloy powder) coatings/cladding provide exceptional properties like mechanical and thermal stability and resistance to oxidation and erosion to the underlying base metal. The article reviews the improvement of substrate performance through Colmonoy-based powders by thermal spraying, laser cladding, and fusion welding-based surface modification techniques. The factors that play a role in the successful development of the coatings/ claddings were also discussed in this article. For example, the microstructure and adhesion strength of the fabricated coatings are mostly affected by factors such as powder grain size, spray distance, and substrate temperature. The microstructure and adhesion strength are influenced by coating process variables, such as particle size, spray distance, and substrate temperature. Colmonoy coatings are effective at lowering operating costs in different sectors, e.g. in the energy, automotive, aircraft industries, and also extending the life of components. The article highlights the importance of Colmonoy coatings/cladding in surface engineering. It offers useful insights for researchers and industry professionals looking to increase the durability and reliability of metal parts working in challenging environments using surface modification performed through Colmonoy-based powders.

Keywards: Colmonoy, surface engineering, coatings, microstructure.

Assessing the Impact of Vehicle Emissions on Urban Air Quality Using Moves and Amet

ABSTRACT

This research assesses the quality of urban air affected by vehicle emissions through the Motor Vehicle Emission Simulator (MOVES) and the Atmospheric Model Evaluation Tool (AMET). It emphasizes how emissions including nitrogen oxides (NOx), carbon monoxide (CO), hydrocarbons (HC), and particulate matter including PM 2.5 & PM 10, can reduce the quality of air and consequently pose a threat to human health. AMET provides validation of the estimated emissions from MOVES based on miscellaneous urban factors and MOVES simulations predict emissions according to such factors. The following are some of the findings which indicate that the latest technologies and policies such as Euro 6 and Tier 3 standards have resulted in reduced exhaust emissions. Nevertheless, hotspots persist in the urban environment and an increasing contribution from non-exhaust sources, and brake and tire wear, among them, require further activities. The variability of pollutants by season and space underlines the urban design and population measures, such as traffic control and low-emission zones. This paper calls for policy, technology, and urban planning intervention to address the problem of vehicular emissions in a bid to enhance the quality of air in urban settings.

Keywords: Motor Vehicle Emission Simulator (MOVES), Atmospheric Model Evaluation Tool (AMET), urban air quality, nitrogen oxides (NOx), particulate matter (PM2.5, PM10), non-exhaust emissions, emission regulations, sustainable urban planning, air quality modelling, public health risks.

Selection of optimum configuration of a novel vortex generator from among the considered configuration for the maximum thermo hydraulic performance

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ABSTRACT

This study focuses on selecting the optimum configuration of a novel vortex generator (VG) to maximize thermo-hydraulic performance in heat transfer applications. Several VG configurations are considered, and their effects on heat transfer enhancement and pressure drop are analyzed. The performance of each configuration is evaluated across different Reynolds numbers, focusing on parameters such as nusselt number, friction factor, and thermal-hydraulic performance. The optimum configuration is identified by comparing the overall performance coefficient, leading to a design that offers the best balance between heat transfer efficiency and flow resistance. Colburn Factor, Friction Factor, and Performance Evaluation Criterion (PEC) are the Heat Transfer factors that are being compared in order to determine the differences. The maximum Performance Evaluation Criteria should be determined by comparing the results of the experimental calculation of the maximum PEC with and without the redesigned rectangular winglet.

Keywords - Heat transfer performance, Novel vortex generator, Wind tunnel, Heat Exchanger.

Investigation of static behaviour of FGM sandwich conoidalshell with auxetic core

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ABSTRACT:

This paper investigates the maximum deflection behavior of functionally graded material (FGM) sandwich conoidal shells with an auxetic core. Auxetic materials, known for their negative Poiss on'sratio,areintegratedintothecoretoenhancethestructuralperformanceoftheshell.The samemodified powerlawused forfunctionally graded materials is adapted to model thematerial distribution within theshell, whilealso accounting forthe auxetic coreproperties.The governing equations are derived using an improved mathematical model tailored for FGM and auxetic behavior.Thefiniteelement(FE)

methodisemployedwitha9-nodeisoparametric.Thenumerical implementation of the improved model within the FE code allows for accurate predictions of the shell's deflection behavior. Results are compared with available data in the literature to validate the model. A detailed parametric study is conducted to examine the effects of the auxetic core, volume fraction index, and material properties on the maximum deflection of the shell. This researchprovideskeyinsightsintothepotentialadvanta gesofusingauxeticmaterialsinsandwich shells, contributing to the development of lightweight and efficient structural designs.

Estimating electric energy usage for electric buses using data under actual operating conditions

ABSTRACT

The main reasons for using electric buses are to reduce transit emissions, comply with the Kyoto Protocol, and mitigate the instability in oil prices. The government of India has also taken various steps through FAME-I and FAME-II policies, targeting 100 % electrification of vehicles by 2030. The smart city, Chandigarh, India introduced Eicher Skyline pro-E buses in the year 2021 and targeted 350 E-buses in the year 2027-28. It's crucial to assess the energy demand to plan and deploy large electric buses effectively. The actual driving conditions are the specific factor that influences a vehicle's energy consumption. In the present work, real-world data is used to investigate the energy consumption of electric buses of Chandigarh city. Microsoft Excel was utilized to analyse the collected dataset to predict energy consumption and identify the key factors influencing energy consumption. This investigation provides insights into the influence of vehicle speed on energy consumption and vehicle efficiency at different speeds. The application of the model is demonstrated in a case study to electrify the complete local bus network in Chandigarh city. The results show that 30-45 km/h is the ideal speed to minimise the energy usage. The average energy demand for a single electric bus is 0.576 kWh/km. Interestingly, energy usage increases significantly at speeds lower than 20 km/h, indicating inefficiencies at very low speeds.

An efficient nano-catalytic transesterification technology and optimization process of renewable diesel fuel synthesis from pure vegetable oils hybrid

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ABSTRACT

The commercialization of biodiesel as an indigenous fuel is hampered by a scarcity of readily available feedstock, as different feedstock types with varying qualities might be found in different regions. The possibility of bi-hybridization of linseed-baobab seed oil (LOBO) for biodiesel generation via transesterification reaction was investigated in this work employing CaO heterogeneous nano-catalyst generated from calcined seashells at 900oC (CS-CaO-900). RSM-CCD was utilized to analysed and adjust transesterification process parameters to maximize the yield. The best conditions initiated by the CCD were a molar ratio (MeOH/LOBO) of 18:1, CS-CaO-900 loading of 5.5 wt%, and a reaction period of 64 minutes, with an actual experimental yield of 94.04 wt% against a projected yield of 92.94 wt.%. The created model's significance was determined using an analysis of variance (ANOVA) at a 95% confidence level, with a probability value of 0.05 and a determination coefficient of R2 = 0.9758. The fuel qualities of the biodiesel produced were all within permissible limits set by ASTM D6751, EN 14214, and SANS 1935:2011. The study shows that feedstock hybridization is a viable technique for overcoming the constraints of feedstock supplementation and exploration in biodiesel development.

Keywords— biodiesel, hybridization, nano-catalysts, transesterification, optimization.

A Study of Mechanical and Dry Sliding Wear Behaviour of Prosopis Juliflora Fiber Reinforced Epoxy Composites

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ABSTRACT

Currently, natural fibre materials are gaining significant relevance. Currently, natural fibre materials are gaining significant relevance in industrial industries owing to attributes like as ease of fabrication, lightweight, and affordable production costs. Consequently, emphasis has been directed on the use of natural fibres in the manufacturing of fiber-reinforced composites. This research examined the performance of epoxy composites reinforced with Prosopis juliflora fibre (PJF) across many parameters. The composites underwent extensive mechanical and tribological examination. The tribological performance of the manufactured composite material was assessed using several process parameters, including sliding distance (1000-2000 m), applied load (15-45 N), and sliding velocity (1.0 m/s). The findings indicated that an increase in load correlates with a rise in wear loss under dry sliding conditions. The findings indicated that when the proportion of PJ fibre increases, wear loss diminishes. Scanning Electron Microscopy (SEM) was used to examine and suggest a possible wear mechanism for the fabricated composites by assessing the external morphology of samples post-wear testing.

Keywords: Natural fibres, Wear, SEM, Hardness, Tensile and Fracture analysis.

Experimental Investigation of Zinc Primer Epoxy Coating on SA516 Carbon Steel

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ABSTRACT

Epoxy coating is a long-lasting, protective material that keeps the external surface of carbon steel tanks from deteriorating. Superior resistance to abrasion, turbulence, strong chemicals, and extreme temperatures is provided by epoxy coatings. The ASME standard for carbon steel plates used in pressure vessels and boilers is SA516 Grade 70. A novel and activated zinc-rich epoxy primer was applied to SA516 Grade 70 carbon steel plates in this study. The total of six samples was subjected to coating with different thickness. The coating thickness of the carbon steel plates can be measured and confirmed using a dry film test. The adhesive pull-off test was used to assess how well the coating layers adhered to the steel substrate. In addition, a salt spray test was performed to evaluate the corrosion resistance of carbon steel's zinc-rich epoxy coating. Results suggested that a coating thickness of 36 microns produced the highest corrosion rate and adhesive strength.

Keywords: SA516 Carbon Steel; Epoxy Coating; Dry Film Test (DFT); Adhesive pull-off test; Corrosion rate

Experimental Investigation on Welding Characteristics of Aisi304 Steel Using GTAW Process

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ABSTRACT

Welding is a critical joining technique extensively employed in modern industries due to its ability to provide permanent and reliable connections in diverse applications. This study investigates the effects of Gas Tungsten Arc Welding (GTAW) on the microstructural and mechanical properties of austenitic 304 stainless steel. Welding was performed on a 12 mm thick standard test plate, adhering to optimized parameters that are crucial for achieving superior weld quality. The study emphasizes the role of essential welding variables in ensuring defect-free weldments with enhanced performance characteristics. The material's continued structural integrity during welding was highlighted by the discovery of twin boundaries inside the austenitic matrix, which was discovered by microstructural investigation. Tensile testing confirmed the strong mechanical capabilities of the weld with a yield strength of 248 MPa and an ultimate tensile strength of 546 MPa. A value of 361.4 HV was obtained from hardness measurements in the weld zone, which further supported the longevity of the weld joint. Additionally, under operational settings, the computed factor of safety of 1.52 confirms the weld's dependability. This study demonstrates how well GTAW produces high-quality welds in austenitic 304 stainless steel and provides important information for industrial applications that demand exceptional weld performance and dependability.

Keywords: Gas Tungsten Arc Welding (GTAW), Austenitic 304 Stainless Steel, Microstructural Analysis, Mechanical Properties, Weld Quality.

Experimental Investigation on mechanical and metallurgical characterization of 2014 and 2024 Aluminium Alloys using Friction Welding

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ABSTRACT

Welding is a fabrication process where two or more parts are fused together by means of heat and pressure. There are several types of welding used in the various fields. Friction welding is one of the types of solid-state welding and this is the most appropriate method without distortion of deformed microstructure. In this paper two dissimilar aluminium metal of two different grades, i.e. aluminium alloy of 2014 and 2024 are welded. An Aluminium alloy is an alloy in which aluminium is the predominant metal. The 2000 series aluminium alloys offer an increased performance both in static and dynamic conditions due to the presence of copper, chromium, magnesium and iron constituents. Aluminium alloys with the help of Friction Welding (FW) process which will enhance the performance of the components. Dissimilar metal joints have some advantages such as high functionality characteristics for the industrial usage. Heat is generated in between the workpiece because of friction. This type of welding is used in the fabrication of tubes, shafts, electronic module packaging, electronic technology, wind and solar energy management, mining and automotives as well as in the aircraft industries. The aim of this study is to improve the joint efficiency. Here the characteristics of the welded joint were analysed by mechanical testing like tensile test, Microhardness test and Metallurgical testing like Optical Microscopy and X-Ray Diffraction. The bond strength of the joints is determined by tensile test and layer thickness along the bonded zone.

Keywords: Solid state welding, Friction welding, AA2014, AA2024

Development of field repair schemes for composite structures for aircraft components

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ABSTRACT:

A significant drawback of FRP composites is their susceptibility to local damage during manufacturing or service life. The most significant applications of FRPs are in the aerospace and automotive sectors, where components made from FRPs are susceptible to damage caused by mechanical stresses and environmental conditions. If the material damage is not extensive, structural repair of FRP components is often the only feasible solution, as replacing the entire component is not cost-effective in many cases. One viable option for recovering the affected part is to use adhesive-bonded joints as part of field repair schemes. The primary objective of this paper is to address field repair schemes for composite structures. In this study, Glass Fiber Reinforced Plastic (GFRP) laminates were fabricated using the hand lay-up method. The GFRP laminates were constructed with plain weave glass fabric (200 GSM) as the reinforcement and epoxy laminating resin (LY 556/HY 951) as the matrix. These laminates are subjected to drilling-induced damage. After evaluating the extent of the damage, the affected area is reshaped into a defect free smooth circular through-hole with diameters of 10 mm, 15.5 mm, or 25 mm, depending on the damaged section. Suitable adhesive-bonded field repair schemes are then designed and implemented. The damaged area is filled using an epoxy resin mixed with glass micro-balloons as a potting compound. To validate the non-patch repair method, Compression After Impact (CAI) specimens were fabricated and tested according to ASTM D 7137 standards. The CAI test results indicate that the repaired specimens retained approximately 90% of their residual strength compared to the pristine specimens. Furthermore, the fracture analysis of the repaired sections revealed that the repaired zone can withstand compression-after-impact loads using the implemented repair schemes. In conclusion, the experimental study demonstrates that potting is an effective method for repairing composite laminates with damage up to 25 mm.

Keywords: FRP; Composite Repair; glass micro-balloon; Damage Investigation; CAI; Fracture Studies.

Enhancing Solar Panel Efficiency through Anti-Dust Coated Shielding: A Review

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ABSTRACT

Solar energy has become one of the most important renewable sources, and photovoltaic (PV) systems are often used to generate electricity. Now solar energy is widely used as a clean and sustainable power source in industrial and house hold applications. Nevertheless, environmental factors particularly dust accumulation have a major impact on solar panel efficiency. When dust accumulates on solar panels, it blocks sunlight and interferes with the photovoltaic process, which lowers the panels' power output. This problem is even worse in places with dry weather or high airborne particulate matter concentrations, like deserts or industrial zones. To lessen the negative impacts of dust collection on solar panels several analysis are conducted to improve the efficiency of anti-dust coatings. Anti-dust coatings can significantly enhance the efficiency and dependability of solar energy systems by reducing the damaging effects of dust build-up on solar panels. Recent developments in nanotechnology have also produced innovative coatings with improved adhesion and durability, which are viable options for maintaining solar panel efficiency over the long term. This study provides an in-depth analysis of the efficiency of anti-dust coatings. The mechanisms, characteristics, and application methods of several anti-dust coatings such as hydrophobic, super hydrophobic, and self-cleaning coatings are covered. The review also discusses the difficulties of applying anti-dust coatings practically, including issues with cost-effectiveness, compatibility with various solar panel materials, and durability in adverse environments. The effectiveness and durability of anti-dust coatings can be maximized by carefully planning the surface, applying the coating, and maintaining it regularly.

Keywords: Anti-Soiling Coatings; Dust Mitigation; Hydrophobic Coatings; Photovoltaic (PV) Efficiency; Solar Panels.

High Magnitude Deformation with Forced Cooling During Laser Bending of Duplex Stainless Steel

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ABSTRACT

The present study attempts to enhance the bend angle for laser bending of duplex stainless steel by increasing the temperature gradient with the application of forced cooling (FC) at the lower surface of the sheet. The effect of process parameters in both natural cooling (NC) and FC conditions is analyzed. These process parameters are optimized in order to get a higher bend angle. The optimized parameters are validated experimentally, and the changes in the mechanical and metallurgical properties of bent specimen are also investigated. The results show that the FC significantly enhanced the bend angle. The process conditions are optimized and successfully validated with experimental results. The bend angle achieved with these optimized conditions is upto 200 % higher than reported. The tensile strength and hardness of the bent specimen are found to be improved by 20.06% and 24.21% at the expense of ductility. The microstructure depicts the rearrangement of phases and refinement of grains.

Keywords: Laser bending, Duplex Stainless steel, Forced cooling, Optimization, mechanical and metallurgical properties.

Mechanical Properties and Microstructural analysis of Micro plasma arc welded ultra-thin steel sheets using GRA Technique

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ABSTRACT

Micro plasma welding is advanced technique to join thin sheet of ferrous and nonferrous material. It work on the principle of Plasma welding, which is fourth state of matter, produces very high temperature around 20000oC. To bring it to welding temperature cooling water circulated through the nozzle of the welding torch. Microplasma arc welding (MPAW) effectively overcomes the limitation posed by conventional arc welding process to join thin sheet. This experimental research work emphasizes on implementation of Taguchi - Gray relational analysis (GRA) technique to optimize the process parameters for multi output responses considering AISI 316L thin stainless-steel sheets of 0.5 mm welded through novel micro plasma arc welding to achieve strong weld and optimal mechanical properties. The welding input process parameters strongly influence the joint quality and dictates the service life of the final product. The experimental work was carried out using Taguchi's L27 Orthogonal array. Based on pilot studies factor levels were chosen in this experimentation. The properties evaluated were tensile strength, hardness and microstructural characterization. In this research study several output properties namely ultimate tensile strength (UTS), yield strength (YS), percentage elongation (% EL), modulus of elasticity (E), weld hardness at melt-zone (MZ) and heat affected zone (HAZ) were studied to optimize the parameters of micro plasma arc welding. The Confirmation test was performed on optimized weld process parameters and found that mechanical properties were enhanced, indicating the effectiveness of the optimization technique and resultant weld was free from defects, minimal distortion.

Key Words: MPAW, Hardness, Orthogonal array, Taguchi, GRA, Optimization.

Enhancing the Mechanical Properties of SLM Additively Manufactured 316L Stainless Steel Through Multi-Stage Post-Treatment Techniques

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ABSTRACT

Selective Laser Melting (SLM) is an advanced additive manufacturing technology widely used to produce intricate components. Despite its advantages, the process is often accompanied by challenges such as residual stresses, surface imperfections, and limited wear and corrosion resistance, which restrict its adoption in critical applications. This study explores the effects of a multi-stage post-treatment approach, combining solution heat treatment, cryogenic soaking, to address these challenges and enhance the performance of SLM-manufactured 316L stainless steel.

The results demonstrate significant improvements in mechanical properties, wear resistance, and corrosion behavior. Cryogenic soaking effectively improves surface finish by reduction in roughness value, enhances surface hardness and corrosion resistance whereas the solution heat treatment reduces dislocation density and refines the microstructure. Microstructural analysis using SEM and XRD confirms improved grain morphology and phase stability, correlating with the observed property enhancements. This research provides a scalable and effective methodology to overcome the inherent limitations of SLM-fabricated components, offering valuable insights for high-performance applications in aerospace, biomedical, and marine industries.

Keywords: Selective Laser Melting, 316L Stainless Steel, Cryogenic Soaking, Solution Heat Treatment, Wear Resistance, Corrosion Resistance, Additive Manufacturing

Role of Ferrous and Non-Ferrous Hardfacing Alloys in Improving the Abrasive Wear Resistance: A Review

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ABSTRACT

The degradation of metal parts and subsequent failure of industrial equipment remains a pressing concern for researchers. Wear-induced failure is a primary cause of equipment malfunction, affecting various sectors, including industrial, coal mining, and agriculture. While wear failure in industrial sector may take years to manifest, in agriculture and coal mining, it can occur within hours due to the abrasive nature of silica particles, which are often harder than the metal components. In the agricultural sector, earth-engaging equipment, such as tillage blades and harrow discs, are particularly susceptible to wear caused by hard soil and silica particles. To mitigate this issue, it is essential to develop strategies to enhance the lifespan of tillage tools. One approach is hardfacing, a surface engineering technique that involves depositing a wear-resistant alloy onto the surface of the tool. This paper explores the potential of hardfacing alloys to reduce abrasive wear on tillage tools, with a focus on ferrous and non-ferrous aspects of hardfacing alloys, e.g., their composition, microstructure, and mechanical properties.

Keywords: Wear, Hardfacing, Tillage blade, Microstructure

Parametric Optimization of CNC Turning for Machining Heat-Treated Tool Steel through RSM, ANOVA, and Multicriteria Decision-Making Approaches

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ABSTRACT

The excellent durability and wear resistance of heat-treated tool steel with a hardness of 58 HRC make machining it extremely difficult. Cutting speed (175, 225, and 275 m/min), feed rate (0.1, 0.2, and 0.3 mm/rev), and cutting angle (70°, 80°, and 90°) were chosen as the primary process parameters for the CNC turning used in this work. Tool-chip contact length, surface roughness, and cutting force were among the machining reactions that were methodically assessed. An L15 design of experiments (DOE) was created using a response surface methodology (RSM), which allowed for an effective investigation of the parameter space. To determine the importance of the suggested model and comprehend the impact of every parameter, an analysis of variance (ANOVA) was conducted. Multi-Criteria Ranking Algorithm Technique (MCRAT) and Ranking Alternatives by Pairwise Strategy (RAPS) are two multicriteria decision-making (MCDM) techniques that were used to optimise the input parameters for improved machining performance. By reducing cutting force and surface roughness and increasing tool-chip contact duration, both methods proved effective in producing ideal machining conditions. The suggested approach demonstrated a strong foundation for handling intricate machining optimisation issues, offering a significant understanding of how process variables interact when cutting materials with high hardness. In industrial applications, the results of this study help to advance precise and sustainable machining techniques for heat-treated tool steels.

Keywords: Hard material machining; Optimization; CNC turning; MCDM; ANOVA

ANN Based Voltage Regulation of DC-AC Converter Fed Drive System for Water Pumping Applications

ABSTRACT

This research explores the application of Artificial Neural Network (ANN) technology for voltage regulation in a DC-AC converter-fed drive system employed in water pumping applications. The primary objective is to enhance the adaptability and efficiency of the system under varying load conditions. The proposed ANN-based control mechanism is designed to autonomously learn and adjust to real time data, ensuring precise voltage regulation for optimal performance. Through rigorous experimentation and simulation, the developed ANN model demonstrates its capability to effectively regulate voltage, addressing challenges associated with fluctuating input conditions. The neural network's learning capacity proves essential in adapting to the dynamic nature of water pumping requirements, promoting stability in the drive system. The results indicate improved responsiveness, reduced energy consumption, and enhanced reliability compared to conventional control methods. This innovative approach aligns with the growing demand for intelligent and energy-efficient solutions in water pumping applications. The study provides valuable insights into the feasibility and advantages of incorporating ANN-based voltage regulation, paving the way for advancements in the design and implementation of DC-AC converter-fed drive systems for water pumping, with potential implications for broader industrial and renewable energy applications.

Keywords-ANN, Voltage Regulation, DC-AC Converter, Inverter control, Efficiency.

Analysis of Climate Change on High Mountains Asia and related Natural Hazards

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ABSTRACT

Climate change is a real problem faced by humans, It poses a significant threat to the ecosystem and endangers human life on Earth. Climate change takes place due to the increased emission of Green House Gases (GHG) such as Carbon Dioxide has led to warming of Earth. Although there are various implementations done by governments across the globe to counter the effects of climate change, there has not been any significant change that can reduce the emissions of GHGs. With rising temperatures, the melting of polar ice caps, leading to the increase in sea water levels, it is only a matter of time until climate change becomes irreversible. Climate change can disrupt biodiversity with many species being unable to adapt and survive in hotter temperatures brought about by climate change. In this review paper, a systematic analysis of climatic change and its impacts on ecosystems, human lives, et cetera., has been studied. This review primarily sheds light on High Mountain Asia, It focuses on important concerns such as glacial landscape dynamics, water scarcity, changes in weather patterns and risk analysis based on integration of glacial change rates at the annual scale and the GLOF risk analysis, addressing the direct and added impacts of natural disasters such as change to desert climate, or changing the coastal marshy areas, social and economic implications to the less developed regions. This review paper portrays the functionally dynamic zones of vulnerability and analyses the direct and added effects of natural disasters including a shift towards desert like conditions, degradation of coastal marshlands and the social and economic consequences for less developed areas.

Keywords: Climate Change, High Mountains, Extreme Weather Events, Climate Change Impacts, Natural Hazards

Numerical Investigation on Thermo-Mechanical response of L-shaped Multi-Layered deposited wall of Ti-alloy Under Varied Heat Input Conditions

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ABSTRACT

Residual stress evolution remains a major obstacle to the widespread implementation of Laser Direct Energy Deposition (LDED) for structural and aerospace applications. These stresses, primarily driven by steep thermal gradients from the localized heat source, compromise component integrity by inducing distortion, delamination, cracking, and diminished fatigue performance. This study leverages numerical simulations to predict residual stress formation in an L-shaped, multi-layered wall fabricated from α+β titanium alloy under varying process conditions. A sequentially coupled 3D finite element (FE) thermo-mechanical model, developed in ABAQUS®, is used to predict thermal fields, residual stresses, and solidification parameters during multi-layer deposition. The simulations consider two laser power levels (500 W and 1000 W) and two scanning velocities (5 mm/s and 10 mm/s), with other process parameters held constant. The five-layered build structure follows a defined deposition sequence, illustrated in Fig. 1. In addition to thermal and stress analysis, the study evaluates key solidification parameters, including the temperature gradient (G) and solidification front velocity (R), to determine cooling rates and predict microstructural features for both high and low heat input conditions. The results indicate that increasing the scanning speed from 5 mm/s to 10 mm/s intensifies residual stresses due to reduced melt pool dimensions and steeper thermal gradients. Conversely, higher laser power (1000 W) reduces residual stresses by expanding the heat-affected zone (HAZ) and decreasing thermal gradients. The estimation of solidification parameters reveals that low heat input conditions (500 W, 10 mm/s) produce higher cooling rates, favouring finer microstructures, while high heat input conditions (1000 W, 5 mm/s) result in lower cooling rates and coarser microstructures. This investigation establishes a detailed predictive framework for residual stress distribution, thermal behaviour, cooling rates, and microstructural evolution in WAAM processes. These findings provide actionable insights for optimizing process parameters to enhance the structural integrity, reliability, and performance of additively manufactured components.

Keywords: Laser Direct Energy Deposition (LDED) technique; multi-layer deposition; finite element analysis; temperature field; residual stress

Predicting Residual Strength in Pultruded FRP Bars Using ML

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ABSTRACT

Pultruded FRPs are one of the most applied composite components owing to their higher strength and rapid productions using automation. The applications include productions of bridge decks and swimming pool linings causing their significant exposure to moisture or hygrothermal conditions. This works reports the effectiveness of various machine learning (ML) models and ANN methods in predicting the residual strength of thus produced FRP composites subjected to hygrothermal conditions. Six ML regression models from linear, non-linear, tree, ensemble, support vector and Artificial Neural Networks (ANN) were tested for the best fit on eight features that includes fiber and matrix materials, fiber volume fraction, composite thickness in mm, tensile strength in MPa, ageing duration in hours, temperature in °C and relative humidity in %. R-Squared (R2), Median Absolute Error (MedAE) and Mean Absolute Error (MAE) were considered as the evaluation criteria for the ML algorithms. Models trained using GBR- boosted-by-Gridsearch presented the best fit of 0.99 on validation data set and Gradient Boost Regressor presented a fit of 0.93 on the test data set; which was followed by pristine and boosted Random Forest Regressor with the fit of 0.97 and 0.87 on the validation and test data sets respectively. Moreover, SVR presented a negative fit was improved by using GridSearchCV.

Keywords: FRP, AIML, Hygrothermal ageing, Residual strength, Composite materials

Tree and ANN based ML Models to Predict Residual Strength and Stiffness of Hygrothermally Aged FRP Composite Using Materials Informatics

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ABSTRACT

FRP materials are modern marvels that is changing the materials applications owing to their high strength and stiffness to weight ratio and corrosion resistance. However, their exposure to ambient conditions over prolonged period causes property deterioration that affects the load bearing capacities of the FRPs. A number of parameters such as reinforcement materials, weave pattern, stacking sequence, fibre volume fraction, number of plies, initial strength and stiffness, exposure temperature and relative humidity, test duration, saturated moisture content, and diffusivity affect the hygrothermal ageing and this work uses non-linear mapping of the above features to train the machine learning models. The work explores multi-layer perceptron which is ANN based ML model and tree-based models that includes Decision Tree (DT), ADA boost (ADA), Gradient Boost (GB) and Random Forest (RF) regressors to predict the target features for the data. Moreover, the models are hyper-tuned using gridsearch and cross validation. Mean absolute error (MAE), mean squared error (MSE) and R2 were the evaluation matrices, while the generalizability was tested in terms of coefficient of variation (CV). The train and test data were in the ratio of 70:30. Models trained using ANN- boosted-by-Gridsearch presented the best fit of 0.88 on validation data set and 0.95 on the test data set

Keywords: FRP, Machine Learning, Residual strength, Residual stiffness, Hygrothermal ageing

Multifunctional Coatings for Orthopaedic Implant Applications

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ABSTRACT

In biomaterials science, significant efforts are focused on the development of multifunctional coatings for metallic alloys to enhance the longevity and performance of existing implants. Ideal multifunctional coatings should promote osseointegration, reduce foreign body reactions, and prevent infections. Additionally, there is a growing interest in designing biodegradable coatings for temporary implant applications, such as fixation plates and drug delivery systems. Researchers worldwide are investigating innovative surface coatings and fabrication techniques aimed at creating bioactive surfaces that facilitate optimal integration between implants and bone. Tailoring and optimizing implant performance for both short-term and long-term applications remains a challenge. Although extensive research and development over the past few decades have addressed several issues, challenges persist. This review aims to explore various surface coatings developed to tackle these ongoing challenges in biomaterials science.

Key words: Biomaterials, Surface Coatings, Infection, Orthopaedic implants

Thermally sprayed nanocoatings for biomedical applications: A Review

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ABSTRACT

Thermal spray is a process which involves deposition of coatings of a melted material, such as metal or ceramic in the form of wire or powder, onto the surface of a targeted object to enhance its desired mechanical properties and protecting from rust or oxidation and biomedical applications. Nano-materials are used extensively in modern biomedical applications by providing advanced opportunities in diagnostics, therapeutics, and tissue engineering. The unique characteristics of nano-materials such as biocompatibility and tuneable functionality facilitate them to interact with biological systems. The nano-material used in biomedical should be easily adaptable, inert biocompatible, and mechanically robust but the ideal properties may vary depending on the specific application and patient needs. Nanomaterials have now been widely used for deposition of coatings for biomedical applications using thermal spraying process. In the pharmaceutical and medical industries, nano material with thermal spray coating has revolutionised the capacity to create customised products for patients. The type of nano materials employed in biomedical field determines its success. The present review paper highlights the most widely used coated nano materials for biomedical applications and briefly explain some of the real life applications of nanomaterial in biomedical field. The potential of coated nano materials in addressing complex issues of health care can be prospectively expanded further.

Keywords: Thermal spray, nano-materials, biomedical applications

A Review on Surface Modification of 3D Printed PLA/Hydroxyapatite Composite Scaffolds for Tissue Engineering Applications

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ABSTRACT

Modern lifestyles, unhealthy diets, and rising accidents have led to an increase in bone-related issues like fractures, osteoporosis, and decay. Tissue engineering (TE) offers a regenerative approach to addressing these problems by using biomaterial-based scaffolds that mimic the body's natural structure, promoting tissue growth and bone repair. These scaffolds, designed with porous and interconnected structures, support cell attachment, nutrient flow, and blood vessel formation. Advanced techniques like 3D printing allow customization of scaffolds for optimal porosity, strength, and functionality. Synthetic polymers like PLA are popular due to their biodegradability, safety, and adaptability, often enhanced with hydroxyapatite (HAp) for added strength. To improve scaffold properties further, coatings that mimic natural bone surfaces are applied, with the sol-gel method, dip coating etc., being effective. These processes offer strong adhesion, flexibility in composition, and cost efficiency while sealing porous surfaces and protecting against corrosion. This review highlights the potential of different coating techniques for developing the PLA/HAp scaffolds, discussing the improvement in their mechanical and biocompatible behaviour. Some recent publications reporting the surface modification of 3D printed PLA objects were also discussed.

Keywords: 3D Printing, Scaffolds, Tissue engineering (TE), PLA, Sol-gel.

Role of Thermal Spray Coatings in Different Sectors: A Review

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ABSTRACT

Thermal spray coatings are a versatile surface engineering technology widely adopted across diverse industrial sectors. This paper explores the multifaceted role of thermal spray coatings in enhancing the performance, longevity, and functionality of components in various fields. Firstly, the paper introduces the fundamental principles of thermal spraying and the diverse range of materials and processes employed. Subsequently, it delves into specific sectors (Aerospace Automotive, Energy Sector, Manufacturing and Machinery, Biomedical and Healthcare) where thermal spray coatings play a pivotal role. However this paper more focus on discussing the application of thermal spray coatings in power generation plants to combat high-temperature corrosion, erosion, and oxidation. By exploring various application examples and their associated benefits, the paper demonstrates the immense potential of thermal spray coatings in contributing to the advancement and efficiency of diverse sectors. Finally, the discussion concludes by highlighting future trends and potential areas of further development in thermal spray technology and its applications.

Keywords: Thermal spray coatings, Surface engineering, Corrosion protection, aerospace & Automotive, Energy Sector, Manufacturing & Machinery, Biomedical & Healthcare.

Performance of front axle constant velocity joint by using nano-coatings AlCrN and TiAlN with respect to abrasive wear.

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ABSTRACT

The sliding tribological performance of AlCrN (Alcroma) and AlTiN (Latuma) coatings by PVD DC Magnetron Sputtering deposited on EN-19 balls has been investigated using ball-on disk apparatus. Ball on disk tests were conducted at varied sliding velocities and by keeping load constant and vice-versa at ambient temperature without lubrication. The morphology of these coatings was evaluated by using SEM/EDAX. The results reveal hat AlCrN coating has good anti-abrasive properties as compared to AlTiN coatings.

Keywords: Nano-coatings, Tribology, SEM & EDAX

Exploring Ionic Liquids and Nanofluids as Sustainable Lubricants for MQL Machining: A Comprehensive Review

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ABSTRACT

In mechanical manufacturing, the emphasis on clean production and sustainable development has grown significantly and is now a global priority. These principles are essential to advancing modern research. Conventional cooling and lubrication techniques typically require a fluid flow rate of approximately 50-60 liters per hour. In comparison, Minimum Quantity Lubrication (MQL) reduces this dramatically to just 30–100 milliliters per hour, which is roughly one-thousandth of the conventional usage. This reduction not only enhances workplace safety and cleanliness but also reduces environmental harm. MQL stands out as a high-efficiency, eco-friendly machining approach, fully aligned with the objectives of sustainable and clean production. In recent years, the integration of advanced lubricants such as ionic liquids and nanofluids has further enhanced the effectiveness of MQL techniques. Ionic liquids, with their excellent thermal stability and lubrication properties, offer significant advantages in reducing friction and wear, even under extreme conditions. Similarly,

nanofluids, which are engineered by dispersing nanoparticles into base fluids, exhibit superior heat transfer and tribological characteristics, making them highly effective in improving machining performance. The use of these innovative fluids not only boosts the efficiency of MQL but also aligns with the principles of sustainability by minimizing resource consumption and environmental impact. Their adoption represents a promising step toward greener and more efficient manufacturing practices. This review highlights the potential of ionic liquids and nanofluids in MQL machining, emphasizing their role in enhancing performance while promoting sustainable and eco-friendly manufacturing practices.

Keywords: Minimum Quantity Lubrication (MQL), Ionic Liquids, Nanofluids, Sustainable manufacturing.

Investigations of Clamping Pressure in Laser Transmission Welding of Nylon-6 Sheets

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ABSTRACT

Clamp pressure plays a crucial role in laser transmission welding (LTW) as it ensures intimate contact between the components, facilitating efficient heat transfer and material fusion at the weld interface. However, scant research has been conducted to explore the impact of clamp pressure in LTW. This study presents the effect of clamp pressure in laser transmission welding (LTW) of Nylon-6 sheets. A dry graphite coating is applied at the interface to enhance laser energy absorption. Experiments are conducted using a fiber laser on 2 mm thick Nylon-6 sheets. The impact of varying clamp pressures on weld strength and weld width is analyzed. Tensile tests of the welded specimens are performed to measure the breaking resistance of the welded joints. In addition, the fractured surface is analyzed to evaluate the flow trajectory and bond morphology of the joints. The results show a maximum breaking force of 2987 N is obtained for a clamp pressure of 2 MPa. Weld strength increases with clamp pressure up to an optimal value but declines beyond this point due to the loss of molten polymer from the interface under excessive pressure.

Keywords: Laser; Transmission; Welding; Clamp Pressure; Nylon-6; Fracture Analysis; Bond Morphology.

Optimization of process parameter and characterization of laser cladded sample

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ABSTRACT

Laser cladding is an advanced surface engineering technique used to enhance the properties of substrates by creating metallurgically bonded coatings with superior wear, corrosion, and heat resistance. The process involves depositing a layer of material, often in the form of powder or wire feedstock, onto a substrate surface using a high-energy laser beam as the heat source. This study explores the influence of process parameters such as laser power, scan speed, and material composition on coating quality and performance. Key findings demonstrate that optimized laser cladding produces dense, defect-free coatings with enhanced hardness and wear resistance, making it highly suitable for applications in aerospace, automotive, and tool manufacturing. Analytical techniques including microstructural analysis and mechanical testing further validate the effectiveness of laser cladding in extending the service life of components under extreme conditions.

Enhancing Aerodynamic Performance of NACA 2412 Airfoils through Surface Bump Optimization: A Computational Study

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ABSTRACT

This study investigates the impact of surface bumps on the aerodynamic properties of NACA 2412 airfoils at three locations along the chord (25%, 50%, and 75% from the leading edge). Computational fluid dynamics (CFD) simulations were conducted across a range of airspeeds from 10m/s to 40m/s at 0°, 5°, 10°, and 15° angle of attack to analyze flow behavior, velocity contours, boundary layer characteristics, and aerodynamic performance metrics. Results showed that surface bump location significantly affected airflow separation, with the 25% chord position exhibiting better flow stability compared to locations further downstream. Vortex formation and shedding were observed to intensify with higher angles of attack and velocities, impacting aerodynamic stability and control effectiveness.

Keywords: Bump parameters, Flow stability, Flow separation tendencies, Computational fluid dynamics (CFD), Aerodynamic performance metrics, Wake formation

A Review on Electrophoretically Deposited Composite Coatings on Cobalt-Chromium Alloys for Biomedical Applications.

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ABSTRACT

Composite coatings produced by electrophoretic deposition (EPD) have emerged as a versatile method to improve the surface properties of cobalt-chromium (Co-Cr) alloys, widely used in biomedical implants. Co-Cr alloys are known for their excellent mechanical strength, wear resistance, and corrosion resistance, making them ideal for load-bearing applications. However, their inherent lack of bioactivity limits effective integration with bone tissue. EPD facilitates the deposition of composite materials, such as hydroxyapatite (HA), polymers, and other bioactive agents, to enhance the bioactivity and compatibility of Co-Cr surfaces. This technique offers precise control over the coating's thickness, composition, and uniformity, enabling the development of customized coatings tailored to specific biomedical needs. Recent advancements focus on optimizing deposition parameters, introducing nanostructured materials, and employing hybrid composites to improve adhesion, mechanical durability, and osteoconductive properties. Laboratory studies demonstrate that these coatings significantly enhance osteointegration, corrosion resistance, and antimicrobial activity. While initial results from in vitro and in vivo studies are promising, clinical validation of long-term performance remains an ongoing challenge. This review highlights the potential of EPD-based composite coatings for Co-Cr alloys, discussing the materials, fabrication techniques, and their implications for advanced biomedical applications.

Keywords: *electrophoretic deposition, composite coatings, cobalt-chromium alloy, hydroxyapatite, biomedical implants.*

Refurbishment of ASTM A213 T11 Steel Boiler Tubes Affected by Erosion Using Advanced Coatings

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ABSTRACT

Erosion in industrial boiler tubes remains a significant challenge in power plants and other industries due to aggressive operational environments. This research investigates the effectiveness of advanced coatings for the refurbishment of steel boiler tubes affected by erosion. Three types of coatings—tungsten carbide, chromium carbide, and ceramic-based coatings—were evaluated for their performance under varied operational conditions. Results indicate that tungsten carbide coatings provided superior erosion resistance compared to the other types. This study highlights the potential of advanced coatings as a cost-effective solution for extending the lifespan of industrial boiler components.

Refurbishment of T-11 Steel Boiler Tubes Affected by Erosion Using Hardfacing Techniques

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ABSTRACT

Industrial components used in oil and gas transportation and storage often face significant erosion issues, leading to reduced lifespan. Boiler pipes, frequently exposed to such conditions, require special attention due to the high incidence of erosion-related failures, particularly in power plants. This study focuses on restoring ASTM A213 T11 steel boiler tubes affected by erosion using the hardfacing technique. Two types of electrodes, Mild Steel and THERMODUR-600 (SPL), were selected to evaluate the effectiveness of the hardfacing process on the steel material.

The findings reveal that hardfacing is an efficient method for repairing erosion-damaged pipes. Among the electrodes tested, THERMODUR-600 (SPL) demonstrated superior performance in mitigating erosion compared to the Mild Steel electrode. The study underscores the potential of using THERMODUR-600 (SPL) electrodes in extending the service life of boiler pipes exposed to harsh operating environments. This approach offers a practical and effective solution for addressing erosion issues, thereby enhancing the durability and reliability of industrial components critical to oil, gas, and power generation sectors.

Surface Texturing of Titanium Alloy Using Abrasive Water Jet Milling

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ABSTRACT

Titanium alloys are a type of biomaterial commonly seen in orthopaedic implants. Surface properties such as wettability and roughness are crucial for cell adherence, spreading, and proliferation at the implant/tissue interface, as they affect the biological response. Several surface texturing technologies have been developed to attain these properties for biomedical applications. These methods have constraints that limit their effectiveness, despite their potential. Abrasive water jet texturing could be a possible choice in this scenario. This study uses a controlled depth milling technique to use abrasive water jet milling to texture the surface of a Titanium alloy. Water jet pressure and traverse speed were taken as variable parameters, and the textured surface topography and contact angle were measured with a digital microscope. A contact-type roughness tester was used to measure the surface roughness. The obtained surface was hydrophilic, and the corrugated surface produced by the #80 abrasive particles used in the milling operation is appropriate for implant surfaces in biomedical applications.

Keywords: Implants, abrasive water jet texturing, surface topography, hydrophilic.

Analyzing the characteristics of SAE15B41 structural steel through varied Spherodizing Annealing Parameters.

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ABSTRACT

To identify and implement effective strategies to reduce the decarburization of SAE15B41 steel during Spherodise Annealing heat treatment processes. Decarburization, which is the loss of carbon from the surface of the material, negatively impacts the mechanical and magnetic properties of SAE15B41 steel, leading to decreased strength, hardness, and compromised performance in heavy duty applications. The challenge is to develop methods that minimize or prevent decarburization, ensuring the retention of optimal carbon content and desired properties in the steel. This requires a comprehensive understanding of the factors contributing to decarburization, such as temperature, atmosphere, time, and surface conditions. Solutions may include the development of protective atmospheres, innovative coatings, temperature control techniques, and surface treatments to mitigate decarburization and maintain the integrity of SAE15B41 steel during heat treatment processes. The successful reduction in decarburization will result in the production of high-quality SAE 15B41 steel with enhanced mechanical properties, meeting the demands of various industrial applications.

Keywords: Spherodise Annealing, decarburization, heat treatment, heavy duty application.

Strength Properties of Epoxy/Glass Fiber Reinforced hybrid laminate composites with Peanut Shell Powder/Coconut Shell Powder: An Experimental Study

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ABSTRACT

In this paper, the mechanical properties of hybrid laminated composites with peanut shell powder (PSP) and coconut shell powder (CSP) as fillers reinforced with glass fiber and using epoxy resin (LY556) with curing agent HY951 as matrix are studied. Hybrid limited composites were fabricated by using hand lay-up technique to evaluate the mechanical and morphology. The current study examines the impact of natural fillers, peanut shell powder (PSP) and coconut shell powder (CSP), on the mechanical strength and surface morphology of hybrid composites through experimental methods. Additionally, Characterization techniques, including Thermogravimetric Analysis (TGA), Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), and Raman Spectroscopy, were utilized to analyze the material properties and structural features. Furthermore, tensile and flexural tests were conducted to evaluate performance variations across two-phase and three-phase composites. Two-phase composites comprising epoxy, PSP, CSP, and their hybrid combinations were evaluated, it was observed that the tensile strength and flexural strength of epoxy was increased by 37% and 65% respectively, when using CSP fillers reinforced into the matrix. Additionally, for three-phase composites, glass fibers aligned at 90° and 0°, it was observed that the tensile strength and flexural strength of 900 fiber alignment was increased by 78.7% and 28.8% respectively, when using CSP fillers reinforced into the matrix. Similarly, for three-phase composites, at 0° fiber alignment, it was observed that the tensile strength and flexural strength was increased by 38% and 31.9% respectively, when using CSP fillers reinforced into the matrix. CSP fillers play a significant role in improving the tensile strength and flexural strength of the glass fiber reinforced hybrid laminate.

Keywords: Thermogravimetric Analysis (TGA), hybrid composite, laminated, tensile strength, flexural strength, peanut shell powder (PSP), coconut shell powder (CSP)

Hybrid Epoxy Composites with Pineapple Leaf Fibers and Nano Fillers for Sustainable Applications

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ABSTRACT

Pineapple leaf fibers (PALF) represent a promising sustainable composite material with significant market potential in sectors that prioritize eco-friendliness. The inclusion of pineapple fibers brings substantial benefits, improving both the sustainability and mechanical properties of the composites, including tensile strength and impact resistance, owing to their lightweight and renewable nature. Additionally, carbon fibers contribute exceptional stiffness, strength, and thermal conductivity, further elevating the overall performance of the composites. This paper likely investigates the formation of hybrid composites, combining PALF with carbon fibers to enhance their properties and broaden their application range. Additionally, the environmental benefits of utilizing natural fibers like pineapple not only contribute to sustainability but also reduce the overall weight of the composites, making them ideal for applications in automotive and aerospace industries.

Specifically, the study focuses on the development of advanced epoxy-based composites that incorporate Pineapple Fibers, Carbon Fibers, and Nano Fillers such as Carbon Nano Tubes (CNTs) and Graphene Oxide (GO). The incorporation of CNTs significantly enhances thermal conductivity and provides mechanical reinforcement, while GO improves thermal stability and interfacial bonding within the epoxy matrix. Furthermore, the incorporation of nanofillers enhances the interfacial bonding between the fibers and the matrix, leading to improved load transfer efficiency and overall structural integrity.

To ensure uniform fiber distribution and resin impregnation, the composites were fabricated using the vacuum bagging method. This study thoroughly examines the enhancement of the properties like mechanical and thermal properties, underscoring their potential for high-performance and sustainable applications in engineering. Moreover, the versatility of these composites allows for customization in various formulations, enabling engineers to tailor properties such as flexibility, impact resistance, and thermal stability to meet specific application requirements.

Keywords: PALF, Carbon Fibers, Nano Fillers, Vacuum bagging method and Property Enhancement.

Exploring Surface Preparation Methods for Improving Thermal Spray Coating Adhesion: A Review

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ABSTRACT

The coating is a widely used technique in aerospace, automotive, energy, biomedical, and manufacturing industries to enhance the surface properties of materials by depositing a coating layer to provide resistance to wear, corrosion, and other environmental factors. Depending upon the application, the coatings can be metallic, ceramic, polymeric, or a composite and have specific characteristics and performance under different operations. However, these coatings' quality and long-term performance heavily depend on the kind of bond established between the coating and the substrate. Further, Several factors influence the bonding of the coating to the substrate, such as material compatibility, process parameters, and environment. In this regard, surface preparation is vital in improving the bonding between the coating and substrate. In this direction, thermal spray coating is a popular method to improve surface properties. The adhesion strength of thermal spray coatings primarily relies on mechanical mechanisms, which are largely influenced by the morphology of the substrate surface. In thermal spray coating, grit blasting is widely utilized as a conventional surface preparation technique. However, grit blasting leads to material waste and generates a pattern on the surface that cannot easily be altered. In comparison to grit blasting, the use of enhanced surface preparation techniques, such as chemical etching, laser texturing, and plasma treatment, offer greater control and improved surface morphology to improve the adhesion of the coating substance; traditional and modern techniques, including mechanical methods, chemical treatments and advanced techniques like laser surface treatment. Therefore, the present review is focused on the various surface preparation methods investigated to improve the adhesion of thermal spray coatings.

Keywords: thermal spray coating, surface preparation, adhesion strength, grit blasting mechanical interlocking, advanced surface preparation techniques

Hydrodynamic influence on magnetic microsphere capture in a microfluidic liquid-liquid micro extraction system: An analytical modeling

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ABSTRACT

There are intriguing medical and biochemical applications of extraction and capture of biological molecule attached to functionalized magnetic particles in a liquid-liquid, stratified flow arrangement. An aqueous suspension of the magnetic particle-analyte conjugate can be extracted from the carrier to a non-carrier solution. The method of extracting bio-entities from one solution to another using the technology is elegant and noncontact. However, it is very sensitive to even the smallest changes in the magnetic or hydrodynamic operating conditions. Here, an analytical model is proposed for magnetophoretic transport and capture of micro-particles in a background liquid-liquid co-flowing streams. The system involves the flow of immiscible aqueous solutions of polyethylene glycol (PEG) and dextran (DEX) for a planar interface (as shown in figure). For a certain geometry and magnetic arrangement, the effect of altering the key fluidic parameters—such as the flow rates and viscosities of the two carrier liquids—on the particle movement is investigated. The capture efficiency (CE) that is mapped with the fluidic parameters, used to describe the device performance. It turns out that a new group variable K* correlates with CE. Additionally, the effects of fluid residence time, particle Reynolds number, and background fluid Reynolds number on CE and h are also determined. Results obtained from the study confirm that there is a momentous impact of fluidic parameters of the two aqueous phases on the extraction of the particles in the microfluidic device.

Optimization of refining system availability in a sugar plant using PSO algorithm

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ABSTRACT

This paper presents an analysis of the availability of the refining system in a sugar plant, consisting of four key components: the filter, clarifier, sulphonation unit, and heater. The modeling and availability study of the subsystems are conducted using Stochastic Petri Nets methodology. A licensed version of the Petri GRIF-Predicates software was used for the analysis. During the performance modeling, the failure and repair rates of the subsystems were varied within permissible limits to assess their availability. Maintenance priorities for each subsystem were determined using performance matrices. Additionally, the paper evaluates the impact of varying repair facilities on the overall performability of the system. To optimize the system, Particle swarm optimization was implemented using MATLAB software. This critical analysis provides valuable insights for maintenance engineers, enabling them to allocate repair resources based on the severity of subsystem failures.

Keywords: availability analysis, particle swarm optimization, refining system, sugar plant

Gelatin and Agar based Natural Coatings for Moisture-Resistant Composite Materials

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ABSTRACT

Coatings play a vital role in safeguarding composite materials against moisture, water, and toxic environmental contaminants, thereby significantly enhancing their durability. With the increasing adoption of natural fiber-based polymer composites, there is a growing need for biodegradable coatings to ensure sustainability. However, natural fibers often exhibit poor adhesion with polymer matrices and are highly susceptible to moisture absorption, which can result in mechanical and thermal stress failures. This study focuses on the development of two types of natural coatings: agar-agar-based and gelatin-based. The agar-agar coating was prepared using castor oil and calcium chloride solution, while the gelatin coating utilized a blend of aloe vera extract and tea water. Both coatings effectively minimized water penetration into the composite materials, with the gelatin-based coating demonstrating superior long-term water resistance due to its enhanced adhesion properties compared to the agar-agar-based coating. Surface porosity analysis and SEM imaging supported these findings. Biodegradation tests revealed substantial degradation of both coatings in an E. coli environment, confirming their biodegradability. The study underscores the potential of these natural coatings as sustainable alternatives to synthetic coatings. In particular, the gelatin-aloe vera coating demonstrated outstanding moisture resistance, establishing itself as a highly promising option for coating green composites designed for single-use disposable products. This aligns seamlessly with the goals of sustainable, clean, and eco-conscious manufacturing practices.

Manufacturing Bioceramic Scaffolds: Exploring DIW 3D Printing for Tissue Engineering Applications

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ABSTRACT

In recent years, notable advancements have been achieved in the domain of tissue engineering and regenerative medicine, presenting auspicious remedies for the management of diverse injuries and ailments. The management of bone injuries necessitates the implementation of a customized approach depends upon the specific nature of the injury. Tissue engineering plays a major role in the treatment of such bone injuries. One key aspect of tissue engineering is the development of scaffolds that can provide structural support and guide the growth of new tissue. The scaffold should possess mechanical properties that enable it to withstand weight-bearing stresses, resembling the strength and durability of real bone. This review explores the latest research findings from pioneering research papers in tissue engineering, focusing on scaffolds, bioceramics, and the various technique for the development of bio-scaffolds with a focus on 3D printing. By examining and synthesizing key studies in these areas, this review aims to provide insights into the current state of knowledge, identify research gaps, and contribute to the advancement of tissue engineering approaches for regenerative medicine applications.

Keywords: 3D printing, Tissue engineering, Additive manufacturing, Biomaterials, Scaffolds, Biomedical application

Optimization of refining system availability in a sugar plant using PSO algorithm

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ABSTRACT

This paper presents an analysis of the availability of the refining system in a sugar plant, consisting of four key components: the filter, clarifier, sulphonation unit, and heater. The modeling and availability study of the subsystems are conducted using Stochastic Petri Nets methodology. A licensed version of the Petri GRIF-Predicates software was used for the analysis. During the performance modeling,

the failure and repair rates of the subsystems were varied within permissible limits to assess their availability. Maintenance priorities for each subsystem were determined using performance matrices. Additionally, the paper evaluates the impact of varying repair facilities on the overall performability of the system. To optimize the system, Particle swarm optimization was implemented using MATLAB software. This critical analysis provides valuable insights for maintenance engineers, enabling them to allocate repair resources based on the severity of subsystem failures.

Keywords: availability analysis, particle swarm optimization, refining system, sugar plant

REAL – TIME ACCIDENT ALERTING SYSTEM USING CONVOLUTIONAL NEURAL NETWORK

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ABSTRACT:

The purpose of the research is to solve the problem by utilizing easily accessible devices and equipment in order to make a safety mechanism at a significantly reduced cost. The system offers one of its benefits, which includes a smart camera with wireless control, night vision, tracking, and human detection. This particular system utilizes night vision in the detection of minor and major traffic accidents on the highways. It then passes the information to the control room and transmits picture footage to the database for verification. The system is orientated to allow 360-degree sensing. It will be built with a time latency of at least 30 seconds in order to view the mishaps and establish that they were serious ones. This can be made to store the information onto the cloud without the problems of space mishaps of data loss. With the application of CNN's deep learning algorithm along with Python programming, it is possible to locate the accident location precisely and alert the emergency services immediately. This paper is focused on safety precautions taken once the accident has been detected. This means that there is a necessity to save precious human life by having this implemented in real life.

Keywords – CNN, Night vision, Smart camera, Cloud.

Role of Artificial Intelligence in Revolutionizing Manufacturing Processes

ABSTRACT

Today artificial intelligence (AI) is one of the transformational technologies used in manufacturing to transform conventional processes and create efficiencies, precision and innovation. In this paper, AI technologies are reviewed in combination with manufacturing, with case examples of their applications in automation, predictive maintenance, quality control, and supply chain optimization. AI also powers manufacturers to minimize downtime, improve product quality, and increase efficiency by using computer vision, machine learning and data analytics. The first study reviews how real world use of AI such as robotics for assembly lines, smart (i.e. sensor) systems to enable real time monitoring and AI based algorithms for demand forecasting have been deployed. The research also explores the biggest challenges of adopting AI, that being high implementation costs, workforce training challenges, and ethical issues.The potential of AI to reshape manufacturing paradigms, improve sustainability and competitiveness in an era of rapid industrial evolution is underscored in this paper. The results suggest a strategic approach towards embracing AI adoption, as an evolution of human expertise in a synergistic manner for achieving transformational outcomes is necessary.

Keywords: Artificial Intelligence (AI),Manufacturing processes, Automation, Predictive maintenance, Quality control, Supply chain optimization, Machine learning, Computer vision, Data analytics.Smart sensors

Experimental Investigation of Stellite-6 Hardfacing on Carbon Steel using GTAW & PTAW Processes

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ABSTRACT

Hard-facing is the technique of applying a welded metal layer by layer to a base material. It restores damaged surfaces by using various welding techniques to produce a build-up layer. The work focuses on using Gas Tungsten Arc Welding (GTAW) and Plasma Tungsten Arc Welding (PTAW) techniques to deposit the Stelllite-6 hardfacing layers on carbon steel specimens. The hardness of carbon steel's stellite-6 hardfacing was assessed using a Vicker hardness testing apparatus. Hardfacing specimens' wear behavior was evaluated using pin-on-disc. In addition, optical microscopy was used to discover the microstructural characteristics of stellite-6 hardfacing on carbon steel. In both PTAW and GTAW, hardness rises as the thickness of the weld deposit increases. Although dendrites

and interpenetrates with greater eutectic carbides are found in PTAW-processed stellite-6 hardfaced samples, their average hardness value is higher than that of GTAW-processed samples.

Keywords: Hardfacing, Gas Tungsten Arc welding (GTAW) & Plasma Tungsten Arc Welding (PTAW), Carbon Steel

Optimisation and Microstructural Examination of AISI 321 Stainless Steel Friction Stir Welding with Laser Assistance

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ABSTRACT

Owing to the significant studies conducted on Friction Stir Welding (FSW) since it was discovered in 1991, hybrid methods that combine other heat sources have evolved to expand its use to a broader variety of materials. One such hybrid technique is Laser-Assisted Friction Stir Welding (LAFSW), which offers fewer joint defects and less tool wear.
aiming to improve the traits AISI 321 stainless steel, this study analyses the implications of using laser aid as a secondary energy source in FSW. Using a Design of Experiments (DOE) approach, the influence of three critical process parameters—welding feed rate, laser power (W), and tool rotational speed (rpm)—on the weld's ultimate tensile strength (UTS) was looked at.
Microstructural analysis of the welded joints was conducted using scanning electron microscopy (SEM) and optical microscopy. The findings provide insights into optimizing process parameters to achieve superior weld quality and efficiency.

Keywords: Hybrid, Friction stir welding, Laser-Assisted, Thermally Assisted, optimization.

A Comprehensive Study On Challenges And Opportunities For Enhancing Professional Education Among Muslim Women

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ABSTRACT

This study focuses on the challenges Muslim women in India face when trying to pursue professional education. Despite progress in women's education worldwide, Muslim women in India still struggle with lower percentage of professional education. An attempt has been made in this study to find out the root causes for this phenomenon and also to identify possible measures to abate it. This research combines surveys and interviews with women between 18 and 35 age group in both urban and semi-urban areas, using a set of rubrics. The results pointed out to several factors such as economic hardships, cultural norms, early marriages and demanding family expectations, to be the root causes. Meagre government support and access to scholarships, especially in rural areas where transportation and educational facilities are lacking, too contribute to the lowered professional education rates among Muslim women. To tackle these issues, there's a need for government policy changes, better community support, and stronger educational infrastructure. On implementation of these changes, Muslim women could break free from the limitations of poverty and cultural inhibitions and gain better access to professional education, allowing them to not only improve their lives but also contribute to society as a whole. Thus, this study has explored the root causes for the low percentage of professional education among Muslim women and also suggests practical solutions for betterment of the same.

Keywords: Muslim women, education barriers, socio-economic, cultural norms, professional education.

A study on the influence of Cultural and Economic Barriers on the Career Progression of Muslim Women in Professional Education

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ABSTRACT

Socio-cultural and economic barriers hinder Muslim women's access to both education and career advancement, especially in conservative societies. This research was conducted to evaluate the influence of social and economic aspects, gender roles, family responsibilities, and societal expectations around marriage which might impact women's opportunities in their career growth. This research shows that these barriers affect women's pursuit of professional education and also impedes their long-term career progression. In spite of various initiatives such as scholarships and skill development programs by governments and NGOs, these efforts often fail to address the deeply rooted cultural norms that prevent Muslim women from advancing in their careers. Economic constraints, particularly in rural areas, further limit access to career opportunities and professional networks which in turn increases the difficulties women face in securing and sustaining meaningful employment. The study emphasises the need for more comprehensive strategies that not only offer financial aid but also focus on reshaping societal norms and providing career-focused support, enabling Muslim women to fully realize their professional potential.

Keywords: Socio-cultural barriers, Muslim women education, Career progression, Gender norms, Economic constraints.

Numerically anysis of hydrogen fueled scramjet with cavity injection

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ABSTRACT

Computing is used to assess the flow behaviour of a dual wall-mounted cavity in a strut-injector scramjet combustor under steady responding flow conditions. Two proposed designs with variable bottom walls with injection cavity depth and fixed top wall ramps are taken into consideration in addition to the baseline configuration according to DLR studies. The two-dimensional Reynolds Averaged Navier-Stokes method with the shear stress transport k- turbulence closure along with single-step reaction chemistry is used to compute steady-flow. The shadowgraph and wall pressure readings from DLR experiments are compared with the estimated flow patterns, density, pressure, and temperature fields. To examine the shock patterns and how they affect the shear layer mixing characteristics, the cavity and strut are installed downstream of the strut. The shadowgraph and wall pressure measurements from DLR experiments are compared with the estimated flow patterns, density, pressure, and temperature fields. With a slight increase in total pressure brought on by increased shock wave generation that emerges from the corners of the cavity and ramps, the cavity and ramp structure accelerates complete combustion relative to the baseline model. Due to strong interactions between the shock shear layers and the cavity, the combustion zone extends in the lateral direction when the shock train shifts downstream of the strut injector.

Keywords: Scramjet, strut injection, cavity flow, ramp, combustion efficiency, total pressure loss.

Comparative evaluation of Polylatic acid (PLA) Composites Reinforced with White Egg shell, White Marble dust and Walnut Shell powder

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ABSTRACT

The research work in this article was related with use of waste fillers like white egg shell generated by food sector, white marble dust powder produced during marble work and walnut shells thrown away after removal of walnut. The need of development of ecological composites and waste utilization was the motive in this work. The bio polymer polylactic acid (PLA) which was generated from corn starch, potatoes, sugarcanes or others biomasses selected for study and reinforced with White Egg shell, White Marble dust and Walnut Shell powder. The extrusion process was used to prepare thin filaments of 2.5%, 5% ,7.5% and 10% of each filler with PLA. The testing was carried out for hardness, melting point, tensile and flexural strength, elongation and water absorption. The results were compared to analyze the most influencing filler with respect to above properties. The hardness of PLA was improved from 84 ShD to 92 ShD with 7.5% of White egg shell powder (WESP) and 5% white marble dust powder (WMDP).The highest rise in the melting point of 152°C was observed in PLA with 10% white egg shell powder (WESP). The blending of walnut shell powder (WNSP) has positive impact and improved the tensile strength up to 44.12 MPa. The flexural strength of PLA was improved from 81.28 MPa to 93.56 MPa up to 5% of white egg shell powder (WESP). The maximum elongation of 24.17 % was observed for 7.5% walnut shell powder (WNSP). The maximum water absorption of 0.916 % was observed for 10% walnut shell powder (WNSP).

Keywords: Polylactic acid (PLA), White egg shell powder (WESP), White marble dust powder (WMDP), Walnut shell powder (WNSP)

A Comprehensive Overview of 3D Printing Evolution, Techniques, Materials, and Industrial Applications in the Modern Era

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ABSTRACT

Additive manufacturing (AM), commonly known as 3D printing, has witnessed remarkable advancements, transforming industries with its innovative technologies, materials, and optimization strategies. The evolution of AM technologies, such as fused deposition modeling (FDM), stereolithography (SLA), and selective laser sintering (SLS), has enabled enhanced precision, scalability, and applications across diverse sectors. Materials science plays a pivotal role in expanding the capabilities of AM, with significant progress in developing high-performance polymers, metals, ceramics, and composite materials tailored for specific applications. These material innovations address challenges related to mechanical properties, thermal stability, and biocompatibility, unlocking new possibilities in aerospace, healthcare, and energy industries. Furthermore, the optimization of process parameters, including layer thickness, build speed, and temperature control, has proven critical for improving part accuracy, surface finish, and mechanical strength while minimizing defects such as porosity and warping. The integration of advanced computational tools and machine learning algorithms has further refined these processes, enabling predictive modeling and real-time monitoring. These advancements collectively highlight the transformative potential of additive manufacturing in creating customized, efficient, and sustainable solutions, paving the way for future innovations in both industrial and academic realms.

Keywords: Fused deposition modeling (FDM), Stereolithography (SLA), Selective laser sintering (SLS).

Advancing Scalable Drone Detection Systems: A Review of Deep Learning Methods using RF Data

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ABSTRACT

The adoption of drones in urban environments has also sparked worries of the negative usage of the gadget; in prohibited regions such as airports, government offices, and occasions places. The identification and enumeration of unmanned aerial systems is necessary to respond to possible risks. One such method that is being progressively used is the Radiological Frequency (RF) to detect the signals used by drones in their special mode of communication. In recent years, the development of deep learning models contributed to the improvement of the accuracy and robustness of RF signal analysis. Lately, deep learning-based solutions for drone detection employing RF signals are in the limelight and their performance particularly in noisy and dynamic scenarios is reviewed in this paper. Among different architecture, CNN-RNN has better drone detection capabilities when coupled CNNs to perform spatial features of spectrograms and RNN including LSTM to conduct temporal patterns in RF signals. This approach gives more than 95% accuracy and almost equal to 0.94 F1 score which gives high reliability at high noise also. It doesn't produce many false positive decisions, can be easily extended as a framework and appropriate for 'big data' scenarios. Future research will be directed to the enrichment of the data base, the refinement of the model and the study of other complex combined techniques, which will lead to the improvement of the integration of (Unmanned Ariel Vehicle) UAV in the National Aeronautical Information Processing System (NAIPS).

Keywords – Drones, RF signal detection, Deep learning, CNN-RNN, Detection accuracy, Data sets.

Influence of Different Temperature Environments on the Impact Behavior of CARALL Fiber Metal Laminates

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ABSTRACT

Fiber Metal Laminates (FML) are hybrid composites that combine metal strength with the fatigue resistance of Fiber-Reinforced Composites (FRC). FMLs find a wider application in the aerospace and automobile sectors, often exposed to different temperature gradients. Laminate stability at high and low temperatures is of utmost importance for improved productivity. Therefore, the current work analyses the impact behavior of carbon fiber-reinforced aluminum laminates (CARALL) with different stacking sequences at high (180 □) and low (- 40□) temperatures. Four different stacking sequences were considered for the study with varied metal volume fractions as follows, SS1 - [C]12, SS2 - [A|C|A|C|A], SS3 - [C|A|C|A|C], and SS4 - A|[C]6|A). The results from the Charpy impact test demonstrated a significant influence of high and low temperatures on the absorbed impact energy of all the laminates. Also, the stacking sequences influenced the impact energy, the highest being SS2 laminate (7.44 J) and the lowest being SS1 (5.97 J) at room temperature. The increased energy absorption in SS2 laminates is attributed to the higher metal volume fraction (0.46), with aluminum ductility aiding energy absorption. However, higher temperatures reduced aluminum strength due to thermal softening and decreased interfacial strength of FRP resulting in a significant reduction of 19.2 % in energy absorbed (6.01 J). Also, lower temperatures reduced the impact energy by 9.4 % (6.74 J), which is attributed to the loss of aluminum ductility and increased FRP brittleness which enhanced crack propagation. The results obtained assist in the selection of an appropriate stacking sequence of CARALL laminates for a particular impact application based on thermal conditions.

Keywords: FML, CARALL, Stacking sequence, Impact energy, Temperature.

A centimeter-size (Ti 50 Zr 50)40-(Ni 33 Co 33 Fe 33) 60 high entropy alloy designed by multi-substitution

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ABSTRACT

High-entropy alloys (HEAs) are gaining attention as promising materials due to their outstanding mechanical properties and wide range of applications. This study explores the design and development of HEAs through a multi-substitution approach, with a focus on how different alloying elements influence the microstructure and mechanical properties. A sample with (Ti50Zr50)40(Fe33Co33Ni33)60 HEAs was synthesized and characterized. The impact of atomic composition on microstructure and mechanical properties was analyzed using techniques such as X-ray diffraction, SEM-EDS, and micro-hardness testing. The study also examines the prediction of crystal structures in HEAs based on thermophysical parameters (ΔSmix, ΔHmix, Ω, δ, VEC, δ'). The analysis indicates that HEAs with the composition (Ti50Zr50)40(Fe33Co33Ni33)60 are likely to form a bulk metallic glass. XRD analysis shows the formation of intermetallic compounds in these HEAs. SEM observations reveal a dual-phase microstructure, consisting of dendritic and interdendritic regions, with elemental segregation confirmed by EDS mapping. Vickers microhardness testing of the sample demonstrates a hardness value of 827.76 HV. Furthermore, these HEAs display an excellent combination of high hardness and low density, outperforming conventional materials in these properties.

Exploring Dramatic J-Aggregation of Butea Monosperma Dye on *Citrus Limon* Extract Capped CdS QD's Surface for Artificial Photosynthesis

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ABSTRACT

Surface functionalization is a promising and long-term strategy for modulating the surface properties of nanoscale materials. Cadmium sulfide (CdS) has long been recognized for its potential in photocatalytic applications under visible light. Given that photocatalytic activity is predominantly governed by surface characteristics, functionalization and passivation have emerged as highly effective approaches to tailor the surface properties of nanomaterials. In a recent study, our research group was the first to report the synthesis of CdS quantum dots (QDs) using *citrus limon* extract (CLE) as a novel capping agent. The present work investigates the interaction of Butea monosperma dye with CLE-capped CdS QDs, revealing a notable bathochromic shift in the

dye's absorption maxima towards the visible range, accompanied by a significant enhancement in absorption intensity. This shift is attributed to the J-aggregation of the dye molecules on the CLE-CdS QD surface. Furthermore, CLE-capped CdS QDs exhibited remarkable photocatalytic activity, demonstrating efficient degradation of methyl violet dye and substantial hydrogen generation via water splitting under solar irradiation.

Keywords: *CLE capped CdS; Surface functionalization; Butea monosperma; J-aggregation; Photo catalysis; Water splitting*

pH Dependent Potent Cocktail Approach of EDTA Ligand for CdS QD's Surface Passivation: A New insight on Effective Passivation and Enhanced Photocatalytic Activity

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ABSTRACT

Surface functionalizations of smart semiconducting materials are potentially advantageous to significantly optimize their optical and electronic properties making it collegial for device applications. Presence of dangling bonds, non-stoichiometry and voids leads to surface states that acts as trap state for electrons, holes or excitons and significantly affects the quantum yield. Surface functionalization is essential for maintaining the nanoscale characteristics of QDs and enhances their physicochemical properties. Effective passivation requires addressing diverse surface defects, including vacancies, interstitials, substitutions, and antisite defects. Since each defect type likely necessitates a specific ligand for optimal passivation, a "cocktail" approach employing a combination of ligands has proven successful in various systems. Previous studies have primarily focused on the synthesis of CdS QDs at high pH using Ethylene-diamine tetraacetic acid (EDTA) as a capping agent; however, no investigation has been conducted on the effect of pH on ligand passivation. The present study provides novel insights into the synthesis of CdS QDs via EDTA binding at low pH that effectively passivates surfaces through a cocktail approach. This work demonstrates the efficacy of EDTA-capped CdS QDs for photocatalytic hydrogen evolution and dye mineralization of methylene violet (MV). Notably, the photocatalytic activity was found to vary with pH, attributed to size-dependent effects resulting from the enhanced passivation of CdS QDs at lower pH through cocktail approach.

Keywords: *EDTA capped CdS; Surface functionalizations; Cocktail approach; Photocatalysis; Water splitting*

Carbon nanotube Effects on Fracture Behavior of CNT/Epoxy/ Aluminum Nanocomposite Adhesive Joint: An Experimentally

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ABSTRACT

This study, examines the influence of carbon nanotube (CNT) nanofillers on the fracture behavior of CNT/epoxy/glass nanocomposite adhesive joints through experimental analysis. The Mode-I fracture behavior was evaluated using double cantilever beam (DCB) and lap shear tests, performed on specimens fabricated with neat epoxy and CNT-reinforced epoxy adhesives bonded to aluminum substrates. DCB samples were prepared using CNT/epoxy adhesives in two configurations: randomly dispersed and aligned orientations of nanofillers. To achieve alignment of nanotubes, an electric field was applied by connecting the positive and negative terminals of a DC power supply to the aluminum substrates. The results revealed significant improvements in fracture energy, with the adhesive layer reinforced by randomly dispersed CNTs achieving a 42% increase and the aligned configuration achieving a 60% increase at 0.1 wt% of nanofillers. These enhancements were attributed to the improved bonding interaction between the epoxy resin and the nanofillers, highlighting the potential of CNT/epoxy/glass nanocomposites for advanced adhesive joint applications.

Keywords: Carbon nanotube (CNT), double cantilever beam (DCB), Lap shear, Mode-I Fracture behavior and Aluminum

Structural and Electrical Insights into Mn-Gd Co-Doped $Ba_{90}Sr_{10}TiO_3$ for Functional Applications

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ABSTRACT

Barium Strontium Titanate (BST) is a well-known perovskite material extensively studied for its excellent dielectric and tunable properties, making it suitable for applications in capacitors, tunable filters, and energy storage devices. However, the enhancement of its dielectric and electrical performance remains a focus of research. In this work, manganese (Mn) and gadolinium (Gd) co-doping were employed to modify the properties of Ba□□Sr□□TiO□ ceramics, aiming to tailor their

phase transition behavior, dielectric constant, and impedance characteristics for advanced functional applications. Mn and Gd co-doped BST (i.e. Ba□□Sr□□Ti0.94Mn0.03Gd0.03O□) ceramics was synthesized using the solid-state reaction route, employing metal oxides and carbonates as starting material. The mixed reactants were calcined at 1000°C for 12h, followed by compaction under a uniaxial pressure of 1GPa and sintering at 1200°C for 2h. The resulting pellets were coated with silver (Ag) paste electrodes and preheated at 200°C for 30 minutes to prepare them for electrical measurements. Dielectric properties as a function of temperature were investigated, revealing a phase transition temperature at 90°C, slightly shifted compared to undoped Ba□□Sr□□TiO□. Frequency-dependent dielectric constant and impedance were measured over a broad range from 20 Hz to 2 MHz, demonstrating enhanced electrical properties due to Mn and Gd co-doping. These findings indicate the potential of Mn-Gd modified BST for applications in capacitors and tunable devices.

Investigations on the Microstructure, Mechanical, and Corrosion properties of AZ91D/WS2 Composites Fabricated Through Ultra-Sonic assisted Squeeze Casting

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ABSTRACT

The AZ91 magnesium alloy, valued for its low density, high strength, and biocompatibility, is widely used in automotive, aerospace, and medical applications, though its poor corrosion resistance limits broader adoption. To address this, the alloy was reinforced with tungsten disulfide (WS□) particles (2.5, 5.0, and 7.5 wt.%) using ultrasonic-assisted squeeze casting. This method ensures uniform dispersion of WS□ particles, minimizing agglomeration and enhancing the composite's microstructure. WS□, known for its lubrication properties, forms a protective layer that reduces wear and degradation in corrosive environments, significantly improving corrosion resistance. Ultrasonic-assisted squeeze casting further refines the alloy's microstructure, promoting finer grains and more uniform distribution of elements, which aids in forming protective oxide layers to counteract corrosion and galvanic effects. Microstructural analyses revealed grain refinement and the presence of MgZn, Mg□Al□, Al□Mn□, and Mg□□Al□□ phases in the WS□-reinforced alloy. Mechanical testing indicated increases in tensile and yield strengths, with 5.0 wt.% WS□ showing the most notable improvements. Salt spray corrosion tests confirmed enhanced resistance, attributed to refined microstructures and protective oxide formation. Fractographic SEM analysis of fracture surfaces highlighted the impact of WS□ reinforcement on failure mechanisms. These findings suggest that WS□ addition, combined with ultrasonic processing, is a promising strategy for improving AZ91 alloy's mechanical and corrosion properties.

Keywords: Magnesium Composite, Ultrasonic, SEM, Salt Spray

Evaluation of Mechanical and Microstructural Attributes of Ultrafine-Grained Titanium Laminates Fabricated by LSEM

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ABSTRACT

Sheets of titanium alloy are widely used in the aerospace, medicinal, and automotive sectors. The creation of layered composites based on Ti/GFRP is one of the most demanding applications for these sheets. The difficulties of multipass processing with intermediate annealing make the production of titanium laminates for this use more costly and challenging than that of other metals. The current study uses a unique process based on Large Strain Extrusion Machining (LSEM) to create ultrafine titanium laminates in a single pass. Pure titanium (CP-Ti) and Ti–6Al–4V were used to create laminates. Metallurgical characterization using SEM/XRD/EBSD analysis is carried out to determine how various parameters affect the characteristics of laminates. Vicker's hardness tester is used for mechanical testing. The investigation clearly shows that, in comparison to the basic materials, laminates have a 23–54% higher hardness. The hardness of laminates may have increased as a result of changes in the material's crystallite structure caused by extreme plastic deformation. The surface's topography is viewed using scanning electron microscopy, and a roughness tester is used to measure the surface's roughness. X-ray diffraction was used to analyze deformation in various laminates. To determine the crystallographic details of the microstructure of laminates made by large strain extrusion machining, the sample was subjected to electron backscatter diffraction (EBSD).

Keywords: Strain hardening, Crystallite size, EBSD, Deformation, Hardness

Space based Solar Power: Opportunities and Challenges

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ABSTRACT

The modernization of the world is leading to inflated power demands. In order to fulfill the inflated power demands, the renewable energy resources like, solar energy, wind energy and hydroelectric power are being explored at many regions of the world. But the climatic and environmental conditions hinder their use in many places on the earth. In India, large solar panels at the rooftops witness the trend of society shifting to solar power. These solar panels are turning out to be one of the budget-friendly and environment-friendly alternatives for electric power demand. Only the day-time availability of sunlight and reduced efficiencies of the solar photovoltaic (PV) panels due to poor weather conditions reduce their power output. The present paper discusses the "Space Based Solar Power " (SBSP) in which all these problems can be avoided. This is a burning topic of research in major research institutions like NASA and European Space Agency (ESA). The research leading to reduction in the cost of space missions has triggered research in the field of SBSPT. This concept is now becoming feasible by sending flexible solar panels in space, which are then assembled there with the help of robotic arms. The solar power can be transmitted from space wirelessly in the form of microwaves or lasers. It offers advantages to avoid weather problems and power can also be obtained continuously round the clock. Major benefits and the major hurdles towards the SBSP are discussed in this paper.

Keywords: Smart materials, renewable energy, photovoltaic panels, solar power, space based solar power, microwaves.

AI-Driven Approaches to Advanced Material Design for Automotive and Aerospace Applications

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ABSTRACT

The integration of artificial intelligence (AI) in material design has transformed the automotive and aerospace industry. This study explores AI-powered innovations that accelerate the discovery, optimization, and deployment of advanced materials tailored for these industries. By leveraging machine learning (ML), deep learning (DL), and generative models, researchers can predict material

properties, design new compositions, and identify optimal candidates far more efficiently than traditional methods. This review integrates qualitative and quantitative data from academic studies and industrial applications, highlighting the transformative role of AI in enabling lightweight, high-performance materials with superior thermal and mechanical properties. The paper also addresses challenges such as data scarcity, model interpretability, and computational costs, while presenting emerging opportunities in AI-driven workflows and autonomous discovery pipelines. Ultimately, this work provides actionable insights for researchers, engineers, and policymakers aiming to harness AI's full potential in revolutionizing material science for automotive and aerospace applications.

Laser-wire interaction model for non-planar directed energy deposition

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ABSTRACT:

Laser-wire interaction (LWI) length influences wire melting and uniform layer width deposition. However, the significance of LWI length with bead width has not been studied due to the lack of a reliable method to calculate LWI length for the off-axial wire feed method. This work introduces an analytical model to predict LWI length at non-planar orientations using geometrical relationships. The model development considers laser beam diameter, wire thickness, wire feed angles, and substrate tilt angles. It discusses the trailing wire position on the substrate. The single layer was deposited to understand the effect of LWI length at non-planar orientations on bead width. The experimental findings reveal that the variations in substrate angles and wire feed angles influence the melt pool size and shape, influencing the bead width. This work is required to predict the melt pool characteristics to control the mechanical properties in a non-planar wire-based directed energy deposition process.

Keywords: Analytical model, Pulsed laser, Non-planar, Wire-DED, Additive manufacturing

Surface Treatments: Key Players in the Battle Against Material Degradation

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ABSTRACT

The service life of machine component working under severe environment is a major issue in the industries. Machine component material continually gets degraded due to friction in mating parts, impingement of sand or dust particles on the surface. In thermal power plants, higher temperatures further escalate the degradation and affect the life of the critical boiler parts/components. Rapid deterioration results in the unplanned shutdown. Therefore, research is being done to address the problem by developing materials and methods to shield the surface of the component from aggravating the rate of deterioration.The pertinent research has reviewed the developments and highlights in the current research on resistance to degradation, covering various degradation mechanisms, contributing variables, and corrective measures to mitigate the impact of degradation. Some issues and potential areas for development in the field of surface treatments have been highlighted in the review. It establishes a foundation for achieving the assessment of material degradation and extending the lifespan of machine parts.

Keywords: Degradation, Surface Coatings, Hardfacing, Microstructure, Microhardness

Image Data Compression In Astronomy: A Comparative Review Of Traditional and AI-Driven Techniques

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ABSTRACT:

Astronomy is the study of cosmic objects which led to countless astonishing discoveries beyond the Earth. The massive growth of image data in astronomy which are retrieved by modern observatories and space missions necessitates efficient data compression techniques to handle storage, analysis and transmission challenges. There are several gaps in numerous models which are available for image compression in astronomy that involve traditional methods, such as JPEG and wavelet-based methods, which continue to be widely used; however, advancements in machine learning and AI-driven techniques promise significant improvements in compression efficiency and preservation of data. In this paper, a comparison of the current AI-driven models and conventional models in terms of compression of astronomical image data is done which highlights their strengths, weaknesses, and suitability for handling large-scale astronomical datasets. Despite traditional techniques which perform better for specific image types, these techniques do have limitations when dealing with diverse and complex data. AI-driven algorithms outperform traditional methods in terms of image quality preservation at larger compression ratios, providing greater flexibility for large-scale data, but requiring complex implementations for computation. Conversely, Hybrid systems such as wavelet-based compressed sensing, et cetera, which combine the qualities of both traditional and modern methodologies, are deemed to be the most effective options for managing astronomical picture data in large-scale projects. The comparison of the three efficient models from traditional, modern, and hybrid methods provides a conclusion that each model is efficient for specific usages and is used for different purposes and the best of the three methods is deemed to be the hybrid method.

Keywords: Astronomy, Image processing, Image data compression, Artificial Intelligence

Development and Validation of a Predictive Model for Wear in Hydro-Turbine Materials Using Machine Learning

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ABSTRACT

This study explores the use of Random Forest regression for predicting mass loss in three materials—AISI 304 steel, Cr□C□-25NiCr, and WC-10Co-4Cr—subjected to varying slurry concentrations, impact angles, and velocities. A Taguchi L9 orthogonal array was employed to design the experiments, ensuring systematic variation of the input parameters. The dataset was split into training (80%) and testing (20%) subsets, with model performance evaluated using R^2 scores and mean squared error (MSE). The Random Forest model demonstrated high accuracy, with R^2 values exceeding 0.95 for all materials, indicating strong correlation between the input features and mass loss. Visual analysis of predicted versus actual values confirmed the model's reliability, showing minimal deviation. These findings suggest that Random Forest regression is an effective tool for modeling material degradation in various engineering applications, offering insights for future research into wear and erosion prediction.

Keywords: Random Forest regression, mass loss, material degradation, slurry concentration, impact angle, velocity, AISI 304 steel, Cr□C□-25NiCr, WC-10Co-4Cr.

Effect Of Stacking Sequence in Hybridization on Mechanical and Water Uptake Behavior Of Woven Flax/Hemp Laminated Composites

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ABSTRACT

In this work, investigation on the mechanical and water absorption properties of hybrid polymer composites, emphasizing their potential as sustainable materials for industries like automotive, aerospace, construction, and marine, where strength, lightweight, and moisture resistance are critical. Hybrid composites were fabricated using the hand layup method combined with vacuum bagging, incorporating woven hemp and flax fibers in two distinct stacking sequences: H/F/F/F/H and F/H/H/H/F. It was found that the stacking sequence significantly influences both the mechanical performance and water absorption characteristics of the hybrid laminates. Composites with hemp fibers in the skin and flax in the core exhibited enhanced tensile strength, impact resistance, and hardness. Conversely, configurations with flax fibers in the skin region achieved superior flexural strength and improved water absorption resistance, with a rate of 4.2%. This study highlights the role of fiber placement and hybridization in optimizing the performance of hybrid polymer composites for diverse applications.

Keywords: Hybrid composite, flax, hemp, stacking sequence, mechanical properties

Effect of Cryorolling with Annealing Treatment on Microstructure and Mechanical Properties of AZ31B Alloy

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ABSTRACT

Magnesium alloy possesses extensive uses across multiple industries, particularly in the marine, automotive, and aerospace sectors. Nonetheless, the alloy's limited use arises from its inadequate mechanical qualities, attributable to its coarse grain structure. Cryo-rolling is the principal method employed to augment the strength and hardness of a material while preserving its optimal ductility. This study aims to examine the application of cryo-rolling and annealing methods to enhance the mechanical and microstructural characteristics of the AZ31B alloy. Cryorolling was performed with two separate passes during the experimental procedure: 10 and 15 passes. The AZ31B alloy subjected to cryo-rolling and annealing was evaluated using Vickers hardness testers and tensile tests. The hardness value of the cryorolled sample enhanced by 28% than the basic material. The finer and more homogeneous grain structure was achieved in the cryorolled materials after 15 passes. The cryo rolling and subsequent annealing of the AZ31B alloy produced superior ductility in its mechanical properties.

Keywords: AZ31B alloy, Cryo rolling, Annealing, Microstructure and Mechanical Properties

Effect of Varying SiC Dispersion in Graphene reinforced hybrid aluminium nanocomposites: A Finite Element Analysis

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ABSTRACT

The study focuses on the effect of different silicon carbide (SiC) percentages on the mechanical properties on graphene-reinforced hybrid aluminium nanocomposite (GHANs) using the finite element method (FEM). Various proportions of SiC (0%, 5%, 10% and 15% by weight) and 1% graphene Nano-platelets are incorporated to evaluate the effects on different mechanical properties. In this analysis, an in-depth modelling and analysis of the aluminium matrix has been carried out, followed by the inclusion of the GNPs and the spherical SiC particles.

The results demonstrated that the addition of SiC enhances different mechanical characteristics. As the amount of SiC increases, hardness, wear resistance and impact strength enhances due to the

excellent properties of the ceramic reinforcement. At higher concentrations (10% & 15%), the risk of particle agglomeration becomes more significant, and introduced stress concentrations. Despite this, the composite continues to have high hardness and durable properties, and still retains a uniform distribution of GNPs to help with the stress distribution and mechanical stability of the composite. The research also demonstrates that the optimal combination of hybrid reinforcements i.e. graphene & SiC can lead to realizing high-performance SiC-Graphene hybrid aluminium nanocomposite, which can offer promising solutions for applications in a wide range of fields including aerospace, automotive, and structural-related applications

Keywords: Nanocomposites, Graphene, Ceramics, SiC, Finite Element Method

Electrochemical Synthesis of ZnO Nanowire for using as Degradation Agent for Rhodamine B dye

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ABSTRACT

The concept of shape-controlled synthesis of metal nanowire is investigated by considering the growth mechanism of metal nanoparticles. Zinc Oxide (ZnO) nanowires have been synthesized by electrochemical method. For physiochemical studies XRD, FTIR techniques have been performed. For morphological studies SEM , TEM have been performed. The size obtained from TEM analysis of ZnO nanowire was found 200 nm-300 nm. During the research work, various parameters such as p H, contact time, effect of temperature, adsorbent concentration and adsorbate concentration were op timized.The results indicated that ZnO nanowires could be a low-cost adsorbent for the removal of Rhodamine B dye.

Keywords: ZnO nanowire; Electrochemical Synthesis; Rhodamine B; Adsorption isotherms.

Evaluating Machine Learning Models for Material Classification in Additive Manufacturing: A Comparative Study

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ABSTRACT

This study investigates the efficacy of machine learning (ML) algorithms for classifying materials in extrusion-based additive manufacturing. A dataset of 171 samples encompassing five polymers (ABS, Nylon, PEEK, PETG, PLA) was derived from peer-reviewed literature (citation included in main text). To ensure balanced representation, two samples per class were reserved for validation, resulting in training (129 samples), testing (32 samples), and validation (10 samples) sets. Three ML models—Logistic Regression (LR), Naive Bayes (NB), and K-Nearest Neighbors (KNN)—were evaluated using accuracy, AUC, recall, precision, F1 score, Kappa, and Matthews Correlation Coefficient (MCC). NB achieved superior validation accuracy (100%) and robust test performance (81.25% accuracy, AUC: 0.9086, MCC: 0.7619), demonstrating optimal generalizability. LR attained 71.88% test accuracy (AUC: 0.9627, MCC: 0.6049) and 80% validation accuracy, while KNN mirrored LR's validation performance (80%) but lagged marginally on the test set (71.88% accuracy). Confusion matrices revealed distinct classification patterns, with NB exhibiting zero validation errors and minimal test misclassifications. The results underscore NB's reliability for material selection tasks, attributed to its probabilistic foundation and resilience to small-sample overfitting. This study validates data-driven ML approaches for enhancing material selection in additive manufacturing, emphasizing methodological rigor through stratified validation. The findings advocate NB as a high-precision tool for industrial applications, reducing trial-and-error in material design. Future work will explore larger datasets and advanced algorithms to address multi-material complexities.

Keywords: Machine Learning, Material Extrusion, Polymer Classification, Model Evaluation, Additive Manufacturing.

Flexural and Interlaminar Shear Strength (ILSS) of Basalt Fibre Composites Post-Low-Velocity Impact with MWCNT Reinforcement

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ABSTRACT

The study investigates the low-velocity impact (LVI) on the flexural and interlaminar shear strength (ILSS) properties of basalt fibre composites reinforced with multi-walled carbon nanotubes (MWCNTs). The excellent mechanical properties and environmental resistance of basalt fibre composites drive their increasing use in structural applications. However, their performance under impact loading, particularly in terms of their residual flexural and ILSS properties, is crucial for ensuring their durability and functionality in real-world scenarios. We hypothesise that the incorporation of MWCNTs will enhance the impact resistance and overall mechanical performance of these composites. We did a lot of low-velocity impact tests on specimens made of basalt fibre composite that were strengthened with pure BFRP and multi-walled carbon nanotubes (MWCNTs). We measured the flexural strength and ILSS before and after the impact tests to evaluate the extent of damage and mechanical degradation. We used scanning electron microscopy (SEM) and other relevant characterisation methods to look at the failure modes and figure out how MWCNTs work to reinforce things at the microscopic level. The results show that adding MWCNTs greatly enhances the flexural and ILSS properties of basalt fibre composites, even after being impacted at low velocity. The study highlights the potential of MWCNT-reinforced basalt fibre composites for applications requiring high impact resistance and mechanical stability. These results provide valuable insights for developing advanced composite materials with enhanced durability for aerospace and automotive applications.

Flexural and Interlaminar Shear Strength (ILSS) of Basalt Fibre Composites Post-Low-Velocity Impact with MWCNT Reinforcement

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ABSTRACT

The study investigates the low-velocity impact (LVI) on the flexural and interlaminar shear strength (ILSS) properties of basalt fibre composites reinforced with multi-walled carbon nanotubes (MWCNTs). The excellent mechanical properties and environmental resistance of basalt fibre composites drive their increasing use in structural applications. However, their performance under impact loading, particularly in terms of their residual flexural and ILSS properties, is crucial for ensuring their durability and functionality in real-world scenarios. We hypothesise that the incorporation of MWCNTs will enhance the impact resistance and overall mechanical performance of these composites. We did a lot of low-velocity impact tests on specimens made of basalt fibre composite that were strengthened with pure BFRP and multi-walled carbon nanotubes (MWCNTs). We measured the flexural strength and ILSS before and after the impact tests to evaluate the extent of damage and mechanical degradation. We used scanning electron microscopy (SEM) and other relevant characterisation methods to look at the failure modes and figure out how MWCNTs work to reinforce things at the microscopic level. The results show that adding MWCNTs greatly enhances the flexural and ILSS properties of basalt fibre composites, even after being impacted at low velocity. The study highlights the potential of MWCNT-reinforced basalt fibre composites for applications requiring high impact resistance and mechanical stability. These results provide valuable insights for developing advanced composite materials with enhanced durability for aerospace and automotive applications.

FSW Process Parameter Optimization For Dissimilar Aluminium And Magnesium Alloys

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ABSTRACT

The optimization of friction stir welding (FSW) process parameters is critical to achieving high-quality joints between dissimilar aluminum and magnesium alloys. These materials exhibit significant differences in physical, mechanical, and thermal properties, making their joining a challenging task. This study focuses on investigating the influence of key process parameters—such as tool rotational speed, welding speed, axial force, and tool geometry—on the mechanical properties and microstructural characteristics of the dissimilar welds. A systematic approach using design of experiments (DOE) and response surface methodology (RSM) is employed to identify the optimal combination of parameters that maximize joint strength while minimizing defects such as porosity and intermetallic compound formation. The mechanical properties are evaluated through tensile and hardness testing. The findings provide valuable insights into the interplay between process parameters and material behavior, offering guidelines for producing reliable and robust joints in aluminum-magnesium material for aerospace, automotive, and other engineering applications.

Keywords: FSW, RSM, Aluminium AA6061 alloy, Magnesium AZ31B Alloy, Tensile strength, Hardness.

Identifying And Utilizing Key Features For Accurate Green House Gas Emission Predictions

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ABSTRACT

CO2 emission is one of the leading greenhouse gases and contributing factor to the global warming, becoming a major concern across the world. These emissions are generated from various activities such as transportation, industrial activities power generation et cetera. With rising global concerns, it is important to target the major contributors to global warming, which is essential for obtaining data that is necessary to formulate a plan to limit their level of emission. This project aims to develop

a machine learning algorithm which is designed to forecast CO2 emissions in the foreseeable future. This model can be used to determine the causes of increase in CO2 levels and take action upon the major contributors. For this project we have set a goal: to create an effective model which can identify patterns and can make predictions. This project is directed to assist policy-makers, environmental groups, and industries which can formulate other specific measures that will tackle the emissions' problem. Hence, targeting key emission reduction activities. In addition, this will help to reduce emissions through the improvement of cleaner technologies, which can optimize the utilization of resources and effective policies as well.

Keywords: carbon dioxide emissions, greenhouse effect, global warming, machine learning, predictive model, CO2 levels, emission sources.

Rare Earth Elements Added Ceramic and Composite Coatings Under Simulated and Actual Boiler Environment-A Review

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ABSTRACT

This study discusses the impact of rare earth oxide additives on coating materials produced via the thermal spray coating (TSC) process on diverse engineering substrates. Rare earth oxide additive is included into the coating formulation to enhance the several mechanical, chemical, and corrosion characteristics. Rare earth oxides, specifically CeO_2, Y_2O_3, and La_2O_3, are the most common types of rare earth oxides utilised in TSC coatings. The limited amount of rare earth oxide compound may lead to improvement in the coating performance. Rare earth oxide is used as a nutrient in coating materials because of its appealing qualities, which include grain refinement, the transformation of coarse structure into fine dendritic structure, and reduction in the residual stresses in the oxide layer. The primary objective of coating is to improve the surface properties of a material, including its hardness, corrosion resistance, and abrasion resistance. Moreover, the addition of rare earth elements in the coatings reduces the solid-state diffusion along the grain boundaries results in thin oxide layer developed on the surface of the coating. The present paper aims to review the performance of rare earth elements added ceramic and composite coatings under high temperature environment.

Keywords -Hot corrosion, Coating, Oxide Scale, Residual Stresses, Rare Earth Elements

A Comparative Study on Human Keypoint Detection

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ABSTRACT

Human keypoint detection is a critical application in computer vision, which uses spanning healthcare, surveillance, sports analytics, and human-computer interaction. This study compares six prominent deep learning models - CNN, Faster R-CNN, YOLOv3, ResNet, MobileNet, and MobileNetV3 evaluating their performance on key metrics such as accuracy (mean Average Precision), inference time, frames per second, model size, and error rates. The models were tested on 100 representative images from COCO, PoseTrack, and CrowdPose datasets, alongside video sequences running at 30 frames per second to simulate real-world scenarios. Challenges like occlusion, scale variation, and crowded environments were considered to provide a holistic analysis. The results highlight distinct trade-offs among the models. While MobileNet and MobileNetV3 are highly efficient and suitable for resource-constrained environments, ResNet and Faster R-CNN excel at handling complex poses with higher accuracy. YOLOv3 achieves a balance between computational efficiency and detection accuracy, making it a versatile tool for real-time applications. This comparative analysis not only identifies the strengths and limitations of each model but also provides guidance for selecting optimal models for resource-limited or high-precision contexts. Additionally, the study highlights the potential of deep learning models in advancing human keypoint detection to meet diverse application requirements. The results reveal that MobileNetV3 excels in resource-constrained environments, offering high efficiency for real-time applications, while ResNet and Faster R-CNN achieve superior accuracy for complex poses. YOLOv3 provides a balanced approach, suitable for versatile use cases. These findings guide users in selecting appropriate models based on specific needs, with future opportunities in optimizing lightweight architectures for emerging technologies.

Keywords: Human Keypoints Deep Learning CNN Faster R-CNN YOLOv3 ResNet MobileNet MobileNetV3 COCO Dataset Pose Estimation Efficiency Accuracy Evaluation

Hybrid Method To Detect Phishing

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ABSTRACT

This paper introduces a phishing detection system that combines rule-based techniques with machine learning algorithms to address both content-based and behaviour-based attacks. For content- based threats, the model employs decision trees alongside predefined rules to examine website and email content, including suspicious URLs, deceptive forms, and unusual content patterns, to distinguish between legitimate and phishing sites. To tackle behaviour-based phishing, the system utilizes Support Vector Machine (SVM), XG Boost, and Decision Tree (DT) algorithms to identify anomalies in user interaction data, such as login patterns, mouse movements, and clicking behaviour. These three models are integrated using ensemble methods like stacking or voting to enhance overall detection accuracy. The hybrid approach enables simultaneous analysis of contentrelated and behavioural anomalies, resulting in improved adaptability to phishing challenges. The effectiveness of this method is evaluated using standard metrics, including accuracy, precision, recall, and F1-score, to strengthen its capability in detecting both conventional and sophisticated phishing tactics.

Keywords: phishing detection, SVM, XG Boost, DT

Impact of Surface Treatments on the Mechanical Properties of Hemp, Jute, and Bamboo Reinforced Hybrid Epoxy Composites

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ABSTRACT

Natural fiber reinforced composites (NFRCs) are gaining increasing attention in various engineering applications due to their eco-friendly and cost-effective characteristics. This study investigates the impact of surface treatments, specifically alkali and saline treatments, on the mechanical properties (tensile and flexural strength) of hemp, jute, and bamboo reinforced epoxy composites. The fibers were subjected to alkali and saline treatments at varying concentrations (1, 3, 5, and 7 wt. %) prior to composite fabrication. The composites were prepared using the hand lay-up method.

Experimental results revealed that both tensile and flexural strengths of the composites improved by following treatment with alkali and saline solutions. The highest enhancements in tensile and flexural strength were observed at a 5 wt. % alkali concentration, yielding improvements of 15% and 12%, respectively, compared to the untreated hybrid composite. These findings indicate that surface treatments, particularly alkali treatment, can significantly improve the mechanical properties of the composites. The treated hybrid composites exhibit promising characteristics, making them a viable and sustainable alternative for use in automotive components and other lightweight structural applications.

Keywords: Natural fibers, hybrid composite, Surface treatments, Mechanical properties.

Improving surface finish of tubular internal surfaces by magneto AFM

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ABSTRACT

Magneto Abrasive Flow Machining (M-AFM) is a process leveraging magnetic energy for surface finishing, rated highly for its low specific energy consumption and its pivotal role in determining product performance through surface quality. It involves the smoothing of workpiece surfaces by microchip removal using abrasive particles within a magnetic field during the finishing stage. This study focuses on applying M-AFM to commercially available aluminum tubes, achieving significantly reduced surface roughness and processing time compared to untreated aluminum tubes. While M-AFM is well-established for achieving fine-finish standards in stainless-steel pipes, its adaptation to softer metals like aluminum has been challenging due to their characteristics. This research identifies optimal parameters for internal finishing of aluminum tubes, employing optical micrographs to analyze specimens before and after finishing, alongside recording and studying surface roughness measurements to assess finishing quality. Roughness improvement rate (RIR) and Ra values initially improved with increased extrusion pressure and working cycles, but after 500 psi of extrusion pressure and 15 working cycles, RIR and Ra value gets diminished. RIR is maximum (61.2%) at 500 psi of extrusion pressure and 15 working cyclesfor all values of number of cycles followed by 500 psi and 300 psi of extrusion pressure.

Keywords: Magneto Abrasive Flow Machining, optical, Aluminum Tube, Internal Surface Finishing, Roughness

An overview of the Quantum Computing Era in Industry 5.0: Its applications and benefits from a global perspective

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ABSTRACT

Artificial Intelligence (AI), robotics, and quantum computing all play key roles in Industry 5.0. Humans, machines, and advanced technologies collaborate to make this possible. It focuses on human creativity, intelligence, and emotional connections to technology, in contrast to Industry 4.0, which is centered on automation, connectivity, and data exchange. There are different stages in the evolution of industrial development related to Industry 5.0, each with significant changes in the production, manufacturing, and business processes. In shaping this next industrial revolution, quantum computing offers unprecedented computational power and solves problems that were previously intractable. There is no doubt quantum computing will transform industries in profound ways, and the automobile industry is no exception. Quantum computing has several significant advantages for automotive companies due to its ability to solve complex problems and process vast amounts of data exponentially faster than classical computers. Introducing Industry 5.0 signifies a transformative approach to industrial processes, emphasizing human-centric solutions, sustainability, and enhanced human-machine collaboration. This evolution can be attributed to quantum computing, a technology that promises unparalleled computational power and problem-solving capabilities to revolutionize industries. In this article, we explore some key applications and benefits of quantum computing in Industry 5.0.

Keywords: Industry 5.0, Quantum Computing, Artificial Intelligence, Robotics, Machine Learning etc.,

Investigations on microstructure and mechanical properties of Stir cast Mg/ZrO2 composites

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ABSTRACT

The primary goal of companies working in the automotive sector is to cut down the fuel consumption, which is a key demand from consumers. Additionally, environmental regulations compel manufacturers to develop lightweight materials in order to minimize CO2 emissions from vehicles. The overall body weight of automobiles can be significantly reduced by using aluminum and magnesium, which are known for their lightweight properties Magnesium-based materials, in particular, offer a promising solution as they are considerably lighter than both steel and aluminum. However, magnesium's inherent strength is lower compared to traditional materials, which can be enhanced by adding suitable reinforcements. In this study, magnesium/ZrO2-based composites were prepared by stir casting technique and two level of ZrO2 reinforcement. The addition of ZrO2 reinforcement resulted in improvements in grain size, hardness, and yield strength, although there was a slight decrease in percentage elongation.

Keywords: Stir casting, Composites, Microstructure, Macrohardness.

Manufacturing of High Purity Sputtering Target Using Different Techniques: A Review

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ABSTRACT

Sputtering targets are essential components in the sputtering deposition process, extensively used for fabricating thin films in various industries, including electronics, optics, and semiconductors. This review article explores various manufacturing techniques for sputtering target manufacturing and compares their advantages, challenges, and suitability for advanced sputtering target applications. It highlights the target fabrication techniques such as cold spray, spark plasma sintering (SPS), hot isostatic pressing (HIP), and cold isostatic pressing (CIP) have revolutionized sputtering target

production. In addition, a detailed discussion on emerging techniques such as additive manufacturing and spark plasma sintering (SPS) emphasis for their potential to fabricate complex-shaped and high-performance sputtering targets A detailed discussion on deposited target properties, including purity, uniformity, and mechanical strength, is provided. Additionally, the use of various materials, such as copper and its alloys, aluminum, titanium, and tantalum, is highlighted, with an emphasis on copper alloys for their dominant role in semiconductor applications. This review serves as a comprehensive resource for researchers and industry professionals, offering insights into optimizing sputtering target fabrication methods to meet the evolving demands of thin-film deposition technologies.

Keywords: Sputtering; Targets; Thin-film deposition; Cold spray; Additive manufacturing; Copper alloys.

Computational Analysis of Zr-Nb Alloys hip implant with ZrO_2 Coatings to Enhance Implant Longevity

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ABSTRACT:

With the increasing demand for durable, cost effective and reliable hip implants the need for advanced materials and designs to increase the mechanical performance and wear resistance. This present study investigates the wear behavior and tribological performance of a zirconium-niobium (Zr-Nb) alloy with an oxidized zirconium (ZrO_2) coating as a potential material system for hip implants. In the current work focuses the thin oxidized zirconium layer has been applied on the neck area of the femoral stem, which comes into contact with the ultra-high molecular weight polyethylene (UHMWPE) cup. Finite element analysis using ANSYS has been carried out to evaluate wear performance using the Archard wear model. The critical parameters such as contact pressure, sliding distance, and frictional coefficients has been taken into account for the study. The analysis is carried out for gait activities viz. standing up, sitting down, and the stance phase, to achive simulate real-world conditions. Key findings include the calculation of Archard wear, total deformation, and induced stresses, which demonstrate the significant role of the oxidized zirconium layer in enhancing wear resistance. The computed results show that the Zr-Nb alloy with ZrO_2 coating effectively reduces wear rates, improves stress distribution, and optimizes implant longevity. Additionally, the study examines the effects of varying coating thickness and highlights the optimal design for improved tribological performance.

This work underscores the potential of the Zr-Nb alloy with a thin ZrO_2 layer as an advanced material system for hip implants, offering improved durability, reduced wear, and greater suitability for long-term orthopedic applications. The optimized model and findings provide a valuable foundation for future studies and clinical applications.

Impedance Spectroscopic Characterization of Lanthanum and Gadolinium Co-modified PZT Ferroelectric Ceramics

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ABSTRACT

The use of electrocaloric materials has increased recently due to the need for solid-state refrigeration. Lead Lanthanum Zirconate Titanate (PLZT) is one of the promising materials that has exhibited a giant ΔT of 12K around its TC = 226oC at the applied field of 480 kV/cm. A constant effort is being carried out for reducing this phase transition temperature near to room temperature without losing its ferroelectric characteristics, by modifying with various dopants. This work focuses on the Cole-Cole analysis of Nyquist plots for La-Gd co-modified PZT ceramics, Pb0.91La0.045Co0.045Zr0.95T i0.05O3 . The material was synthesized using the solid-state mixed-oxide method. The wet mixed oxides and carbonates were calcinated for 12h at 850°C. Structural characterization was carried out using X-ray diffraction measurement and it is confirmed that a single-phase perovskite structure had formed. The calcined powder was densified into pellets by applying 1 GPa pressure beneath the uniaxial pelletizer. These compacted pellets were sintered at 1000°C for two hours. The polished pellets were coated with Ag paste and heat treated at 200°C before measurements. The electrical and dielectric characterizations were carried out from room temperature to 550°C at different frequencies ranging from 20 Hz- 2MHz. Real part of impedance (ε′) decreases with increasing frequency, signifying reduced resistance at higher frequencies. The imaginary part (ε′′) shows a peak at characteristic frequencies, corresponding to relaxation phenomena. The Nyquist plots (Cole-Cole plots) were derived by plotting the real part (ε′) of the impedance against the imaginary part (ε′′). The analysis provided insight into the relaxation mechanisms of the La-Gd co-modified PZT material. The relaxation process in PLZT-Gd ceramics is non-Debye in nature, as evidenced by asymmetric peaks in the modulus spectra. The presence of Gadolinium ions contributes to localized structural distortions, influencing relaxation dynamics.

Machinability Study of Abrasive Water Jet Process Parameters on AA7175/ZrB2 Composite for Automotive Application

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ABSTRACT

In present investigation to study the performance surface characteristics on AA7175-15 wt.% ZrB2 composites prepared two step stir casting. The machining process is carried out through abrasive water jet, with abrasive garnet with size of 80 mesh, with varying traverse speed, pressure, stand of distance. To determine the link between three key process independent variables: to the surface roughness, kerf angle and material removal rate. The response surface methodology with central composite design (RSM-CCD) was used to perform the experimental interpretations. The influence of individual abrasive aqua jet cutting (AAJC) factors was determined using analysis of variance technique (ANOVA). Regression models were obtained for kerf characteristics. Contribution of traverse speed was found to be more than other parameters in affecting top kerf width. SEM analysis was used to discuss the morphological observations and to explore the quality and defects of the machined surfaces.

Key words : Composite, Al7075, abrasive water jet machining, kerf, surface roughness

Machining performance of graphene-based BFRP composite by abrasive waterjet

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ABSTRACT

Abrasive water jet machining is highly versatile and can cut through hard and unevenly structured materials. A thermoset polymer matrix was created using multiple strong rock fibers, such as basalt fibers, combined with graphene as a secondary reinforcement, resulting in a high-performance structural material. The aim of the work is to investigate the cutting dimensionality of graphenedoped basalt fiber-reinforced polymer (BFRP) composite using an abrasive water jet machine. In this study, the vacuum-assisted hand lay-up technique (VAHLT) was used to prepare a symmetric composite made of eight layers of woven basalt fiber (380 GSM) arranged in a stacking sequence of [(0°/90°)/±45°/±45°/(0°/90°)]s with varying graphene content of 0%, 1%, 2% and 2.5% by weight, followed by curing in an autoclave. The mechanical properties of composites are improved by changing the amount of graphene. The improvement in mechanical properties is due to the polymer chains ending with graphene, which increases the cross-link density. The linear progression of mechanical properties was limited by the agglomeration of graphene. The fracture mechanism and failure modes were observed as matrix cracking, delamination, and fiber breakage. Surface roughness, kerf taper, delamination factor, and MRR (Material Removal Rate) were analyzed with varying weight percentages of graphene on Abrasive Water Jet Machining (AWJM). The results showed that adding graphene improved the surface quality and reduced delamination during machining.

Keywords: Basalt fiber, Graphene, Polymer composite, Surface roughness, Kerf taper.

An Investigation of process parameter of Hydroxyapatite using Laser Beam Machining

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ABSTRACT:

Hydroxyapatite is widely recognized as a desirable implant material due to its bioactive properties, which make it effective for repairing and regenerating bone tissue abnormalities. Biomaterials are designed to endure highly biological environments without causing harm to themselves or their surroundings. However, machining complex, three-dimensional microstructures on bioceramics presents significant challenges. This research explores the use of laser beam micromachining to address these challenges, focusing on optimizing parametric settings to achieve precise and efficient micromachining of bioceramics.

Keywords: Laser beam machine, micro machining, biomaterials.

Performance Analysis of Zr(NO)□and WS□Particles on Wear Resistance of Magnesium Hybrid Composites

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ABSTRACT

The emphasis of this exploration was to examine the physical, mechanical, microstructure and tribological performance of Mg (Magnesium) specimen and Mg- $Zr(NO_3)_4$ and WS_2 composites produced via the powder metallurgy technique. The AZ91D alloy and AZ91D/ $Zr(NO_3)_4$/ WS_2 composites are made with distinct weight percentages at the unit aspect ratio. The powders and composites characterization are executed by SEM (Scanning Electron Microscope), EDS (Energy Dispersive Spectrum) with an elemental map, and XRD (X-ray Diffraction) examination. With the increasing weight fraction of $Zr(NO_3)_4$, the particles gradually exhibit enhanced homogeneous distribution. The mechanism model for decrease in compressive strength of AZ91D/ $Zr(NO_3)_4$/ WS_2 composite material was identified as boundary slip. From the mechanical test and tribological study, findings demonstrated an increased hardness (6–35%), and the formation of stable oxide surface layers. When compared to magnesium alloy that was cast in its original form. The $Zr(NO_3)_4$/ WS_2 reinforced hybrid composites demonstrated improved wear resistance (9–29% higher wear resistance). The worn surface of the investigated specimen underwent wear processes such as wear melt, induced delamination, oxidation, and particle cracking.

Keywords: AZ91D alloy, tribology, powder metallurgy, SEM

An Optimized Wear Behavior of Self Lubricating Properties of Al356 Composite Reinforced with hybrid TiB2 – hBN Particles

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ABSTRACT

This work investigates the tribological behaviour of a hybrid composite composed of an Al/Si alloy A356 matrix, titanium diboride (TiB□) at 3, 6, and 9 wt.%, and hexagonal boron nitride (hBN) at 3 wt.%, using the Box–Behnken experimental design and response surface approach. The stir-squeeze casting technique yields the composites. The microstructure was analysed through optical microscopy, and phase analysis is studied through X-ray diffraction. The tribological analysis is carried out through pin-on-disc with varying applied load (20-60 N), sliding velocity (1.2-1.8 m/s), and sliding distance of 1800 m. The wear traces were measured within the experiment, namely the wear intensities were calculated, and results analysis was performed by application of the design expert software. To determine the optimal parameters, we reduced the experiments to various combinations. The regression model made was adequate as the values of R2 and R2 (adj) were above 95%. Adequacy of the model was predicted through a regression equation, and the error was found to be less than 8%. The scanning electron microscope analysis carried out for the worn-out surfaces showed maximum wear resistance due to the formation of a stable lubrication layer on the composite.

Nanoparticle-Enabled Reduction of Emissions and Fuel Consumption in Compression Ignition LHR Engines

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ABSTRACT:

This study examined how adding nanoparticles affected the diesel engine's performance parameters. Aluminum and cerium are two of the metallic nano additives used in this field thus far. Moreover, a wide range of work in this field is manifested by the potential to use different metals, modify additive structures, and enhance or alter the fundamental fluid. The silver nanoparticles were added to the net diesel fuel for this reason. The data show that the engine power, oil temperature, and percentage

of pollutants released have all significantly changed. By quickening the burning process, the metallic nanoparticles inside the combustion chamber increase heat transfer to fuel and reduce the ignition delay. In the meantime, during the spraying stage, these particles may help fuel particles penetrate even deeper into the compressed air. The combination of all these characteristics will enhance combustion, resulting in a reduction of unburned carbons and other pollutants. These findings would result in a considerable decrease in the rate of CO and NOx, to 20.5 and 13%, respectively, with the net diesel and HC levels being experience the greatest change, up to 28%. The outcomes also show a 3% decrease in fuel consumption and a 6% increase in engine power, with nanoparticles being used in the majority of these instances. Chugh et al. (2021) investigated the green synthesis of silver nanoparticles (AgNPs) using algae as a sustainable and eco-friendly approach. The study highlights the crucial role of capping agents in controlling the size, shape, and stability of AgNPs. The authors explored various capping agents, including polysaccharides, proteins, and polyphenols, to optimize AgNP synthesis.

Keywords: Emissions; Fuel; Diesel; Engine; Nanoparticle; Additive
Keywords: Self Lubrication, Optimization, Scanning Electron Microscope, Wear and Friction.

Hybrid Nanolubricants and Green Refrigerants for Enhancing Performance of Retrofitted Vapour Compression Refrigeration Systems: A Review

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ABSTRACT

This review paper explores recent advancements in enhancing the performance of retrofitted vapour compression refrigeration systems (VCRSs). Researchers have employed various strategies, including the use of eco-friendly hydrocarbon (HC) refrigerants as alternatives to halogenated refrigerants and the incorporation of nanoparticles, to enhance the performance of retrofitted VCRSs. The HC refrigerant R600a is commonly preferred over other HC refrigerants. Nanoparticles, in both mono and hybrid forms, are introduced either through mixed-in refrigerants or compressor lubricants. Recently, hybrid nanolubricants have gained preference over mono nanolubricants due to their better ability to enhance the performance of retrofitted VCRS. Moreover, the better thermo-physical and tribological properties of hybrid nanolubricants as compared to mono nanolubricants play a significant role in enhancing the performance of the VCRS. This paper presents a comprehensive overview of the experimental methodology, results, and implications of incorporating hybrid nanofluids in VCRS to improve performance parameters, including refrigeration effect, compressor power savings, and coefficient of performance (COP).

Keywords: VCRS, Nanoparticles, Mono nanolubricant, Hybrid nanolubricant, Green refrigerants

Optimization of ECAP Parameters to Enhance Brinell Hardness and Grain Size of AA-7075 Alloy Using Computational Design of Experiments

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ABSTRACT

The Equal Channel Angular Pressing (ECAP) process is a prominent technique for grain size refinement and mechanical property enhancement in aluminium alloy 7075 (AA-7075). This study focuses on optimizing ECAP parameters to maximize Brinell hardness and control grain size using computational tools, specifically Design of Experiments (DoE). Key ECAP parameters such as die angle and number of passes were investigated to determine their influence on material properties when processed at room temperature. A factorial design approach was employed, incorporating varying numbers of passes (2, 4, 6) and die angles (90, 92, 94 degrees) to systematically collect and analyze data. Brinell hardness and grain size were measured as response variables to evaluate the effects of different parameter combinations. Statistical analyses, including ANOVA and regression modeling, were utilized to identify significant factors and their interactions, providing comprehensive insights into the process-property relationships. The computational approach facilitated efficient exploration of a broad parameter space, identifying optimal conditions for simultaneous enhancement of hardness and grain refinement. The Brinell hardness was maximized after six ECAP passes with a 90-degree die angle. Initial passes showed rapid hardness increase, while subsequent passes improved sample homogeneity. Grain size was minimized to 1µm at six passes, as observed via optical microscopy, validating the Hall- Petch Theory. The study's unique approach of improving both hardness and grain size homogeneity underscores its novelty. AA-7075 alloy processed through this method is well-suited for aerospace, marine, and defense industries due to its superior strength-to-weight ratio.

An Influence Rice Husk and Coconut shell ash Particles on Dry Sliding Wear Behavior of AA7068 Composites Fabricated through Squeeze Casting

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ABSTRACT

The effect of temperature on the dry sliding condition of a Zinc rich 7068 aluminum alloy reinforced with of rice husk ash (RHA) and coconut shell ash (CSA), fabricated by stir-squeeze casting were investigated. Wear tests were conducted on RHA and CSA reinforced cast samples using the pin on disc apparatus under 20-60 N with 1-2 m/s sliding speeds for 1200 m sliding distances. Scanning Electron Microscope (SEM) and Energy Dispersive Spectroscopy (EDS) analysis were conducted on worn out surface and subsurface of the composite specimens to determine the wear mechanism. From the results, it was found that the wear behavior of Al hybrid composite was superior to unmixed reinforcements. The composites with dual ceramic reinforcement have shown lesser wear rate and coefficient of friction than composites with base material. Metallographic studies performed to delineate the rate controlling wear mechanisms revealed that low wear rates in lower load resulted from the load-bearing capacity of RHA and CSA particles and the formation of transfer layers on the contact surfaces of the composites. The particles at the surface ruptured as a result of the application of an applied load that was higher than the fracture strength of the particles, and wear occurred as a result of the process of subsurface crack propagation. The transition to severe wear rate regime is shown to be controlled by frictional heating to a critical temperature.

Key words: Aluminum composites, Stir Casting, Mechanical Behavior, Oxidative Wear, friction, SEM

Wear and Corrosion resistance of ZrN and CaF2 deposited by Magnetron Sputtering on SS316 L for Low-cost Biomedical Implants

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ABSTRACT

Stainless steel (SS), cobalt-chromium (Co-Cr) alloys, titanium, and its alloys are the most widely used materials for biomedical implants due to their excellent mechanical properties and corrosion resistance. Stainless steel can be used as a low-cost implant material but has several limitations. It is highly corrosive, releases metal ions, and is unstable for long-term applications. Coating of ZrN and CaF2 is the best option to improve its effectiveness. Zirconium nitride (ZrN) and Calcium Fluoride are members of the hard ceramic family, having excellent wear and corrosion resistance. These ceramics can be applied as thin film coatings and offer high hardness and corrosion resistance. In this work, a zirconium nitride (ZrN) and calcium difluoride (CaF2) coating was deposited using the magnetron sputtering method on Stainless Steel SS306L.

X-ray diffraction, FESEM, EDS, and Raman spectroscopy were used to assess the deposited coating's structure, morphology, and chemical composition. The results of the present study reveal that adding calcium difluoride (CaF2) to zirconium nitride (ZrN) leads to progressive texture modification, improves grain size, and decreases the coefficient of friction to some extent. The deposited coating has a granular structure. Further, the deposited coating of ZrN and CaF2 shows a polycrystalline structure. The ball-on-disc test was used to determine the friction and wear of the developed coating, revealing that the coefficient of friction decreases with an increase in the applied load. The lowest value of the coefficient of friction was found to be 0.0487 at 1.5N. The decrease in friction was due to the formation of an oxide layer and a tribolayer. The wear rate increases with the increase in load, and the lowest wear rate was 1.27×10-6mm3/Nmm at 0.5 N. The micro-scratch test reveals the coating adheres well to the substrate with an adhesion strength of 125 mN.

Keywords: SS316L, ZrN, CaF2, Magnetron Sputtering, Corrosion and Wear

A review on biological air filters for the prevention of the occurrence of air borne disorders

ABSTRACT

Air pollution continues to pose a grave threat to public health, underscoring the critical importance of effective air filtration systems. Among these, nano-fiber membranes have emerged as crucial components, offering heightened filtration efficiency that targets fine particulate matter and ultimately contributes to improving air quality. However, the fabrication of nano-fiber membranes presents multifaceted challenges, including the attainment of uniform fiber structures, mitigation of solubility issues with bioactive compounds, and precise control over fiber diameter. Moreover, complexities and cost implications in composite membrane production, as well as the optimization of concentrations and drying processes, further underscore the need for ongoing research and development efforts. While various approaches have been explored for biological filters, there remains a notable gap in literature focusing on reviewing electrospinning techniques for air filtration, polymer blends, medicinal herb integration, and the utilization of biodegradable polymers in air filtration. This review seeks to clarify the strategies employed to enhance the efficacy of biological filters, offering a comparative analysis to underscore the effectiveness of diverse techniques. Furthermore, it outlines future directions aimed at addressing existing challenges and bolstering the production of high-quality air filters, thus fostering a healthier environment for all.

Keywords: bio filter, nanofibers, polymer blends, electrospinning,

Friction welding: an important material joining technique

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ABSTRACT:

Friction welding is a solid state joining process where coalescence is produced by the heat generated by the rubbing of the materials against each other. Friction welding is used for joining the materials due to its advantages such as low heat input, ability to join dissimilar materials and environment friendliness. Friction welding can be used to join different kinds of materials which cannot be welded by conventional fusion welding processes. The rotational speed and the axial pressures are the important parameters that play the major role in determining the strength of the joint. In this study an attempt was made to join austenitic stainless steel (AISI 304) with low alloy steel (AISI 1021) at higher rotational speeds and at different axial pressures and then determining the strength of the joint by means of mechanical properties such as tensile strength, torsional strength, impact strength and micro hardness.

Key words: Friction welding; dissimilar materials; mechanical testing.

Emotion Detection with EEG and Peripheral Physiological Data Using Enhanced ID Convolutional LSTM Networks

ABSTRACT

This research focuses on classifying human emotions using a hybrid 1D Convolutional Long Short-Term Memory (CNN-LSTM) neural network with emotion recognition, a critical aspect of affective computing, benefits significantly from integrating Electroencephalogram (EEG) signals and peripheral physiological data. This study proposes a novel hybrid deep learning framework combining enhanced identity-preserving (ID) mechanisms with Convolutional Long Short-Term Memory (Conv LSTM) networks. Leveraging Transformer-based modules and AI-driven denoising algorithms, the proposed model enhances EEG signal quality, ensures real-time edge deployment, and integrates multi-domain features (time-series, frequency, and spatial) with peripheral signals such as galvanic skin response (GSR) and heart rate variability (HRV). To improve transparency and trust, SHAP (Shapley Additive explanations) is employed for model explainability. EG and peripheral physiological data. The study utilizes the DEAP dataset, comprising 32 EEG channels and 8 peripheral physiological channels. The proposed 1D CNN-LSTM model achieved 91.19% accuracy for valence and 91.51% for arousal, outperforming traditional classifiers such as Support Vector Machines (SVM), K-Nearest Neighbours (KNN), and Random Forest (RF). The study also investigates emotion classification performance based on different brain lobes and hemispheres, revealing that the frontal lobe and left frontal region combined with peripheral data deliver the highest accuracy. Experimental validation on multimodal datasets, including DEAP and AMIGOS, demonstrates that the framework achieves robust emotion classification accuracies exceeding 95%, outperforming traditional methods. Applications include mental health monitoring, human-computer interaction (HCI), and adaptive learning systems, highlighting its transformative potential in real-world settings.

Keywords: Enhanced ID Conv LSTM Networks, Transformer-Based Modules, AI-Driven Denoising Algorithms, Multi-Domain Feature Fusion, SHAP (Shapley Additive explanations), EEG, Emotion Recognition, Affective Computing.

Development of Nano Material Incorporated High Performance Light Weight Polyurethane Foam Concrete

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ABSTRACT:

Light Weight Concrete (LWC) has promising benefits such as low density and good workability. However, it has poor mechanical strength and durability properties. Nanomaterials have large total surface area and high reactivity. In this study an attempt has been made to incorporate the nano materials, Nano Alumina (NA), Nano Silica (NS) and Nano Graphene Oxide (NG) into Polyurethane Foam Concrete (PUFC) to form PUFC-NA, PUFC-NS and PUFC-NG respectively to develop light weight polyurethane foam concrete with improved mechanical properties and durability.

Characterisation studies such as Scanning Electron Microscopy and EDAX were performed to confirm formation of the new compounds. Tests were done on rheology, drainage, compressive strength, split tensile strength, flexural strength, shrinkage and uniformity of the various synthesised LWCs in this study. PUFC-NG, achieved a maximum of 28 N/mm2 compressive strength after curing for 28 days, compared with PUFC, which achieved 15 N/mm2 strength. Similarly, split tensile strength and flexural strength improved by up to 50% on incorporation of various nano materials into them. Also, the shrinkage reduced by 30% with PUFC-NG compared with the control mix. Results of chloride penetration tests revealed superior durability on testing for 90 days. Thus, these findings show that incorporation of nano materials can significantly improve the mechanical strength, rheological, drainage, shrinkage, uniformity and durability properties of PUFC.

Key words: Lightweight Concrete (LWC), Polyurethane Foam Concrete (PUFC), Nano Alumina (NA), Nano Silica (NS), Nano Graphene (NG), Mechanical Strength, Durability.

AI-Enhanced Profiling of Driver Behavior Using Zero- Permission Embedded Sensors

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ABSTRACT

The proliferation of intelligent transport systems demands sophisticated tools to understand and optimize driver behavior without compromising privacy or system integration. This research proposes a groundbreaking framework leveraging zero-permission embedded sensors, such as accelerometers, gyroscopes, and magnetometers, in mobile and in-vehicle devices to profile driver behavior comprehensively. The core innovation lies in employing AI-enhanced edge analytics powered by federated learning, ensuring data processing remains local to the device. This approach addresses privacy concerns while maintaining high model accuracy. By integrating self-supervised learning (SSL) techniques with sensor data streams, the system autonomously detects and labels complex driving patterns such as aggressive acceleration, harsh braking, and distracted driving. Additionally, the framework utilizes Graph Neural Networks (GNNs) to model and analyze dynamic road environments and driver-vehicle interactions, offering unparalleled insights into driving behavior in diverse traffic conditions. Generative AI models, such as diffusion-based architectures, simulate potential driving scenarios, aiding real-time decision support systems. This research showcases exceptional scalability by deploying energy-efficient AI accelerators for on-

device inference, enabling continuous monitoring with minimal power consumption. Experimental validation on datasets from smart cities demonstrates enhanced behavioral profiling accuracy (98%) and latency reductions (40%) compared to traditional cloud-based models. Applications include advanced driver-assistance systems (ADAS), fleet management optimization, and insurance telematics, paving the way for safer, more efficient, and driver-centric transport ecosystems.

Keywords: Zero-permission sensors,Federated learning, Self-supervised learning (SSL),Graph Neural Networks (GNNs),Advanced driver-assistance systems (ADAS)

Parametric Optimization of Laser Cutting Process Parameters for Galvanised Iron Using TOPSIS

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ABSTRACT

The laser cutting method is an advanced machining technique that utilises heat energy to cut materials without direct contact with the workpiece. Galvanised steel is highly preferred due to its exceptional durability, combining the strength and formability of steel with the corrosion resistance provided by the zinc-iron coating. This work demonstrates the application of TOPSIS, a multi-criteria decision-making model, in combination with the Taguchi approach to identify the optimal laser cutting parameters for improving surface quality. A fibre laser machine was employed to cut a 3 mm galvanised iron sheet utilising the most predominant cutting parameters, determined by Taguchi through the Minitab application. The effects of laser power, gas pressure, and cutting speed on cutting time, kerf width, and surface roughness were examined. The analysis of variance (ANOVA) is conducted to determine the impact of each input process parameter on the output responds. The findings suggest that the TOPSIS method is suitable for addressing multi-criteria optimisation of process parameters. The results indicated that a laser power of 1000 W, gas pressure of 8 bar, and cutting speed of 18 m/min comprise the optimal combination of process parameters.

Keywords: Galvanised Iron, Laser cutting, Taguchi , ANOVA, TOPSIS method

Digital Twin: A Comprehensive Review of Core Components, Challenges, and Future Directions for Bridging the Physical and Digital Worlds

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ABSTRACT

Digital twin (DT) technology has emerged as a transformative tool for real-time monitoring, simulation, optimization, and accurate forecasting. Despite significant advancements in machine learning, IoT, and big data, the widespread implementation of DT has not achieved its full potential due to challenges such as the lack of universal frameworks, domain-dependence, security concerns, and insufficient performance metrics. This review provides a comprehensive examination of DT research and industrial applications, focusing on its core components, unique features, and successful implementations. Through an analysis of existing literature and real-world case studies, this work identifies key factors impeding adoption, including fast-evolving concepts and dependencies on maturing technologies. Additionally, the review conceptualizes DT, differentiating it from related paradigms like simulation and autonomous systems, and outlines novel research questions critical to advancing the field. By addressing technical, methodological, and practical gaps, this study contributes to a systematic understanding of DT and its role in bridging the physical and digital domains, ultimately paving the way for future development and widespread adoption.

Tuning Dielectric and Electrical Properties of Barium Calcium Titanate via Gd and Fe Co-Doping

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ABSTRACT

The electrocaloric effect (ECE) is a promising phenomenon for energy-efficient cooling applications, where a material undergoes a temperature change in response to an applied electric field. The use of electro caloric materials has increased recently due to the need for solid-state refrigeration. Barium Calcium Titanate (Ba1-xCaxTiO3-BCT) is one of the promising candidate with its ferroelectric to paraelectric phase transition falling in the range of room temperature to 120°C based on Ca

concentration in BCT. However, Ca doping deteriorates the ferroelectric properties of BCT. Therefore, a constant effort is being carried out for reducing phase transition temperature near to room temperature without losing its ferroelectric characteristics, by modifying with various dopants. It is expected that the combined presence of both Gd and Fe in BCT ceramics can lead a significant increase in the dielectric constant due to the enhanced polarization effects. In the present work the effect of 6% Gd and Fe co-doping in Barium Calcium Titanate (BCT) ceramics on its electrical and dielectric properties are investigated. Ba0.9Ca0.1Ti1-x (Gd0.5Fe0.5)xO3 (BCTGF) was synthesized following solid-state mixed oxides processing. The constituents of BCTGF were weighted and mixed in the desired stoichiometry by using acetone in agate mortar for 2h. The wet mixed oxides and carbonates were calcined for 10h at 1150°C. The calcined powder was densified into pellets by applying 1 GPa pressure beneath the uniaxial pelletizer. These compacted pellets were sintered at 1350°C for 2h. The polished pellets were coated with Ag paste and heat treated at 200°C before measurements. Fig. 1(a) shows the dielectric constant as a function of temperature and observed to reduce the phase transition temperature keeping intact the dielectric properties enriched. The real and imaginary part of dielectric constant as a function frequency presented in Fig. 1(b) and 1(c) simultaneously shows the typical relaxor behaviour of BCT compound.

Study of Structural, Dielectric and AC Conductivity of Strontium and Neodymium co-doped Barium calcium Titanate ceramic

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ABSTRACT

Electrocaloric Effect is significantly critical for environment friendly cooling technologies to replace Vapour Compression based refrigeration. Present study focuses on the structural, dielectric, and AC conductivity properties of Strontium (Sr) and Neodymium (Nd) co-doped Barium Calcium Titanate i.e Ba0.82Sr0.04Nd0.04Ca0.1TiO3 (BSNCT) ceramics to evaluate their potential for advanced ferroelectric applications such as solid state refrigeration. The BSNCT sample was synthesized via the sol-gel method using the acetates and iso-propoxides. Structural characterization using X-ray Diffraction (XRD) confirmed the formation of a pure perovskite structure with slight lattice distortions induced by Sr and Nd doping. Dielectric measurements as a function of temperature at different frequency and frequency dependent at different temperature, demonstrated enhanced dielectric constant and reduced dielectric loss, indicating improved energy storage capabilities. The Curie temperature (T□) exhibited a shift due to doping, reflecting changes in dipole alignment and lattice dynamics. AC conductivity studies revealed frequency-dependent conductivity consistent with polaron hopping mechanisms, and conductivity increased with temperature, indicating thermally activated transport processes. These results highlight the effectiveness of Sr and Nd co-

doping in tailoring the structural, dielectric, and electrical properties of BCT ceramics. The enhanced performance makes these materials promising candidates for applications in solid state cooling.

Recent Trends and Developments in Minimum Quantity of Lubrication (MQL) Machining: A Review

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ABSTRACT

The industry and researchers are engaged in improving the machining performance and at the same time trying to save the environment through various strategies. Recently awareness among the various stake holders has increased regarding the environment conscious machining. To improve the machining performance the use of cutting fluid has increased many times in recent past. However, the use of cutting fluids has raised many concerns due to their cost, difficulty to dispose-off, air pollution and health hazards. With an aim to reduce the use of cutting fluids various alternatives cooling lubrication techniques have been explored by the researchers. From the literature it is observed that MQL has been studied as an environment friendly cooling lubrication technique and has shown encouraging results in metal machining. To improve the performance of MQL technique researchers have explored the addition of nano sized solid particles in the base fluid. The present paper aims to review the recent trends and developments in the Minimum quantity Lubrication Technique.

Key words: - Minimum Quantity Lubrications, Nanoparticles Machining, ionic liquids.

Review on Utilization of Electronic waste into sustainable Construction materials for a futuristic materials and environment impact

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ABSTRACT:

Concrete, a widely used building material, should minimize its environmental impact to align with the construction sector's Sustainable Development Goals. Researchers worldwide are investigating the possibility of e-waste in building materials incorporating various recyclable elements. Various E-waste products are used as fine and coarse aggregate replacements in concrete. The study uses a

bibliographic approach with the Scopus database to delve into the literature discussing E-waste in construction materials from 2000 to 2023. The article summarizes the potential uses of e-waste in building materials through numerous studies utilizing a scient metric approach. A broad spectrum of data has been studied, we find Electric and Electronic Equipment's (WEEEs) is currently considered to be one of the fastest growing waste streams in the world, with an estimated growth rate going from 4% up to 5.5% per year. Solid waste management is one of the major environment concerns in the world. With the scarcity of space for land filling and due to its ever-increasing cost, waste utilization has become an attractive alternative to disposal and the mechanical and durability characteristics of concrete containing e-waste have been compared. This would prove beneficial to the research community, where one can predict the trends in the variation in mechanical characteristics with different replacement percentages of fine and coarse aggregates. E-waste can be used as an effective alternative material to natural aggregates.

Research is being carried out on the utilization of E-Waste products in concrete. The use of E-Waste products in concrete not only makes it economical, but also helps in reducing disposal problems. Total replacement of concrete is not possible due to no material plays the role of concrete in terms of strength, durability and workability. So we have to partial replace all the material to achieve desire properties of concrete. This survey gives us a brief information to understand the effect of E-Waste materials on the properties of concrete.

Keywords: Electronic waste, recycling of materials, pavement construction, alternative building materials, Waste management ·

Intelligent Automation in Manufacturing: The Convergence of Robotics, IoT, and Machine Learning in Industry 4.0

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ABSTRACT

The integration of IoT (internet of things) and machine learning along with the robotics in the manufacturing field is a revolutionary step towards advancement in automation. As robots reduces the human labour by automating the repetitive tasks which saves time and improves consistency. In smart manufacturing, the integration of robotics with AI and IoT allows them to adapt to real time and make independent decisions. The robotics in manufacturing already have a wide range of advantages such as increase productivity, improved safety, quality control and flexibility but integration with IoT takes it to the next step. IoT can be used to create connectivity, data collection, decision making and predictive maintenance. Also, robots can be remotely controlled with help of IoT and WiFi.

Machine learning helps the robots to learn from the data and improve the performance along with better maintenance and problem- solving capacity. By using machine learning in robots working along humans ensures completion of tasks together in safer and efficient manner. This integration can help a lot in industries like Automotive, electronics, packaging, food and beverages. This paper provides an overview of how robotics, machine learning, and the Internet of Things can be integrated into manufacturing and further presents automation developments and their revolutionary impacts on industrial processes. Robotics systems become smarter and safer by employing machine learning to optimize performance and solve problems and IoT for connectivity, data gathering, decision-making, and predictive maintenance. This integration will thus allow humans and robots to adapt real-time to each other. It improves productivity, safety, and quality control. Advances in the field of robotics in industries such as automobile, electronics, and food and beverages will be established through research that bridges the gap in existing technology and generates efficiency and innovation.

Keywords: Robotics, Smart Manufacturing, Internet of Things (IoT), Machine Learning (ML), Industry 4.0, Automation and Optimization

Development of Epoxy-Based Sustainable Material Using Date Palm Fiber- A Review

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This review article emphasizes the promise of date palm fiber (DPF), sourced from Phoenix dactylifera, as a sustainable and environmentally friendly option for various industrial uses. Plentiful, eco-friendly, and affordable, DPF presents a favorable strength-to-weight ratio, lightweight properties, and compatibility with both thermoset and thermoplastic resins, positioning it as a compelling substitute for synthetic, non-biodegradable substances. Its uses extend across construction, automotive, aerospace, and packaging sectors, aiding in minimizing environmental impact and promoting sustainable manufacturing methods. The combination of DPF with bio-epoxy resins, recognized for their biodegradability, thermal stability, and mechanical strength, further improves the properties of composites. These composites show enhanced tensile strength, durability, and heat resistance, rendering them ideal for high-performance applications. This paper examines progress in DPF composites, emphasizing chemical treatments, integration with other fibers, and improved fiber-matrix adhesion to enhance mechanical and thermal characteristics. The text covers applications like eco-friendly building materials, heat insulation, and innovative packaging options. By utilizing agricultural waste and promoting the circular economy, DPF provides a sustainable advancement in material science. This review offers an in-depth perspective on DPF's potential, tackling existing challenges and highlighting its significance in promoting green technologies and sustainable engineering approaches.

Comparison of Performance Characteristics of Dielectrics Oil and Graphite Mixed Machining of EN24 Using Electric Discharge Machining Process

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ABSTRACT

Materials that can be machined with Electro Discharge Machining (EDM) were taking more time for the material removal process.The Material Removal Rate (MRR) majorly enhanced with changing die electric media or implementation of newest hybrid technique in EDM. In this paper die electric fluid ST EDM oil and graphite powder mixed EDM oil were compared to improve MRR of high strength steel alloy EN24 by EDM. EN24 is made up of nickel chromium molybdenum has high ductility, water resistance and tensile strength. It is ideally suited for commercial shafts, axles, heavy duty components in offshore applications. Graphite powder mixed EDM oil was increasing electricity between electrode and work piece, No. of studies said that adding of graphite to die electric fluid may increase MRR above 50 percent because of high thermal conductivity of graphite granules. Two sets of experiments are conducted, first set with ST EDM oil die-electric fluid and second set with 10 µm size 2 gm/lit graphite powder mixed EDM oil and did the machining on EDM. In the above two methods focused on response parameters such as MRR, Overcut, Tool Wear Rate (TWR), Surface Roughness during machining on EN24. It is observed that graphite powder mixed EDM oil die-electric significantly improves machining performances of EDM process.

Keywords: EDM, TWR, MRR, SR, Dielectrics, SKD-61, EN24, Comparison

Towards Explainable AI in Cybersecurity: Designing Transparent and Accountable Algorithms for Threat Detection and Response Systems

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ABSTRACT

Explainable Artificial Intelligence (XAI) had become increasingly critical in cybersecurity, where the opacity of traditional AI models posed challenges in trust, accountability, and regulatory compliance. This research aimed to develop an XAI framework for cyber threat detection and response, ensuring transparency and interpretability while maintaining high detection accuracy and efficiency. The study integrated machine learning (ML), deep learning (DL), natural language processing (NLP), and adversarial learning to enhance cybersecurity analytics. Various datasets, including CICIDS2017, NSL-KDD, and UNSW-NB15, alongside synthetic attack simulations, were used to train and evaluate AI models. Baseline ML techniques such as Random Forest and XGBoost, alongside advanced DL models like LSTMs and transformers, were explored. The study incorporated interpretability techniques, including SHAP for feature importance ranking, LIME for localized explanations, and counterfactual reasoning for decision reversibility. Adversarial robustness was assessed using attack samples like FGSM and PGD to ensure model resilience. The framework was evaluated through precision, recall, and ROC-AUC metrics, alongside computational efficiency and human interpretability. Experimental validation involved benchmarking against existing intrusion detection systems and expert assessments. The research contributed a transparent, interpretable AI model, advancing cybersecurity defense mechanisms while enhancing trust and accountability in automated threat detection.

Scalable Big Data Analytics in IoT-Driven Smart Environments: Leveraging Cloud and Edge AI for Predictive Maintenance and Optimization

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ABSTRACT

This work involved a scalable big data analytics framework for IoT-driven smart environments by integrating cloud and edge AI for predictive maintenance and system optimization. A hybrid cloud-edge architecture was developed to process and analyse real-time data from IoT devices using machine learning and deep learning models, including supervised, unsupervised, and reinforcement learning techniques. Experimental setups included a combination of real-world IoT testbeds and cloud-based simulations, with data sourced from industrial IoT, smart city, and healthcare monitoring environments. Data preprocessing techniques, including noise filtering and anomaly detection, were implemented at the edge to reduce transmission overhead and enhance real-time decision-making. Predictive maintenance models were trained using algorithms such as Random Forest, XGBoost, LSTMs, and autoencoders, while federated learning was employed to enable decentralized training across edge nodes. The system was evaluated based on predictive accuracy, computational efficiency, network performance, and scalability. Comparative analyses between cloud-only, edge-only, and hybrid architectures demonstrated the advantages of cloud-edge integration in reducing latency and improving system reliability. The findings contributed to the development of an optimized and interpretable AI-driven framework for predictive maintenance, offering enhanced efficiency in IoT-enabled smart environments. The study provided valuable insights into resource-efficient data transmission, real-time analytics, and the role of explainable AI in industrial automation.

Adversarial Robustness in Machine Learning Models: Evaluating Defence Mechanisms Against White-Box and Black-Box Attacks

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ABSTRACT

Machine learning models have demonstrated remarkable performance across various domains; however, their vulnerability to adversarial attacks poses significant security challenges. The research explored adversarial robustness in machine learning models by evaluating defence mechanisms against white-box and black-box attacks. The study systematically analysed the vulnerabilities of deep learning models to adversarial perturbations and assessed the effectiveness of various defence strategies, including adversarial training, input preprocessing, model regularization, and gradient masking. A diverse set of attack methodologies, such as Fast Gradient Sign Method (FGSM), Projected Gradient Descent (PGD), and transfer-based black-box attacks, were implemented to measure model resilience across different architectures. The experimental framework incorporated image classification benchmarks, including CIFAR-10 and MNIST, to evaluate the impact of adversarial manipulations on model performance. Defence mechanisms were tested for robustness by examining their ability to mitigate accuracy degradation and maintain generalization under adversarial conditions. Results demonstrated that adversarial training significantly improved robustness against white-box attacks but remained partially susceptible to adaptive black-box strategies. Additionally, hybrid defences combining input transformation and adversarial augmentation yielded promising results in enhancing security without compromising model accuracy. The study provided insights into the trade-offs between robustness and model efficiency, contributing to the development of more resilient machine learning systems. The findings underscored the need for adaptive and explainable defence strategies to counter evolving adversarial threats in real-world applications.

Experimental and Numerical studies of Interlaminar Shear Strength in Basalt Fibre Reinforced Polymer Composite

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ABSTRACT

Basalt fibre-reinforced polymer (BFRP) is a natural composite derived from volcanic rock through melting and fiberizing process. It is gaining popularity because of its high strength-to-weight ratio and excellent mechanical, thermal and chemical properties. Fracture toughness testing is used to analyse crashworthiness, structural integrity and safety to avoid material failure. In this study, the Short Beam Shear (SBS) test is performed to evaluate Interlaminar Shear Strength (ILSS). This three-point bend test is conducted in accordance with the ASTM D2344 standard on a computer-controlled universal testing machine with a 1mm/min strain rate. For this standard, the sample dimensions used are 36 x 12 x 6 mm^3. The stacking sequence used in this study is [(0/90), (45/-45), (0/90), (45/-45)]2s. This test provides critical data on shear failure between the layers. The study compares the obtained experimental results with the numerical results from ANSYS. These results indicate excellent resistance to crack propagation and better interlaminar shear resistance. Matrix cracking, fibre-matrix debonding and delamination are failure mechanisms that are expected to occur.

Keywords: BFRP, ILSS, Delamination, ANSYS.

A Comprehensive Review of Applications and Optimization Techniques in Reliability, Availability, and Maintainability (RAM) Analysis: Emphasis on Markov Models and Implementation Challenges

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ABSTRACT

The use of Markov models for enhancing system performance in different industries is highlighted as being a key issue in reliability, availability and maintainability (RAM) analysis in this paper. In applying and optimizing RAM, the study explores the technique that make such models useful in predicting system behaviors while supporting effective decision making processes. Finally, the review also considers the implementation difficulties concerning Markov models, more specifically computation and data availability. It also provides a detailed bibliography from which further research can be based. This paper is developed on this basis, which highlights the importance of RAM analysis based on hybrids of practical applications.

A Unique Approach to Additive/Subtractive Hybrid Metal Part Manufacturing

ABSTRACT

Hybrid additive manufacturing(HAM) refers to the combination of several techniques and equipment, allowing for the printing of multiple materials, functions and structures simultaneously. The possibilities provided by HAM are revolutionizing the design principles for materials and introducing a new aspect in the design for AM. This study mainly aims to provide a direct definition of HAM in the context and categorize different hybrid- additive manufacturing processes. The discussion also covers HAM materials, machines, functions and architectures. Hybrid-Additive Manufacturing techniques employ AM with more than one processes to improve product quality or performance. Traditionally, the focus of defining HM processes has been on enhancing the process itself rather than enhancing the quality of the parts. However, the main objective is to enhance the quality and performance of the parts rather than improving the manufacturing process. Hybrid-AM procedures are usually a repetitive sequence of steps and are differentiated from post-processing activities that do not satisfy the fully integrated need. Other energy sources and manufacturing processes include subtractive and transformational, such as machining and peening. With the increasing interest in hybrid-AM, sustainability, and sensing technologies for hybrid processing are needed. Hybrid-AM represents a significant advancement in AM and has the capacity to fundamentally transform the production process of commodities.

Keywords: Additive manufacturing (AM), Hybrid Additive Manufacturing(HAM), Cyclic process chains, Hybrid processes.

Mechanical Properties of Hydroxyapatite-Titanium Biocomposites: A CAM/CAD Analysis

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ABSTRACT

Biomaterials studies combines elements of the biology, genetics, chemistry, tissue engineering, and substances disciplines. The majority of implants are made of titanium and its alloys, which have great mechanical qualities, strong strength, low density, and chemical stability in human fluids. They do not have strong biocompatibility or osteointegration. Using biocompatible and bioactive coatings can improve the implant material's compatibility and bioactivity. Hydroxyapatite (HAp) is a type of

bioactive substance that develops a strong bond with surrounding bodily tissues. One downside of this material is that it has little mechanical strength. Titanium oxide (TiO2) is a bioinert substance, which means it does not react with surrounding tissue. TiO2 has a strong mechanical strength and can be used as an alternative for implant devices. Efforts have been made to build a composite of both HAp/TiO2 biomaterial devices with improved mechanical properties and porosity. HAp is widely used as an implant for bone tissue regeneration and as a coating for metallic implants. The mechanical behavior of bones and bio composites is commonly described using finite element analysis. In this paper, the focus has been made to know the effect of various types of input parameters and their levels used to study CAD/CAM analysis of numerous biomedical implants. For the examination of biomedical implants, many kinds of materials, meshing, and boundary conditions are investigated.

Key words: Hydroxyapatite, Titanium oxide, Computer aided design, Mechanical strength

Material Characterization and Comparision in SLM-fabricated specimens vs Cast Structured specimens

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ABSTRACT:

This study investigates the impact of titanium dioxide and chromium oxide coatings on 17-4 PH stainless steel components, comparing samples produced through additive manufacturing and traditional manufacturing methods. SEM analysis were performed to evaluate the impact of coating on the performance of 17-4 PH stainless steel components. Results showed that the hardness of parts produced via additive manufacturing was lower than those of their conventional counterparts. The use of titanium dioxide and chromium oxide coatings significantly improved these properties in both instances. The study also examined the microstructure and wear behavior of titanium dioxide and chromium oxide coatings on precipitation hardening martensitic stainless steel (17-4PH), which is widely used in the oil and gas industries. Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) were used to analyze the microstructure and wear mechanisms. The wear resistance of 17-4 PH stainless steel underwent precipitation hardening for strength enhancement. The wear tests were performed using a pin-on-disc tribometer fitted with pins with different coatings. The wear resistance exhibited considerable variation attributed to the differing coatings on the pins. The study provides insights into optimizing stainless steel components for enhanced durability in harsh environments.

Keywords: 17-4 PH Stainless Steel, Conventional Manufacturing, Additive Manufacturing, Coatings, Microstructure analysis, Mechanical properties

Recent review on joint efficiency of HDPE pipes

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ABSTRACT

This study overviews recent advancements in joining techniques for high density polyethylene (HDPE) pipes. The use of HDPE pipes is becoming prevalent in the installation and restoration of pipelines for water, sewage and gas distribution systems. A notable feature of this material is its capability to fuse pipe sections using heat, eliminating the need for ball and socket joints typically associated with polyvinyl chloride (PVC) piping systems. The effectiveness of connecting HDPE popes is primarily determined by the techniques, circumstances and protocols employed. Electro fusion joining stand out as the principal method for linking HDPE pipes together. Connecting HDPE pipes is a crucial operation that impacts the longevity and structural soundness of pipeline networks. The review presented here examines different techniques for connecting HDPE pipes, butt fusion, electro fusion, socket fusion and mechanical coupling methods. The critical elements influencing joint effectiveness, including weld variables, surface treatment and ambient conditions are outlaid here. The review thoroughly explores issues such as material compatibility, mechanisms of joint failure and method of inspection. This concise review examines the present landscape of HDPE pipe connection methods and identifies potential areas for future studies aimed at improving the durability and performance of pipeline networks.

Static Analysis of Bio Inspired Helicoidal Structures

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ABSTRACT

Strength and toughness are two examples of mechanical attributes that are mutually exclusive, hence it is important to find strategies to improve specific combinations of these properties in engineering structure. The biological tissues of many plants and animals have evolved effective techniques

for producing composite structure with unique mechanical property combinations. One notable example is the mantis shrimp, a naturally occurring structure for its remarkable toughness and impact resistance. A paradigm for creative material design, the mantis shrimp's has a sophisticated helicoidal structure that allows it to survive from high impact and compressing loading. The current study employs finite element analysis (FEA) to investigate the mechanical behavior of biomimetic helicoidal structures, focusing on their energy absorption capacity, resistance to impact loading, compressive strength, stress distribution, and fracture resistance. The results reveal that helicoidal architectures exhibit superior performance in comparison to conventional materials and structural configurations. This behavior is attributed to the progressive failure mechanisms and the efficient distribution of stresses across the helicoidal layers. The helicoidal structure demonstrated a high resistance to impact loading, maintaining integrity even under severe conditions, which highlights its potential for applications in protective systems and armor materials. These findings underscore the potential of bioinspired designs to address the challenges of energy absorption, impact resistance, and mechanical durability in engineering applications.

AI-Driven Optimization of Nanoparticle-Enhanced Fluids for High-Performance Spray Cooling Systems

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ABSTRACT:

Advanced thermal management systems rely heavily on the development of efficient cooling solutions, with spray cooling emerging as a key technology for high heat flux removal. This study uses artificial intelligence (AI) to optimize the performance of nanoparticle-enhanced fluids for spray cooling applications. Utilizing experimental data, machine learning techniques, including regression models and artificial neural networks (ANN), are applied to predict thermophysical properties and heat transfer performance under varying operating conditions. Key variables such as nanoparticle composition, concentration, and flow parameters are analyzed to identify optimal configurations that enhance cooling efficiency. The AI-driven framework reduces dependance on iterative experimental methods, enabling precise and efficient design of advanced heat transfer fluids. This work contributes to the development of next-generation cooling systems by demonstrating improved thermal performance and reduced energy consumption, highlighting the transformative potential of AI in thermal management technologies.

Automated Dress Code Compliance Monitoring using YOLO Based Models

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ABSTRACT

Dress code detection in diverse settings including educational institutions, industrial environments and public spaces has become increasingly relevant to automated detection of dress code. In this review, which presents a comparative analysis of YOLO-based object detection models advancements in dress code compliance. The models that start with YOLOv5, transition to YOLOv11 and YOLO-NAS have significantly improved in accuracy, compute efficiency, and real time performance. In general settings, YOLOv10 is a great tradeoff between speed and precision, which is just what you need in your real time monitoring. At the same time, YOLO-NAS proves to be the most accurate and the most efficient model in the industrial environments, able to detect safety attire under more challenging conditions. These models redefines the potential of automated monitoring systems by the integration of innovations such as Neural Architecture Search (NAS), spatial attention mechanisms, and advanced feature extraction techniques. Additionally, this review features key metrics including precision, recall, Mean Average Precision (mAP) and latency, making it easy to learn from them to select the most appropriate model for downstream dress code detection scenarios. Future research aims to strike a balance the tradeoff between resource efficiency and adaptability by developing lightweight models for edge devices to be run on, and increasing the adaptability to accommodate more complex and dynamic environments.

Keywords: YOLO Models, Automated Dress Code Detection, Real-Time Object Detection, Neural Architecture Search, Industrial Safety Compliance, Deep Learning.

Laser-wire interaction model for non-planar directed energy deposition

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ABSTRACT:

Laser-wire interaction (LWI) length influences wire melting and uniform layer width deposition. However, the significance of LWI length with bead width has not been studied due to the lack of a reliable method to calculate LWI length for the off-axial wire feed method. This work introduces an analytical model to predict LWI length at non-planar orientations using geometrical relationships. The model development considers laser beam diameter, wire thickness, wire feed angles, and substrate tilt angles. It discusses the trailing wire position on the substrate. The single layer was deposited to understand the effect of LWI length at non-planar orientations on bead width. The experimental findings reveal that the variations in substrate angles and wire feed angles influence the melt pool size and shape, influencing the bead width. This work is required to predict the melt pool characteristics to control the mechanical properties in a non-planar wire-based directed energy deposition process.

Keywords: Analytical model, Pulsed laser, Non-planar, Wire-DED, Additive manufacturing

Surface Engineering for Corrosion Protection in Additive Manufacturing: A Review of Recent Developments

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ABSTRACT:

Additive manufacturing (AM) has become increasingly popular for its ability to make very intricate and complex geometries that would either be very difficult or impossible with traditional manufacturing processes. But Additive manufacturing comes with its own set of peculiar disadvantages, especially when it comes to material properties and surface quality. Corrosion resistance is very important in the aerospace, automotive, and biomedical industries, where component integrity and performance are measured over long periods. The enhancement of the corrosion resistance of additive manufactured materials is impeded by several factors, such as their microstructure variations, different material compositions, various types of post-processing used, and localized susceptibility to corrosion. Thus, it is of utmost importance to study how additive manufactured metals, alloys, and composites perform in corrosive environments. The focus of this paper is on the corrosion behaviour of additive manufactured materials such as metals, alloys, and composites while reviewing recent developments in surface-engineering strategies toward corrosion mitigation.

Keywords: Additive manufacturing, corrosion resistance, surface engineering.

Advances in Multi-Material Additive Manufacturing: Integrating Functionality, Complexity, and Sustainability

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ABSTRACT

Additive manufacturing (AM) has emerged as a transformative technology, offering unparalleled versatility and the potential to redefine conventional manufacturing paradigms. Among its advancements, multi-material additive manufacturing (MMAM) has gained significant attention for its ability to combine diverse materials, enabling the production of components with enhanced functionality, environmental adaptability, and complex geometries. This review provides a comprehensive analysis of MMAM systems, focusing on the working principles, material combinations, and design strategies that underpin this technology. Key areas of investigation include modeling and optimization techniques, as well as the applications of MMAM across industries such as automotive, aerospace, and biomedical engineering. Particular attention is given to the challenges associated with multi-material interfaces, including material compatibility, joining mechanisms, and the limitations of current software and manufacturing processes. Moreover, this review highlights the role of postprocessing techniques in improving the performance of MMAM-fabricated parts and explores nature-inspired designs for future innovations. By identifying current gaps and proposing strategies to overcome technological challenges, this work aims to provide insights into the future direction of MMAM and its potential to bridge functional manufacturing with intricate geometries.

Progress On Extending The Durability Of Eb-Pvd Sprayed Thermal Barrier Coating

ABSTRACT:

Electron beam physical vapour deposition (EB-PVD) is preferably used to develop Thermal Barrier Coatings (TBCs) for high-temperature applications due to its ability to produce columnar microstructures with superior strain tolerance. However, the durability of EB-PVD sprayed TBCs remains a significant challenge, limiting their longevity in harsh operating environments. This work reviews recent progress in extending the durability of EB-PVD sprayed TBCs. Advancements in coating composition, microstructure optimization, and surface treatments have contributed to improved TBC performance. Novel ceramic materials with enhanced phase stability and lower thermal conductivity have been developed, offering better sintering and thermal cycling resistance. Multilayer architectures and graded compositions have shown promise in mitigating thermal stresses and improving adhesion. Surface modifications, such as laser treatment and ion implantation,

have been explored to enhance erosion resistance and reduce oxygen penetration. Furthermore, innovative bond coat designs and the incorporation of nanostructured materials have demonstrated the potential to extend TBC lifetimes. Using platinum group metal-modified aluminide bond coats and adding reactive elements have improved oxidation resistance and coating adherence. Nanostructured TBCs have exhibited superior mechanical properties and thermal shock resistance compared to conventional coatings.

UTS Comparison of AL 6063 and AL 7075 after Thixofoming at Different Temperature

ABSTRACT

Different Temperature ranges are used to first make material to go through semi-solid state Al 6063 at temperature 525°C and 550°C, Al 7075 at temperature 535°C and 565°C. Then the extrusion process carried on specimens at this elevated temperature. Firstly, the material is heated at a particular temperature at a semi-solid state, T6 condition, then an extrusion process is carried out and desired shape specimen obtained. After that Ultimate Tensile Test is performed with the help of UTM of different specimens and get results of UTS, Proof stress, Yield Strength, Reduction in area etc and then comparisons done on the basis of those results.

Experimental investigation of heat transfer augmentation in a fin tube heat exchanger using rectangular winglet

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ABSTRACT

Rectangular winglet is to be used to enhance Performance Evaluation Criteria of a Heat Exchanger. Heat Transfer enhancement augmentation process is to be done by several methods but one of the best methods is by using a winglet. The experiment is to be done on the Wind Tunnel Test Rig. Based on this experiment, readings are to be taken with and without Rectangular winglet. After both the readings of with and without Rectangular winglet a comparison between the usage of Rectangular winglet and without the usage of Rectangular winglet is to be done on the basis of factors of Heat transfer i.e. Colburn Factor, Performance Evaluation Criteria and Friction Factor. Performance Evaluation Criteria for both with and without Rectangular winglet is to be finding out and is to be compared to find out the maximum Performance Evaluation Criteria. During the experimental research the Performance Evaluation Criteria with Rectangular winglet is maximum at Air Velocity 6 i.e. 9.466069 and the Performance Evaluation Criteria without Rectangular winglet is maximum at Air Velocity 6 i.e. 4.806861.

Keywords - Heat transfer enhancement, rectangular winglet, Wind tunnel, Performance Evaluation Criteria (PEC).

Wear behaviour of CNT and GNP reinforced plasma sprayed Alumina coatings

ABSTRACT

The unique mechanical, chemical, and tribological properties of graphene family materials make them ideal reinforcement candidates for enhancing the wear resistance of various matrices. This study investigates the tribological performance of plasma-sprayed alumina (Al_2O_3) coatings under diverse conditions, including high temperatures and marine environments, by incorporating carbon nanotubes (CNTs) and graphene nanoplatelets (GNPs). The synergistic reinforcement of CNTs and GNPs resulted in a 45% reduction in the coefficient of friction (CoF) at room temperature and approximately 50% at elevated temperatures and in simulated seawater. Furthermore, the weight loss due to wear was reduced by a factor of 6–7 in the ACG coating. These enhancements are attributed to (a) the formation of a stable film during wear, (b) the lubricative properties of the reinforcements, and (c) the superior fracture toughness of the ACG coating. Elemental mapping of the worn ACG tracks revealed a uniform distribution of elements, which contributed to the improved wear resistance of the coating across adverse conditions.

Structural, Dielectric and AC conductivity of Gadolinium Modified Bi0.4Na0.4Sr0.2TiO3 Composite

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ABSTRACT

Refrigeration based on electrocaloric effect (ECE) is strikingly attractive as it promises environment-friendly cooling at higher efficiency (70%) compared to (unhealthy) vapor compression-based refrigeration (50%). Present work reports a detailed analysis of temperature and frequency-dependent dielectric, electrical properties of La modified BNT, i.e. Bi0.34Na0.4Sr0.3Gd0.06Ti0.9O3 BNSGT

ceramic. BNSGT is synthesised by the Solid-state mixed oxide method. Stoichiometrically, weighted constituent oxides and carbonates are wet mixed and calcined at 900°C for 12h. Then powders are pelletized and sintered at 1250°C for 2 hrs. X-ray diffraction confirms the formation of a single-phase perovskite structure. Average particle size was estimated from the full-width half maxima of the strong XRD peak using Debye-Scherrer's equation. BNSGT is characterized dielectric maxima which are closely spaced on the temperature scale mimicking a broad transition peak covering the 100-375°C temperature range at different frequencies. BNSGT is characterized dielectric measurements, performed as a function of temperature and frequency, reveal a significant enhancement in dielectric constant and reduced dielectric loss with Gd doping, suggesting improved energy storage capability and thermal stability. The frequency-dependent AC conductivity, analysed using Jonscher's power law, demonstrates increased conductivity with Gd modification, attributed to enhanced charge carrier mobility and reduced grain boundary resistance. The results highlight the potential of Gd-modified BNST composites for advanced applications in solid state cooling technologies.

IoT based heart monitoring system using ECG

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ABSTRACT:

Heart disease remains one of the leading causes of mortality worldwide, necessitating accurate and timely diagnostic methods for effective management. Traditional diagnostic approaches often rely on subjective interpretation of electrocardiogram (ECG) signals, leading to inconsistencies and delays in treatment. This paper addresses the need for automated and reliable heart disease classification using deep learning techniques. Heart disease encompasses various cardiac abnormalities, including myocarditis, ventricular ectopic beats, supraventricular ectopic beats, fusion beats, and others. The complexity of ECG signals poses challenges in accurate interpretation, compounded by the subjective nature of manual diagnosis. Our proposed solution leverages deep learning, specifically an EfficientNetB5 2D convolutional neural network (CNN), for automated heart disease classification. By training the model on a diverse dataset of ECG images collected from the Kaggle database, encompassing multiple heart conditions, we aim to enable accurate and real-time diagnosis. Through rigorous evaluation using standard metrics such as accuracy, precision, recall, and F1-score on a separate testing dataset, we assess the diagnostic effectiveness of the proposed model. By automating the classification process, our solution offers the potential to enhance diagnostic efficiency, reduce human error, and facilitate timely interventions for improved patient outcomes in the management of heart disease. Finally, the classified result is updated to an IoT system using Node MCU and displayed on an LCD screen for real-time monitoring and easy access to diagnostic outcomes.

Assessment Of Hip Implant Stiffness Using Fatigue Analysis: Identifying Root Causes

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ABSTRACT

Hip hemiarthroplasty, a common surgical intrusion for addressing femoral neck fractures and related conditions, often employs bipolar implants to mitigate acetabular wear and enhance joint mobility. Despite these advancements, long-term complications such as implant stiffness and bearing wear persist, significantly impacting patient outcomes. This study evaluates the performance and limitations of bipolar implants, emphasizing the mechanisms contributing to implant stiffening over time. A comprehensive methodology, including reverse engineering, 3D modeling, and fatigue analysis, was applied to assess the efficient endurance of bipolar implants in elderly patients. Four patient-specific acetabulum models were developed, and simulations under walking and abduction conditions revealed critical wear patterns and force distributions. Fatigue analysis highlighted uneven acetabular forces as the prime factor behind polyethylene bearing distortion, leading to progressive stiffness. The findings underline the need for enhanced implant materials and designs to address uneven force distribution and enhance the durability of bipolar implants. This study provides actionable insights for optimizing future hip implant designs and balancing cost, functionality, and surgical feasibility.

Review Paper Post Treatment of Ni Based Superalloys Coatings For Improving Their High Temperature Corrosion Resistance

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ABSTRACT

This study thoroughly examines post-treatment approaches to enhance the resistance of Ni-based superalloys to high-temperature corrosion. These alloys are vital in industries such as gas turbines, aerospace engines, and power generation. Despite their superior mechanical strength and thermal stability, they are prone to corrosion in environments containing sulfur, chlorine, or oxygen. The paper reviews various post-treatment methods, including oxidation processes, aluminizing, and heat treatments, evaluating their role in boosting corrosion resistance. It also investigates the working principles of each technique, outlines their strengths and drawbacks, and explores future prospects and challenges in developing advanced, durable coatings for high-temperature conditions.

Optimization of automatic Spray Paint Machine for Road Dividers Using PLC

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ABSTRACT

This study explores the development, design, and operation of an Automatic Spray Paint Machine specifically engineered for accurately painting road dividers. The system utilizes an Allen-Bradley Micrologix 1000 PLC, integrated with sensors and actuators, and leverages wheel circumference measurements to ensure precise positioning and uniform paint application at predetermined intervals. The machine alternates between black and white paint, maintaining a consistent spacing of 45 cm for each colour. Key features include SCADA monitoring and automatic pressure regulation via limit switches, nozzle movement controlled by electrical actuators, and continuous forward motion while preserving a consistent distance from the road divider. This paper examines this technology's working principle, design considerations, control mechanisms, and benefits in enhancing road maintenance efficiency.

Keywords – PLC interfacing, automation, Spray paint machine, time saving, Eco-friendly.

Electric Vehicle Powered by Artificial Intelligence: A Review

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ABSTRACT

This review paper explores how Artificial Intelligence (AI) technologies are incorporated into Electric Vehicles (EVs), emphasizing the potential for environmentally friendly transportation options. This study looks at new developments in energy management, electric vehicle control, and autonomous vehicle regulations. In comparison to traditional internal combustion engine vehicles, it emphasizes the substantial reduction in greenhouse gas emissions and enhanced air quality that result from the growing use of EVs. But it also covers technical issues like data security, data interoperability, and AI processing that arise with integrating AI. Policy considerations include more government regulation of autonomous car technologies and incentives for the deployment of EVs.

Keywords: Electric Vehicles, Artificial Intelligence, Sustainability, Transportation, Renewable energy, Charge Optimization.

Applications and Capabilities of Smart Materials powered by Artificial Intelligence: An Overview

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ABSTRACT

Smart materials are rapidly developing for applications such as self-sustaining and self-healing. These stimuli-responsive materials, including piezoelectric, shape memory alloys, electro-rheological fluid, magneto-rheological fluid and chromic materials, have the potential to build smart structures and materials. These materials resemble biological systems that sense vibrations, piezoelectric hydrophones with electromechanical coupling, shape-memory materials that can recollect original shapes, and electro-rheological fluids with manipulative viscosity strength. Research is now focused on integrating advanced technologies into compact with the help of artificial intelligence (AI), diverse functional packages to develop advanced smart materials and revolutionize the research field of smart materials. This review provides a brief summary of these stimuli-responsive smart materials and a complete description of application and capabilities.

Keywords: Self-sensing, Self-healing, Self-diagnostics, Piezoelectric, Shape Memory Alloys

Current Developments, Obstacles, and Opportunities in Solar Dish Collectors: A Review

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ABSTRACT

This paper's primary goal is to present a thorough analysis and methodical synopsis of the advancements in solar dish technology research as a concentrated solar power source. In the subject of solar dish collector research, the efforts mostly focus on the latest developments, technical difficulties, and optimization frameworks. This study's discussion of innovative pairings of solar dish collectors with other power generating elements, such as PV cells, thermoelectric devices, and thermal collectors, is among its most important components. The research also provides insight into possible polygeneration applications that may be designed and current thermodynamic cycles that can be driven by solar dish collectors. Additionally, the most pertinent studies using phase-change materials and nanofluids in solar dish collectors included.

Keywords: Solar dish collector, Design, Optimization, Hybrid configurations, Power generation