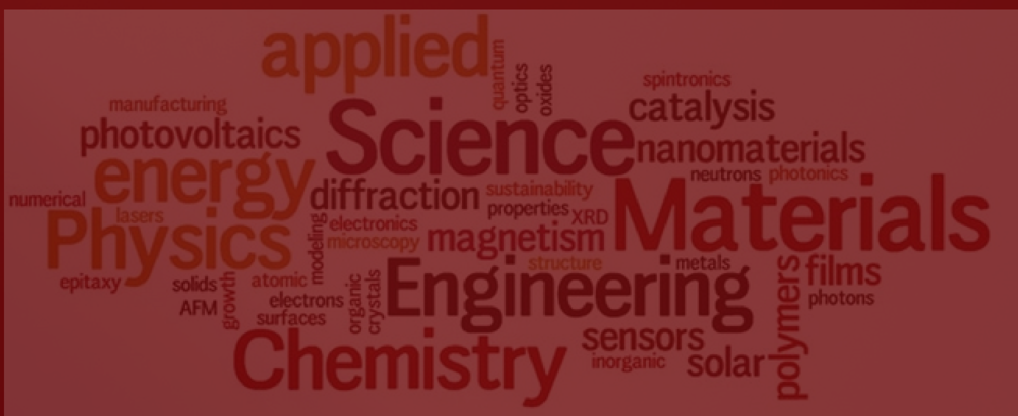
M'hamad Bougara University, Faculty of Technology, Mechanical Engineering Departement/2025

Ahmed Chellil – Samir Lecheb
Hamza Mechakra – Brahim Safi –
Kamel Ikkache – Abdelhakim Daoui. *Editors*

ABSTRACT PROCEEDINGS

4th International Conference on Materials, Mechanics and Technology-ICMMT 2025

Boumerdes, Algeria, on November 25–26, 2025



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Website: https://icmmt.online/

The second The International Conference on Material, Mechanics and Technology (ICMMT'2025) will be held in Faculty of Technology Boumerdes University, Algeria. The main goal of which is to strengthen communication between the higher education family and industrialists, bring the socio-economic sector closer to academic skills and public administration. Our goal is to establish a national ecosystem favourable to investment, through communication between the sectors concerned. Also, through this conference, we wish to draw a roadmap that pushes the economy and national development towards progress.

To this end, this conference focuses on topic below:

Topic 01: Advanced Materials and Composite Structures

Topic 02: Mechanical Construction and Automobile Manufacturing

Topic 03: Vibration, dynamic, Maintenance and Tribology

Topic 04: Fracture Mechanics, Fatigue, Damage, Non Destructive Testing

Topic 05: Energy and Renewables, Green hydrogen and recycling

Topic 06: Mechatronic, Electromechanical and Industrial Engineering

Topic 07: Civil engineering and Process Engineering

Topic 08: Innovation and Startup

Ahmed CHELLIL
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	**PlenaryII - Prof Aicha Bammoun, lorida International University, USA;** *''Synergetic partnerships of Academia and Industry in Achieving theSustainable Development Goal''*
	PlenaryIII - Professor Kebir Hocine, University of Technology, Compiegne France ; *''Ruin mechanisms and numerical models: damage and failure ''*
	**Plenary VI - Prof. Samir LECHEB, Dircetor of Incubator, University of Boumerdes, Algeria ;** *'' Innovation and Entrepreneurship Arrêté ministerial 1275 /008''*
	**PLENARY V: Professeur Boussad Abbes, University of Reims, France :** *'' Modélisation multi échelle du comportement mécanique des fibres végétales comme renforts pour les matériaux composites''*
	PLENARY VI: Professor Khetib Yacine, University of King Abdelaziz, KSA: *'' Group contribution concept for computer aided design of working fluids for refrigeration machines''*

Topics

Interaction Between Metallic Substrate Diffusion and Structural Degradation in CISe Absorber Performance

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Abstract

Currently, chalcopyrite solar cells are increasingly imposed in the photovoltaic market, thanks to its performances comparable to that based on silicon, for this purpose, this study is interested in the elaboration of the absorbent layer CuInSe2 by a less expensive technique "Spray Pyrolysis”, a comparative study was based on the use of two substrates, the glass substrate and the Stainless steel 316 , the Diffraction of x-ray of the CISe deposited on glass shows the presence of four peaks, indexed as (112), (220), (400), and (424). This peaks confirms the CISe polycrystalline structure films, the temperature influence appeared in the peak (112). We remark than the intensity of peak this peak improve with the increase in temperature, and its diffraction angle 2θ changes towards the preferential position, We note a good Cu/In and Se/Cu ratios, confirming a good stoichiometry of CISe at 550°C, the CISe have good optical absorption, especially in the visible range. However the CISe layer deposited on stainless steel shows a great loss of crystallization especially with the high temperature of 550° C, the chemical ratios show a bad formation of CISe. Furthermore, EDX specters for the two layers CISe shows that, a Na signal is observed in the CISe deposited on glass, however, metallic impurities were observed in the CISe layer deposited on stainless steel..

Keywords: *CISe Films, Metallic Substrate, Elemental Diffusion, Structural Degradation.*

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COMPARATIVE NUMERICAL STUDY OF POROUS, FDM-PRINTED, AND IDEAL SOLID PLA-BASED MATERIALS

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Abstract

Additive manufacturing has enabled the fabrication of complex lightweight structures with tunable mechanical properties, making it a promising approach for biomedical implants. In this study, the mechanical performance of three PLA-based implant-like models is numerically investigated and compared using Abaqus finite element analysis. The first model incorporates a porous lattice structure designed to reduce stiffness and enhance load transfer balance. The second represents a solid Fused Deposition Modeling (FDM) printed component, modeled as an orthotropic material to account for printing-induced anisotropy. The third is an ideal isotropic solid model serving as a reference for conventional manufacturing. All models share identical geometry and boundary conditions under static loading. Material properties for the porous and FDM models were estimated based on literature data and preliminary tensile tests. The analysis focuses on comparing global stiffness, peak stress, and deformation behavior. The results demonstrate that porosity effectively reduces weight and stiffness, while FDM anisotropy significantly influences stress distribution compared to the ideal model. This work highlights the importance of considering additive manufacturing effects in the mechanical design and simulation of PLA..

Keywords: *PLA-based materials, Finite Element Analysis, Additive Manufacturing (FDM), Porous structures, Mechanical behavior, Abaqus, 3D printing.*

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DESCRIPTOR-BASED CHARACTERIZATION OF AZO-ETHER LIQUID CRYSTAL MATERIALS FOR ADVANCED COMPOSITE STATIONARY PHASES

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Abstract

Liquid crystal (LC) stationary phases represent a promising class of advanced functional materials, where anisotropic molecular organization leads to highly selective chromatographic behavior. In this work, we investigate two newly designed azo-ether-based liquid crystals intended for integration into composite stationary phase structures for HPLC columns. Although both mesogens share a tetracyclic aromatic core connected through azo-ether linkages and terminated by a carboxylic group, they differ in the terminal substituent, introducing controlled variations in polarity, rigidity, and interaction potential.

To analyze and exploit these structural effects, a comprehensive preprocessing strategy was applied to molecular descriptors generated from SMILES representations. The workflow involved descriptor normalization, constant-attribute removal, variance filtering, multicollinearity reduction, and correlation analysis with experimental retention factors. The refined descriptor subsets emphasize the physicochemical and topological parameters most sensitive to substituent-dependent modifications within the LC framework. This study demonstrates that rigorous descriptor preprocessing is essential for extracting meaningful structure–property relationships in advanced mesogenic materials. By improving data quality and interpretability, the proposed approach provides a reliable foundation for future AI-based retention prediction and for guiding the rational design of next-generation LC composite stationary phases..

Keywords: *Liquid crystal stationary phases, azo-ether mesogens, composite structures, molecular descriptors, data preprocessing..*

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STRUCTURAL, MAGNETIC, AND MAGNETOCALORIC CHARACTERISATION OF DOUBLE PEROVSKITE La2CoMnO6, INFLUANCE OF SYNTHESIS CONDITIONS

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Abstract

Magnetocaloric refrigeration offers an environmentally friendly and energy-efficient alternative to conventional vapor-compression systems. Among magnetically active perovskites, the double perovskite La_2CoMnO_6 (LCMO) is of particular interest due to its structural stability, strong ferromagnetic coupling, and tunable electronic configuration. In this work, LCMO was synthesized using the sol–gel auto-combustion method, followed by calcination and sintering. Compared to conventional solid-state or hydrothermal synthesis, this route enables rapid chemical homogeneity, lower calcination temperatures, fine particle sizes, and large specific surface area, all of which promote phase purity and magnetic uniformity. Thermal analysis revealed complete precursor decomposition below 600 °C, while X-ray diffraction and Rietveld refinement confirmed the formation of a single-phase monoclinic $P2_1/n$ structure . Magnetic characterization revealed a sharp ferromagnetic–paramagnetic transition near 225 K, consistent with Co^{2+}–O–Mn^{4+} superexchange. The magnetocaloric effect, derived from isothermal magnetization, showed a maximum entropy change of 2.8 $J\cdot kg^{-1}\cdot K^{-1}$ under a 5 T field and a relative cooling power of ~140 $J\cdot kg^{-1}$. Critical exponent analysis confirmed a second-order transition following three-dimensional Heisenberg behavior. The results demonstrate the superior efficiency of the sol–gel auto-combustion technique in producing homogeneous, nanostructured LCMO with enhanced physical properties, underscoring its potential as a scalable route for synthesizing high-performance magnetocaloric materials. Further optimization through defect engineering or compositional tuning could shift the working temperature closer to ambient conditions..

Keywords: *Magnetocaloric, double perovskite, sol–gel auto-combustion..*

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Development and Characterization of Crushable Thermoplastic Sandwich Panels Reinforced with E-Glass Fabrics for Energy Absorption Applications

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Abstract

This study investigates the development and mechanical performance of all-composite sandwich panels featuring a thermoplastic matrix and a honeycomb core. Driven by the need for lightweight, recyclable, and impact-resistant materials, two thermoplastic matrices—Polylactic Acid (PLA) and Acrylonitrile Butadiene Styrene (ABS)—reinforced with continuous E-glass fibers were utilized. A novel solvent-assisted manufacturing process combined with thermal cycling was developed to fabricate the laminated composite skins, which were then bonded to a fabricated trapezoidal honeycomb core. Quasi-static tensile and compression tests characterized the fundamental mechanical properties, while low-velocity impact and repetitive impact performance were evaluated using a drop tower test rig. Results indicated that PLA/glass fiber (PLA/GF) composites exhibited higher stiffness and plateau stress (1.86 MPa), whereas ABS/glass fiber (ABS/GF) composites demonstrated superior ductility, energy absorption efficiency (93.63%), and impact force attenuation (91.1%). The ABS-based panels also showed better performance under repetitive impacts, although PLA-based panels withstood a greater number of impact cycles. This work establishes a foundation for using sustainable thermoplastic composites in protective structures, highlighting a trade-off between stiffness and energy absorption tailored to specific application requirements..

Keywords: *Thermoplastic Composites, Sandwich Structures, Honeycomb Core, Energy Absorption, Impact Testing.*

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EXPERIMENTAL and NUMERICAL STUDY OF THE COMPRESSIVE BEHAVIOR OF ALUMINUM HONEYCOMB STRUCTURES

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Abstract

Honeycomb materials are increasingly used in applications requiring a high strength-to-weight ratio and excellent energy absorption capacity. Their extensive use in fields like aerospace and transportation is driven by the critical need for weight reduction without compromising structural integrity. This study presents an integrated experimental and numerical analysis of the in-plane compressive behavior of aluminum honeycombs. A regular hexagonal honeycomb was manufactured via a homemade corrugating machine. Quasi-static compression tests were conducted in the two in-plane directions to characterize the mechanical properties. Experimental results confirmed the in-plane isotropy of the honeycomb, with nearly identical properties in both directions. Numerical simulations were performed using LS-DYNA to model the compressive response. A comparative analysis revealed strong agreement between experimental and numerical results for plateau stress and energy absorption, with relative errors remaining below approximately 15%. However, a significant discrepancy was observed in the elastic modulus. This substantial mismatch is primarily attributed to various manufacturing imperfections introduced during the fabrication process. The study validates the reliability of the presented approach for predicting plastic behavior and energy absorption, while highlighting the critical influence of fabrication quality on elastic properties..

Keywords: *Honeycomb, Compression, Experimental Study, Numerical Modeling, LS DYNA, Energy Absorption..*

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AN INVERSE IDENTIFICATION OF MATERIAL PARAMETERS USING AI-OPTIMIZATION

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Abstract

Inverse analysis is becoming an efficient and one of the most widely used techniques for quantifying the mechanical properties of materials. For this reason, it has been under intense development for decades, certainly with the progress of AI tools. This study aims to clarify the need for an accurate constitutive model capable of providing precise material data, also to explore the machine learning techniques to advance identification technology and understand the plastic behavior of metal sheet by extracting the constitutive parameters of the hardening law based on numerical-experimental methods. This approach relies on uniaxial tensile test results and Finite element simulation to establish an AI optimization model. This calibration strategy guarantees that the numerical results obtained from FE analysis align accurately with experimental data. This work shows the potential of AI in parameter optimization and paves the way for the development of material models capable of reproducing complex material behavior purely from data.

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Keywords: *Material characterization, Inverse identification, Constitutive parameters, Machine learning, Finite Element analysis..*

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Application of Genetic algorithms to optimise the geometric parameters of composite laminates

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Abstract

The present study focuses on the optimization of laminated composite structures design variables, using a Genetic Algorithm approach. An optimization program was developed to solve this class of problems by considering several design variables, including fiber orientation, material type, and the mechanical properties of each lamina in the laminate.

The main objective of this work is to obtain a composite laminate by optimizing its initial geometric parameters such as number of ply, fibers orientation . To achieve this, a computational strategy inspired by biological evolution, namely the Genetic Algorithm, was employed to efficiently explore the design space and determine the optimal design configuration under the same initial conditions.

The optimization program was initially implemented in Matlab due to its robust numerical capabilities and suitability for scientific computation..

Keywords: *genetic algorithm, composite laminate , stacking sequence, fiber orientation, number of plies.*

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SYNTHESIS AND CHARACTERIZATION OF SILVER NIOBATES Ag0.75Na0.25Nb3O8

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Abstract

New alkali niobates Ag0.75Na0.25Nb3O8 and AgNb3O8 were synthesized by soft chemistry via cation exchange from a hydronium precursor $H_3ONb_3O_8$ derived from potassium niobate. The Characterization of the obtained compounds, was performed using X-ray diffraction (XRD), attenuated total electron spectroscopy (ATMS), and scanning electron microscopy (SEM) coupled with EDX analysis. Diffuse reflectance spectroscopy (DRS) revealed a direct optical transition with a band gap (Bg) between 3.45 and 3.60 eV. Furthermore, electrical conductivity measurements using the two-point method showed that the sample exhibits ohmic behavior at room temperature. The exceptional properties of $AgNb_3O_8 \cdot nH_2O$, its lamellar structure that facilitates ion exchange and intercalation, and a suitable band gap make it a promising candidate for various industrial applications, including electrochemical devices and energy storage..

Keywords: *ion exchange and X-ray diffraction; soft-chemistry and layered niobate..*

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Effect of magnesium addition and thermal treatment rate on the structure, spectroscopic and dielectric properties of synthesized glass ceramics

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Abstract

To seek a valorization for waste glasses from healthcare facilities in the production of functional glass ceramics. This research was conducted by investigate the effect of MgO addition, and examine the impact of varying sintering temperatures rates on both the phase formation and physical characteristics of glass ceramics prepared for dielectric applications. These wastes are mainly used as a source of silica, and according to the chemistry of glasses, molar mixtures were established, deficits in magnesia (MgO) offset by addition of pure magnesium oxide. 25,30 and 35 mol % of MgO were added to glass waste to prepare the new glasses samples which were exposed to three sintering temperatures rates 2°C/min , 5°C/min 10°C/min the development of structures was characterized using Raman spectroscopy, X-ray diffraction (XRD), differential thermal analysis (DSC/TG) and Atomic Force microscopy analysis (AFM)..

Keywords: *waste, valorization, glass-ceramics, forsterite.*

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PARAMETRIC STUDY OF THE DYNAMIC BEHAVIOR OF ORTHOTROPIC LAYERED COMPOSITE MATERIALS

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Abstract

This work involves the dynamic behavior of orthotropic Epoxy/carbon laminated composite materials. The simulation is carried out using Comsol Multiphysics software based on the finite element method. The aim of this work is to study the influence of several parameters on the natural frequency and vibration modes. The parameters studied are: boundary conditions, layer stacking, fiber orientation, and the number of layers. The results show that these parameters have a major influence on the dynamic behavior of composites, and they must be taken into account in order to design a more efficient composite material by avoiding resonance frequencies..

Keywords: *Composite materials, Epoxy/carbon, natural frequencies, vibration modes, Comsol Multiphysics, finite elements….*

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MICROSCALE PREDICTION OF EFFECTIVE MECHANICAL PROPERTIES OF CARBON/EPOXY FIBER TOW USING THE ASYMPTOTIC HOMOGENIZATION METHOD

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Abstract

Homogenization techniques are essential for accurately describing the mechanical behavior of composite materials. In this study, we aim to predict the effective mechanical properties of a carbon/epoxy composite fiber tow at the microscale using the Asymptotic Homogenization (AH) method. The AH methodology is numerically implemented using ABAQUS software to solve six unit-strain problems under periodic boundary conditions. The simulation results are compared with those obtained from the Representative Volume Element (RVE) approach and validated against data from the literature. The results demonstrate good agreement, indicating that the AH method offers higher accuracy in simulating periodic Representative Unit Cells (RUCs) for composite materials..

Keywords: *Asymptotic Homogenization, Microscale Modeling, Periodic Boundary Conditions, Representative Volume Element, ABAQUS, Fiber Tow.*

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SPECTRAL AND STRUCTURAL CHARACTERIZATION OF VALUED COMPOSITE MATERIAL

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Abstract

The purpose of our study is to determine the optimal activation conditions (Concentration): 6 M at temperature T = 90 ° C, Activation time = 5h, adsorbed H_2SO_4 = 1.66 meq / g of clay, CEC = 99 meq/100 g of clay) to achieve an adequate activated bentonite aimed to apply for pillaring operation. (Ag, Cu, Ti- oxides Pillared) Clays were synthesized from activated bentonite using $AgNO_3$, $CuCl_2$ and $TiCl_2$ solutions as pillaring agents. The pillared products were characterized by physic-chemical analysis (FTIR, SEM, XRD, XRF, CEC, specific surface area, Average pore diameter).The basal spacing for the (Ag, Cu, Ti-intercalated) bentonite and (Ag, Cu, Ti-pillared) bentonite are 42 A° and 35 A°, respectively. The specific surface areas of (Ag, Cu, Ti-pillared) and natural bentonite are 420 and 62 m^2 g^{-1} respectively. We notice by X-ray fluorescence: the decrease in the chemical composition of structural cations (Ca^{2+} and Na^+) of activated bentonites is due to washing several times with distilled water to remove sulfate ions. Under these conditions, activated bentonites do not undergo any very deep chemical modifications generally leading to the destruction of its crystal lattice which will be better confirmed by X-ray diffraction [1]. Analysis of physical and textural properties of the raw and modified clay materials showing an improvement in the porosity of the modified materials compared with the raw material, which shows an increase in the interlamellar spaces and improving of the porous texture of the materials studied [2]. The (Ag, Cu, Ti-pillared) bentonite was studied by the scanning electron microscope has acquired a uniform and homogeneous structure at the 100 µm scale, which confirms the acid chemical treatment and pillaring operation of its particles which present an agglomeration of macro and microstructures is much more important. With specific properties, the complexing Clay matrices are highly reactive nanomaterials and can be used in industrial wastewater treatment and as catalysts in several chemical reactions.

Keywords: Spectral, Structural, Characterization, Nanomaterial, (Ag, Cu, Ti)-mixed Oxides.

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Keywords: *Spectral, Structural, Characterization, Nanomaterial, (Ag, Cu, Ti)-mixed Oxides..*

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BENDING ANALYSIS OF POROUS FGM PLATES ON A PASTERNAK FOUNDATION VIA A REFINED HIGHER-ORDER THEORY

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Abstract

This study develops an analytical model for the bending analysis of simply supported functionally Graded Material (FGM) plates featuring internal porosity and resting on a Pasternak-type elastic foundation. A refined Higher-order Shear Deformation Theory (HSDT) is employed, which utilizes a shape function, f(z), to represent the transverse shear strain through the plate's thickness. This approach eliminates the need for a shear correction factor by enforcing zero transverse shear stress conditions on the top and bottom surfaces. The material properties of the porous FGM are governed by a power-law model that incorporates a porosity parameter, accounting for both uniform and non-uniform void distributions. The governing equations are derived using Hamilton's principle. For the simply supported boundary conditions, the Navier solution technique is applied to obtain exact analytical solutions for the displacement fields and stress components. The validated HSDT-based model is used to conduct a parametric study, highlighting the coupled influence of porosity and shear deformation. The main findings are:

- The present HSDT predicts significantly larger deflections and more accurate stress distributions than classical plate theories.
- The presence of porosity systematically reduces the global stiffness of the plate, which causes an increase in deflection.
- The stiffening effect of the Pasternak foundation parameters is quantified, demonstrating their significant role in limiting deflections caused by porosity.

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Keywords: *FGM plates, HSDT theory, Static bending, internal porosity, Pasternak- elastic foundation..*

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PHASE STABILITY AND PHYSICAL PROPERTIES OF MRu2As2 (M=Ba, La, Sr) COMPOUNDS: COMPARATIVE STUDY FROM DENSITY FUNCTIONAL THEORY CALCULATIONS

Mokhtar DJELLOUL

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Abstract

In this paper, we perform the density functional theory (DFT) -based calculations by the first-principles pseudopotential method to investigate the phase stability and physical properties of MRu2As2(M=Ba, La, Sr) in the ThCr2Si2-type structure. The optimized structural parameters are in good agreement with the experimental results. The calculated independent elastic constants ensure the mechanical stability of these compounds. The calculated Cauchy pressure, Pugh's ratio as well as Poisson's ratio indicate that MRu2As2 should behave as ductile materials. Due to low Debye temperature, LaRu2As2 may be used as a thermal barrier coating (TBC) material..

Keywords: *MRu2As2 (M=Ba, La, Sr) compounds; Phase stability; Density functional theory (DFT) calculations; ThCr2Si2-type structure..*

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COMPUTATIONAL STUDY ON THE APPLICATION OF COMPOSITE PISTONS AND THEIR SERVICE LIFE

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Abstract

This Paper presents an investigation into the potential use of composite materials in engine construction and industrial applications. The piston, a key component of an engine, operates at very high reciprocating speeds, generating combustion and consequently enabling vehicle motion. The first part of this study focuses on a static analysis of a composite piston made of carbon/carbon material, including the distribution of stress, strain, and displacement fields. The dynamic analysis then examines the first ten mode shapes. Furthermore, the research aims to evaluate the service life of the composite piston through fatigue analysis. To achieve this, various fatigue theories and analytical approaches, such as the S–N and E–N methods, are explored. The fatigue life is estimated using the finite element method (FEM) implemented in Abaqus. The results demonstrate that composite materials exhibit superior performance and durability under damage conditions compared to conventional materials..

Keywords: *Composite piston,static analysis, ten mode shapes,fatique, frequency.S-N ,E-N..*

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CHARACTERISATION OF THE ELASTIC AND SHEAR RESPONSES OF A SYMMETRIC GLASS/EPOXY COMPOSITE LAMINATE

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Abstract

This study presents a thorough experimental characterization of a symmetric glass/epoxy laminated composite aimed at identifying all key elastic constants governing its orthotropic behavior. The material consists of 14 plies of E-glass roving fabric (300 g/m²) infused with Resoltech 1055 epoxy resin. Uniaxial tensile tests on 0° specimens equipped with biaxial strain gauges were performed to determine the longitudinal Young's modulus E_1 (assumed equal to E_2 due to laminate symmetry) and the Poisson's ratio ν_{12}. The in-plane shear modulus G_{12} was obtained through ±45° tensile testing, following standardized procedures. To evaluate the out-of-plane shear moduli G_{13} and G_{23}, three-point bending tests were conducted on short beam specimens, applying a modified Timoshenko beam model that accounts for both bending and shear effects. The complete set of experimentally derived elastic parameters provides a reliable database for the mechanical characterization of glass/epoxy laminated composites and can serve as a reference for future modeling and structural design studies.

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Keywords: *Glass fiber composite; Orthotropic behavior; Shear modulus; Poisson's ratio; Tensile testing; Bending test; Abaqus; Experimental characterization..*

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VIBRATION ANALYSIS OF VISCOELASTIC AND MAGNETORHEOLOGICAL ELASTOMER COMPOSITE SANDWICH BEAM UNDER VARIOUS BOUNDARY CONDITIONS

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Abstract

Vibration analysis of three-layer symmetrical sandwich beams with a viscoelastic and magnetorheological elastomer (MRE) core and conductive aluminum skins subjected to magnetic or non-magnetic field intensity was carried out under various boundary conditions. A numerical simulation of the bending vibration behavior of these beams using the Abaqus calculation code was carried out. The simulation results show that the absorption capacity of the developed magnetorheological elastomer is better than that of the viscoelastic material. The loss factor and shear modulus were found to be strongly influenced by the application of a magnetic field. The results found demonstrated that the natural frequencies of the beam having a magnetorheological elastomer core can be tuned and adjusted in an intelligent manner..

Keywords: *Free vibration, Numerical simulation, Sandwich beam, Viscoelastic materials, Magnetorheological elastomer.*

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CURRENT STATUS OF LITHIUM: CHALLENGES, INNOVATIONS, AND PERSPECTIVES FOR SUSTAINABLE ENERGY AND INDUSTRY

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Abstract

Lithium (Li), a chemical element with atomic number 3, is the lightest solid metal and a key player in the ongoing global energy transition. Due to its remarkable electrochemical properties, lithium forms the foundation of rechargeable lithium-ion batteries, which power a wide range of electronic devices such as mobile phones, laptops, and electric vehicles. Beyond energy storage, lithium is also used in metallic alloys to enhance their mechanical properties, in glass and ceramics manufacturing, and in certain pharmaceuticals for the treatment of mental disorders such as bipolar disorder. This work presents a state-of-the-art review on lithium, covering its physicochemical characteristics, extraction and processing methods, and its main industrial and energy-related applications. A critical analysis of recent scientific literature highlights technological advancements, environmental challenges, and economic prospects linked to this strategic element. The study emphasizes lithium's growing importance in energy storage technologies while underlining the sustainability, recycling, and supply-chain challenges that must be addressed. In conclusion, lithium stands as a cornerstone of the modern energy revolution, requiring an integrated approach that balances innovation, performance, and environmental responsibility..

Keywords: *Lithium, lithium-ion batteries, energy storage, energy transition, sustainability, recycling, industrial applications..*

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SOL-GEL SYNTHESIS OF CU-DOPED SNO2 THIN FILMS FOR OPTOELECTRONIC APPLICATIONS.

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Abstract

In this research, Cu doped SnO2 thin films were synthesized using the sol-gel dip-coating method on glass substrates. The effect of copper concentration (Cu: 0, 2, 3, 5, and 10 wt%) on the structural, morphological and optical properties of SnO2 was studied using X ray diffractometer (XRD), scanning electron microscopy (SEM) and UV-vis spectrophotometer, respectively. XRD patterns confirm that the obtainted SnO2 films are polycrystalline with a rutile type tetragonal structure, evidenced by their highest peaks at the (110) and (101) directions. Two additional peaks were observed at 38.90° and 45.5°, corresponding to (111) and (-202) lattice planes of the monoclinic CuO phase, respectively, confirming the formation of n-SnO2/-p-CuO heterojunction at a low copper concentration (2% Cu). SEM images revealed granular and porous surfaces with layer discontinuities (cracks). The 3% Cu concentration showed the highest pore density. UV-visible transmission spectra showed that the undoped SnO2 had high transmittance. However, as Cu concentration increased, the transparency of SnO2 decreased. In addition, the band gap energy of SnO2 decreased from 3.47 eV to 2.52 eV with increasing Cu doping concentrations. Among all samples, 3% Cu-doped SnO2 presents a good candidate for optoelectronic and gas detection applications..

Keywords: *SnO2, CuO, copper concentration, band gap, Sol-gel..*

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ON THE FREE VIBRATION ANALYSIS OF FUNCTIONALLY GRADED SANDWICH PLATES

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Abstract

This work presents the analysis of the free vibration of FG sandwich plates using theoretical formulation and finite element modeling. Two kinds of FG sandwich plates are studied; the first one is a sandwich plate with an FG core and isotropic top and bottom face sheets, and the second is made of an isotropic core and FG top and bottom face sheets. The variation of material properties across the thickness of the sandwich plate is supposed to be subjected to the power law distribution. Using Hamilton's principle, governing equations are derived, and using Navier solutions, equilibrium equations are presented. Fundamental frequencies are presented by varying the aspect ratio, the side-to-thickness ratio, and the volume fraction index. Finite element modeling is also presented to clearly show the free vibration response of the FG sandwich plate for each model. Results are then compared to prove the effectiveness of the two models..

Keywords: *Free vibration, FG sandwich plate, Hamilton's principal, Navier solution, finite element modeling..*

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ANALYSIS OF THE THERMOMECHANICAL BEHAVIOUR OF THE VENTILATED BRAKE DISC OF A HIGH-SPEED TRAIN

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Abstract

The objective of this study is to analyse the thermal behavior of ventilated brake discs on high-speed trains (TGV) using the ABAQUS calculation code. Modelling the distribution of thermal stresses in the ventilated brake disc requires the identification of all relevant input factors and parameters at the moment of braking, such as the type of braking system, braking speed, design and geometric dimensions of the disc and brake pads, the material used and its physical and mechanical properties. The numerical simulation of the coupled transient thermal field and stress field is performed using a thermomechanical coupling simulation method on ABAQUS in order to evaluate the thermal effect and the stress fields and deformations that occur in the ventilated brake disc during braking. The results obtained from the simulation are satisfactory when compared to those in the specialist literature..

Keywords: *High-speed train (TGV); Ventilated brake disc; Thermomechanical behavior; von Mises equivalent stresses..*

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EFFECT OF CNT GRADATION AND CORE MATERIAL ON THE VIBRATION OF FG-CNTRC SANDWICH BEAMS WITH BALSA AND TI-6AL-4V CORES

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Abstract

This paper presents an analytical study on the free vibration behavior of sandwich beams with soft and hard cores, modeled within the framework of a refined high-order shear deformation theory (HSDT). The proposed formulation involves only three displacement variables while satisfying the zero transverse shear stress condition across the beam thickness. The sandwich structure consists of a core perfectly bonded to two functionally graded carbon nanotube-reinforced composite (FG-CNTRC) face sheets. The carbon nanotube (CNT) volume fraction varies through the thickness of the face sheets according to five distinct distribution patterns: uniform (UD), FG-O, FG-VΛ, FG-ΛV, and FG-X. The governing equations of motion are derived using Hamilton's principle, and for simply supported boundary conditions, analytical solutions for natural frequencies are obtained via the Navier method. An exhaustive validation and parametric study are conducted to examine the effects of CNT distribution patterns and the core-to-face sheet thickness ratio on the vibrational characteristics of FG-CNTRC sandwich beams..

Keywords: *[Free vibration, Natural frequency, Sandwich beam, Carbon nanotube-reinforced composites (CNTRC), Functionally graded Materials]*.

POLYANILINE/MAGNETITE NANOCOMPOSITES FOR THE REMOVAL OF HEXAVALENT CHROMIUM FROM WASTEWATER

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Abstract

Nanocomposites of conducting polymers with magnetic nanoparticles have gained attention due to their unique electrical and magnetic properties, leading to potential applications in electrochromic devices, electromagnetic interference shielding, non-linear optics, and as adsorbents. These materials combine the electrical conductivity of polymers like polyaniline (PANI) with the magnetic properties of nanoparticles such as magnetite (Fe3O4) to create advanced materials for a wide range of technologies. These nanocomposites have attracted a great attention in separation science because they have high selectivity towards toxic metal ions. Chromium, one of the heavy metals, is generated from a wide range of anthropogenic sources in effluent streams including the chrome plating, stainless steel, textile dying, pigment, wood preservation, tanning and anti-corrosion fields. Chromium (VI) is known to be very toxic and hazardous element to living organisms and the environment. Additionally, it is non-biodegradable and is reported as one of the top 16 toxic pollutants to date. In this study, the adsorption of toxic chromium Cr(VI) from wastewater was investigated using PANI/Fe3O4 nanocomposites, tests were conducted under various conditions to study the influence of pH, initial concentration, adsorbent dose and contact time on the adsorption of this metal. The kinetic data fitted well to the pseudo second order kinetic model while the equilibrium data was satisfactorily described by the Langmuir isotherm. Results showed that the Polyaniline/magnetite nanocomposites are effective for removing chromium from wastewater due to the magnetic properties of magnetite for easy recovery and the adsorption/reduction capabilities of polyaniline..

Keywords: *Nanocomposites, Polyaniline/Magnetite, Synthesis, Chromium removal, remediation.*

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INFLUENCE OF HOLE FABRICATION METHODS ON THE MECHANICAL PERFORMANCE OF ADDITIVELY MANUFACTURED CARBON/ONYX COMPOSITES

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Abstract

Additive Manufacturing (AM) of continuous fiber-reinforced composites enables the production of lightweight structural components with high stiffness-to-weight ratios and complex geometries. However, when assembling these components, holes are often required, and their fabrication method can significantly influence the mechanical response. This study examines the effect of two hole-generation techniques ; conventional drilling and direct printing on the mechanical performance of continuous Carbon Fiber-Reinforced Polymer (CFRP) composites.

Open-hole tensile and three-point bending (3PB) tests were carried out on both specimen types. Digital Image Correlation (DIC) was used to evaluate deformation fields, while Acoustic Emission (AE) monitoring enabled the identification of damage mechanisms during loading. Additionally, Finite Element Models (FEM) were developed to reproduce the stress distribution and validate the experimental findings.

Results showed that drilled-hole specimens exhibited higher stiffness and tensile strength, which is attributed to their smoother hole surfaces and reduced void content. In contrast, printed-hole specimens demonstrated higher deformation before failure and a more gradual damage progression, influenced by fiber deposition patterns around the printed hole. Under bending loads, drilled specimens failed in a brittle manner, whereas printed specimens presented a more ductile failure response. The numerical results were in a good agreement with the experimental curves, particularly in the elastic zone, confirming the experimental results and the capablity of the FEM to predict to mechanical behaviour of the AM composite.

This study highlights the importance of hole fabrication strategy in AM composites and provides insight for enhancing their structural performance in engineering applications.

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Keywords: *Additive manufacturing, composites material, Mechanical properties, Finite element Analysis, Acoustic Emission, Digital image Correlation.*

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Welding by cladding a tube for use d'hydrocarbure sujet à la corrosion

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Abstract

Weld overlay is a process that involves depositing a layer of stainless steel filler wire onto a low-alloy steel pipe that is prone to corrosion in order to protect it.This process significantly increases the service life of low-alloy steel, even under severe conditions.In this study, low-alloy A333 Gr 6 steel is overlayed using E316-15 stainless steel wire to make the A333 Gr 6 pipe resistant to corrosion wear in a chemically reactive environment.The corrosion resistance characteristics of the part to be clad must be strictly adhered to, as must its dependence on the filling geometry, which are controlled by the process parameters.The footprint is filled with weld overlay using stainless filler metal on low-alloy steel tubes under variable conditions using the coated electrode electric arc welding process.The mechanical characterisation techniques used are bending and hardness testing, chemical and ferritic analyses, and macroscopic and microscopic observations using an optical microscope.Varying the welding conditions makes it possible to determine the optimal conditions for achieving a good quality weld.
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Keywords: *Welded overlay steels, chemical and ferritic analysis of steel, microstructural characterisation, mechanical characterisation..*

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Microstructural and Micromechanical Characterization of a Carbon Steel X60 /316L Stainless Steel Cladding Interface

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Abstract

Cladding is a surface engineering technique that enables the combination of two or more metallic alloys to obtain materials with superior physico-chemical and mechanical properties. This approach not only enhances the performance of the final structure but also contributes to significant reductions in weight and manufacturing costs. Owing to their excellent corrosion resistance and high mechanical strength, cladded components are extensively employed in critical industrial sectors such as petroleum refining, marine structures, power generation, and nuclear engineering. These properties make them particularly suitable for service under severe conditions involving high pressure, strong temperature gradients, and aggressive chemical environments.

In this study, an austenitic stainless steel 316L layer was deposited on a carbon steel X60 substrate using a cladding process. The work aims to investigate the microstructural features and micromechanical properties of the resulting bimetallic system, with special attention to the interfacial region. Detailed characterization was carried out to understand the diffusion behavior, phase formation, and mechanical property evolution induced by the deposition process, providing insights into the performance and reliability of cladded steel structures..

Keywords: *Cladding, corrosion, alloys, steel, Interface Characterization..*

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FINITE ELEMENT SIMULATIONS OF CAVITATION IN COMPRESSIBLE NEO-HOOKEAN SOFT SOLIDS

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Abstract

Under suitable loading conditions, a small pre-existing defect or void can grow and expand without bound. This phenomenon is known as cavitation instability. It has attracted significant attention across various engineering fields, as it is widely recognized as a critical predictor or precursor of the ultimate failure of many materials, ranging from ductile metals to soft and biological tissues. Additionally, this phenomenon has been harnessed in the development of the cavitation rheology (CR) technique to investigate the local mechanical properties of many complex soft materials. In this study, we investigated the elastic expansion of an internally pressurized, small pre-existing spherical void embedded in a large gel block composed of a hyperelastic, compressible Neo-Hookean soft solid, using the finite element simulation method. The results demonstrate that both the shape factor and material compressibility (Poisson's ratio) play fundamental roles in the cavitation process. We hope these findings will contribute to a better understanding of cavitation phenomena in complex soft materials..

Keywords: *cavitation, soft solid, compressibility, Finite element analysis.*

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Numerical analysis and experiments on thermomechanical corrosion repair of pipelines using different bonded patch materials

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Abstract

Pipeline corrosion is a significant threat to the integrity and lifespan of oil, gas, and water transport systems. Repair methods aim to restore structural integrity, prevent leaks, and slow down crack propagation. This study employs the experimental method and the finite element method to analyze pipeline corrosion repair using various bonded patch materials by calculating the J-integral factors at the crack tip within a thermomechanical framework. It highlights how the properties of the patch, adhesive, and damaged tube affect the J-integral variation. The findings indicate that optimizing certain factors can enhance repair quality, reduce deformation stresses, and slow crack propagation..

Keywords: *Pipelines; Finite element method; Patch materials; Cracking; J-integral, Thermomechanical..*

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DEVELOPMENT OF ELECTRODES BASED ON CONDUCTIVE POLYMERS AND HIGHLY POROUS MATERIALS FOR APPLICATIONS IN SUPERCAPACITORS

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Abstract

This research aims to develop and characterize composite electrodes based on PANI/PEDOT: PSS/graphene oxide (GO) conductive polymers for applications in supercapacitors. The main objective is to improve the electrochemical performance and capacity of the electrodes by varying the GO content relative to the PANI/PEDOT:PSS percentage. An electrochemical synthesis by electrodeposition of PANI/PEDOT: PSS/GO on stainless steel conductive plates, with GO contents ranging from 1 to 5%. The developed materials were characterized by using several physicochemical techniques: UV-Visible, ATIR/FTIR, XRD, optical microscopy, Scanning electron microscopy, and electrochemical techniques: OCP, CV, EIS...

The results obtained show that the addition of GO significantly improves specific capacitance, conductivity, and cyclic stability. Samples containing 2 and 10 % GO and those containing 3 and 5% GO yielded the best electrochemical, specific capacitance, and energy performance.This work improves the specific capacitance of PANI/PEDOT: PSS/GO hybrid materials in the field of energy storage and provides a solid foundation for the future development of high-performance supercapacitors, with the prospect of integrating these materials into real-world devices, particularly in the context of technological innovation projects..

Keywords: *PANI/PEDOT: PSS, graphene oxide (GO), conductive polymers,CV, EIS, supercapacitor*.

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COMBINED EXPERIMENTAL AND DFT STUDY OF ER^{3+}-DOPED $Li_2B_4O_7$ FOR PHOTONIC APPLICATIONS

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Abstract

Density Functional Theory (DFT) is a powerful ab initio method for investigating the structural, electronic, and optical properties of crystalline materials. In this study, we combined experimental characterisations with first-principles calculations to analyse erbium-doped lithium tetraborate ($Li_2B_4O_7:Er^{3+}$, LTB:Er) for photonic applications.The experimental investigations were carried out using X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and UV–visible absorption spectroscopy. Theoretical calculations were performed using the CASTEP code implemented in the Materials Studio suite, with ultra-soft pseudopotentials and the GGA-PBE exchange–correlation functional. A $Li_{16}B_{32}O_{56}$ supercell was constructed with one Er^{3+} ion substituting a Li^{+} site, corresponding to a doping level of 6.25%.The electronic structure of pure LTB exhibits a wide band gap (~5.25 eV), with the valence band dominated by O 2p orbitals and the conduction band mainly composed of Li and B states. Upon doping with Er^{3+}, localised 4f states emerge within the band gap, reducing the band gap to approximately 3.2 eV. These states facilitate additional optical transitions in the near-infrared region (980 nm and 1550 nm), consistent with Er^{3+} intra-4f transitions, and confirming the material's potential for photonic and telecommunication applications.A close agreement was observed between theoretical predictions and experimental results (XPS, absorption), demonstrating the validity of the DFT model. Slight overestimations in lattice parameters, especially along the c-axis, are in line with known GGA limitations. Overall, this work highlights the multifunctional potential of LTB:Er as a candidate for nonlinear optical devices and near-infrared emitters..

Keywords: *$Li_2B_4O_7$ (LTB), Er^{3+} doping, Density Functional Theory (DFT), Near-infrared luminescence..*

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Optimization of the flow and deformation properties of polymer–clay hybrid suspensions for next-generation drilling processes

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Abstract

Artificial intelligence is reshaping healthcare through data-driven and automated diagnostic systems. This study presents an innovative AI-based residual learning framework, employing the This study explores the rheological enhancement of bentonite-based drilling fluids through the incorporation of biopolymeric additives—carboxymethylcellulose (CMC), guar gum (GG), and xanthan gum (XG)—in order to develop hybrid clay–polymer suspensions with improved functional performance. Steady-shear and oscillatory rheological tests show that the introduction of these polymers markedly alters the viscoplastic and viscoelastic responses of bentonite suspensions, producing stronger shear-thinning behavior and improved structural integrity. The non-Newtonian flow characteristics were well captured by the Cross and Souza–Mendes models, confirming synergistic interactions between bentonite particles and polymer chains. The hybrid formulations exhibited higher storage and loss moduli, lower yield stress, and broader linear viscoelastic regions, reflecting the development of more robust particle–polymer networks. Overall, the results indicate that polymer–clay hybrid suspensions constitute advanced multifunctional materials with tunable rheological properties, suitable not only for drilling fluids but also for other engineering and composite fluid systems..

Keywords: *Non-Newtonian fluids; Biopolymeric additives; Carboxymethylcellulose (CMC); Guar gum (GG); Multifunctional materials;Rheological behavior. Particle–polymer. Interactions,.*

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Synthesis and caracterization of a novel membrane material containing the mixture of Dibenzo18 Crown 6 and Di 2 ethyl hexyl phosphoric acid

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Abstract

This work focuses on the development and characterization of a novel membrane material. The study investigates the insertion of two specific carriers: Di 2 ethyl hexyl phosphoric acid (D2EHPA) and Dibenzo18 Crown 6 (DB18C6) known for selectively complexing metal cations in polymeric inclusion membrane preparation. The membrane was synthesized using cellulose triacetate (CTA) as the polymer matrix, 2NPOE as a plasticizer, and the DB18C6-D2EHPA as carriers. The membrane was characterized by using FTIR and SEM analysis. The synthesis result show that the amount of 0.2g of CTA, 0.2ml of plasticizer, 0.2 ml of D2EHPA and 0.07g of DB18C6 are sufficient to obtain a membrane with a good mechanical characteristic. The FTIR results show that the characteristic bonds of the two carriers DB18C6 and D2EHPA are found in the membrane CTA-2NPOE-DB18C6-D2EHPA showing that the two carriers are inserted in the polymeric matrix. This result is also confirmed by the SEM characterization where the pores of the referenced CTA membrane are filled by the plasticizer and the carriers used in the CTA-2NPOE-DB18C6-D2EHPA membrane..

Keywords: *Membrane, Materials, Synthesis, Characterization, DB18C6, D2EHPA.*

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Enhanced Structural And Optical Properties Of Ag-Doped Tio 2 Thin Films Synthesized Via Cost-Effective Sol-Gel Spin Coating

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Abstract

In this study, we present an easy and cost-effective method for the synthesis of pure and Ag- doped TiO_2 thin films by spin coating technique. The effects of dopant on structural, and optical properties of TiO_2 thin films have been systimatically investigated. X-ray diffraction (XRD) patterns align with previous studies, confirming the successful synthesis of anatase phase via the sol-gel method, with no peaks attributable to metallic Ag. Fourier-Transform Infrared (FTIR) spectra, recorded in the range of 4000-400 cm^{-1} , revealed minor changes in band shape and intensity in the lower wavenumber region, this strongly suggests the successful ncorporation of Ag into the TiO_2 lattice. Optical measurements indicated high average transmittance (≥ 85%) across the visible spectrum, which slightly decreased upon Ag doping, but remains suitably high for device applications. UV-Visible spectroscopy confirmed that Ag incorporation significantly modified the electronic structure: a slight redshift in the absorption edge was observed, corresponding to a significant reduction in the optical band gap (Eg) of the anatase phase TiO_2 when doped compared to the pure material. The UV-Vis absorbance and Photoluminescence (PL) spectra further demonstrated that Ag-doped TiO_2 exhibited higher visible light absorption activity and a lower electron-hole pair recombination rate. These results collectively indicate that the incorporated Ag ions successfully broaden the absorption region into the visible light spectrum and inhibit the recombination of photo-generated charge carriers..

Keywords: *TiO_2 Thin Films, Silver Doping (Ag doping), Sol-Gel Spin Coating, Anatase Phase, Band Gap Reduction.*

OFF-AXIS ORIENTATION EFFECT ON THE MECHANICAL PROPERTIES OF ANISOTROPIC MAGNETORHEOLOGICAL ELASTOMERS

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Abstract

Magnetorheological elastomers (MREs) are smart materials whose mechanical response can be actively tuned by an external magnetic field, making them suitable for adaptive vibration control and damping systems. This study investigates the influence of the orientation of ferromagnetic particle chains on the dynamic properties of anisotropic MREs. Samples were fabricated with particle chains aligned at different off-axis angles (0°, 15°, 30°, and 45°) relative to the shear loading direction, and tested under harmonic shear excitation using a dynamic mechanical analyzer. The storage modulus (G′), loss modulus (G″), and loss factor (tan δ) were measured under magnetic fields of increasing intensity. The experimental results reveal a gradual decrease in stiffness and a simultaneous enhancement of the dissipative behavior as the alignment angle increases. These findings highlight the importance of directional coupling in anisotropic MREs and provide valuable insight for designing tunable magneto-mechanical systems with optimized performance..

Keywords: *Magneto-mechanical properties, Magnetorheological elastomers, Anisotropic, Experimental characterization..*

Flexural–Shear strengthening of RC beams by carbon and metallic composites grids

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Abstract

This work evaluate the flexural–shear behaviour of reinforced concrete beams strengthening by embedded carbon fiber reinforced polymer grids (CFRP grids) and metallic grids with hexagonal meshes, under four-point bending test. An experimental investigation was carried out to evaluate the performance of this technical of strengthening, three control beams and twelve strengthened beams in flexural–shear with different configurations have been tested. Several parameters were considered to highlight the efficiency of the technical used, such as; ultimate load, ductility and failure modes. The experimental results The results obtained show that the strengthened beams have higher mecanical properties than that of the CB, the improvement of flexural load varies from 9% to 70%, from 48% to 122% for the midspan deflection, and 35% to 219% for the ductility index depending on the type of strengthening (CFRP grids or metallic grids) and the reinforcement details. The CFRP Grids have a high elastic modulus in tension, which provides a high interval of the elastic area. The metallic grids have a high ultimate elongation allows beams to extend their resistance to shear forces, which explains the large plasticity zone and which directly reflects the value of the ductility index of the strengthening system.

Keywords: *Beams, Composite grids, Flexural- Shear strengthening, Failure modes, FRP.*

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PHYSICAL PROPERTIES OF INSOLATING COMPOUND SUBSTITUTED BY TRANSITION MEATAL ATOMS: DFT STUDY

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Abstract

Full potential linearized augmented plane wave (FP-LAPW) method based on the density functional theory (DFT) is used to investigate the structural, electronic and magnetic properties of Fe and Ni (3d transition metal) substituted Rock-salt wide band gap insulator (M = Fe, Ni). We have performed spin polarized calculations throughout this work with generalized gradient approximation (GGA) type exchange correlation functional. Additionally, the electronic structures and density of states are computed using modified Becke-Johnson (mBJ) potential based approximation with the inclusion of coulomb energy (U = 7 eV). Based on the Vegard's law and structural optimization, the lattice parameter and bulk modulus are found to be in good agreement with experimental values. Moreover, the analysis of electronic band structures reveals an insulating character for Ni substituted MgO while semiconducting and half-metallic character for Fe substituted case. It has been found that the p-d exchange interaction provides a ferromagnetic character due to the 3d transition metal and oxygen atoms. The observed p-d hybridization at the top of the valence band edge in this investigation could be useful for magneto-optic and spintronic applications.

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Keywords: *FP-LAPW; mBJ+U; p-d exchange interaction; half-metallic; magnetic moment..*

EFFECT OF INCORPORATING ALLUVIAL SAND ON THE BEHAVIOR OF POROUS CONCRETE

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Abstract

Porous concrete is a building material that has undergone considerable development in recent decades, thanks to its environmental properties. It is renowned for its high porosity, which occupies 15-35% of its volume, its ecological aspect and its ability to allow rainwater to infiltrate easily into the ground. This material is used to solve practical problems associated with rainwater accumulation, flooding and infiltration, offering an effective solution to these challenges. The addition of sand, a common construction practice, improves the compressive, tensile and abrasive strength of pervious concrete, thereby optimising its performance. This study investigates the effect of adding alluvial sand on the physical, mechanical and draining properties of pervious concrete. The results show that the addition of sand reduces the fluidity, hydraulic permeability and open porosity of pervious concrete, while increasing abrasion strength. In addition, it improves fresh and dry density, as well as compressive strength, splitting tensile strength and flexural strength. Finally, good correlations were observed between mechanical properties, density and draining properties..

Keywords: *porous concrete, incorporating sand, mechanical properties, draining properties, abrasion strength..*

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IMPACT OF PHOTO-OXIDATIVE DEGRADATION ON THE MECHANICAL PROPERTIES OF HALS-STABIIIZED LDPE FILMS

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Abstract

Tensile test analysis of HALS-stabilized LDPE films aged under natural weather conditions reveals a characteristic evolution of mechanical properties, Initially, stress at break of HALS-stabilized LDPE films are improved with 11% by early crosslinking reactions may occur through reactions involving nitroxide and free radicals, during the first few months of aging due to UV-induced crosslinking, which temporarily enhances the film's strength. This phase is followed by a stabilization period where tensile strength remains relatively constant, representing a balance between crosslinking and scission reaction processes. After prolonged aging (beyond 12 months), stress at break typically declines as oxidative chain scission and polymer embrittlement dominate. Meanwhile, elongation at break progressively decreases around 45% after 24 months of exposition period, indicating loss of flexibility and stiffness due to polymer chain damage , as approved by the increase of Young's modulus. These trends highlight the complex interplay between photo-oxidative stabilization by HALS and eventual degradation, underscoring the efficiency of HALS in delaying mechanical property deterioration and extending the useful life of LDPE agricultural films under harsh environmental exposures..

Keywords: *HALS, Stress at break, □b, Young's modulus, Nitroxide.*

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NUMERICAL MODELING AND COMPARATIVE ASSESSMENT OF SIPM PERFORMANCE PARAMETERS

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Abstract

Silicon Photomultipliers (SiPMs) are solid-state photodetectors that combine high gain, compact structure, and excellent sensitivity, making them strong candidates for replacing traditional photomultiplier tubes in nuclear physics and medical imaging. This work presents a simulation-based comparative study of different SiPM models to evaluate their performance under various operating conditions. Using SimSiPM-based simulations and analytical modeling, key parameters such as photon detection efficiency (PDE), gain, dark count rate, afterpulsing, and temperature dependence were investigated. The simulations were carried out by varying overvoltage and temperature to examine their impact on SiPM behavior. Results indicate that the PDE increases with overvoltage up to an optimal level, after which noise effects—particularly dark counts and optical crosstalk—become significant. Similarly, temperature rise leads to a nonlinear increase in dark current and reduction in breakdown voltage, affecting gain stability. Comparative analysis among selected SiPM models highlights specific design differences influencing sensitivity, noise performance, and thermal behavior. These results demonstrate that simulation tools can effectively predict SiPM performance and guide experimental optimization. The study contributes to a better understanding of the balance between detection efficiency and noise management, essential for applications in spectrophotometric analysis, radiation detection, and medical imaging. Future work will extend the modeling to include wavelength dependence and microcell geometry for advanced detector characterization..

Keywords: *Silicon Photomultiplier, Simulation, Photon Detection Efficiency, Overvoltage, Temperature, Gain..*

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STRUCTURAL MORPHOLOGY OF COMPRESSED EARTH BLOKCS WITH ADDED OLIVE POMACE POWDER

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Abstract

This study examines the influence of adding olive pomace powder on the structural morphology of compressed earth blocks (CEBs), with a view to developing environmentally friendly building materials. The incorporation of OPP, derived from agricultural waste recycling, not only acts as a waste recovery agent, but also modifies the internal microstructure of CEBs. Structural morphology, particularly using scanning electron microscopy (SEM), have revealed significant changes in particle arrangement, pore distribution, and material compactness. The micrograph reveals that adding OPP to the soil results in composites characterized by a rough surface. The formation of OPP aggregates of different sizes is visible on the fractured surface. A number of voids can be observed in the soil matrix of the blocks, suggesting low interfacial shear strength between the OPP particles and the matrix. However, the addition of OPP in the manufacture of compressed and stabilized earth blocks has a fairly profound effect on the morphology of the blocks..

Keywords: *Keywords: Compressed earth brick, olive pomace powder, structural morphology, scanning electron microscopy.*

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STRUCTURAL, ELECTRONIC, AND MECHANICAL PROPERTIES OF S^2D^2-CONFIGURED METALS IN THE FM-3M PHASE

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Abstract

Metal dioxides (XO_2) are key materials in catalysis, photocatalysis, and dielectric technologies, yet atomistic understanding of systems such as ZrO_2 and CeO_2 remains limited. Using density functional theory (DFT) with the FP-LAPW method in WIEN2k and the PBE functional, we investigated the structural, electronic, and mechanical properties of cubic Fm-3m XO_2 (X = Ti, Zr, Hf, Ce). The lattice constants increase with atomic mass, except for HfO_2, which deviates due to its stronger ionic bonding. ZrO_2 exhibits the highest stiffness, followed by HfO_2, TiO_2, and CeO_2, reflecting their distinct bonding natures. Electronic analysis shows a narrow band gap for TiO_2 (1.15 eV), wide gaps for ZrO_2 (3.16 eV) and HfO_2 (3.77 eV), and a moderate gap for CeO_2 (2.17 eV) associated with redox activity. PDOS results reveal hybridization between O 2p and metal d/f orbitals, influencing their electronic behavior. These findings clarify the link between structure, bonding, and properties in Fm-3m metal dioxides, providing valuable insights for designing advanced materials for energy, dielectric, and catalytic applications..

Keywords: *DFT,Fm-3m, Metal dioxides, Band gap.*

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SPECTROSCOPIC ANALYSIS OF PHOTOLUMINESCENCE IN FUNCTIONALIZED SODA-LIME GLASS COMPOSITES

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Abstract

This study investigates the development of advanced luminescent glass composite materials through silver ion diffusion into soda-lime glass matrices under different thermo-temporal conditions. The resulting composite glass structures exhibit tunable photoluminescence properties, characterized by measurements under 350 nm excitation, enabling identification of silver nanospecies formed within the glass network.

Emission spectra reveal a band centered at 550 nm whose intensity increases with diffusion duration (5 min to5h), demonstrating controlled incorporation of the functional component (silver species) into the glass matrix. For extended durations (20 h), a shift toward 570 nm with intensity decrease indicates structural reorganization and formation of larger silver complexes within the composite material.

Temperature optimization 320- 400°C enhances photoluminescence through increased formation of luminescent centers distributed throughout the composite structure. At 480°C, luminescence disappears due to reduction of Ag+ ions to non-luminescent metallic Ag0, defining processing limits for the structural integrity of this composite system. Spectral deconvolution reveals three Gaussian components (500 nm, 560 nm, 620 nm) corresponding to isolated Ag+ ions, mixed aggregates (Ag2+, Ag3+), and small clusters (Ag32+), demonstrating the hierarchical nanostructure of the silver species within the composite. Fluorescence decay analyses show bi-exponential behavior with fast (τf = 37-68 μs) and slow (τs = 144-228 μs) components, revealing complex energy transfer mechanisms within the engineered composite structure. These results demonstrate controlled engineering of luminescent composite glass materials through diffusion processing, offering promising applications in photonics and integrated optical devices.

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Keywords: *Advanced materials, functional composite structures, photoluminescence, fluorescence decay, nanostructures..*

AB INITIO PREDICTION OF THE STRUCTURAL, ELECTRONIC AND OPTICAL PROPERTIES OF THE QUATERNARY SEMICONDUCTORS Li2HgSiS4

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Abstract

Understanding the structural, electronic and optic properties of metals, alloys and semiconductors are based on coherent interpretations of varied experiences. The consistency of these interpretations is ultimately based on a correct representation of the electronic structure of these materials, the general framework of which is provided by the band theory. In this work, we will contribute to the theortical study of the quaternary diamond-like semiconductor Li2HgSiS4, by performing a first-principles investigation of their structural, electronic, and optical properties using the full potential linearized augmented plane wave (FP-LAPW) method in the density functional theory (DFT) using the WIEN2K code. The objective of the present study is the theoretical investigation of the structural properties (lattice parameters and compressibility module), electronic (band structure, state density and charge density), optical (dielectric function, reflectivity and absorption coefficient) for quaternary semiconductor (DLS) Li2HgSiS4.The exchange-correlation potential is evaluated using the GGA and LDA . Further, the EV-GGA is also applied for studying the electronic properties. The calculated structural properties such as equilibrium lattice constants, the bulk modulus and its pressure derivative are in good agreement with the available data. The calculations of electronic band structure show that this compound has a direct energy band gap (Γ-Γ) with a mixed ionic and covalent bonding. The absorption coefficient increases with increasing energy, reaching maximum values in the energy range from 8.5 eV to 11.60 eV. It is clear that the DLS studied has the best absorption in ultraviolet, makes thes quaternary semiconductor very competitive for the UV light detector.

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Keywords:

Keywords: DFT, electronic structure FP-LAPW, absorption coefficient..

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STATIC RESPONSE OF LAMINATED COMPOSITE PLATES UNDER SINUSOIDAL AND UNIFORM LOADS USING A SINUSOIDAL SHEAR DEFORMATION THEORY

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Abstract

This study aims to develop an analytical model for the static analysis of laminated composite plates based on a sinusoidal shear deformation theory (SSDT). The proposed formulation introduces a refined displacement field that satisfies the shear stress continuity at the plate surfaces without requiring a shear correction factor, thereby improving the physical consistency and computational efficiency of the model. The governing differential equations are derived from the principle of virtual work and analytically solved using Navier's solution procedure for simply supported boundary conditions under both sinusoidal and uniformly distributed loads. The non-dimensional results, including displacements, normal, and shear stresses, will be compared with available benchmark solutions and data from the literature to validate the accuracy and efficiency of the proposed theory..

Keywords: *Laminated composite plates; Sinusoidal shear deformation theory (SSDT); Static analysis; Bending behavior;.*

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ENHANCED SOLAR PHOTOCATALYTIC DEGRADATION OF DICLOFENAC USING AG-DOPED MGO: INFLUENCE OF CATALYST DOSE AND POLLUTANT CONCENTRATION

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Abstract

The increasing presence of pharmaceutical residues such as diclofenac (DCF) in aquatic systems poses serious environmental and health challenges. This study investigates the solar-driven photocatalytic degradation of DCF using silver-doped magnesium oxide (MgO–Ag) nanoparticles, focusing on two key parameters: catalyst dosage and initial DCF concentration. Under simulated sunlight irradiation, experiments demonstrated a pronounced dependency of degradation efficiency on both variables. Increasing the catalyst mass from 25 to 150 mg resulted in a remarkable enhancement of DCF removal, with efficiency improving from 27.6% to 73.5% after 180 minutes. This improvement is attributed to the increased active surface area and enhanced photon absorption from Ag incorporation. Conversely, higher initial DCF concentrations (5–20 mg/L) negatively affected degradation performance, reducing removal efficiency from 73.5% to 49.2%, primarily due to light attenuation and competitive adsorption at the catalyst surface. These results highlight the synergistic contribution of optimized catalyst loading and pollutant concentration in achieving efficient solar degradation. The findings establish Ag-doped MgO as a sustainable and low-cost photocatalyst for effective sunlight-assisted remediation of pharmaceutical contaminants..

Keywords: *Diclofenac,solar photocatalysis ,Ag-doped MgO nanoparticles, Water remediation .*

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SPIN SPLITTING INDUCED BY SPIN-ORBIT INTERACTIONS (BIA AND SIA) IN A SINGLE GaAs QUANTUM WELL

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Abstract

In this work, we present a theoretical study of the spin splitting induced by spin–orbit interactions in a single GaAs quantum well. The analysis considers the combined contributions of the Rashba effect, arising from structural inversion asymmetry (SIA), and the Dresselhaus effect, originating from bulk inversion asymmetry (BIA).

We variationally calculate the electronic structure of the quantum well within the framework of the envelope function formalism using the effective mass approximation. To describe the Rashba spin–orbit coupling quantitatively, we follow a previous theorical approach that separates the different physical contributions to the total Rashba spin splitting. The Dresselhaus contribution is also taken into account through the linear and cubic terms in the wave vector k.

We study the influence of both the electric field strength and the quantum well width on the total spin splitting induced by the interplay between the Rashba and Dresselhaus interactions. The results show that the spin splitting increases with the applied electric field and depends strongly on the well width, revealing regions where the Rashba and Dresselhaus terms compete or reinforce each other..

Keywords: *spin splitting, GaAs, Rashba effect, Dresselhaus effect, electric field*

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Investigation of Thermomechanical Behavior in Composite Plates

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Abstract

This study presents a detailed investigation of the thermomechanical behavior of composite plates subjected to combined thermal and mechanical loadings. The work aims to understand the coupled effects of temperature variations and mechanical stresses on the deformation and stability of composite structures. A refined higher-order shear deformation theory is developed by introducing undetermined integral terms into the displacement field, resulting in a simplified formulation that requires fewer unknown variables while maintaining high predictive accuracy. The governing equations are derived through the principle of virtual displacements, and closed-form analytical solutions are obtained using Navier's approach for simply supported boundary conditions. The analysis is further extended to functionally graded composite plates (FGMs), where material properties such as stiffness and thermal expansion vary smoothly through the thickness following a power-law distribution. Various types of thermal loading—uniform, linear, and nonlinear—are considered to capture realistic temperature gradients across the plate thickness. Numerical results clearly demonstrate that both temperature distribution and material gradation have a strong influence on deflection, stress distribution, and overall structural performance, confirming the accuracy and efficiency of the proposed theoretical formulation for thermomechanical analysis of advanced composite plates..

Keywords: *Composite plates; Thermomechanical behavior; Higher-order shear deformation theory; Functionally graded materials.*

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MICROSTRUCTURAL AND MECHANICAL EVALUATION OF BRAZED SPACER-CLADDING ASSEMBLIES IN ZIRCALOY-4 ALLOY

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Abstract

This study investigated the microstructural and mechanical behavior of brazed joints between Zircaloy-4 cladding and spacer/pad components, using beryllium as the filler metal within the context of CANDU nuclear fuel assemblies. Visual inspections and macroscopic analyses indicated that proper surface preparation especially sandblasting significantly improved adhesion and uniformity of the beryllium layer. However, some issues were identified, These included localized oxidation and bonding voids due to insufficient filler material. In addition, excessive beryllium occasionally produced irregular joints. These findings highlights the critical importance of strict processing parameter control. Optical microscopy and scanning electron microscopy confirmed continuous, defect-free interfaces, smooth transitions, and Widmanstätten structures in heat-affected zones. Energy-dispersive X-ray spectroscopy mapping indicated a uniform distribution dominated by zirconium, with traces of tin, chromium, iron, and beryllium. Although its quantification remained difficult due to low concentration, beryllium's presence within joints was confirmed.X-ray diffraction analysis identified crystalline phases characteristic of Zircaloy-4, along with intermetallic compounds like $(Fe,Cr)_2Zr$. No distinct beryllium phases were detected, likely because the element exists in an amorphous form or as part of a solid solution. Microhardness tests revealed moderate hardening in the brazed zones, without signs of brittle phase formation, ensuring mechanical stability across the joints. Assemblies incorporating dual spacers exhibited more consistent mechanical performance overall. In conclusion, the research demonstrated that beryllium is a well proven, filler metal for joining Zircaloy-4 components, offering strong bonding and mechanical integrity—provided that surface treatment and thermal processing are carefully controlled. Despite limitations in beryllium detection, the results support its potential for use in nuclear settings and highlight the need for continued investigation into long-term behavior and alternative brazing options..

Keywords: *Zircaloy-4, Beryllium, Brazing, CANDU fuel assemblies..*

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Impact of Al Doping Concentration on the Characteristics of Spray Pyrolyzed ZnO Thin Films

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Abstract

This work reports on the preparation and characterization of zinc oxide (ZnO) thin films by spray pyrolysis on glass substrates. The effect of Al doping with 1% Al, 3% Al, 5% Al,7% Al on the structural, optical and electrical properties of the obtained films was studied. The obtained films are characterized by different techniques such as X-ray diffraction (XRD), UV-visible.The results of the XRD characterization indicate that all the films have the polycrystalline hexagonal wurtzite structure with a preferred orientation (002). Spectroscopic measurements in the UV-VIS-IR wavelength range were found to give good average transmittance values of about 80% in the visible zone with a band gap energy of about 3.2 eV.

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Keywords: *ZnO, thin films, pyrolysis spray,XRD,Al doping..*

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ENGINEERING Fe_3O_4–CuO NANOCOMPOSITES VIA A SIMPLE ROUTE FOR EFFICIENT SUNLIGHT-DRIVEN PHOTOCATALYTIC DEGRADATION

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Abstract

Materials science is driving the development of novel materials with enhanced properties, improved functionality, and lower cost compared to existing ones. With the emergence of nanotechnology, it has become possible to design materials at the nanoscale that exhibit unique magnetic, optical, and catalytic behaviors. In this work, multifunctional Fe_3O_4/CuO nanocomposites were successfully synthesized to combine the superior magnetic properties of Fe_3O_4 nanoparticles with the plasmonic and semiconducting characteristics of CuO. The nanocomposites were prepared via a simple one-pot synthesis method [1], providing a homogeneous dispersion of Fe_3O_4 nanoparticles on the CuO surface.

X-ray diffraction (XRD) patterns confirmed the coexistence of cubic Fe_3O_4 and monoclinic CuO phases, with lattice parameters a = 8.31 Å for Fe_3O_4 and a = 4.61 Å, b = 3.40 Å, c = 5.02 Å for CuO. The average crystallite size was estimated to be around 15 nm, and no additional peaks related to impurities were detected. Fourier-transform infrared (FTIR) spectra showed characteristic metal–oxygen stretching vibrations in the 500–650 cm^{-1} range, confirming the formation of the oxide network. UV–visible spectroscopy revealed a band gap energy of about 1.49 eV [2], indicating a strong light absorption capability. Scanning electron microscopy (SEM) images displayed needle-like morphologies with different orientations. The photocatalytic performance of the Fe_3O_4/CuO nanocomposite under sunlight irradiation achieved a degradation efficiency exceeding 70%, demonstrating its promising potential for environmental and catalytic applications.

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Keywords: *nanomcompsites, Fe3O4, CuO, phototcatalytic degradation..*

NON-DESTRUCTIVE TESTING OF THE OPTICAL CHARACTERISTICS OF TRANSPARENT SPINEL-BASED CERAMICS

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Abstract

Magnesium aluminate spinel ($MgAl_2O_4$) is a transparent ceramic material well known for its high optical transmission and mechanical strength, making it an excellent candidate for optical and protective applications. However, maintaining these properties requires precise control of surface quality, as the presence of micro-defects can severely affect transparency and mechanical integrity.

In this study, transparent spinel pellets of type S25CRX14 were fabricated by Spark Plasma Sintering (SPS) at three different temperatures: 1300 °C, 1350 °C, and 1400 °C. The samples were analyzed before sandblasting using moiré interferometry, a highly sensitive and non-destructive optical technique capable of visualizing surface deformations at the microscopic scale.

The experimental results show that the transparency and surface homogeneity depend strongly on the sintering temperature. The pellet sintered at 1300 °C exhibited visible fringe distortions, indicating incomplete densification and the presence of small surface defects. The 1350 °C sample showed uniform and well-defined moiré patterns, confirming improved transparency and mechanical integrity due to optimal microstructural densification. However, at 1400 °C, the material displayed significant irregularities, such as pits and loss of optical clarity, attributed to grain coarsening and internal stress.

The analysis of moiré fringe deviations allowed for a qualitative evaluation of these surface irregularities, confirming the sensitivity of the method to minor variations in surface topography and internal stress. The correlation between the optical transmission and the moiré fringe deformation provides a clear indication of how processing temperature influences the optical behavior of the transparent spinel ceramics. The results confirm that the temperature of 1350°C offers the best transparency and therefore the best optical quality.

In conclusion, this study confirms that the sintering temperature strongly influences the microstructure and optical performance of $MgAl_2O_4$ ceramics. Moiré interferometry proved to be an effective, accurate, and non-destructive technique for the evaluation of transparent ceramics.

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Keywords: *transparent ceramics, optical characteristics, Moiré, fringes, Sintering temperature.*

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STUDYING THE EFFECT OF NANOCLAY ON THE MECHANICAL PROPERTIES OF POLYPROPYLENE/POLYAMIDE NANOCOMPOSITES

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Abstract

Nanocomposites based on polypropylene/polyamide 66 (PP/PA66) nanoblends containing organophilic montmorillonite (OMMT) and maleic anhydride grafted polypropylene (PP-g-MAH) were prepared by melt compounding method followed by injection molding. Two different types of nanoclays were used in this work. DELLITE LVF is the untreated nanoclay and DELLITE 67G is the treated one. The morphology of the nanocomposites was studied using the XR diffraction (XRD). The results indicate that the incorporation of treated nanoclay has a significant effect on the impact strength of PP/PA66 nanocomposites. Furthermore, it was found that XRD results revealed the intercalation, exfoliation of nanaclays of nanocomposites..

Keywords: *Nanoclay, nanocomposites, polypropylene, polyamide, melt processing, mechanical properties..*

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THERMAL STABILITY OF POROUS FUNCTIONALLY GRADED PLATES WITH PIEZOELECTRIC ACTUATORS

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Abstract

This paper investigates the thermal buckling behavior of functionally graded rectangular plates composed of porous materials and integrated with surface-bonded piezoelectric actuators. The plates are analyzed under the combined effects of uniform temperature rise and a constant actuator voltage using the Navier solution method. The thermomechanical properties are assumed to be temperature-independent and vary through the plate thickness according to a power-law distribution modified to account for even and uneven porosity distributions. The governing stability equations are formulated based on higher-order shear deformation plate theory. The study explores and discusses in detail how key parameters affect the critical thermal buckling temperature of the piezoelectric FGM plates..

Keywords: *functionally graded materials; piezoelectric; porosities; Thermal buckling*

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Study of The Physical Properties of Half-metallic and/or Intermetallic Alloys.

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Abstract

in this study, we perform first-principles calculations based on density functional theory (DFT) to investigate the structural and elastic properties of the cubic MgCuAs Half-Heusler alloy. The exchange-correlation potential is treated using both GGA-PBE and the HSE06 hybrid functional. Key physical parameters such as lattice constant, bulk modulus, elastic constants, and band structure are computed. The results indicate that MgCuAs is a semiconductor with an direct band gap. These findings were obtained in the absence of both experimental measurements and prior theoretical data, yet they provide a valuable reference for future studies.

Keywords: *Half-Heusler, MgCuAs, hybrid functional, HSE06..*

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SYNTHESIS AND ENCAPSULATION OF LAYERED DOUBLE HYDROXIDES (Zn-Al-LDH); APPLICATION TO PHOSPHATE ADSORPTION FROM BRACKISH WATER

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Abstract

The main objective of this work is the development of an anionic adsorbent of the layered double hydroxide type (Zn-Al-LDH), incorporated into an alginate gel to produce a composite material that can be used in dynamic reactors to remove phosphates from brackish water originating from western Algeria. The LDH, prepared by the co-precipitation method, was characterized by XRD, FTIR spectroscopy, and scanning electron microscopy (SEM). Experimental results showed that the amount of phosphate adsorbed increased from 0.66 to 98.35 mg per g of LDH with an increase in flow rate from 0.1 to 0.5 $L \cdot h^{-1}$ and a decrease in particle diameter from 4 to 1 mm. Bed height had almost no influence on this amount. Mathematical modeling was carried out using the Thomas model. It was observed that a decrease in particle diameter led to an increase in the amount of phosphate adsorbed, while an increase in flow rate resulted in an increase in the maximum adsorption capacity q_0. For a flow rate of 0.1 $L \cdot h^{-1}$, q_0 was 46.691 mg/g of LDH, and for 0.5 $L \cdot h^{-1}$, q_0 reached 98.35 mg/g of LDH. These results are of great interest, as the Thomas model overall provided a good description of the experimental data..

Keywords: *Layered Double Hydroxides; phosphate; Zn-Al-LDH; alginate; brackish water..*

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THE EFFECT OF SELENIUM CONCENTRATION UPON PHYSICAL PROPERTIES OF CdSeTe TERNARY ALLOYS: AB-INITIO AND MONTE CARLO STUDIES

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Abstract

In this work, structural and electronic properties of CdSexTe1-x ternary alloy at various concentrations of Selenium (Se) (x =0, 0.25, 0.5, 0.75 and 1) have been determined using the full potential-linearized augmented plane wave (FP-LAPW) based on the density functional theory (DFT). The lattice parameters and the bulk modulus results show good agreement when compared with reports. Band structures calculations indicate direct gap transitions and also yield the energy gap values, with good agreement with reports.

Absolute, photopeak, intrinsic detection efficiencies and the energy of resolution, are investigated using a stochastic approach, which is the Monte Carlo method as implemented in the Geant4 code of these alloys as semiconductor detectors at (1.5 inch * 1.5 inch) in the 511-1332 keV gamma-ray energy range. The calculated parameters are analyzed in the light of the available data. The results will be of practical use to the community of crystal growers, semiconductor challenges and new alloys designers.

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Keywords: *[DFT; Electronic Structure, Tb-mbJ, semiconductor, Geant4; Full-energy peak efficiency..*

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Experimental Study of Honeycomb Sandwich Panels under cyclic loading

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Abstract

In this paper, we study the stresses applied to honeycomb sandwich panels. To do this we have prepared three samples of panels with the same core and faces of different materials and these are carbon fiber fabrics and glass fibers and then applied two types of stresses: tensile and flexural. The present study is focused on studying the honeycomb sandwich panel under cyclic loading in both

experiments. The focus of this study relies on the change of the mechanical characteristics by modifying the skins materials of the panels. Honeycomb sandwich panels were used in the manufacture of spacecraft, due to their strain which can undergo flexural deformations on the one hand and to reduce the masse and optimize the design of the vehicle on the other hand..

Keywords: *honeycomb, sandwich panels, traction, fatigue, cyclic loading..*

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EFFECT OF PROJECTILE SIZE UNDER HYPERVELOCITY IMPACT ON HONEYCOMB SANDWICH PANELS

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Abstract

Increased in population of orbital debris in space environment has posed serious threat to satellite structures. The collision of micrometeoroids and orbital debris (MMOD) with satellite structure can range from small surface pits to complete penetration which may adversely affect the strength and performance of load carrying members. In this paper, the honeycomb sandwich panel with composite facesheets is proposed to be used as a shield for a spacecraft against meteoroid orbital debris. The effect of projectile diameter, velocity impact and honeycomb core cell size on the protection properties of the proposed structure was numerically investigated at normal incidence hypervelocity impact. Cell sizes, wall thicknesses and depths of honeycomb core are defined based on commercial HC cores specifications. Numerical model based on hybrid Lagrange FE/SPH method formulation has been developed to predict the sandwich panel shielding properties. Detailed results are presented in this paper such as: damage features, hole morphology of facesheets and debris cloud velocity changing process..

Keywords: *Honeycomb cell, hypervelocity impact , SPH, finite element analysis, sandwich structures;.*

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Fatigue analysis of a pitch link connecting helicopter rotor blade

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Abstract

In this paper, pitch control linkages can cause stability problems on helicopter rotors. Therefore, fatigue analysis is crucial, especially for key aircraft components such as helicopter control linkages. These parts, which connect the wings to the fuselage, are subjected to significant dynamic loads in flight. The linkages undergo considerable stress, particularly around perforated areas such as mounting holes. These areas, veritable stress concentrators, are especially vulnerable to crack initiation and propagation. An undetected or poorly controlled crack in a linkage can have disastrous consequences, such as the loss of a helicopter blade, compromising stability and potentially leading to damage or a major aircraft failure..

Keywords: *blade, pitch link, fatigue, crack, damage..*

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MODELING OF THIN SILICON FILM DEPOSITION BY INDUCTIVELY COUPLED PLASMA ENHANCED CHEMICAL VAPOUR DEPOSITION (ICP-CVD) USING SILANE, ARGON AND HYDROGEN MIXTURE

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Abstract

Inductively coupled plasma enhanced chemical vapor deposition (ICP-CVD) is a process used to deposit thin films from a gas state (vapor) to a solid state on a substrate. Silicon films have been the subject of great attention in a large-area of electronic devices such as thin-film transistor fabrication, solar cell generation, image sensors and photo-diodes. The inductively-coupled plasma can give high density plasma of ~1012 cm-3 and has been developed for fabricating very high-density silicon integrated circuits. The plasma in this example is generated at a frequency of 13.56 MHz using a mixture of SiH4, Argon and Hydrogen.

In this work, we have studied the effects of external parameters, such as pressure, applied power and hydrogen dilution, on the growth rate of silicon films deposited by ICP-CVD. Our calculations showed that increasing the pressure and applied power causes a moderate increase in the deposition rate of silicon films while increasing the percentage of hydrogen produces its reduction.

The results of our simulation are given in terms of the distribution of electron density, electron temperature, electric field and electric potential in the center of the discharge.

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Keywords: *High-density plasma, Silicon films, Inductively-coupled plasma, Plasma-enhanced chemical vapor deposition, Deposition rate..*

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Experimental approach for optimizing the placement of piezoelectric sensors in Structural Mechanics

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Abstract

In this study, an experimental approach was adopted to evaluate the influence of excitation frequency and sensor position on the detection of disturbances in a vibrating structure. Through the application of intelligent maintenance, this approach aims to guarantee the reliability, durability, and safety of structures by enabling the early detection of defects or preventative damage that could compromise their integrity. The results highlighted the importance of proper sensor positioning, as well as the key role of certain frequencies in improving system sensitivity. This application contributes to the optimization of structural monitoring systems..

Keywords: *piezoelectric sensors, monitoring, optimization, control, vibrations.*

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IMPACT OF OBLIQUE ILLUMINATION ON THE OPTICAL ANISOTROPY OF C-SHAPED METAMATERIALS

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Abstract

This study focuses on the birefringence induced [1,2] by a structure consisting of a periodic array of C-shaped apertures etched into a silver layer deposited on a lithium niobate substrate. The apertures, filled with the same material as the substrate, have inner radius Ri=100nm and outer radius Ro=150 nm. The numerical simulation, performed using an FDTD code in Cartesian coordinates adapted for oblique incidence conditions [3], enables the analysis of the optical behavior of the structure under oblique illumination. This study highlights the specific effects of oblique incidence on the optical properties of the birefringent metamaterial and emphasizes the similarities and differences between various polarization configurations. The obtained results reveal a remarkable stability of the plate's efficiency over a broad spectral range and for different incidence angles. These findings provide a deeper understanding of the propagation phenomena and the induced anisotropy in such artificial structures, paving the way for the design of nano-optical devices with controlled birefringence.
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Keywords: *Metamaterial, Birefringence, FDTD, Oblique Incidence..*

Structural, Optical and Electrophysical Properties of Cu–Ga–Se Polycrystalline Films Synthesized by Controlled Selenization

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Abstract

Polycrystalline Cu–Ga–Se thin films with compositions $Cu_{0.27}Ga_{1.85}Se_{1.88}$ and $Cu_{0.33}Ga_{1.54}Se_{2.13}$ were synthesized using a two-stage controlled selenization process. The effect of selenization temperature on phase formation, microstructure and elemental distribution was examined by X-ray diffraction and scanning electron microscopy. Both films exhibit a chalcopyrite lattice with slight peak shifts associated with Cu/Ga
compositional variations. Raman analysis confirms the presence of A_1 vibrational modes and additional features linked to Cu–Se and Ga–Se bonding. Electrical measurements show two distinct behaviors: high-resistive $Cu_{0.27}Ga_{1.85}Se_{1.88}$ films exhibit impurity-activated conduction with $E_a \approx 0.3$ eV and strong photoconductivity, while Cu-rich films display lower resistivity with transport anomalies at 170 K and 300 K. Optical measurements reveal two
bandgaps (1.65 eV and 3.71 eV) and an Urbach energy of 0.9 eV, indicating significant structural disorder. Impedance spectroscopy demonstrates Debye-type relaxation with $\tau \approx 10^{-4}$–10^{-5} s above 300 K. These findings highlight the strong dependence of the electrophysical and optical behavior on Cu/Ga stoichiometry, relevant for photovoltaic technologies..

Keywords: *selenization temperature, Cu–Ga–Se Polycrystalline Films,Electrophysical Properties.*

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EXPERIMENTAL STUDY OF NATURAL / SYNTHETIC FIBERS EFFICIENCY ON THE MECHANICAL PROPERTIES OF COMPOSITE MATERIALS

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Abstract

The aim of this research is to evaluate the examined samples by developing new materials with optimal mechanical functioning. In fact, natural fiber composites (NFCs) have become a promising alternative to synthetic fiber composites using of specific plants such as jute, to enhance sustainability and environmental safety. The project purpose is to produce sustainable fibers, despite the reassuring results of jute; there are countless prospects to improve its mechanical properties by blending it with other materials to enhance the mechanical properties. The obtained results from hybrid composite samples, mostly those combining glass fibers and jute on the one hand, and jute with steel networks on the other hand, compared with jute specimens and glass fibers specimens, demonstrates a clear advantage in mechanical performance through higher ultimate strength and fatigue strength values. Thus, these composites develop into high-performance, lightweight, and eco-friendly alternatives that satisfy the requirements of advanced engineering..

Keywords: *Synthetic fiber, Natural fiber, Hybrid composite materials, Steel-Networks, Jute, Glass fiber..*

INFLUENCE OF STEEL WIRE REINFORCEMENT ON TENSILE AND FLEXURAL PROPERTIES OF JUTE FIBER COMPOSITES

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Abstract

The use of natural jute fiber composites has gained significant interest in sustainable materials research. Efforts to improve their mechanical properties are ongoing. This study focuses on strengthening natural jute fiber-polyester composites by incorporating steel wires. Steel wires with diameters of 0.56 mm, 1.00 mm, and 2.00 mm were embedded within jute fiber layers to evaluate their effect on mechanical performance. Various wire orientations, including vertical, horizontal, and oblique, were examined using a manual four-layer composite manufacturing process at room temperature. Tensile and flexural tests demonstrated that these small-diameter steel wires significantly enhanced the mechanical properties of the composites: vertical wires significantly improved tensile strength, while larger-diameter horizontal wires increased flexural strength. The mechanical interlocking and orientation of the steel wires improves load transfer within the composite matrix, offering a promising approach to improving the structural performance of sustainable natural fiber composites..

Keywords: *Composite, Jute, Wires, Tensile, Hand lay-up technique, Poyster resin.*

NATURAL HYDROXYAPATITE/ SODIUM SILICATE COMPOSITES FOR BIOMEDICAL APPLICATIONS

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Abstract

In this study, the sintering behavior of sodium silicate–hydroxyapatite (HAp) composites prepared by incorporating varying amounts of sodium silicate (0–30 wt%) into HAp was systematically investigated. The influence of sintering temperature on densification, phase evolution, chemical bonding, and mechanical performance (Vickers hardness) was examined. X-ray diffraction (XRD) analysis revealed the formation of multiple crystalline phases, with HAp and α/β-tricalcium phosphate (TCP) as the dominant components, accompanied by secondary phases of wollastonite and silicon. The composite containing 5 wt% sodium silicate exhibited optimal performance when sintered at 1300 °C, achieving a bulk density of 2.7 g cm^{-3} and a Vickers hardness exceeding 3.5 GPa. Complementary evaluations of shrinkage, apparent density, open porosity, and microstructure further confirmed that the incorporation of sodium silicate enhanced the physicochemical and mechanical properties of the material. These improvements are attributed to the formation of bioactive glassy phases that promote structural densification and potential bioactivity. Overall, the optimized sodium silicate–HAp composites demonstrate promising characteristics for biomedical applications, particularly in bone repair and surgical dentistry..

Keywords: *Hydroxyapatite (HAp); Sintering behavior; Sodium silicate; Biomedical applications*

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DETERMINATION OF THE FIBER SATURATION POINT OF 2 OAK WOOD SPECIES, ZEAN AND AFARES, FROM THE AKFADOU FOREST.

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Abstract

Green wood contains a large quantity of water distributed in the cellular cavities and between the cells. This water, termed "free water," can be eliminated without causing any change in the dimensions of the wood. Once this water is evaporated, only the "bound water" remains, attached to the cell walls by physico-chemical forces. The progressive elimination of this bound water leads to wood shrinkage, which is often responsible for deformations. The Fiber Saturation Point (FSP) corresponds to the moisture threshold below which wood begins to change volume in response to variations in ambient air humidity. This point constitutes an essential parameter for anticipating wood behavior during drying and evaluating its dimensional stability or, conversely, its tendency to deform ("nervousness") in service. The FSP is most often between 20% and 40% depending on the species, but generally falls between 15% and 30%. The two studied oak species, Afares oak (Quercus afares) and Zean oak (Quercus canariensis), are among the most common forest species in Algeria. Despite their availability, their utilization remains restricted, mainly due to certain use-limiting properties, such as high nervousness..

Keywords: *Keywords: Afares oak, Zean oak, Fiber Saturation Point, Radial shrinkage, Tangential shrinkage..*

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INFLUENCE OF FILM THICKNES ON THE FUNCTIONAL PROPERTIES OF SOL-GEL GROWN AZO THIN FILMS

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Abstract

Aluminum-doped zinc oxide (AZO) thin films were synthesized on glass substrates using the sol–gel dip-coating method. This study investigates the influence of film thickness on structural, morphological, optical, and electrical properties using X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM), UV–Visible spectroscopy, photoluminescence (PL), and Hall-effect measurements. XRD confirmed a hexagonal wurtzite structure with preferred c-axis orientation. As thickness increased, crystallinity improved, evident from enhanced (002) peak intensity and larger crystallite size. SEM and AFM revealed increased grain size and surface roughness with thicker films. Hall-effect measurements showed thinner films had better conductivity, with lower resistivity, and higher carrier concentration and mobility. Optical transmission remained high (76.9–81.1%) but slightly decreased with increasing thickness. A redshift in the absorption edge and a narrowing of the optical band gap were also observed. PL spectra exhibited emissions in the UV-blue and blue-green regions (375–550 nm), with reduced intensity and redshifted UV peaks for thicker films. These findings highlight the significant role of thickness in tuning AZO thin film properties for transparent electronics and optoelectronic applications..

Keywords: *AZO thin films, film thickness, optical and electrical properties, sol-gel dip-coating..*

DEVELOPMENT OF CERIUM-BASED PASSIVATING COATINGS FOR THE PROTECTION OF ZINC ALLOYS

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Abstract

The search for more environmentally friendly anticorrosion solutions has led to the exploration of new passivating materials, particularly rare-earth-based compounds. In this work, cerium oxide (CeO_2) coatings were developed by electrodeposition on zinc substrates to enhance their corrosion resistance. The deposited layers were characterized using various techniques, including X-ray diffraction (XRD), scanning electron microscopy (SEM), and electrochemical impedance spectroscopy (EIS). The analyses revealed a homogeneous and crystalline structure of the coating, as well as a significant improvement in corrosion protection in a chloride medium (3.5% NaCl) compared to the uncoated substrate. These results confirm the effectiveness of CeO_2 coatings as protective barriers, paving the way for sustainable and non-toxic alternatives to conventional anticorrosion treatments..

Keywords: *Cerium Oxide, Electrodeposition, Corrosion, Thin Films..*

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DEVELOPMENT OF IONIC LIQUID-MODIFIED ACTIVATED CARBONS: STUDY OF STRUCTURAL, SPECTROSCOPIC, AND THERMAL PROPERTIES

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Abstract

This research focuses on the development of activated carbons (AC) modified with two types of ionic liquids (IL). The primary objective is to investigate the influence of this modification on the structural, spectroscopic, and thermal properties of the activated carbons. The methodology involved the fabrication of activated carbons from carbonaceous materials, followed by the incorporation of ionic liquids into their pores. Structural analyses were performed using X-ray diffraction (XRD), while spectroscopic characteristics were examined through infrared spectroscopy (IR). Thermal behavior was assessed using thermogravimetric analysis (TGA). Results indicate that XRD analysis reveals the insertion of ionic liquids within the pores of the carbons. IR spectra highlight the presence of characteristic bands associated with CH_3 and CH groups, suggesting interactions between the activated carbons and the ionic liquids. TGA results show significant variations in degradation temperatures, indicating that solid ionic liquids are located on the surface, while liquid ionic liquids are incorporated within the porous structure..

Keywords: *Activated carbons, ionic liquids, thermal properties, XRD, IR, TGA.*

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STRUCTURAL, MECHANICAL AND THERMODYNAMIC PROPERTIES OF TERNARY INTERMETALLIC COMPOUNDS CaPd2P2 AND SrPd2P2: A FIRST PRINCIPLE STUDY

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Abstract

Using first-prciples total energy calculations within the local density approximation (LDA) and the generalized gradient approximation (GGA), we have investigated the structural, elastic and thermodynamic properties of CaPd2P2 and SrPd2P2 having well- known ThCr2Si2-type tetragonal structure. The present research confirm that the optimized structural parameters are in good agreement with the experimental results. Two compounds satisfy the mechanical stability relations and also show ductile nature and hence convenient for fabricating devices. In addition, the mechanical anisotropy of CaPd2P2 and SrPd2P2 is also discussed. The Debye temperature of two compounds has a relative high θD value indicating that they possess good thermal conductivity. The mean sound velocities have a progressive decrease from Calcium (Ca) to tin Strontium (Sr)..

Keywords: *CaPd2P2 and SrPd2P2 compounds; Structural properties; mechanical properties; first principle calculations..*

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DFT-BASED COMPARATIVE ANALYSIS OF THE PHYSICAL PROPERTIES OF Tin+1, FeTin, CoTin AND NiTin CLUSTERS

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Abstract

The investigation of the physicochemical properties of nanomaterial clusters formed from a few atoms to a few hundred atoms, also known as clusters, is today one of the most areas of scientific research in materials science [1]. We focused on the lowest-energy structures of pure titanium and titanium doped with Fe (FeTin), cobalt (CoTin) and nickel (NiTin). Our comparative study will be based on the stability of the clusters from the curves obtained for the cohesion energy per atom (eV/atom), HOMO-LUMO gap Eg (eV) and the magnetic moment μ (μB/atom) of the most stable structures of FeTin, CoTin and NiTin clusters (n = 1-10). The generalized gradient approximation (GGA) of the density functional theory (DFT) has been employed with the Perdew-Burke-Ernzerhof (PBE) parameterization of the exchange correlation functional and the first principles pseudopotenial implemented in SIESTA method [2].

References:

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Keywords: *Cluster, ab inito simulation, DFT, Tin, Ti-Fe,.*

Temperature Dependence of the Gaussian Inhomogeneous Schottky Barrier Parameters of Au/3C–SiC Diodes Based on Werner's Model

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Abstract

This work investigates the temperature-dependent behavior of the inhomogeneous parameters in Au/3C-SiC Schottky barrier diodes using an analytical simulation approach. The 3C polytype of silicon carbide was chosen for its compatibility with silicon substrates and cost-effective fabrication , while gold was selected for its excellent thermal and electrical stability . The simulation was based on Werner's Gaussian distribution model, which accounts for spatial inhomogeneities in the Schottky barrier height . Using MATLAB, we analyzed the variation of saturation current (Js) over a temperature range of 100 K to 300 K, considering multiple values of the standard deviation (σ), which quantifies the degree of barrier inhomogeneity. The results show a clear increase in Js with temperature and reveal that higher σ values lead to significantly enhanced current at low temperatures, due to increased contribution from regions with lower barrier heights.

Keywords: *Schottky barrier , Au/3C-SiC, inhomogeneous parameters.*

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PREPARATION AND CHARACTERIZATION OF A COMPOSITE OF BA0.48(NAXLI1-X)0.52(ZR0.61TI0.39) O3 – POLY (VINYLIDENE FLUORIDE-TRIFLUOROETHYLENE)

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Abstract

The present work describes the preparation and properties of a novel ceramic–polymer composites using Ba0,48 (Na0,42 Li0,1) 0,52 (Zr0,61 Ti0,39) O3 (BNLZT) as a ceramic filler and poly (vinylidene fluoride trifluoroethylene) [P(VDF-TrFE)] as a polymer matrix. The BNLZT ceramics were prepared by the conventional solid-state reaction route whereas the BCZT–P(VDF-TrFE) composites with various BCTZ volume fractions were prepared by the combined method of solvent casting and hot pressing. The densities of the products produced were calculated by a theoretical law and measured experimentally by an automatic gas pycnometer of the Quantachrome brand. The crystal phase of P(VDF-TrFE) and BNLZT/P(VDF-TrFE) films were determined and measured by Fourier transform infrared spectroscopy (FTIR). the microstructure of the films was measured by SEM analysis. The mechanical properties of the composites were investigated. Finally, a study of the mechanical properties of composites through the tensile test was carried out by dynamic mechanical analysis (DMA)..

Keywords: *Elaboration, lead-free piezoelectric ceramic, piezocomposite, crystallinity, mechanical properties.*

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Structural, electronic, magnetic and thermodynamic properties of Half-Heusler compounds LiSrB and NaSrB : Ab initio study

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Abstract

A significant number of intermetallic Heusler alloys are theoretically predicted to be half-metals at room temperature. The prime feature of these alloys is their possible applications in spintronic. In fact, the relatively high Curie temperatures are desirable in this field so that the spin polarization can reach 100% at the Fermi level. These alloys are classified into two categories: the half-Heusler and full-Heusler alloys. A promising class among these materials is the ferromagnetic Half-Heusler Mn-Based alloys which received a considerable attention in the theoretical studies.

In this work, We have performed a theoretical study using the full potential linearized augmented plane wave approach (FP-LAPW) based on the density functional theory (DFT) to determine method to examine the structural, electronic and magnetic properties of Mn Based Half-Heusler alloys. The exchange-correlation potential is treated by generalized gradient approximation (GGA).

The calculated structural properties such as the equilibrium lattice parameter, the bulk modulus and its pressure derivative are in good agreement with the available data. The obtained results for the band structure and the density of states (DOS) show that the compounds LiSrB and NaSrB have an direct gap (X-X). The dependence of the energy band gaps with pressure is nearly linear..

Keywords: *Half-Heusler, Lattice parameter, Bulk modulus.*

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Prediction Study of the Structural, electronic, magnetic and thermodynamic Properties of the CuCoMnC ,CuCrMnC Compounds

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Abstract

The electronic structure, magnetic and thermodynamic properties of CuYMnC (Y= Co and Cr) quaternary Heusler compounds were investigated using the full-potential linearized augmented plane wave (FPLAPW) method in frame work of the density functional theory(DFT). The results showed that CuYMnC (Y = Co and Cr) compounds were stable in Type2 structure and were true half-metallic (HM)ferromagnets.

We also presented the thermal effects using the quasi-harmonic Debye model, in which the lattice vibrations are taken in to account. Temperature and pressure effects on the structural parameters, heat capacities, thermal ex-pansion coefficient, and Debye temperatures are determined from the non-equilibrium Gibbs functions

.

Keywords: *Thermodynamic ; Half-metallic; Quaternaly Heusler; FPLAPW, HM, Deybe Model.*

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A THEORETICAL INVESTIGATION ON THE STATIC RESPONSE OF FUNCTIONALLY GRADED SANDWICH BEAMS USING RHSDT

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Abstract

This work presents a Refined Hyperbolic Shear Deformation Theory (RHSDT) for the static analysis of functionally graded sandwich beams subjected to various boundary conditions. The proposed model assumes that the material is isotropic at each point, with properties varying smoothly across the beam thickness according to a power-law distribution in the functionally graded core or skins. The governing equations are derived from the principle of minimum potential energy. The present formulation, which represents a new class of third-order shear deformation theories, introduces undetermined integral variables to accurately describe the transverse shear strain distribution through the thickness, ensuring zero shear stresses at the outer surfaces without requiring any shear correction factor. An analytical solution based on trigonometric series expansion is developed to satisfy different boundary conditions. The obtained results demonstrate that the proposed RHSDT model can efficiently and accurately predict the static bending behavior of both isotropic and functionally graded sandwich beams, confirming its reliability through comparative studies with existing models..

Keywords: *Static bending; Functionally graded sandwich beams; Energy method; RHSDT; Hyperbolic shear deformation; Analytical solution; Boundary conditions..*

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FIRST-PRINCIPLES STUDY OF THE STRUCTURAL AND ELECTRONIC PROPERTIES OF FERROMAGNETIC FULL-HEUSLER ALLOYS

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Abstract

This study examined the structural, electrical, and magnetic properties of full Heusler rare earth-based alloys Pr2CoZ (where Z = In and Ga). Our calculations utilized density functional theory (DFT) based on full potential linearized augmented plane wave (FP-LAPW) implemented in the WIEN2k code. We employed the generalized gradient approximation (GGA) to obtain all properties. The electrical and magnetic properties were computed based on the optimal cell parameters of the ferromagnetic Hg2CuTi type with space group 216. The results obtained validate the half-metallic behavior of both alloys, which exhibit a significant magnetic moment of 4 µB, making them suitable candidates for spintronic and storage applications..

Keywords: *DFT; Full Heusler; rare earth; WIEN2k; Half metal;Spintronics.*

EFFICIENT REMOVAL OF DYES FROM AQUEOUS SOLUTIONS USING MODIFIED HYDROXYAPATITE DERIVED FROM ALGERIAN PHOSPHATE ROCK

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Abstract

Cationic dyes, such as methylene blue and brilliant yellow, cause significant environmental pollution. Most common dye adsorbents are difficult to produce and are not environmentally friendly. In recent years, a number of scientific studies have focused on the preparation and use of grafted hydroxyapatite. In this context, we prepared hydroxyapatite using Algerian natural phosphate and grafted it with sodium metasilicate (MNP-MSi) via the precipitation method to precisely improve certain physico-chemical properties to increase the adsorption capacity for methylene blue and Brilliant yellow dye. The successful synthesis of MNP-MSi was evaluated through multiple techniques including X-ray diffraction (XRD), Scanning electron microscopy coupled with energy dispersive X-ray spectrometry(SEM/EDS), Fourier Transforms Infrared spectroscopy (FTIR), and thermogravimetric analysis (TGA).

Batch adsorption experiments were conducted, and the influence of experimental parameters such as contact time (up to equilibrium), adsorbent dose (1–6 g/L), pH ((2–9)±0.2) and initial dye concentration (10 and 200 mg/L) was studied. The optimum conditions were pH 7±0.2 and adsorbent dose of 1 g/L for BY and 2g/L for MB, with maximum adsorption percentages reaching 100.0% for brilliant yellow and 98.7% for methylene blue at 10 mg/L. For 200 mg/L, the adsorption efficiency declined to 98.13% and 86.19% for brilliant yellow and methylene blue, respectively.

Kinetic data revealed that the driving force behind the adsorption process in both systems could be explained by a pseudo-second- order mechanism. The equilibrium details for BY were well described by the Freundlich isotherm, whereas the adsorption equilibrium data for MB obeyed the Langmuir model. The regeneration study demonstrated that MNP-MSi2 could be effectively reused for removing MB and BY dyes for at least four successive adsorption-desorption cycles, using NaOH and HCl as desorption agents.

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Keywords: *Phosphate rock; adsorption; isotherm; methylene blue; Brillant yellow; sodium metasilicate..*

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IN SITU SYNTHESIS OF (2AMINOPHENYL DISULFIDE)/SIC NANOCOMPOSITE WITH DIFFERENT AMOUNTS OF SIC AND THEIR CHARACTERIZATION AND ELECTROCHEMICAL PROPERTIESE

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Abstract

Poly (2aminophenyl disulfide)/SIC a New hybride,were préparer by chemical oxydative polymerization in acidic medium of hydrochloric acid(1M) using ammonium persulfate (APS) as oxidant. The obtained matériels poly (2APhS/SIC with different amounts of SiC :0,5g,1g,1,5gand2g) were characterized using various analytique technique such as XRD,FTIR and ultraviolet spectroscopy UV measurements. The résultats confirme the successeur formation of the poly(2APhS/SiC)composite.the electrochemical prophéties of the composite were characterized by the cycliste voltmètre..

Keywords: *2 aminophenyl disulfide; nanocomposite;electrochemical properties; SIC..*

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OPTICAL ANISOTROPY IN HYDROGEN/HALOGEN FUNCTIONALIZED SILICENE NANORIBBONS

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Abstract

This study investigates the effects of hydrogen and halogen edge functionalization on the structural, electronic, and optical properties of planar silicene nanoribbons (SiNRs) with armchair (ASiNRs) and zigzag (ZSiNRs) edges, using density functional theory (DFT) calculations. The findings reveal that X-edge functionalization efficiently tunes and opens the band gap in planar SiNRs while maintaining a metallic character. Density of states (DOS) analysis indicates a strong hybridization between halogen-p and edge Si-p orbitals, unlike the weaker interaction observed between H-s and Si-p states. Charge density contours confirm the ionic nature of Si–X (X = H, F, Cl, Br, I) bonds, whereas Si–Si bonds remain covalent. Optical investigations show that 7-ASiNR-X and 5-ZSiNR-X exhibit significant optical anisotropy in the infrared, visible, and ultraviolet regions under both polarizations, suggesting potential for optoelectronic and polarization-sensitive photodetector applications. Furthermore, pristine ASiNR and ZSiNR display strong absorption peaks at 0.32 eV and 0.36 eV, respectively, indicating their suitability for infrared devices. The main absorption peaks at 5.17 eV (ASiNR-H) and 4.5 eV (ZSiNR-H) correspond to high UV absorbance, making them promising candidates for photovoltaic applications..

Keywords: *silicene nanoribbons SiNRs; (hydrogen /halogen) edge- functionalization ; electronic properties; optical properties; DFT..*

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DEVELOPMENT AND NON-DESTRUCTIVE CHARACTERIZATION OF THE MICROSTRUCTURE OF A COPPER–ALUMINUM–BASED ALLOY

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Abstract

This work is an experimental study, and non-destructive characterization, of a ternary-based alloy Cu-28%Al-2%Zn obtained by high frequency (HF) melting under magnetic induction. The copper-aluminum-zinc alloy, here studied, was quenched from the liquid state to room temperature. With regard to the solidification structure, optical microscopy (OM) showed that the alloy has a microstructure with a dendritic solidification front developed in secondary branches. Scanning electron microscopy (SEM), in back scattered electron mode, revealed the presence of two phases with different chemical contrasts. X-ray diffraction (XRD) and differential scanning calorimetry (DSC) showed, moreover, that the microstructure of the ternary Cu-28%Al-2%Zn alloy contains not only three intermetallic compounds Cu5Zn8, AlCu3 and Al4Cu9 but also the metastable phase Cu3Zn which appears with an endothermic peak in the DSC measurement..

Keywords: *Copper; HF melting; Alloys; characterization; Phases..*

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A COMPARATIVE STUDY OF CU-AL AND CU-AL-ZN ALLOYS OBTAINED BY HIGH FREQUENCY (HF) MELTING UNDER MAGNETIC INDUCTION

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Abstract

This work is a comparative study of two alloys, binary and ternary, based on Cu-15%Al and Cu-13%Al-2%Zn obtained by high frequency (HF) melting under magnetic induction. With regard to the solidification structure, optical microscopy (OM) showed that the two alloy grades are structurally different. The binary alloy has a microstructure with a dendritic solidification front developed in secondary branches, while in the ternary alloy it consists of a flat front, which shows the role played by Zn in the solidification process. X-ray diffraction (XRD) and differential scanning calorimetry (DSC) showed, moreover, that the microstructure of the binary Cu-15%Al alloy consists only of the solid solution of Al in Cu. The ternary Cu-13%Al-2%Zn alloy, due to the addition of Zn, contains not only the intermetallic compound CuZn2 but also the Cu2O type oxide, having a truncated pyramid morphology visible by optical microscope..

Keywords: *Copper; Aluminum; Zinc; HF melting; Alloys; Phases..*

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Structural and Electronic Insights on an Oxide Material Using DFT: Guidelines for Composite Material Design

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Abstract

In this study, density functional theory (DFT) calculations were performed to evaluate the structural and electronic properties of copper oxide (CuO) as a functional material for composite applications. The full-potential linearized augmented plane wave (FP-LAPW) method, implemented within the ELK code [1], was used under the local density approximation with the Hubbard U correction (LDA+U). Structural optimization confirmed the geometric stability of the CuO lattice, with calculated Cu–O bond lengths (~1.96 Å) in agreement with previously reported data [2]. Electronic structure investigations revealed semiconducting behavior, with a bandgap of approximately 1.4 eV, and the projected density of states (PDOS) indicated proper localization of Cu 3d states. These theoretical predictions align well with experimental findings available in the literature [3]. Overall, the study demonstrates that CuO combines structural robustness with electronic tunability, positioning it as a promising material for incorporation into advanced composite structures, including photocatalytic membranes, electronic devices, and protective systems.
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Keywords: *DFT, ELK Code, Composite Materials, TDOS, PDOS, Copper (II) Oxide (CuO), Electronic Properties, Structural Properties..*

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THEORETICAL INVESTIGATION OF NB1-XTIXFESB HALF-HEUSLER ALLOYS FOR THERMOELECTRIC APPLICATIONS

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Abstract

The world at present is facing two major problems relating to energy. One is the energy crisis and another is its environmental impact arising from conventional ways of utilizing energy resources. The first problem is driving research for alternative energy resources and the second problem concerns better ways of utilizing the energy resources. Thermoelectricity is considered to be one of the potential ways towards addressing both these problems. Since, it is able to convert heat into electricity without causing pollution to reduce our reliance on fossil fuel, Using Thermoelectric materials. Half-Heusler alloys are considered to be potential thermoelectric materials [1]. In this work we perform first-principles calculations based on density functional theory implemented in the Wien2K code [2] and semi-classical Boltzmann method with BoltzTraP2 code to compute the structural, electronic, and thermoelectric properties of

Nb1-xTixFeSb Half-Heusler alloys. In doing do, a 2×2×2 supercell have been created. Our results suggest a noticeable deviation from the linear dependence predicted by Vegard's law. The presence of Ti atoms has led to significant modifications in the band structure, and increasing their concentration has resulted in variations of the band gap, which in turn caused an increase in charge carrier concentration and electrical conductivity. However, due to the high thermal conductivity, the figure of merit (ZT) remains limited, reaching a maximum slightly above 1 with 25% titanium doping at 1200 K.

.

Keywords: *Thermoelectric Properties, Half-Heusler alloys, DFT, FP-LAPW, BoltzTraP2.*

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MULTISCALE MODELING OF THE EFFECT OF NANOCLAY ADDITION ON MOISTURE DIFFUSION IN JUTE FIBER REINFORCED POLYMER COMPOSITES

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Abstract

The utilisation of composite materials faces major environmental challenges, mainly related to moisture. Moisture uptake by both the polymer matrix and the natural fibres generates internal stresses that weaken the structure and degrade performance. Therefore, developing solutions to mitigate moisture diffusion is essential to enhance the durability of these materials in humid environments. In this study, the effect of nanoclay incorporation on moisture diffusion in polymer/clay/fibre hybrid composites is investigated using a multiscale numerical modelling approach. A novel method was developed to determine the representative elementary volume (REV), improving the accuracy of simulations and the description of actual microstructures. Two nanostructural configurations were examined: exfoliated and intercalated. The results revealed Fickian diffusion behaviour, with a marked decrease in the diffusion coefficient as the nanoclay content increased. For instance, at 5 wt% nanoclay in the exfoliated configuration, the diffusion coefficient decreased by about 84% compared with the neat polymer, due to the barrier effect of clay layers. Exfoliated structures were found to be more effective than intercalated ones in limiting moisture transport..

Keywords: *Multiscale modeling, hybrid composites, Moisture diffusion, Nanoclay, Jute fibre.*

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INFLUENCE OF ALLOYING AND MAGNETIZATION ON HYDROGEN DIFFUSION AND EMBRITTLEMENT RESISTANCE IN FCC AUSTENITIC STAINLESS STEELS: FIRST-PRINCIPLES INSIGHTS

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Abstract

Hydrogen embrittlement (HE) represents a key limitation for metallic materials in hydrogen storage and transport systems. To address this challenge, the present work investigates how alloying and magnetic effects influence hydrogen diffusion mechanisms in austenitic stainless steels (ASS) with a face-centered cubic (FCC) structure. Density functional theory (DFT) simulations were performed for Fe-based systems reflecting 304 and 316 compositions, incorporating alloying elements Ni, Cr, Mn, Mo, P, S, Si, N, and C. The results reveal that specific alloying additions, namely Cr, S, Mo, Si, Mn, and P, significantly raise the energy barrier for hydrogen penetration into the FCC slab, while N, C, Cr, Mo, Si, and Mn similarly hinder hydrogen migration through the bulk. These modifications in diffusion energetics effectively suppress hydrogen mobility and accumulation, thereby mitigating the onset of embrittlement. Moreover, the observed magnetic contributions underscore the complex interplay between electronic structure and hydrogen transport in these alloys. The findings provide mechanistic guidance for the microstructural and compositional design of FCC stainless steels with enhanced performance and reliability in hydrogen-rich environments..

Keywords: *Hydrogen diffusion, Austenitic stainless steel, Alloy design, Magnetization effects, Embrittlement resistance, First-principles calculations.*

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SUSTAINABLE COPOLYMERS VIA GREEN CATALYSIS: TOWARD ADVANCED HYBRID MATERIALS

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Abstract

This study focuses on the synthesis of innovative copolymers using an eco-friendly natural catalyst. The process was carried out under mild conditions, aiming to develop sustainable and high-performance polymeric materials. Characterization analyses confirmed the efficiency of the catalytic system and the successful formation of stable hybrid copolymers. These findings highlight the potential of green catalysis in producing advanced materials with promising applications in environmental and industrial fields..

Keywords: *Green catalysis, copolymerization, sustainable materials, hybrid polymers, advanced materials..*

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EFFECT OF ANNEALING TEMPERATURE ON THE STRUCTURAL AND OPTICAL PROPERTIES OF CMTS THIN FILMS PREPARED BY SPRAY DEPOSITION

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Abstract

Cu2MgSnS4 (CMTS) films are successfully deposited on glass substrates by spray pyrolysis technique. CMTS thin films were subsequently annealed at 450 C° to enhance their physical properties. The structural properties were investigated using X-ray diffraction proven that the kesterite structure with (112) preferential orientation was the best crystalline quality is obtained after annealing. The morphological study shows a smooth surface after annealing using scanning electron microscopy (SEM). The optical properties using UV–vis spectroscopy showed high absorbance and an absorption coefficient of about 104 cm−1 in the visible region with an optimum band gap energy about 1.5 eV. Which is suitable for to be used in solar cell application. Photoluminescence (PL) measurements revealed strong emission intensity after annealing, these results demonstrate that annealing at 450 C° significantly enhances the structural and optical performance of CMTS thin films, highlight their potential for optoelectronic and photovoltaic applications. These experimental findings may open new practices for the CMTS compound.

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Keywords: *Cu2MgSnS4; Annealing; spray pyrolysis; structural properties; optical properties..*

Advanced Evaluation of Inhibition Zones in Co-Doped SiO_2 Nanostructures for Antimicrobial Applications

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Abstract

This study presents the synthesis and evaluation of cobalt-doped silicon dioxide (SiO_2) nanostructures with dual antimicrobial activity against both bacterial and fungal strains. The nanomaterials were synthesized using a sol-gel method and subjected to thermal treatment to optimize their structural and functional properties. Antimicrobial activity was assessed using zone of inhibition tests. To ensure accurate and reproducible quantification, inhibition zones were analyzed through digital image processing techniques. This method enhances precision and eliminates subjective measurement errors commonly associated with manual evaluations. The results reveal that the antimicrobial efficiency of the nanostructures depends significantly on cobalt doping levels and thermal processing conditions. This work underscores the potential of Co-doped SiO_2 nanostructures in biomedical and environmental antimicrobial applications and demonstrates the value of integrating nanomaterials research with image-based quantification techniques..

Keywords: *Co-doped SiO_2, antibacterial, antifungal, inhibition zone, image processing, nanostructures.*

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Comparison of hyperelastic models for the analysis of a pressurized hollow cylinder

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Abstract

The primary objective of this study is to conduct a comparative analysis of two hyperelastic material models applied to a hollow cylinder subjected to pressure. The goal is to evaluate the differences in the mechanical responses predicted by each model. Both analytical methods and numerical simulations using finite element analysis (FEA) software were employed. The study focuses on stress distribution and the sensitivity of the results to the choice of constitutive model. The findings indicate that the selection of the hyperelastic model has a significant impact on the accuracy of the predicted mechanical behavior. This comparison offers valuable insights into the appropriate use of hyperelastic models in the design of pressure-loaded elastomeric components. Selecting a suitable model is essential to ensure both reliability and mechanical performance..

Keywords: *Hyperelasticity, Cylinder, Pressure, Simulation.*

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Enhanced JAYA-ANN Optimization coupled with Numerical modeling for Predicting the mechanical behavior of CFRP Laminated Composites

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Abstract

Recent advancements in artificial intelligence have significantly improved the optimization of multilayer composite structures. The main objective of this study is to investigate how geometric parameters, such as fiber orientation and number of layers, on the mechanical properties of CFRP (Carbon Fiber Reinforced Polymer) laminated composites with epoxy resin. A numerical model based on the Hashin damage criterion will therefore be implemented under the ABAQUS environment to simulate the behavior of CFRP composites under bending load, to generate training data for an improved artificial neural network. Then, a hybrid E-JAYA-ANN optimization technique will be used to predict these properties during bending tests, and its results will be compared with those of the hybrid JAYA-ANN technique. The objective is to better understand the influence of geometric parameters on mechanical properties in order to optimize a better architecture of unidirectional laminated composites during the development phase..

Keywords: *Composite laminate ; fiber orientation ; number of layers ; optimization ; JAYA-ANN ; Enhanced JAYA-ANN..*

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Prediction of composite plate behavior under low-velocity impact using an ANN-based parametric finite element approach

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Abstract

Keywords: *Composite plate ; stacking sequence ; ABAQUS ; simulations ; FEM ; Artificial Neural Networks ;.*

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STUDY OF ELABORATED MEDIUM Mn STEEL FOR AUTOMOBILE MANUFACTURING

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Abstract

Recently, the utilisation of lightweight and high-strength steels has emerged as a primary focus in the automotive industry. In response to these demands, specific steels with a combination of high strength/ductility have been developed. Among them, medium Mn steel presents an important candidate for such an application. Our work focuses on the elaboration of Mn medium steel using an induction melting furnace, where we started with two different mixtures. The RFX analysis shows that the final chemical compositions of obtained steels were as follows: F1 (Fe-0.8C-6.7Mn-2.70Si-2.57Al (Wt. %)) and F2 (Fe-0.27C-8.4Mn-2.85Si-2.4Al (Wt. %)). The mechanical properties and microstructures of obtained specimens were revealed and discussed.

Keywords: *medium Mn steel, Automotive manufacturing, strength, ductility.*

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TILE‑WISE FUSION STRATEGIES FOR ROBUST HIGH‑RESOLUTION IMAGE SEGMENTATION

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Abstract

High‑resolution semantic segmentation often exceeds the GPU memory limits, leading practitioners to process images in a tile‑wise manner. This tiling introduces severe border artifacts, making it challenging to obtain smooth, pixel‑accurate masks without any prior knowledge of the scene content. We present TileFusion, a modular framework that fuses two complementary strategies to mitigate these artifacts. (i) Overlap‑and‑Average extracts overlapping tiles, passes each through a standard encoder‑decoder, and aggregates the per‑pixel logits onto a global output map. (ii) Context‑Padding expands each tile with a halo region that supplies surrounding context, and the central region is then extracted and stitched directly, without overlap. Both strategies are integrated into a single end-to-end pipeline that requires no architectural modifications and adds a modest computational overhead. Experiments on the Kolektor Surface Defect Dataset (KSDD) show that TileFusion consistently improves mask coherence and overall segmentation quality—higher Dice coefficient and Intersection‑over‑Union (IoU) scores compared with naïve tiling, confirming the effectiveness of the presented strategies and providing a solid basis for further investigation..

Keywords: *Image Segmentation, High‑Resolution Imaging, Tile-wise Fusion, Encoder‑Decoder Networks.*

MULTILAYER WIRE ARC ADDITIVE MANUFACTURING PROCESS MODELLING FOR RESIDUAL STRESS AND DISTORTION PREDICTION

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Abstract

Wire arc additive manufacturing (WAAM) has emerged as a promising technique for producing large-scale metallic components owing to its high deposition rates. Its capability to build and repair parts makes it increasingly attractive for both production and maintenance applications across various industries. Nevertheless, the extreme thermal cycle inherent to WAAM often leads to significant residual stresses (RS) and geometric distortion, compromising structural integrity and dimensional accuracy. This study presents a comprehensive finite element method-based thermomechanical model for predicting RS and distortion of parts obtained via the WAAM process. The model accounts for transient heat transfer, temperature-dependent material properties, and realistic conditions to replicate the complex thermal and mechanical behaviour of the deposited material. A multilayer deposition strategy is represented to capture the cumulative effects of thermal loading across successive layers. The predicted stress and displacement fields are analysed to identify critical zones of stress concentration and deformation, and improve the quality of the components while minimising costly trial-error adjustments. Although the methodology can be followed to study different metallic materials, the focus is on Ti-6Al-4V titanium alloy. A reference problem from the literature studying the production of a Ti-6Al-4V wall on a substrate via WAAM is investigated to benchmark the performance of our model. The error on the mean von Mises stress result is less than 3%. The simulated z-axis deflection of the structure is 6.662 mm instead of the experimental value of 6.477 mm, which corresponds to an unsignificant overprediction of only 2.9%. Our model is then found to be highly accurate..

Keywords: *wire arc additive manufacturing, residual stresses, distortion, thermomechanical modelling, finite element method.*

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ANALYSIS OF RADIAL STRESS IN SHRINK-FIT ASSEMBLIES THROUGH SIMPLIFIED EQUATIONS

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Abstract

Shrink-fit assemblies have been used for centuries, initially to provide wooden wheels with more durable running surfaces. Today, shrink-fitting refers to the process of joining two cylindrical components by thermal or mechanical interference, without the need for a third element, making it an economically efficient technique. This method is widely applied in various engineering fields such as automotive, aerospace, oil and gas, and railway industries. The process requires the outer radius of the inner cylinder to be slightly larger than the inner radius of the outer cylinder; this dimensional difference is known as interference. Interference plays a crucial role in enhancing the strength of the assembly, as it induces radial and tangential stresses at the contact interface. In this study, we investigate the influence of interference on radial stresses under elastic conditions, particularly when the interference is small and its effect may be negligible. Theoretical analyses based on simplified equations are performed to estimate potential errors, and numerical simulations using the finite element method are conducted to validate the analytical results..

Keywords: *shrink-fit assemblies, interference, radial stress, elastic behaviour, finite element method.*

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NUMERICAL INVESTIGATION OF FORM DEFECTS IN THIN-WALLED CYLINDERS

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Abstract

Shrink-fit assembly is one of the most widely used mechanical joining methods due to its simplicity and cost-effectiveness, as it requires only two components: a shaft and a hub. In this process, the outer diameter of the shaft is slightly larger than the inner diameter of the hub, creating an interference fit. This technique is commonly employed in various industrial applications, including the manufacturing of aircraft, automobiles, and the connection of oil and gas pipelines. The assembly can be achieved by heating the hub, cooling the shaft, or applying force directly. During the process, contact pressure develops at the interface between the shaft and the hub. Although this contact area is often assumed to be perfect, in reality, it contains form defects of varying size and distribution. This study investigates the influence of form defects and interference on the extraction force and the overall integrity of the 3D shrink-fit assembly using numerical simulations. Experimental tests of component separation were also conducted to validate the simulation results..

Keywords: *Radial stress; Hoop stress; Strain, Interference; Shrink-fit; Form defect.*

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CRYSTAL PLASTICITY ANALYSIS OF MICROSTRUCTURAL EFFECTS ON THE GLOBAL RESPONSE OF TI-6AL-4V

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Abstract

Fretting fatigue is a critical damage mechanism in contacting components such as turbine blades and disk assemblies, where small oscillatory motions at the interface can lead to premature crack initiation and failure. Understanding the microstructural effects in this phenomenon is essential for improving material performance under such contact conditions. The objective of this work is to study the influence of microstructure on fretting behavior of a duplex α- β phase Ti-6Al-4V titanium alloy, focusing on the distribution and modes of cyclic plasticity within the α grains. Since β-phase volume fraction is below 8%, the study considers only the α-phase. This part of the study focuses on the influence of microstructure on the global mechanical behavior of Ti-6Al-4V alloy. A representative volume element (RVE) was generated using a Voronoi tessellation approach to model grains with an average size of 30 µm, and assigned random crystallographic orientations. The material behavior was simulated using a crystal plasticity constitutive model that accounts for nonlinear kinematic hardening and incorporates three slip families: basal, prismatic, and second-order pyramidal systems. The numerical results show that the global stress–strain response of the model accurately reproduces both elastic and plastic regimes. Moreover, individual grains exhibited distinct yielding points due to their different crystallographic orientations relative to the applied loading..

Keywords: *Fretting, Ti6Al4V, crystal plasticity, cyclic plasticity, RVE, global behavior*.

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THE EFFECTS OF Mg AMOUNT AND THE T5 HEAT TREATMENT ON THE MICROSTRUCTURALS CHARACTERISTICS AND THE MECHANICALS PROPERTIES OF Al-Si BASED ALLOYS.

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Abstract

Al-Si based alloys are intended to be used in the automotive industry due to their enhanced mechanical properties. They are used in cylinder blocks, cylinder heads, pistons and valve lifters.

The microstructure and the mechanical properties of Al –Si alloys, are not only dependent on the silicon content but are primarily governed by the amount of Mg additive. The latter is the most used ternary additive which is always associated to the transition from the irregular eutectic acicular structure to the dendritic morphology resulting from hypo-eutectic composition. In this contribution, we study the effect of magnesium amount and the T5 heat treatment on the microstructural characteristics and the mechanical properties of three different groups of as-cast Al-Si based alloys: (i) B413 (Al-13 wt %Si), (ii) AS10G (Al-10 wt%Si-0.35 wt% Mg) and A356 (Al-7 wt%Si-0.60 wt% Mg). Furthermore, this investigation is carried out, for the three groups of alloys, in order to show the influence of T5 temperature (consisting of direct aging at 500°C for aging times ranging from 0.5 h to 8h) on their microstructural and mechanical properties.

Different characterization techniques have been used for microstructural examination namely: optical microscopy, scanning electron microscopy (SEM), Energy Dispersive Spectrometry (EDS), as well as X-Ray Diffraction (XRD). Mechanicals properties, consisting of Ultimate Tensile Strength (UTS), Yield Strength (YS) and Elongation to fracture (%El), have been measured by using tensile tester.

Our alloys are observed to exhibit the best mechanical properties, with the highest values, of UTS and YS, in T5-temper with aging at 500°C for 5h. Moreover, the highest values of elongation to rupture El% are obtained, after 1h, for the three groups of alloys. This behaviour is interpreted in terms of: (i) silicon particles shapes and Mg_2Si amount obtained after T5-treatment with aging at 500°C for 5h.

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Keywords: *Al-Si based alloys, microstructures characteristics, mechanicals properties.*

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NUMERICAL SOLUTION OF THE AXISYMMETRIC INDENTATION PROBLEM FOR A TWO ELASTIC LAYERS OF THE DIFFERENT MATERIALS ON THREE RIGID BASES

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Abstract

Contact problems in solid mechanics involving elastic layers resting on elastic half-planes, as well as elastic and rigid foundations, have been extensively studied due to their relevance to a wide range of practical engineering applications. A computer simulation method for contact problems within the Finite Element Method (FEM) has been developed. The study focuses on an axisymmetric contact problem containing two infinitely long layers of finite thickness made of different materials. These layers are partially supported by three rigid, circular bases of identical dimensions, with the distance between the bases equal to their length. The layers are in contact along their upper surface via a rigid stamp. Both layers are assumed to be homogeneous and exhibit linear isotropic elastic behavior. It is further assumed that all contact surfaces are frictionless. The Von-Mises stress, normal stress, and vertical displacement are numerically evaluated. Additionally, the impact of the layers' thickness on these physical quantities is investigated..

Keywords: *Contact Mechanic, Elastic layers, Rigid Bases, Material, Finite Element Method, ABAQU..*

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CONTACT MECHANICS MODELLING OF LAYER THICKNESS ON TWO RIGID BASES OF THE DIFFERENT MATERIAL

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Abstract

The emergence of numerical calculation methods, which provide approximate solutions through computer programs, has made it easier to address long-term engineering challenges compared to traditional analytical techniques. Contact problems in solid mechanics involving elastic layers resting on elastic half-planes, as well as elastic and rigid foundations, have been extensively studied due to their relevance to a wide range of practical engineering applications. A computer simulation method for axisymmetric contact problems within the Finite Element Method (FEM) has been developed. This study focuses on an elastic layer partially supported by two rigid circular bases made of the different material and indented along its upper surface by a rigid stamp. Various simulations were conducted to examine the distribution of Von Mises stress, normal stress, and vertical displacement within the layer. The significant influence of the layer thickness and the radius of the rigid bases of the different material on these physical parameters was demonstrated..

Keywords: *Contact Mechanic, Elastic Layer, Rigid Bases, Rigid stamp, Finite Element Method, ABAQUS..*

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SELF BALANCING ROBOT

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Abstract

Self-balancing robots are intriguing and innovative machines that demonstrate the ability to maintain balance without external assistance. They employ advanced control systems and precise motor control to stabilize themselves in an upright position. These robots have garnered significant interest in recent years due to their applications in various fields, including robotics, automation, and even entertainment. The primary objective of this paper is to explore the concept, design, and control of self-balancing robots. It delves into the underlying principles and technologies involved, providing a comprehensive understanding of the key components and mechanisms required for achieving balance. Additionally, a comparison between proportional integral derivative, Fractional Order and Complex Fractional-Order Controllers is considered in this the paper to examines the challenges associated with building and controlling self-balancing robots, along with potential solutions..

Keywords: *Self-balancing robot, fractional-order PID; complex fractional orders control.*

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Numerical Simulation of Heat Transfer in Steel under Different Cooling Media Using ANSYS

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Abstract

Steel is considered a fundamental material in mechanical industries, and the cooling process is a key step in controlling its microstructure and mechanical properties. The results vary depending on the cooling medium (water, oil, air, or saline solutions), as the cooling rate determines the resulting structure: rapid cooling leads to hard and brittle martensite, while slow cooling allows the formation of pearlite or ferrite with greater ductility. The relationship between temperature, time, cooling medium, and cooling rate represents an interconnected system that defines the final properties of steel.

In this study, ANSYS simulation was employed as an effective tool to analyze these phenomena. It enables the study of heat transfer within the specimen, the plotting of temperature curves against time or distance, and provides the possibility of comparing different cooling media on a precise quantitative basis.

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Keywords: *stell, cooling medium,cooling rate, Ansys*

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Load-carrying capacity of potted insert on honeycomb sandwich panels under static loads used in aerospace applications.

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Abstract

This study presents a numerical analysis for modeling inserts in honeycomb sandwich structures. The main objective is to investigate the mechanical behavior of the insert region under static loading in three orthogonal directions. The numerical model captures the stress distribution, deformation, and displacement fields within the core and both upper and lower skins. The results reveal significant variations in stress and deformation patterns depending on the loading direction, highlighting the sensitivity of the insert–core interface. These findings contribute to a better understanding of insert performance and provide useful insights for the structural design and optimization of sandwich panels used in aerospace applications..

Keywords: *Insert; potting; honeycomb cell; sandwich panel,.*

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INVESTIGATION OF MQL AND CNC TURNING PARAMETERS ON THE MACHINABILITY OF TITANIUM ALLOY TI6AL4V

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Abstract

Titanium alloys are widely used in the aerospace, energy, and gas turbine engine industries. Most titanium components are manufactured using traditional machining techniques such as turning, milling, drilling, etc. The machinability of titanium alloys is poor due to a number of inherent properties. Titanium alloy Ti6Al4V is renowned for its exceptional strength-to-weight ratio and corrosion resistance, making it a highly sought-after material in various engineering applications, particularly in aerospace and biomedical fields. However, its inherent properties, such as low thermal conductivity and high chemical reactivity, pose significant challenges during machining processes. This work is dedicated to the evaluation of the performance and the determination of mathematical models of the different phenomenal studied (resulting cutting force Fr, surface roughness Rz and cutting power Pc). These models make it possible to express the mathematical relationship between the elements of the cutting regime (cutting speed Vc, feed f, and depth of cut ap) and the technological parameters studied during the MQL machining of Ti6Al4V titanium alloys by uncoated carbide tools (H13A) using the Response Surface Methodology (RSM). The tests were carried out according to a complete experimental design of 27 trials, varying three input factors: cutting speed, feed rate, and depth of cut. A Pareto analysis was used to find the contribution of each factor and to determine which parameters had a significant influence on surface roughness. The results were used to propose a mathematical model for predicting Rz, Pc and the resulting cutting force Fr.

The RSM quadratic model combined with the desirability optimization technique was used to find the optimum values of the machining parameters with respect to the objective of minimizing the output responses..

Keywords: *Titanium alloy Ti-6Al-4V, MQL, Cutting force, surface roughness, RSM;.*

OPTIMIZATION OF MACHINING PARAMETERS IN TURNING OF AISI O2 HARDENED STEEL USING NANOMQL AND MOAVOA: A MULTI-OBJECTIVE APPROACH

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Abstract

The investigation aimed to explore the machinability of AISI 02 hardened steel using three lubrication methods: dry, MQL, and NANOMQL. The analysis assessed the influence of cutting speed (Vc), feed rate (f), and depth of cut (ap) on surface roughness (Rt), and axial force (Fa). The experimentation employed the Taguchi L36 plan, and the impact of input parameters on the examined turning factors was analyzed using ANOVA. The research established mathematical prediction models through response surface methodology (RSM) and optimized the investigated factors using a genetic algorithm. The findings indicate that adopting the NANOMQL lubrication method significantly affected surface roughness, axial force, and cutting power. The results offer valuable insights into optimizing cutting parameters and utilizing multi-objective African vultures optimization algorithm (MOAVOA) for multi-objective optimization in machining processes..

Keywords: *AISI 02, MQL, NANOMQL, Cutting force, Roughness, ANOVA, RSM, and MOAVOA.*

Enhancing Surface Roughness Prediction in Hard Turning of AISI D2 Steel Using a Hybrid Model combining Transfer Learning and GPR

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Abstract

In this study, we focus on predicting surface roughness during dry hard turning of AISI D2 steel. Hard turning is an alternative to the grinding process, which is often time-consuming and costly, and surface roughness serves as a key indicator of the functional and tribological quality of machined components. Our investigation involves the development of a hybrid predictive model (TL-GPR) for surface roughness (Ra), combining Transfer Learning (TL) and Gaussian Process Regression (GPR). The developed model uses the following input variables: feed rate (f), cutting speed (Vc), cutting time (tc). And the source variables: power consumption (Pw), and resultant force (Fm), while the predicted output is the surface roughness (Ra). To evaluate the statistical performance of the predictive model, several performance metrics were employed, including the coefficient of determination (R^2), the root mean square error (RMSE), and the mean absolute percentage error (MAPE). The results for the present case study show that the R^2 value is close to 1, while RMSE and MAPE are relatively low. Therefore, the predictive capability of surface roughness using TL-GPR is highly promising..

Keywords: *Keywords: Surface roughness, hard turning, AISI D2 steel, TL, GPR..*

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IDENTIFICATION OF RHEOLOGICAL PARAMETERS AND NUMERICAL SIMULATION FOR ORTHOGONAL MACHINING OF AISI D2 HARD STEEL

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Abstract

In this study, a methodology was developed for the identification of the constituent parameters of the Johnson-Cook law (J-C) for AISI D2 hard steel (62 HRC). The identification was carried out on the basis of stress-strain curves obtained at different temperatures and strain rates by the JMATPRO software. Also, a numerical model FE in orthogonal section was elaborated using the identified J-C law and the Arbitrary Lagrangian-Eulerian (ALE) formulation. The latter facilitates the numerical simulation of chip formation by avoiding distortion of mesh elements, and eliminating the need for a specific damage criterion. The simulation results, relating to the prediction of cutting force and chip thickness, were compared with experimental data where good agreement was found..

Keywords: *Keywords: Johnson-Cook parameters, identification, JMATPRO, AISI D2 steel, Cutting orthogonal, ALE formulation..*

Surface hardening of AISI 316L stainless steel using the vibro-abrasion process

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Abstract

Improving surface quality has a major impact on the reliability of moving and stationary parts. Mechanical vibration technology is used to improve the quality and performance of the surface finish. The vibratory abrasion process is a chemical-mechanical process involving the use of low-frequency impact vibration in the presence of abrasive and chemical additives. This work focused on the study of the surface hardening process of 316L alloy welded by rotary friction using a linear vibration device. The aim of this work was to define the optimum treatment parameters relating to the surface hardness of 12mm 316L alloy.

The friction welding parameters were fixed for all the samples, and the improvement in surface quality was determined as a function of three vibratory parameters: the treatment time, the alloy of the balls and the amplitude of oscillation of the working chamber..

Keywords: *superficial hardening, rotary friction welding, vibro-abrasion.*

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TOWARDS AN AUTONOMOUS FATIGUE-AWARE DIGITAL TWIN FOR PREDICTIVE MAINTENANCE OF TOWER CRANES

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Abstract

This paper presents an adaptive and autonomous Digital Twin (DT) strategy for tower crane predictive maintenance through fatigue life-cycle modeling in Industry 4.0 settings. Incorporating DTs into construction is a quantum leap towards data-driven, autonomous asset management. Through the real-time building of a virtual twin of the crane, the DT perpetually aligns sensor data with real-world operation behavior, enabling precise monitoring of structural health and identification of incipient fatigue damage. The envisaged system combines machine learning methods with physics-based fatigue analysis, providing a hybrid and adaptive solution to predict crack initiation and propagation in critical welded connections of the tower crane boom. With access to cloud computing and high-fidelity simulation, the DT learns dynamically according to the changing structural integrity of the crane. Through real-time feedback and adaptive learning, predictive decisions can minimize unscheduled downtime, enhance safety, and optimize equipment life. To facilitate this degree of independence, various technologies are combined, such as IoT-based sensing, knowledge graphs, and extended reality (XR) for rich human–machine interaction. In combination, these elements facilitate real-time visualization, data interoperability, and automated decision-making. Pledging progress despite issues, data standardization, model scalability, and cybersecurity issues remain.

The paper highlights the revolutionary potential of autonomous self-aware DTs in Industry 4.0 predictive maintenance. The adaptive and self-configuring nature of the proposed model opens the door towards fully autonomous maintenance systems, bridging the gap between the physical and virtual worlds for bulky industrial machinery such as tower cranes..

Keywords: *Digital twin, Predictive maintenance, Fatigue life modeling, Industry 4.0, Machine learning,.*

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PERFORMANCE OF MICRO-TEXTURED FOIL BEARINGS: A NUMERICAL STUDY OF THE MICRO-WEDGE MECHANISM

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Abstract

Surface micro-textures can significantly enhance the tribological performance of lubricated contacts. This is particularly relevant for oil-free air foil bearings, which support high-speed rotors in applications where oil contamination is prohibited, such as fuel cell air compressors. This paper presents a computational study on the effect of texture bottom profiles on the performance of textured air foil journal bearings. A theoretical model is developed, coupling the steady-state Reynolds equation for a thin viscous film with a nonlinear compliant structure model. The finite difference method is employed to solve the system, accounting for textures in both the full-film and cavitation regions. Three texture shapes are evaluated: spherical, hemispherical with a convergent arc, and hemispherical with a divergent arc. Results demonstrate that the micro-wedge mechanism generated by the texture geometry is a critical performance parameter. A convergent wedge effect significantly enhances bearing performance by improving load capacity and reducing friction, whereas a divergent wedge action degrades it. Performance gains are most pronounced at high eccentricity ratios and with high texture density. This study confirms that optimizing texture shape to promote a convergent wedge is a viable strategy for substantially improving the operational characteristics of journal bearings..

Keywords: *Air journal bearing, Reynolds equation, surface texturing, bottom profile, wedge effect..*

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IMPACT OF DAMAGE ON THE VIBRATION OF A CANTILEVER BEAM

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Abstract

This study investigates the influence of damage on the dynamic response of a cantilever beam through the analysis of Frequency Response Functions (FRFs) and natural frequencies. The FRFs were obtained using impulse excitation and single-point measurements, allowing the identification of variations with respect to crack depth. Numerical simulations were performed using Altair software to evaluate the effect of damage on the dynamic parameters of the structure. In addition, experimental tests were conducted to validate the numerical results and to illustrate the influence of crack depth on FRFs and frequency shifts. The results show that the presence of a crack leads to a decrease in natural frequencies, an impact on FRF amplitudes, and noticeable changes in their shapes. These variations reflect a local loss of stiffness and provide relevant indicators for structural health monitoring. The proposed approach thus highlights the effectiveness of frequency-based parameters for the diagnosis and monitoring of structural integrity..

Keywords: *Structural damage, Vibration, Frequency Response Functions, Natural frequencies.*

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DEVELOPMENT AND IMPLEMENTATION AN INTERFACE FRICTIONAL MODEL -APPLICAYION FOR SPHERE ELASTIC

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UMMTO

Abstract

A lot of Contact problems involve friction dissipation . The frictional load ,can produce slip or slide between a contacting surfaces .The friction phenomenon describes nonlinear relationship between the normal and tangential tractions on a contact surface. Classical friction model cannot predict the gradual progress of sliding displacement with increase tangential traction , it can be formulated as a constitutive relation in a similar form to that of the elasto-plastic constitutive equation of materials, the present paper studies sliding and slip rules of elastic frictional contact by using the formalism of multi-surface plasticity, for regularized passage from stick to sliding in contact of solids. It purpose is to present new approach for regularized constitutive model for interface contact elastic with friction, this model is implemented in finite element code ABAQUS by user subroutine Fric, it was tested in conform and no conform surface contact to simulate the traction and slip displacement . the numerical simulation results have been compared to used penalty and analytical method, and shows good agreement..

Keywords: *Slip rules; Frictional contact; subloading friction model; slip memory rules; plasticity theory; contact ABAQUS.*

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THE INFLUENCE OF SIO2 NANOPARTICLES ON ADHESION OF CUSN/SNBI MULTI-MATERIAL COATING DEPOSITED BY PM PROCESS USING SCRATCH TESTS

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Abstract

This work investigates the adhesion and mechanical behavior of copper-based multi-materials reinforced or not with SiO_2 nanoparticles, using the scratch test as the main characterization technique. A comparative study between reference materials and multi-materials highlights the predominant role of plastic deformation during the experimental analyses. The incorporation of silica nanoparticles was found to enhance the scratch resistance and hardness of the multi-materials. The aim of this study is to assess the influence of nanosilica on the mechanical and tribological properties of materials manufactured through conventional powder metallurgy. The scratch test provides valuable insights into the adhesion of the anti-friction film and enables the correlation between mechanical response and tribological performance through damage analysis, particularly delamination and plastic deformation, supported by SEM observations and interferometric profiling (VEECO)..

Keywords: *Copper; SiO2 nanoparticles; scratch test; CUSN/SNBI MULTI-MATERIAL COATING.*

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GATED RECURRENT UNITS FOR MODELLING DYNAMICAL SYSTEMS

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Abstract

Modelling dynamical systems through data is a crucial part of identifying point of failure and abnormal behaviour in real world systems as such a model is an essential tool for maintenance. however more often than not said real world system's internal workings might not be accessible or outright unknow and using classical identification approach might not be feasible all together with systems in which the underlying dynamics are directly interpretable from data. Therefore, in this study an attempt was introduced into applying a universal function approximators in modelling the dynamics of several different order systems while introducing a pseudo-continuous memory variable through Gated Recurrent Units, a cell that builds on recurrent neural networks to treat variable length sequential data while avoiding the vanishing and exploding gradient recurrent networks are known for. With the goal of improving the inaccuracies introduced by the discrete nature of the real-world data and the discrete nature of the numerical integrator used for data comparison later on. The choice of structure of our approximator is then explained alongside the simulation and training loop used, finally the results were displayed while discussing the limitation of our approach alongside a potential improvement that build upon this work..

Keywords: *Systems dynamical modelling, maintenance, pseudo-continuous memory, Gated Recurrent Units GRU, Neural networks.*

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Natural Frequencies of a Cylindrical Pipe Filled with Fluid under Different Boundary Conditions

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Abstract

This study focuses on analyzing the dynamic behavior of a cylindrical pipe filled with an incompressible fluid under laminar flow conditions. It is based on the theory of fluid-structure interaction (FSI), which examines the mutual influence between the motion of the fluid and the deformation of the pipe wall. Using Hamilton's principle, the expressions of kinetic and strain energies are derived, leading to the formulation of a set of partial differential equations in cylindrical coordinates. These equations accurately describe the coupling between the fluid and the structure by relating stresses to displacements. To solve these coupled equations, the Galerkin method is applied to the structure, while the Galerkin–Time method is used for the fluid. These numerical approaches make it possible to determine the natural frequencies of the system while satisfying various boundary conditions, such as clamped, free, or mixed ends.The results show that boundary conditions have a significant influence on the natural frequencies and vibration modes of the system. Furthermore, the presence of the fluid modifies the dynamic response of the pipe, primarily by introducing hydrodynamic damping effects that reduce certain natural frequencies. This work contributes to a deeper understanding of vibrational phenomena in coupled cylindrical systems and offers valuable insights for applications in fluid mechanics, aerospace engineering, and industrial fluid transport networks..

Keywords: *Natural Frequencies , Cylindrical pipe, fluid-structure interaction, boundary conditions.*

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PERFORMANCE COMPARISON OF CIRCULAR AND ELLIPTICAL JOURNAL BEARINGS AT DIFFERENT OPERATING TEMPERATURES

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Abstract

This study presents a numerical comparison between circular and elliptical hydrodynamic journal bearings, focusing on the influence of temperature on their tribological performance. The analysis was conducted using the finite element method applied to the Reynolds equation, considering the variation of the lubricant's dynamic viscosity (10W40 oil) corresponding to operating temperatures of 30 °C, 60 °C, and 100 °C. The objective was to evaluate how temperature-dependent viscosity affects the pressure distribution, load-carrying capacity, and minimum film thickness of both bearing geometries. The results reveal that temperature has a significant impact on bearing performance, as the decrease in viscosity with increasing temperature leads to a reduction in hydrodynamic pressure and film thickness. However, the elliptical bearing consistently demonstrates superior performance compared to the circular configuration across all temperature ranges. Its geometry promotes better load support and maintains a thicker lubricant film, thereby enhancing stability under thermal variations. These findings highlight the effectiveness of elliptical journal bearings in maintaining reliable lubrication and improved operational performance in thermally stressed environments..

Keywords: *Hydrodynamic, bearings, viscosity, temperature effect..*

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Diagnosis of Bearing Faults Using Machine Learning Techniques

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Abstract

Rolling bearings are essential components in rotating machinery, and their failure can lead to unexpected breakdowns, production losses, and costly maintenance operations. Therefore, developing accurate and efficient fault diagnosis methods is of great industrial importance to ensure system reliability and safety. In this study, a hybrid deep learning approach is proposed by combining Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks for automatic bearing fault detection and classification. The vibration envelope data are first preprocessed and reshaped into 2D matrices to be analyzed by the CNN, which extracts meaningful spatial features from the input signals. These learned features are then fed into an LSTM network to capture their temporal correlations and improve the diagnostic accuracy. The proposed CNN–LSTM architecture was trained and tested using experimental bearing vibration data. The obtained results demonstrate that the hybrid model achieves a testing accuracy of 99%, proving its robustness and effectiveness in detecting and classifying different bearing fault types under varying operating conditions..

Keywords: *Rolling bearing, Hilbert transform, envelope analysis, 1D convolutional neural network, Long Short-Term Memory..*

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ASSESSING THE IMPACT OF TRAM NOISE ON RESIDENTIAL COMFORT IN CONSTANTINE CITY

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Abstract

Noise generated by urban rail transport systems is a significant source of disturbance for residents in many countries around the world. This paper investigates the impact of tram noise on residential comfort in the city of Constantine, Algeria. The methodology consists of two parts: the first involves an analysis of noise levels measured in a strategically selected area in the city, and the second examines residents' perception of noise inside their homes through a survey conducted in the same location. The study area, situated in the City Centre, was selected based on two main criteria: the distance of built-up areas from the tram track and the population density. The results reveal significantly high noise levels, with 93.33% of respondents reporting that the noise inside their homes is very loud. The study concludes by recommending several measures to mitigate the negative impacts of tram noise on the comfort of Constantine's residents..

Keywords: *Tram, Noise, Comfort, Residents, Constantine city..*

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ACCURACY ASSESSMENT OF FINITE ELEMENT MODELS BASED ON DYNAMIC EXPERIMENTATIONS USING SHAKING TABLE.

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Abstract

The evaluation of the accuracy of the developed numerical models based on the finite element method is a crucial phase to ensure the reliability of dynamic structural predictions. In this work, experimental validation was carried out through dynamic experimentations performed on a reduced-scale steel model using the shaking table of the RISk Assessment and Management laboratory (RISAM) at the University of Tlemcen. A finite element model of this steel model is performed. The natural frequencies and mode shapes obtained experimentally are compared with those predicted by the numerical model in order to assess the consistency between these two approaches. Based on experimental tests results, the finite element model can be calibrated. First, it is important to identify potential sources of error and then adjust the model parameters, if necessary, to improve its accuracy. In this study, the comparison of results demonstrates a good agreement between the numerical and experimental approaches. This methodology contributes to enhancing the credibility of the numerical model and ensuring a reliable representation of the real dynamic behavior of structures..

Keywords: *Numerical models, shaking table, experimental results, natural frequencies, mode shapes, dynamic behavior..*

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HYBRID VIBRATION CONTROL USING PIEZOELECTRIC MATERIALS AND SHPE MEMORY ALLOYS

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Abstract

Vibration control plays a vital role in enhancing the performance and durability of engineering systems, particularly in the automotive and aerospace sectors. This research introduces a hybrid vibration control strategy that integrates piezoelectric materials with Shape Memory Alloys (SMAs) to achieve superior damping characteristics. Piezoelectric materials are known for their ability to convert mechanical deformation into electrical energy and vice versa, offering a responsive means of controlling vibrations. Meanwhile, SMAs contribute a semi-passive mechanism through their unique ability to undergo reversible shape changes when exposed to thermal or mechanical variations.

The combination of these two smart materials creates a synergistic effect: piezoelectric elements provide active or semi-active control, while SMAs generate recovery forces that oppose and dissipate unwanted vibrations. Simulation and theoretical analyses indicate that this hybrid system substantially reduces vibration amplitudes, enhances structural stability, and minimizes energy losses. Overall, the proposed approach offers an efficient and adaptable solution for next-generation vibration control in complex engineering structures..

Keywords: *Piezoelectric materials, Shape Memory Alloys (SMAs), Smart materials, Vibration control..*

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STUDY OF THE VIBRATION BEHAVIOR OF THE SPEED REDUCER AT THE LEVEL OF TURBO GENERATOR

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Abstract

This unit is a high speed steam turbine driving a 1 800 rpm (04 Poles) generator through a speed reducing gearbox. The steam turbine operates at 9 500 rpm. A severe oil whirl (over 10 mil pp at 9 200 rpm) is witnessed on the pinion bearing during shutdown. This occurs immediately following removal of load and the shaft centerline at the pinion bearing is subsequently displaced. This is probably a natural result of the pinion being designed to withstand the high radial loads in loaded operation, but not for no-load operation. Unloading of this bearing causes instability of the journal in the bearing. The orbits of the steam turbine bearings are elliptical, with their main axis vertical. This is due to the special orientation of the lobe bearings. Instead of the traditional horizontal orientation of the lobes, the steam turbine bearings are lobe bearings. With the lobes oriented vertically. This produces a lower dynamic stiffness in the vertical direction than in the horizontal, producing vertical oriented elliptical orbits. The radial bearing in this machine train on the low speed side show a constant phase roll during the transient runs. This is caused by a simulation of a keyphasor signal for the low speed side. Since the low speed side lacked a permanently installed keyphasor, a keyphasor muliiplier/ divider was used on the high speed keyphasor to produce a simulated low speed keyphasor. The proper gear tooth ratio was not used (slightly off). This produced the phase roll effect. A significant amount of glitch is also present on these channels..

Keywords: *Condition-based maintenance, Steam turbine, Speed, Bearing, Orbits, Keyphasor..*

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ANALYTICAL MODELING OF FRACTURE ENERGY WITH COHESION EFFECTS BASED ON EXPERIMENTAL INVESTIGATIONS

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Abstract

The experimental characterization is the most exact method which describes and studies the material's real behavior and its response to different mechanical solicitations otherwise conducting experimental tests for every case is often impractical. This work present an analytical model that describes the concrete fracture energy variation in function of the specimen's length, the crack initial length and the Sand fines ratio basing on experimental investigations. Three point bending tests were conducting on concrete specimens, using an MTS testing machine and according to the ASTM norms. The obtained experimental results were used to generate an analytical model based on ANOVA and experimental plan principles. The model was validated and adjusted. It has been found that the weakening of the studied specimens is majorly related to the increasing on the specimen's and crack initial lengths or by decreasing the sand fines ratio and the model shows in addition to that a clear parameter's classification, the sand fines ratio is the most influential factor and all the interactions including the sand fines ratio or the crack initial length present high effects. A high coherence between the model and the experimental values in term of fracture energy was noticed and that according to relative error that did not exceed the 28%. After adjustments, the error was highly ameliorated. The model helps in studying the concrete general behavior and offers a reliable tool contributing to the evaluation of the Fracture energy without going through experimental tests considered as costly in terms of time and price..

Keywords: *Concrete; Experimental investigation; Fracture energy; Analytical modeling; Sand fines ratio; Crack initial length.*

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COMPARISON BETWEEN ULTRASONIC AND MECHANICAL YOUNG'S MODULUS OF FSWED ALUMINUM ALLOY

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Abstract

The ultrasonic method is considered to be one of the most effective nondestructive testing methods due to its wide applicability across various solid materials, such as metals and composites. It is therefore used in different industries to ensure the integrity of components like welds. The ultrasonic waves have the advantage to be in direct relation with the mechanical behavior of the material. This is why mechanical waves are often involved in solid material testing and the evaluation of their mechanical properties.

The objective of the present work is to determine the Young's modulus in different zones of FSWed aluminum alloy using two different methods. The first one is nondestructive, is the ultrasonic method. The second method is destructive, and uses the nanoindentation technique, and inverse method of calculations.

In order to determine the ultrasonic Young's modulus, the longitudinal and transversal velocities of the wave propagation in the welded sheet are measured in pulse echo mode, with the technique of contact using a transducer of 5 MHz center frequency. Nanoindentation experiments were carried out on an Anton Paarnanohardness tester equipped with a Berkovich pyramidal indenter. The Young's modulus was calculated using the model developed by Oliver and Pharr. The results show a clear correlation between the ultrasonic measurements of Young's modulus and the mechanical method.

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Keywords: *Young's modulus, ultrasonic, nanoindentation..*

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ULTRASONIC EVALUATION OF ANISOTROPY IN BOVINE TRABECULAR BONE

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Abstract

Understanding the anisotropic nature of bone is crucial for accurately determining its structural organization and mechanical performance. Among the various techniques used to evaluate anisotropy in trabecular bone, ultrasonic wave propagation has emerged as a promising non-destructive method. In this study, an experimental approach is applied to investigate the anisotropy of bovine trabecular bone samples using ultrasonic waves. Bone specimens are prepared and subjected to ultrasonic testing in multiple spatial orientations to measure wave velocity and attenuation. From the collected data, anisotropy factors are calculated to quantify the directional dependence of wave propagation. The experimental findings enhance our understanding of how ultrasonic waves interact with trabecular bone microarchitecture, and contribute to the development of reliable methods for bone quality assessment. This work holds particular significance in the context of osteoporosis diagnosis and monitoring, where early detection of mechanical deterioration is essential. Moreover, the results offer potential applications in orthopedic implant design, where knowledge of bone anisotropy can improve fixation and load distribution. Overall, this study demonstrates the viability of ultrasonic testing as a valuable tool in the non-destructive characterization of bone mechanical properties, paving the way for further clinical and biomechanical applications..

Keywords: *trabecular bone, ultrasound, anisotropy, bone mechanics, osteoporosis*

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COMPUTATIONAL CRACK LOCALIZATION IN BEAMS STRUCTURES USING MODAL ANALYSIS AND FINITE ELEMENT METHOD

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Abstract

This study introduces a numerical computational framework for vibration-based crack detection in beam structures using modal analysis. A finite element model is employed, that accurately captures local stiffness variations through refined meshing and fracture mechanics principles. The method analyzes shifts in natural frequencies and mode shapes, with special attention to higher vibration modes due to their heightened sensitivity to local damage. The proposed algorithm effectively localizes cracks, even small ones which representing 25% of the beam height, and under various boundary conditions such as fixed-fixed, cantilever, and simply-supported. Combining modal information via weighted indices enhances detection accuracy and minimizes false positives compared to single-mode methods. The results demonstrate the method's robustness and potential as a non-destructive, real-time structural health monitoring tool, with promising applications to more complex structures and broader engineering contexts..

Keywords: *Crack Detection, Vibration Analysis, Modal shape, Finite Element Method, mesh refinement.*

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BORIDING TREATMENT AND SLURRY VELOCITY IMPACT ON SLURRY EROSION RESISTANCE OF X52 STEEL

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Abstract

Pipeline transportation of gas and oil faces a significant problem with slurry erosion. This study examined the effect of velocity on the resistance to slurry erosion before and after boriding API X52 steel. Two slurry velocities of 4 and 6 m/s, and slurry concentration of 800 g/l were utilized. A powder mixture of 5% B4C, 5% NaBF4, and 90% SiC was used to perform boriding at 900 °C for 4 h. It was found that the erosion rate or weight loss increases as the slurry velocity increases. Compared to the unboronized X52 steel, the resultats showed that the surface hardness and slurry erosion resistance were significantly improved by the formation of boride layers..

Keywords: *Slurry erosion, X52 steel, Boriding, slurry velocity.*

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ELASTIC FIELDS IN A HALF-SPACE WITH AN EMBEDDED ANNULAR CRACK UNDER RADIAL SHEAR LOADING

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Abstract

Annular cracks represent an idealized form of flattened toroidal cracks commonly found at material interfaces or within homogeneous solids. They also encompass penny-shaped and external circular cracks as special cases. This study analytically investigates the three-dimensional elastic fields in a semi-infinite medium weakened by an annular crack subjected to a prescribed radial shear stress. The crack lies at a finite depth below the free surface, resulting in a three-part mixed boundary-value problem that cannot be simplified by geometric symmetry.

Using Boussinesq's displacement potentials and the Hankel transform technique, the governing equations are reduced to a coupled system of triple integral equations involving zeroth- and first-order Bessel functions. By applying some integral identities and the Gegenbauer addition formula, this system is further reduced to an infinite set of linear algebraic equations. Closed-form expressions for displacements and stresses are then obtained in terms of the solution of this algebraic system. Numerical evaluations are performed to analyze the influence of the crack radii and depth on the elastic fields. The accuracy of the analytical solution is confirmed through comparisons with finite-element simulations.

This study provides insight into the elastic response and deformation mechanisms of solids containing embedded annular cracks subjected to radial shear loading. The obtained solution serves as a valuable analytical benchmark for validating numerical models and assessing defect-induced elastic behavior in engineering materials. It also offers a foundation for the subsequent evaluation of stress intensity factors, which play an essential role in predicting crack propagation and material failure in fracture mechanics.

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Keywords: *Elastic deformation; Semi-infinite medium; Annular crack; Mixed boundary-value problem; Triple integral equations; elastic field.*

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TORSIONAL BEHAVIOR OF AN ELASTIC LAYER WITH AN EXTERNAL CRACK UNDER COAXIAL RIGID DISC LOADING

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Abstract

Cracks and structural discontinuities critically affect the mechanical response of materials, often leading to severe degradation or failure under torsional loads. This work presents an analytical investigation of the axisymmetric torsion of a homogeneous elastic layer containing an external crack, subjected to dual coaxial rigid discs rotating in the same direction. The configuration induces complex shear deformation, providing valuable insight into the influence of crack geometry on the elastic fields. The problem is formulated as a mixed boundary value problem, then transformed via the Hankel integral transform into a system of dual integral equations. By applying Abel's transformation, the system is reduced to a pair of Fredholm integral equations of the second kind, which are solved using a series expansion in Jacobi polynomials. The analytical procedure converts the problem into an infinite set of algebraic equations, efficiently handled through truncation methods. Closed-form expressions for displacement and stress distributions are obtained, and the proposed analytical results show excellent agreement with numerical simulations. Contour plots further illustrate the influence of the crack on the elastic fields. The study establishes a rigorous analytical framework for evaluating crack-induced stress concentrations under torsional loading, offering a reliable benchmark for validating numerical models and guiding material design and structural integrity analysis..

Keywords: *Axisymmetric torsion; Elastic layer; External crack; Mixed boundary-value problem; Dual integral equations; Fredholm integral equations.*

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RESIDUAL STRESS RESPONSE OF THIN ALUMINIUM SHEETS TO SINGLE-SPOT LASER SHOCK PEENING.

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Abstract

The objective of this study is to present a numerical simulation that calculates the mechanical states of both residual stresses and deformations induced by Laser Shock Peening (LSP). Given the high cost of full-scale testing for advanced techniques like LSP, simulations are crucial. This research specifically investigates and compares the residual stress response across four distinct, high-performance thin aluminum sheets subjected to a single, focused LSP strike. The materials under investigation are: AA2024-T351, AA2139-T3, AA7050-T76, and AA7075-T6.

The simulation is performed using Abaqus with the explicit-implicit method, where pulse parameters are optimized for a stable solution. LSP generates high-pressure pulses that create internal stress waves, leading to localized plastic deformation and the development of beneficial compressive residual stresses beneath the strike zone. These localized stresses significantly enhance surface properties such as fatigue, wear, and corrosion resistance. The Finite Element model replicates the deformation and the highly concentrated residual stress development in each alloy, utilizing the Johnson–Cook (J-C) model to accurately capture the dynamic material behavior under shock loading. This provides a comparative analysis of how different high-performance aluminum alloys react to the intense, localized energy of a single LSP treatment..

Keywords: *LSP; Residual stress; High-Performance Aluminum Alloys; Finite element analysis; Johnson–Cook model..*

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THE IMPACT OF DAMAGE MECHANICS ON THE NON-LINEAR MECHANICAL BEHAVIOUR OF REINFORCED CONCRETE STRUCTURES

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Abstract

A better understanding of the behavior of reinforced concrete requires nonlinear analysis, due to the nonlinearity of the matrix and reinforcement (concrete and steel). By modeling the behavior of steel-concrete material under static and monotonic loading using damage mechanics, we were able to deduce the evolution of its mechanical characteristics in the nonlinear domain, based on existing physical and mechanical phenomena. This approach led to the proposal of an initial model for predicting the nonlinear behavior of concrete up to failure. This idea was then developed and extended to reinforced concrete structures. The proposed model considers the mechanical characteristics of homogenized reinforced concrete in the nonlinear domain as variables. Two independent damage variables are then deduced and applied to the material: a deviatoric variable and a volumetric variable. The first affects the Young's modulus of homogenized reinforced concrete, while the second affects the Poisson's ratio. The model then takes into account the confinement of the concrete, the shear, the percentage of steel, and the geometry of the reinforced concrete element (beam with or without transverse reinforcement, three- or four-point beam, or wall). This contribution aims to demonstrate the impact of applying damage mechanics to track the nonlinear behavior of reinforced concrete structures, and shows that the introduction of damage variables with the ductility factor, which reflects the contribution of the concrete stretched between two cracks, has a considerable influence on the model results. This makes it possible to track the actual behavior of reinforced concrete elements up to failure..

Keywords: *Homogenization, Reinforced-Concrete, Nonlinear, Damage-Mechanics, Ductility.*

DEVELOPMENT OF AN INTERFACE FOR EXPLOITING DATA (10 HZ – 10 MIN) FROM STRAIN GAUGES INSTALLED IN SITU ON A WIND TURBINE.

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Abstract

As wind turbines approach the end of their design life, assessing structural fatigue based on real operational conditions is increasingly important. This project presents a MATLAB-based interface designed to process and exploit in situ strain gauge data acquired on a wind turbine at a sampling rate of 10 Hz. The tool facilitates both the visualization and analysis of strain and reconstructed stress profiles over defined time windows (e.g., 10 minutes), helping engineers better interpret field measurements. The interface provides a complete workflow: importing and synchronizing raw data, resampling for computational efficiency, visualizing deformation trends, and performing fatigue analysis through cycle counting using MATLAB's built-in Rainflow function. Fatigue damage is then estimated using Miner's rule. This modular tool supports effective data exploitation for structural health monitoring, maintenance planning, and life extension strategies in wind energy applications. The workflow is broadly aligned with international standards such as IEC 61400-1 and IEC 61400-13, ensuring consistency with accepted practices in wind turbine design and load monitoring.

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Keywords: *Wind turbine, strain gauge data, fatigue analysis, Rainflow counting, structural health monitoring, MATLAB interface.*

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INTEGRATED EXPERIMENTAL–NUMERICAL INVESTIGATION OF DD14 AND DC04 STEEL SHEET FORMABILITY BASED ON TENSILE TEST CHARACTERIZATION

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Abstract

In sheet metal forming workshops, defects such as necking and fracture were observed more frequently in hot-rolled DD14 steel compared to cold-rolled DC04 steel. This study focuses on a comparative formability assessment of these two grades through an integrated experimental–numerical approach. Uniaxial tensile tests were conducted on specimens cut at 0°, 45°, and 90° to the rolling direction in order to evaluate the anisotropy and mechanical behavior of both steels. The plastic response was modeled using the Hill48 yield criterion, while finite element simulations of the tensile tests were carried out in Abaqus/CAE to validate the experimental data. A detailed comparison of true stress–strain curves and key mechanical properties; yield strength, ultimate tensile strength, and anisotropy coefficients was performed. The good agreement between experimental and numerical results confirms the reliability of the proposed modeling strategy. Based on these findings, the formability of DD14 and DC04 steels was critically assessed, highlighting the superior performance of DC04 in deep drawing applications..

Keywords: *Keywords: [Steel Sheets, Formability, Tensile Test, Characterization, Numerical Simulation]*.

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Contribution to the Assessment of the Ductile Behavior of HDPE Using the Essential Work of Fracture Method

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Abstract

This study experimentally investigates the fracture behavior of high-density polyethylene (HDPE) pipes using fracture mechanics principles. Tests were performed on Double Edge Notched Tension (DENT) specimens extracted from HDPE pipes used for water distribution. To evaluate the monotonic mechanical response, two strain rates (0.1 and 0.01 s^{-1}) were applied. The material exhibited the characteristic behavior of semicrystalline polymers. The resulting stress–strain curves revealed pronounced ligament plasticization followed by ductile fracture. Under plane stress conditions, the fracture toughness was assessed by analyzing two key parameters: the essential work of fracture (EWF) and the non-essential work of fracture (Wp). This approach provides a comprehensive understanding of the material's resistance to crack initiation and propagation..

Keywords: *High density polyethylene; Triaxiality; Fracture; J integral; EWF method..*

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COUPLED THERMO-MECHANICAL EFFECTS ON CRACK PROPAGATION IN POLYMER MATRIX COMPOSITES THROUGH AN INTEGRATED FINITE ELEMENT AND ANALYTICAL INVESTIGATION

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Abstract

This study investigates the coupled thermo-mechanical effects on crack propagation in polymer matrix composites, which are known for their high sensitivity to early structural failure caused by crack initiation and growth during service. An integrated numerical–analytical framework was developed, combining the Finite Element Method (FEM) with analytical modeling to accurately evaluate the influence of thermal stresses on crack behavior. Simulations performed on a composite plate containing a crack under thermal gradients of 80°C, 90°C, 100°C, and 120°C revealed that the Crack Tip Opening Displacement (CTOD) increases by approximately 5% to 15%, indicating the strong influence of temperature on matrix flexibility and fiber response. Conversely, the maximum stress near the crack tip was observed to decrease by about 3.1%, 2.5%, and 2.2% compared to reference values, reflecting a local stress redistribution caused by the coupled thermo-mechanical interaction. These findings highlight the high sensitivity of polymer composites to temperature variations and confirm the accuracy of the proposed methodology as a predictive tool for detecting and evaluating early crack propagation. The study provides a robust scientific foundation for developing early failure prediction and repair strategies, enhancing the understanding of fracture mechanisms in advanced composite materials and expanding their potential use in modern engineering structures..

Keywords: *Key words: Thermo-mechanical, coupling Crack propagation, Polymer matrix composites, Finite Element Method (FEM).*

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INVESTIGATION FOR IMPACT OF GREEN CORROSION INHIBITOR ON HYDROCARBON PIPES

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Abstract

Metal corrosion is an issue for which scientists are continuously searching for a drastic remedy. To lessen the corrosion phenomena, petroleum firms employ industrial inhibitors; nevertheless, these inhibitors are costly, have an adverse economic impact on nations, and are poisonous, which makes them bad for the environment overall. Since major countries are searching for a host, green inhibitors which are harvested from all sections of plants using various techniques have been exploited as non-toxic, renewable, and ecologically friendly inhibitors. We use the Calotropis Procera extract plant. We conducted a simple bending test on mild steel in 1 M of sulfuric acid, with a 5% concentration of the plant extract. we observe the deflection changes by the force applied to the samples, we find that ($f\ max$ 5%) and ($E\ max$ 5%) at 5% of the CP extract has become converging in value with the sample we took as a reference ($f\ Re$), ($E\ Re$). Where: $f\ max$ 5% = 0.56 mm; $E\ max$ 5% = 1960000 MPa; and $f\ Re$ = 0.52 mm; $E\ Re$ = 2110769.231 MPa. We found that the samples were able to restore some of their mechanical properties when a plant extract from Calotropis procera was added..

Keywords: *Corrosion, Green inhibitors, bending test..*

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FEM analyses of Crack growth behavior of the 17CrNi steel within Very High Cycle Fatigue range

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Abstract

In order to simulate the crack growth, linear elastic-plastic theory have been ap-plied to the fatigue field, assuming that the crack growth rate da/dN is in term of stress intensity factor range, in which r is the crack length and N is the number of cycles. Through Extended Finite Element Method (XFEM), the crack propaga-tion process is numerically simulated in the Very High Cycle Fatigue area. The model was established using 17CrNi cylinder specimen with circular-crack placed in the center. The simulation of crack propagation path has been obtained using the XFEM. The stress gradient and the stress intensity factor were deter-mined along the crack path. The numerical results were in good agreement with experimental results..

Keywords: *Crack growth; numerical simulation; Very High Cycle Fatigue; carburized 17CrNi high-strength steel; linear elastic-plastic theory; XFEM..*

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FINITE ELEMENT ANALYSIS OF GIMBAL STRUCTURES WITH AND WITHOUT INTEGRATED PROPELLANT FEED LINES FOR SMALL LRE

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Abstract

Gimbal structures are key component in the launch vehicle; gimbal structures pose a critical challenge regarding the inclusion or exclusion of propellant feed lines. The decision to incorporate or omit propellant feed lines within the gimbal structure is a multifaceted problem that demands careful consideration. The purpose of the designed mechanism is to obtain a gimble for a small rocket engine, enabling precise control over both pitch and yaw. In this paper, two distinct designs were proposed for the gimbal structure for a small rocket engine: an exclusive and an inclusive propellant feed lines design for the gimbal structure. The displacements and the stresses are calculated for the specified loads and boundary conditions. The exclusive method demonstrated the lowest equivalent stress, indicating superior stiffness compared to the alternative methods. The analysis and simulation affirm that the exclusive method is an effective way to improve the strength of the gimbal and give it a high strength-to-weight ratio..

Keywords: *Keywords: Gimbal, Propellant feed lines, Cross joint, Liquid rocket engines (LREs)..*

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Finite Element Analysis of Critical Stress in Corroded Pipe Tees Subjected to Internal Pressure

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Abstract

This study presents a finite element analysis of the critical stress behavior in corroded pipe tees subjected to internal pressure. The investigation focuses on the structural response of steel tees containing rectangular corrosion defects, particularly in the crotch region—a known site for stress concentration and crack initiation. Through detailed simulations, the study evaluates how defect geometry and pipe tee design parameters influence stress distribution and potential failure. A series of parametric analyses were conducted to assess the effects of internal pressure, defect dimensions, crotch radius, and wall thickness. The results demonstrate that corrosion defects significantly increase localized stress levels, especially in geometrically complex regions. Enhancing crotch thickness and radius effectively reduces peak stress magnitudes, while the interaction between defect depth and spacing plays a decisive role in crack propagation. These findings underscore the importance of precise defect characterization and optimized design strategies to improve the reliability and extend the service life of pressure-bearing pipe tee connections..

Keywords: *Pipe tee, Crotch region, Residual stress, Rectangular corrosion defect, Defect size, Finite Element Analysis (FEA), Corrosion defect..*

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Improved Artificial Neural Network for Void Prediction in Friction Stir Welding

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Abstract

Accurate prediction of void formation in Friction Stir Welding (FSW) is essential for ensuring weld quality, but conventional modeling approaches requiring extensive datasets often prove impractical due to experimental constraints. This challenge intensifies in machine learning applications, where model accuracy typically demands large datasets proportional to input parameters to prevent overfitting.

This study introduces an improved Artificial Neural Network (ANN) model achieving high accuracy in void formation prediction using exceptionally limited data. The model utilizes only 70 training samples (0.65%) and 30 testing samples (0.28%) from 108 experimental cases while handling 11 input parameters. The key innovation integrates meta-heuristic algorithms—Runge Kutta Optimizer (RUN) and Artificial Rabbits Optimization (ARO)—with Deep Neural Networks (DNNs) to overcome local optima convergence issues inherent in traditional training methods.

The approach employs strategic data selection methodology, carefully sampling training points across critical parameter ranges, particularly welding and rotation speeds fundamental to void formation. This ensures comprehensive problem space coverage despite dataset limitations. Results demonstrate the RUN-optimized DNN achieved 100% classification accuracy, significantly surpassing existing benchmarks including XGBoost (90%) and Bayesian NN (83.33%), while exhibiting exceptional generalization on validation and testing datasets. Beyond FSW void prediction, this study provides valuable insights into effective modeling strategies for material processes with limited experimental data. By examining relationships between algorithm selection, network architecture, and data sampling strategies, this work advances reliable predictive tools for welding defect analysis and offers a transferable framework for data-constrained engineering applications in binary classification tasks..

Keywords: *ANN, Model Optimization, Meta-Heuristic Algorithms, Data Selection Technique, FSW, Binary Classification.*

NUMERICAL ANALYSIS OF PIPELINE PERFORMANCE UNDER HIGH INTERNAL PRESSURE: CASE OF DEFECT-DEFECT INTERACTIONS

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Abstract

The presence of defects that act as stress concentrators, such as notches, cracks, corroded areas, or scratches, can appear in pipelines used for transporting hydrocarbons under high pressure. These defects cause local stress concentrations, which may lead to crack initiation and propagation, and eventually to sudden failure or even pipeline bursting. Such incidents can result in severe environmental and human disasters. To make this type of transport more efficient and meet the growing demand for hydrocarbons in emerging countries, it is necessary to increase the flow rate, and therefore the internal pressure. However, these high pressures can trigger the initiation of cracks originating from such defects. This study, based on the finite element method (FEM), aims to predict the reliability and performance of pipelines operating under high internal pressures. The behavior of the material was analyzed in terms of variations in the Stress Intensity Factor (SIF) for modes I and II. Several parameters were investigated, including crack size, internal pressure, crack interaction, and defect–defect interaction acting as stress sources. The results clearly show that bursting, characterized by a sudden crack propagation, is highly probable when the internal pressure reaches a critical threshold. This behavior is more pronounced for long cracks. The risk of pipeline bursting becomes significantly higher when two stress-concentrating defects are located very close to each other. The study also shows that very short cracks, initially stable, become highly unstable when they are initiated near another crack. Furthermore, two short cracks located close to each other are considerably more unstable than a single long crack. Finally, the study highlights the existence of a critical inter-defect distance below which the interaction effect becomes dominant. This phenomenon leads to a rapid increase in the Stress Intensity Factor, which is a key indicator of pipeline bursting..

Keywords: *Pipeline, Pressure, Interaction, Crack, Stress Intensity Factor..*

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NUMERICAL PREDICTION OF PIPELINE DAMAGE

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Abstract

The development of pipeline networks is of crucial importance to ensure the safe, continuous, and efficient transport of liquids and gases, whether for water supply, hydrocarbon transport, or natural gas distribution. These infrastructures play a key role in industrial and economic development, as they enable the circulation of essential resources across multiple sectors. However, over time, pipelines may experience various forms of mechanical or physical degradation, such as fatigue cracks caused by corrosion, particularly stress corrosion phenomena. These defects, sometimes invisible to the naked eye, can weaken the structure and significantly reduce the mechanical strength of the pipeline. Such deterioration increases the risk of leaks, ruptures, or explosions, leading to potentially severe environmental, public health, and safety consequences. Therefore, the design, manufacturing, and maintenance of pipeline networks must comply with strict quality and safety standards. Regular inspection, the use of suitable materials, and the implementation of modern monitoring techniques are essential to prevent failures and extend the service life of these infrastructures. This study fits within this context and aims to analyze the mechanical behavior of cracked pipelines subjected to high internal pressures, with the objective of optimizing hydrocarbon transport efficiency and meeting the growing global demand for oil and gas..

Keywords: *Pressure, external loading, pipeline, crack, burst..*

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DIAGNOSIS OF A LEAKY PIPELINE CARRYING MULTIPHASE FLOW UNDER PLUG FLOW CONDITIONS

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Abstract

Multiphase flows play a vital role in the oil and gas sector, as many petroleum companies simultaneously produce and transport both gas and oil. Unfortunately, pipeline leaks often arise due to issues like corrosion, aging, and metal deterioration. When such incidents occur, the energy sector faces not only financial losses but also significant environmental and safety concerns. Hence, creating an effective tool for quick detection of leaks in pipelines is essential. In this study, we conducted numerical simulations of a leaky pipeline transporting multiphase flow using Ansys-Fluent, specifically under plug flow conditions. The numerical results were then compared and validated with experimental data gathered from a dedicated setup. Following validation, we utilized analysis techniques including Probability Density Function (PDF), Wavelet Transform (WT), and Empirical Mode Decomposition (EMD) on the resulting time series signals. Additionally, we explored various machine learning models such as Random Forest (RF), Support Vector Machine (SVM), and k-Nearest Neighbors (k-NN) to enhance our analysis. Notably, the Empirical Mode Decomposition method showed superior performance in identifying leaks effectively..

Keywords: *Turbulent flow; Multiphase flow; Leaky pipeline; Time series; Computational fluid dynamics, Machine learning.*

A Kinetics-Informed Machine Learning Approach for Accurate Prediction of Biohydrogen Yield via Dark Fermentation

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Abstract

The integration of mechanistic knowledge into data-driven models represents a promising strategy for improving the predictive accuracy and interpretability of machine learning (ML) frameworks in bioenergy research. In this study, we propose a kinetics-informed ML approach for predicting biohydrogen yield during dark fermentation of organic wastes. Kinetic parameters derived from the Modified Gompertz model were incorporated as input descriptors to capture substrate-specific behavior, alongside key operational variables such as temperature, pH, hydraulic retention time, and substrate concentration. The inclusion of these kinetic features significantly enhanced model performance and generalization ability, as validated through a Bayesian Optimization-Artificial Neural Network (BO–ANN) architecture. The optimized model achieved a high predictive accuracy (R^2 = 0.998, RMSE = 0.0117, MAE = 0.0062) and provided interpretable insights into feature relevance using SHAP analysis. The results demonstrate that integrating kinetic parameters into ML frameworks offers a biologically grounded and scalable tool for understanding substrate influence and optimizing biohydrogen production systems..

Keywords: *Biohydrogen Production; Dark Fermentation; Kinetic Modeling; Machine Learning; Artificial Neural Network; Bayesian Optimization..*

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South-West Algerian Renewable Energy Potentials: Experimental Investgation Of Geothermal And Wind Energy Techniques Integrated as Structural And Building Devices

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Abstract

Renewable energy is becomming one of the biggest research fields. Wind, solar and geothermal are types of renewable energy could be used easly with high efficiency. Geothermal energy has various applications, including penetration and heating systems. In 2024, global geothermal power generation capacity reached 14 GW, representing a 5.3% increase from the year 2023. To investigate national geothermal potential, an exepimental study was conducted in Algeria south west region. An earth to air heat exchanger EAHE made of PVC pipes were buried at 2 meters depth to ameliorate outside air temperature. Obtained results showed that outside air temperature increased by 11 °C with zero energy consumption and ameliorate also relative humidity at the device outlet by at least15%. Obtained results could be easily integrated in buildings to reduce a significante amount of consummed energy..

Keywords: *renewable energy, geothermal, heat capacity, Algeria, earth to air heat exchanger, EAHE.*

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CHARACTERIZATION OF DENSE AND POROUS OF TiO2 THIN FILM FOR PHOTOVOLTAIC APPLICATION

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Abstract

Hybrid solar cells based TiO2 nanoporous thin films have attracted recently much more attention due to their feasibility as low-cost solar energy conversion devices. In this study, we report a solid state dye-sensitized solar cell (SSDSC) with architecture consists of a dense TiO2 thin film as a blocking layer of 150um in thickness, was deposited on the fluorine-doped tin oxide (FTO) using spray pyrolysis technique. The TiO2 porous thin films of 2um in thickness was deposited by spin coating technique infiltrated by the organic hole conductor 2,2',7,7'-tetrakis(N,N-dip-methoxypheny-amine)-9,9'-spirobifluorene (Spiro-MeOTAD) using a organic dye (D102) as the sensitizer. The SSDSCs give short circuit photocurrent density (Jsc) of 9.65 mA.cm-2, open circuit voltage (Voc) of 0.85V, and fill factor (FF) of 0.47, corresponding to the photoelectric conversion efficiency of 3.81% at AM 1.5 illuminations (100mWcm-2).

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Keywords: *porous thin film, TiO2 dense, spiro-Ometad, sDSSC.*

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OPTICAL AND ELECTRICAL PROPERTIES OF TIO2 NANOSTRUCTURED THIN FILM USED AS ANODE IN DYE SOLAR CELLS

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Abstract

Dye-Sensitized Solar Cells (ssDSSC) based on nanostructured TiO2 represent a promising alternative relative to silicon-based photovoltaic devices. The main objective of this work is to determine the optical and electrical properties of a TiO2-based photo-anode sensitized with a D102 dye, synthesized using the spin-coating technique. The optical properties of nanostructured TiO2 determined by the spectrophotometer UV-Visible technique through the absorption curves showed a clear contribution of the dye in the visible range relative to the non-sensitized electrode. The degree of structural disorder and the electronic transitions defined by the Urbach energy were also elucidated. The result obtained shows that D102 has significantly reduced the disorder in the TiO2 crystal structure.The permittivity of nanostructured TiO2 sensitized to the D102 dye was also determined in the visible range by the Snawpoel method. The result obtained shows a permittivity of the order of 1.9, slightly different from that of the dense TiO2 layer, which is 2.5.

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Keywords: *ssDSSC, Porous TiO2, Gap, Urbach energy, refraction index.*

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A NOVEL APPROACH TO UNDERSTANDING THE EFFICACY OF BIO-INHIBITORS IN HIGH-TEMPERATURE ENVIRONMENTS

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Abstract

Enhancing the thermal resilience of green corrosion inhibitors is essential for their application in high-temperature industrial processes, particularly in the oil and gas sector. Recent studies indicate that their thermal stability often deteriorates at elevated temperatures. To address this challenge, we propose three primary strategies. First, combining two bio-inhibitors frequently produces synergistic effects that enhance adsorption strength, film stability, and, consequently, inhibition efficiency—especially under high-temperature conditions. Second, formulating green inhibitors with a minimal amount of synthetic inhibitors leverages synergistic interactions to improve stability and surface coverage at elevated temperatures. Third, incorporating nanomaterial (nanoparticles) as carriers or additives significantly enhances adsorption and barrier properties, resulting in a more durable protective film on metal surfaces. These hybrid approaches mitigate thermal degradation, extend the effective range of eco-friendly inhibitors, and facilitate their industrial adoption..

Keywords: *Bio-inhibitors, high tempretarure, synergy, thermal efficiency.*

ENERGY STUDY OF A PHOTOVOLTAIC/DIESEL HYBRID SYSTEM

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Abstract

This work constitutes a contribution to the study of the conversion systems of power electric hybrids associated with a system with storage for a site except network. The test bench retained exploits the behavior of a unit controls made up of several sources of production of electricity and makes it possible to give its characterization. We give an analytical state of the art of the components of the hybrid system which enabled us to put forward the properties of the conversion systems of energy renewable through their modeling, their operation and their impact.
Mathematical models were proposed and exploited to study the various components of the pilot system. Tests of characterization on the elements of the chains of solar conversion are given by Matlab and HOMER through the operation of the pilot device. In the same way, the confrontation of the theoretical and experimental results especially made it possible to obtain the validation of work. Thus, from resulted significant are obtained in connection with management, the exploitation and the maintenance of the system, according to these parameters of operation in tension, while running, in power and output.
Then, in the study of possible architectures of the various configurations techniques and economics for a management optimized in the center of which are the system of storage. Lastly, the study is applied to a real site of Algiers.
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Keywords: *Photovoltaic; Hybrid system; Homer; Matlab; Solar conversion.*

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HYBRID MODELING APPROACH FOR PREDICTING PHOTOVOLTAIC MODULE PERFORMANCE UNDER REAL CLIMATIC CONDITIONS

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Abstract

This study presents the modeling and performance analysis of photovoltaic module using real climatic data. The objective is to evaluate the accuracy of both the standard modeling approach and multiple linear regression in predicting the electrical behavior of a solar panel. The first approach is based on the single-diode equivalent circuit model, implemented in MATLAB, which provides the current–voltage (I–V) and power–voltage (P–V) characteristics of the module. Simulation results show that temperature and solar irradiance significantly affect the maximum current and output power. The second approach applies a multiple linear regression model to establish an empirical relationship between the output current and climatic variables such as temperature, sunshine duration, and global solar radiation. Model parameters are estimated using the least squares method, and the fitting quality is assessed through the coefficient of determination (R^2).The results demonstrate a strong correlation between the current predicted by the regression model and that obtained from the standard simulation, with a maximum error below 2.25%. This combined approach, integrating physical and statistical modeling, provides a reliable tool for predicting photovoltaic performance and forms a solid basis for the future integration of artificial intelligence techniques in the optimization of solar energy systems..

Keywords: *Photovoltaic modeling, MATLAB, multiple linear regression, energy efficiency, solar irradiance..*

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General model for inclined hourly solar radiation estimation in two Algerian sites with different climates

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Abstract

Although global solar radiation data on an inclined plane is very important for photovoltaic or bioclimatic applications, it cannot be available on a full-time compared to radiation measured on a horizontal one because of the additional costs of the pyranometers to be used. Also, the most exploited conventional methods (statistics, correlations) for conversion to an inclined plane are not always efficient. So, in this work we tested the exploiting limits of automatic learning based techniques (Artificial Neural Networks ANN and Support Vector Machine SVM) by choosing two sites with two different climates (humid and arid) for the estimation of hourly tilted global solar radiation from the horizontal radiation and the temperature in addition to other calculated parameters. The investigations carried out in this work to improve prediction were firstly the study of the impact of variation in the sample sizes used during training, secondly the study of the influence of temperature in the construction of site-specific estimation models. Finally, the estimation of the inclined hourly solar component in both sites from a single general model..

Keywords: *Estimation, inclined hourly global solar radiation, Support Vector Machine, Artificial Neural Networks, arid, humid climate*

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USE OF THE BASEMENT CELLARS FOR HEATING AND COOLING OF PREMISES IN SOUTHWEST ALGERIA

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Abstract

In Algeria, the building sector represents 30% of the country's final energy consumption. The integration of passive or semi-passive cooling/heating systems in construction is now essential for reducing energy consumption while improving thermal comfort. Among the systems used is the air-ground exchanger. Basement cellar is underground space using for preserving food materials. We presented a mathematical modeling based on the K-ε turbulence model of a basement cellar for heating and cooling premises in south western Algeria where the climate is arid. An obstacle has been introduced in the basement cellar to improve heat exchange. to this end we changed the position and the height of the obstacle .We calculated the temperature at the exit of the basement cellar using a numerical simulation. The results obtained were validated with previous studies. The parameters: (1) the Reynolds number and (2) local Nusselt were studied. An optimal solution of the temperature according to an obstacle inserted in the cellar has been chosen..

Keywords: *ground air exchanger — turbulence model K ε- forced convection.*

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ELABORATION AND PERFORMANCE OF ALKALI-ACTIVATED MORTARS FROM IRON-RICH SLAG: TOWARD LOW-CARBON SOLUTIONS FOR THE PAVING AND PREFABRICATION INDUSTRIES

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Abstract

The increasing need for sustainable and low-carbon materials has encouraged the valorization of industrial by-products as alternative binders within a circular economy framework. This study investigates the elaboration and long-term performance of eco-efficient alkali-activated mortars produced from air-cooled grey cast iron slag derived from metallurgical waste. The effects of sodium hydroxide concentration (6, 8, and 10 M) and the sodium silicate-to-sodium hydroxide ratio (SS/SH = 2 and 2.5) on the solidification process and mechanical strength evolution were analyzed. Mortar specimens were cured at 65 °C in a dry environment, and their compressive and flexural strengths were assessed at 7, 28, 90, and 528 days. The results showed a progressive increase in strength with curing age, achieving up to 43.5 MPa in compression and 8.6 MPa in flexure after 528 days. The optimum mechanical behavior was obtained with [NaOH] = 8M and SS/SH = 2, promoting the formation of a compact gel (N–A–(Fe)–S–H) that ensured continuous strength development. These findings highlight the potential of iron-rich slag as a sustainable precursor for alkali-activated mortars, offering promising perspectives for use in paving elements and prefabricated products, thereby contributing to waste valorization and the development of low-carbon eco-materials..

Keywords: *alkali activated materials, air-cooled grey cast iron slag, NaOH concentration, SS/SH, low carbon cement, waste valorisation, circles economy..*

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RHEOLOGICAL BEHAVIOR OF PHPA DRAG REDUCER DILUTE POLYMER SOLUTIONS: IMPACT OF CONCENTRATION, SALINITY AND TEMPERATURE

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Abstract

Rheological characteristics of dilute aqueous solutions of partially hydrolysed polyacrylamide PHPA polymer were investigated using a rotational rheometer model Anton Paar MCR 302e.The polymer concentrations were varied between 4000 ppm and 8000 ppm at a temperature range between 293 K and 333 K. Shear rate ranged between 10 S-l and 500 S-1. The results obtained show that these polymer solutions drag reducter exhibits shear-thinning behavior where viscosity is inversely proportional to temperature. Different models were used to describe the rheological behavior of the PHPA dilute solutions. The famous power law formulated by Ostwald and Waels describes this phenomenon. Salinity were found to have a strong influence on the rheology of PHPA solutions. The models developed had an excellent fit and would be useful for manufacture and applications.

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Keywords: *polymer, rheometer, viscosity, shear rate, temperature, shear-thinning, drag reducter reducer, concentration, temperature, Salinity.*

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Numerical Investigation of a Lean Premixed Low Swirl Burner: effects of Parameter Variation and hydrogen addition

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Abstract

Low-swirl burner (LSB) technology offers very interesting results in reducing pollutant emissions. These emissions can be minimized through combustion techniques; particularly lean combustion combined with flame stabilization adaptations. In this work, a numerical simulation was performed using Ansys Fluent to study a turbulent, swirling lean premixed methane-air flame in a non-confined configuration. The main objective of this study is to examine the effects of varying parameters such as the equivalence ratio, swirl number, and hydrogen addition, with the aim of improving combustion efficiency and reducing pollutant emissions. The results show that a decrease in the equivalence ratio leads to a significant drop in temperature, which in turn substantially reduces NO_x emissions. Moreover, CO emissions are directly influenced by the mixture's equivalence ratio. The swirl number plays a dominant role in determining the flame mode; increasing it lowers the temperature and shifts the flame fronts closer to the burner tip. Hydrogen, which has a much higher combustion speed than methane, offers several advantages when blended with methane. This approach presents an effective solution to flame stability issues and enables ultra-lean premixed combustion.

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Keywords: *LSB , NOx emissions, hydrogen addition to methane, lean premixed flame.*

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EVALUATING BINARY CYCLE SYSTEM for GEOTHERMAL ENERGY HARNESSING in ALGERIA

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Abstract

The transition to renewable energy is essential, representing a strategic opportunity to ensure sustainable economic growth that is respectful of the environment. In this context, renewable energies, including geothermal energy, are gaining increasing interest. The main objective of this research is to examine and determine the most effective method for utilizing geothermal resources in Algeria, based on the specific characteristics of the reservoirs. In this work, we consider the exploitation of Algerian geothermal resources for electricity generation through binary cycle power plants. The configurations considered in this work include the simple Organic Rankine Cycle, the Organic Rankine Cycle with recovery, and the Organic Rankine Cycle with superheating. The performance of the different cycles is evaluated, specifically the power produced, energy efficiency, and exergy efficiency. To assess these performances, energy and exergy models are developed. The results obtained revealed the capacity of ORC cycles and enhanced ORC cycles to generate significant useful power, with important performance values for the proposed cycles in terms of energy and exergy efficiencies, as well as the diversity of organic fluids used and their specific characteristics. The effects of operating parameters, such as evaporation temperature, heat source temperature, heat source flow rate, and the efficiencies of the turbomachines used, on the thermodynamic performance of the cycle are discussed. The parametric analysis allowed for the determination of optimal operating conditions for each cycle, enabling maximum electrical power production. By utilizing binary ORC cycles, Algeria can harness its geothermal potential in a modular, cost-effective, and environmentally friendly manner.

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Keywords: *Geothermal Energy, Binary Cycle, Power Generation, Energy Efficiency, Exergy Efficiency..*

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Impact of Blade Pitch Adjustment on the Performance of a Kaplan Turbine: A CFD Study

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Abstract

Among renewable energies, the hydropower sector is considered one of the most interesting due to its environmentally friendly nature and its significant potential available worldwide. Turbines play an important role in a hydroelectric power plant's generation capacity then performance of hydro turbines needs always to be improved. This paper aims to study the effect of blade pitch adjustment on jet adaptation and hydraulic losses at the inlet of a Kaplan-type turbine using CFD approach.

The objective is to identify clear trends for the initial blade setting under conditions close to the best efficiency point. The approach involves comparing three pitch configurations with constant flow and head. Simulations are conducted on a domain that includes the modeled guide vanes, the space without blades, and the runner. a steady-state Frozen Rotor calculation can initialize a transient with sliding mesh to refine the flow description. The k–ω SST turbulence model is selected to accurately represent shear gradients and the evolution of structures at the inlet of the channels. The analyzed indicators include the average incidence angle at the leading edge, the circumferential speed uniformity, and a loss coefficient based on total pressure. The results show that a slightly positive pitch improves jet adaptation to the runner passages, reduces incidence dispersion, and decreases local losses at the inlet, while a negative pitch exacerbates non-uniformities and dissipation. The study provides decision-making elements for the presetting of blade pitch, directly linking pitch to flow and hydraulic performance criteria at the inlet.

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Keywords: *Kaplan turbine; performances; blade pitch; stator -rotor interaction; hydraulic losses..*

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Numerical Analysis of the Effectiveness of Turbulence Models for Predicting the Aerodynamic Performance of Wind Turbine Blade Using S809 Airfoil

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Abstract

With the world's energy supply becoming increasingly scarce, wind power is gaining popularity as a clean source of renewable energy which is good for the environment. S809 airfoil designed by National Renewable Energy Laboratory (NREL) is widely used in horizontal axis wind turbine blades. This study undertakes a detailed flow numerical analysis over the S809 airfoil profile to enhance the performance of the horizontal axis wind turbine while seeking to improve its efficiency. We particular focus on the effectiveness of various turbulence models, including k-ω SST, k-ω, k-ε, and Spalart-Allmaras to accurately model the flow and predict phenomena that may occur, such as stall. The methodology performed was CFD analysis in 2D using ANSYS FLUENT to get the main parameters of the airfoil such as the lift, drag and moment coefficients, the speed, and pressure contours for different angles of attack from 0° to 20° and for different Reynolds numbers from 10e6 to 3.10e6. Stall characterized by the detachment of the boundary layer has been noticed for different angles of attack depending on the turbulence model and the Reynolds number. The comparison of the aerodynamics characteristics obtained with experimental results reveals that κ-omega (κ-ω) SST-model is more accurate in predicting the effect of flow transition and separation than the other models used in this work. These results allow us to define the operating parameters to avoid stall, which leads to a drop in the performance of the wind turbine..

Keywords: *S809 airfoil, turbulence models, aerodynamic coefficient, stall, CFD.*

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Numerical Investigation of a Lean Premixed Low Swirl Burner: effects of Parameter Variation and hydrogen addition

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Abstract

Low-swirl burner (LSB) technology offers very interesting results in reducing pollutant emissions. These emissions can be minimized through combustion techniques; particularly lean combustion combined with flame stabilization adaptations.

In this work, a numerical simulation was performed using Ansys Fluent to study a turbulent, swirling lean premixed methane-air flame in a non-confined configuration.

The main objective of this study is to examine the effects of varying parameters such as the equivalence ratio, swirl number, and hydrogen addition, with the aim of improving combustion efficiency and reducing pollutant emissions.

The results show that a decrease in the equivalence ratio leads to a significant drop in temperature, which in turn substantially reduces NO_x emissions. Moreover, CO emissions are directly influenced by the mixture's equivalence ratio. The swirl number plays a dominant role in determining the flame mode; increasing it lowers the temperature and shifts the flame fronts closer to the burner tip. Hydrogen, which has a much higher combustion speed than methane, offers several advantages when blended with methane. This approach presents an effective solution to flame stability issues and enables ultra-lean premixed combustion..

Keywords: *LSB , NOx emissions, hydrogen addition to methane, lean premixed flame.*

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COMPARATIVE ANALYSIS OF CENTRIFUGAL COMPRESSORS FOR SUPERCRITICAL AND TRADITIONAL FLUIDS

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Abstract

Supercritical carbon dioxide (s-CO 2) compressors represent a promising technological advancement aimed at improving energetic efficiency and reducing the environmental impact of energy production systems. This work presents a numerical comparative study between two centrifugal compressors: the NASA CC3, which operates with air, and the SNL compressor designed for s-CO 2 . The objective is to analyze the influence of the fluid and the design of each compressor on the internal flow behavior and aerodynamic performance. CFD simulations are conducted in steady-state conditions to observe the pressure and velocity distributions in each machine. This approach highlights the differences related to the density, compressibility, and thermal capacity of the two fluids, while taking into account the specific geometries of each compressor. This work contributes to a better understanding of the operation of compressors intended for s-CO 2 cycles and situates their performance relative to traditional air compressors..

Keywords: *centrifugal compressor, s-CO 2 , CFD, energetic efficiency, aerodynamic performance.*

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Numerical study of depollution efficiency in a ventilated cavity using the LBM-MRT

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Abstract

This study investigates a numerical analysis of thermal comfort in the residential buildings using the Lattice Bolltzmann method (LBM). The research aims to enhance indoor air quality, depollution efficiency and thermal comfort. The physical model considered consists of a rectangular cavity, characterized by an aspect ratio of two and ventilated by two diagonally opposite openings. The system of equations was solved using the Lattice Boltzmann method with multiple relaxation times (LBM-MRT). The extended Darcy Brinkman-Forchheimer model was used to simulate the porous material. The influence of different control parameters, including Rayleigh (Ra), Reynolds (Re), and Darcy numbers (Da), on flow dynamics, heat transfer and mass transfer was analyzed. the results found that the chemical reaction reduces the air renewal time, potentially lowering energy costs associated with ventilation. Increasing the Reynolds number (◌̇◌̢Re) enhances the ventilation process by accelerating air flow, which improves removal depollution efficiency. Additionally, increasing the Rayleigh number (◌́◌̢Ra) aids in contaminant removal due to buoyancy-driven forces, which intensify with higher temperature gradients. These findings provide essential insights for the design of advanced ventilation systems, ultimately contributing to improved indoor environmental quality..

Keywords: *Thermal comfort, reactive porous medium, Depollution effeciency, LBM-MRT..*

MODELING AND SIMULATION OF DECOUPLED WATT-VAR CONTROL FOR VOLTAGE REGULATION IN PV-INTEGRATED DISTRIBUTION SYSTEMS USING MATLAB/SIMULINK

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Abstract

The increasing penetration of photovoltaic (PV) generation in distribution grids introduces new challenges in maintaining voltage stability and power quality. PV penetration often causes voltage fluctuations, particularly during periods of variable solar irradiance. Conventional voltage regulation techniques, such as On Load Tap-Changers (OLTC) and Static Var Compensation (SVC), may not respond quickly enough or efficiently handle these dynamics, particularly under fast-changing PV outputs. To address these challenges, advanced control strategies at the inverter level have been developed. Among them, Decoupled Watt-Var control offers a promising approach by allowing independent control of active (Watt) and reactive (Var) power, thus enhancing voltage regulation capabilities while maintaining optimal power injection. Unlike conventional coupled Volt-Var methods, Decoupled Watt-Var control can respond dynamically to voltage variations without compromising active power generation, which is crucial for maximizing PV power utilization. In this paper, the effectiveness of Decoupled Watt-Var control of voltage regulation in a distribution grid connected to 200 kW PV array has been investigated. A detailed simulation model is developed in MATLAB/Simulink software, representing the PV system, inverter controls, and distribution feeder characteristics. Simulation has been done, the impact of Decoupled Watt-Var control on voltage profiles, reactive power behavior and overall grid stability have been evaluated. The results demonstrate that Decoupled Watt-Var control significantly improves voltage regulation compared to conventional Volt-Var control strategies presented in literature, making it a valuable solution for distribution grid connected PV systems under variable climate conditions.
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Keywords: *PV Systems, Converter; Active power, Reactive Power, Watt-Var Control, Grid.*

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NUMERICAL SIMULATION OF LONG-TERM GEOLOGICAL STORAGE OF CO2

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Abstract

The environment is a system formed by interdependent natural and artificial elements, which tend to be modified by human action. Environmental sustainability is always an important issue for the public, policymakers, and researchers. Excessive CO_2 levels in the atmosphere lead to many problems and threaten environmental sustainability. Carbon capture, utilization, and storage (CCUS) is one of the most important technologies to solve CO_2 emission problems and has received great attention from countries around the world. It offers promising CO_2 emission reduction potential but also carries significant risks. This study concerns numerical simulation of long-term geological storage of CO_2 with Computer Modeling Group (CMG) software. A generic 2D well model was used. The results helped to understand the dynamics of CO_2 migration over time and to analyze its behavior under different conditions. The results from numerical simulation provide an integrated view of CO_2 dynamics and enable the development of more secure and efficient storage strategies..

Keywords: *Key words: simulation, storage, emission, reduction, migration.*

BOOSTING THE EFFICIENCY OF THERMOELECTRIC MODULE THROUGH STRAIN ENGINEERING

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Abstract

Thermoelectrics enable the direct conversion of heat into electricity and vice versa without any moving parts. This technology is particularly valuable for recovering waste heat from engines, industrial systems, or even body heat, helping to improve overall energy efficiency. $CuGaTe_2$ is a promising chalcopyrite compound for thermoelectric energy conversion. In this work, we investigate the effect of biaxial strain—both compressive and tensile—on its thermoelectric properties using density functional theory (DFT) implemented in Wien2K code combined with the semi-classical Boltzmann transport formalism. Biaxial deformation on the plane was simulated by modulating the c/a ratio while keeping the volume constant. we optimized structural parameters and electronic properties. After, we studied the thermoelectric parameters as a function of carrier concentration (p and n) and through these parameters, we modelised a thermoelectric module and calculate its conversion efficiency as a function of the type and intensity of strain applied. Our first-principles calculations reveal a significant improvement in thermoelectric performance under moderate compressive strain of 4%, with noticeable enhancements in the Figure of merit ZT (from 0.63 to 0.91), and the calculated conversion efficiency (from 4.7 % to 6.5% for a temperature difference of 75°C) . These findings highlight the potential of strain engineering as a viable strategy to optimize the electronic transport properties of $CuGaTe_2$ and similar chalcopyrite materials for high-efficiency thermoelectric applications..

Keywords: *Chalcopyrite, energy conversion, Biaxial deformation, Figure of merit, conversion efficiency, strain..*

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OPTIMIZATION OF BIODIESEL SYNTHESIS VIA CATALYTIC TRANSESTERIFICATION: A SYNERGISTIC APPROACH USING STATISTICAL AND NATURE-INSPIRED TECHNIQUES

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Abstract

This study investigates the transesterification of waste cooking oil using a newly developed heterogeneous catalyst containing calcium, zinc, and molybdenum. The influence of key reaction variables—methanol-to-oil molar ratio, catalyst dosage, reaction time, and temperature—was systematically examined and optimized through Response Surface Methodology (RSM). Under optimal conditions, a biodiesel yield of 94% was obtained. The CaO/Zn/Mo catalyst exhibited excellent reusability and catalytic stability over six successive reaction cycles, underscoring its potential for sustainable fuel production. Although RSM proved effective for process optimization, the application of bio-inspired computational tools such as Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) is proposed for future studies to enhance prediction accuracy, manage complex optimization scenarios, and minimize experimental trials. The findings emphasize the promising integration of advanced catalysis and intelligent optimization frameworks toward environmentally responsible biofuel technologies..

Keywords: *Biodiesel, CaO/Zn/Mo catalyst, RSM, Renewable energy, Catalytic transesterification.*

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IMPACT OF INTERFACE DEFECT DENSITY ON THE PERFORMANCE OF SIS SOLAR CELLS: A SCAPS-1D SIMULATION STUDY

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Abstract

The influence of interface defect density on the performance of semiconductor heterostructures has been examined through SCAPS-1D numerical simulations. Special attention was given to the insulating interlayer that separates the p-type and n-type regions, as it strongly governs carrier recombination and charge transport across the junction. Simulation results indicate that increasing interface defect density enhances recombination losses and limits charge collection, leading to a reduction in open-circuit voltage (Voc), short-circuit current density (Jsc), fill factor (FF), and overall power conversion efficiency (PCE). In contrast, minimizing interfacial defects to 1012 cm-3 allows for a highly efficient junction with Voc = 0.84 V, Jsc = 42.09 mA.cm-2, FF = 86.42%, and PCE = 30.65% under standard AM1.5G conditions at 300 K. These results highlight the crucial role of interface engineering in optimizing carrier dynamics and achieving enhanced photovoltaic performance in advanced semiconductor systems.

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Keywords: *SIS solar cell, interface defects, TiO2 layer, SCAPS-1D simulation, photovoltaic performance..*

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Effect of effective section for capturing defect on optoelectronic performances of detector structure with n-B-n architecture: InAsSb/AlAsSb/InAsSb.

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Abstract

Yes.

Keywords: *Infrared detector,InAsSb/AlAsSb/InAsSb,Interface defects,no radiative recombination..*

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Use of the Life Cycle Assessment Method for a Comparative Study Between Stretch Film Paper and Honeycomb Kraft Paper

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Abstract

In order to guide choices toward packaging solutions with lower environmental impact, a rigorous assessment based on the Life Cycle Assessment (LCA) methodology is essential. In a context where the use of plastic materials remains predominant, companies are encouraged to intensify their innovation and research efforts to design more environmentally friendly alternatives, thereby reducing harmful emissions affecting ecosystems, human health, and natural resources. The approach adopted in this study aims to identify the most suitable packaging option in terms of sustainability for the company's packaging activities, while promoting the gradual integration of eco-responsible practices. The analysis was carried out using the SimaPro software, based on the international Ecoinvent database and the IMPACT 2002+ characterization method, in accordance with the ISO 14044 standards related to LCA. The results obtained thus provide a solid foundation for guiding strategic decisions regarding the selection of sustainable packaging, in line with current environmental responsibility and sustainable development challenges.

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Keywords: *Keywords: [Life Cycle Assessment (LCA), environmental impact, Sustainable packaging, SimaPro software, ISO 14044 standard].*

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A COMPARATIVE REVIEW AND SCAPS-1D SIMULATION STUDY OF BAZRSE$_3$ AND BAZRS$_3$ PEROVSKITE SOLAR CELLS

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Abstract

Lead-free chalcogenide perovskites are gaining attention as promising alternatives to toxic and unstable Pb-based perovskite solar cells (PSCs). In this study, we present a comparative SCAPS-1D simulation of BaZrSe3 and BaZrS3 absorbers, focusing on the effects of bandgap tuning, layer optimization, and transport layer selection on device performance. For BaZrSe3, modeled in the structure FTO/TiO2/BaZrSe3/NiO/Au, the optimized device achieved a power conversion efficiency (PCE) exceeding 30%, with a short-circuit current density (Jsc ≈ 29 mA/cm2), open-circuit voltage (Voc ≈ 1.03 V), and fill factor (FF ~80%) at an optimal absorber thickness of 500 nm. In comparison, BaZrS3 devices with the architecture FTO/CdS/BaZrS3/HTL/Ir demonstrated maximum efficiency when PEDOT:PSS was employed as the hole transport layer,

yielding a PCE of 18.50%, with Jsc ≈ 23.46 mA/cm2, Voc ≈ 0.886 V, and FF = 8.90% (as reported from simulation, though atypically low for PSCs). The higher efficiency of BaZrSe3 is attributed to its narrower bandgap (~1.35 eV) and superior near-infrared absorption, whereas BaZrS3 benefits from stronger experimental validation and favorable band alignment with PEDOT:PSS. These findings highlight the complementary advantages of the two absorbers and underline their potential as stable, eco-friendly alternatives for next-generation photovoltaic technologies..

Keywords: *perovskite solar cells (PSCs); hole transport layer (HTL); power conversion efficiency (PCE); open-circuit voltage (Voc); short-circuit current density (Jsc); fill factor (FF).*

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PERFORMANCE EVALUATION OF ANN AND P&O MPPT TECHNIQUES FOR PHOTOVOLTAIC SYSTEMS

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Abstract

Optimizing energy extraction from photovoltaic (PV) systems necessitates effective maximum power point tracking (MPPT) solutions owing to the nonlinear properties of PV modules and the fluctuation of ambient circumstances. Traditional algorithms like Perturb and Observe (P&O) are prevalent due to their simplicity; yet, they frequently demonstrate steady-state oscillations and diminished accuracy in conditions of rapidly fluctuating irradiance. In contrast, Artificial Neural Networks (ANN) provide adaptive and nonlinear modeling capabilities, facilitating more accurate MPP prediction. This study conducts a comparative comparison of ANN-based and P&O MPPT approaches for a boost-converted photovoltaic system utilizing MATLAB/Simulink simulations. The artificial neural network (ANN) is executed as a Multi-Layer Perceptron (MLP) trained on photovoltaic current-voltage datasets under diverse irradiance and temperature conditions, whereas the Perturb and Observe (P&O) method depends on iterative duty-cycle perturbation. Simulation results indicate that the ANN-based MPPT attains quicker convergence, diminished oscillations, and superior tracking efficiency relative to the traditional P&O method, especially in dynamic weather circumstances. These findings validate the efficacy of ANN-based controllers in enhancing PV system performance..

Keywords: *MPPT, Artificial Neural Networks (ANN), Perturb and Observe (P&O), Photovoltaic (PV) System, MATLAB/Simulink..*

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IMPACT OF METEOROLOGICAL VARIABLES AND OPTIMIZER SELECTION ON PV POWER FORECASTING USING LSTM: APPLICATION TO AIN SALAH, ALGERIA

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Abstract

Accurate photovoltaic (PV) power forecasting is vital for improving grid reliability and supporting the large-scale integration of renewable energy sources. This study proposes a deep learning–based forecasting model using real operational data from the 5 MW grid-connected PV station located in Ain Salah, Algeria. The dataset includes electrical and meteorological parameters such as the produced power (PV), solar irradiance (G) and ambient temperature (T). Several preprocessing stages are introduced and two Long Short-Term Memory (LSTM) networks were implemented: one using only historical PV data, and another integrating irradiance and temperature as additional features. Model performance was evaluated using the coefficient of determination (R^2), mean absolute error (MAE), and root mean square error (RMSE). Furthermore, a comparative analysis of optimization algorithms; Adam, RMSprop, SGD, Adamax, and Nadam, was conducted to examine their effect on learning stability and forecasting accuracy. The results indicate that including meteorological parameters significantly enhances prediction performance. This research highlights the importance of data correction, normalization, and optimizer selection in deep learning–based PV forecasting. The proposed framework demonstrates strong potential for reliable short-term solar power prediction in real-world conditions, contributing to smarter energy management and improved renewable energy integration within Algeria's power network.

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Keywords: *[Photovoltaic forecasting- LSTM- optimizer comparison-deep learning-renewable energy integration]*.

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ARTIFICIAL INTELLIGENCE-BASED OPTIMIZATION OF PID CONTROLLERS FOR TWO-AREA AGC SYSTEMS USING GENETIC ALGORITHM OPTIMIZATION

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Abstract

Automatic Generation Control (AGC) is essential for sustaining reliable and consistent electricity in linked systems. AGC is also tasked with efficiently distributing loads among generators, ensuring frequency stability, and regulating exchanges over tie lines. This work suggests the utilization of an AI-based optimization strategy to boost the performance of Automatic Generation Control in a two-area power system.

More specifically, the tuning settings of the Proportional-Integral-Derivative (PID) controller are optimized using the AI algorithm known as genetic algorithm (GA).

The study evaluates Automatic Generation Control (AGC) performance in a two-area linked power system, considering load changes. Three control strategies are evaluated: Conventional Automatic Generation Control (CAGC), Tie-Line Bias (TLB) Control, and Genetic Algorithm-Optimized Proportional-Integral-Derivative (GAPID) Control. The results show that GA-PID outperforms CAGC and TLB in reducing transient deviations, facilitating quicker stabilization, and preserving steady-state accuracy. It also significantly reduces overshoot by 90% and eliminates undershoot in many instances. GA-PID is essential for power systems that must accommodate unpredictable load fluctuations.

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Keywords: *PID, Automatic generation control, Genetic algorithm, simulink*

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analysis of nickel-doped antifluorite compounds with magnesium, silicon, and germanium, and their thermoelectric characteristics.

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Abstract

The push for clean energy sources has driven researchers to focus on alternative, non-fossil compound options, including thermoelectric materials. This study concentrates on the thermoelectric compound Magnesium Silicide and Magnesium Germanide ($Mg_2Si_{0.5}Ge_{0.5}$) doped with varying amounts of Nickel to enhance the figure of merit, ZT. The compound was synthesized using solid-state reaction and high-pressure methods, followed by high-temperature sintering. Compositional and structural analyses revealed that the samples recrystallized well in antifluorite phases, with Nickel occupying interstitial positions. Thermoelectric properties were evaluated across temperatures from 300 to 825 K.

As the Nickel content increased, electrical conductivity (σ) saw a significant uptick, while the Seebeck coefficient (α) decreased, likely due to increased carrier concentration. Despite higher electrical conductivity with increased Nickel doping, total thermal conductivity (ktot) decreased, showing a minimum value of 1.66 W/mK for $Mg_2Si_{0.5}Ge_{0.5}Ni_{0.03}$ at 823 K. This reduction in thermal conductivity was attributed to the considerable point defect scattering induced by Nickel impurities. Consequently, the compound with a Nickel content of 0.03 achieved a maximum ZT value of 0.62 at 823 K.

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Keywords: *thermoelectric, figure of merit, thermal conductivity, Seebeck coefficient.*

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DATA-DRIVEN PREDICTION OF ENERGY PERFORMANCE IN A NATURAL GAS FRACTIONATION DISTILLATION COLUMN

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Abstract

Improving energy efficiency in the fractionation section of liquefied natural gas (LNG) production remains a major industrial and environmental challenge. This work focuses on developing a data-driven predictive framework to analyze the energy performance of a distillation column used for propane and gasoline separation within an LNG fractionation train. A multivariate time-series dataset collected from real plant operations over a period of time is explored through comprehensive exploratory data analysis (EDA) to characterize process dynamics and identify the most influential variables affecting thermal demand. Based on these insights, artificial intelligence models are trained to predict the column's energy consumption under varying operating conditions. The resulting predictive tool provides a foundation for advanced monitoring and data-informed decision-making, enabling operators to better understand the impact of operating parameters on energy usage. This study highlights the potential of data-centric and AI-based approaches to enhance energy efficiency and promote sustainable operation in natural gas fractionation processes.

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Keywords: *Natural Gas Fractionation; Distillation Column; Energy Efficiency; Predictive Modeling; Artificial Intelligence; Sustainable Process Engineering.*

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Model Predictive Control for Maximum Power Point Tracking in Quasi-Z-Source Inverters under Partial Shading Conditions

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Abstract

Solar energy generation is inherently variable, and this variability becomes more pronounced under partial shading conditions, posing challenges in optimizing energy extraction from photovoltaic (PV) systems. This paper introduces a model predictive control MPPT (MPC-MPPT) for a quasi-Z-source inverter (qZSI) in standalone systems with power transfer to a resistive load. This MPC-MPPT approach uses predictors to predict solar irradiance changes and sets the inverter operating points accordingly for maximum power extraction. Simulation results of comparison with conventional MPPT methods like Perturb and Observe (P&O) and Incremental Conductance (IncCond) show that MPC-MPPT not only maximizes the accuracy for tracking, but also reduces the response time during abrupt changes of solar conditions. It is concluded from the results that MPC-MPPT helps to mitigate power oscillations and improve overall system efficiency, which qualifies it for standalone PV applications. In this paper, we promote the efficient energy management methods of PV systems considering partial shading, to help alleviate the propriety usage of renewable-energy technologies..

Keywords: *Solar Energy; Photovoltaic Systems; Model Predictive Control (MPC); MPPT; Quasi-Z-Source Inverter (qZSI); Partial Shading Conditions.*

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AN ENHANCED HYBRID PSO-GWO-BASED MPPT STRATEGY FOR STANDALONE PHOTOVOLTAIC SYSTEMS

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Abstract

This paper presents an enhanced hybrid Particle Swarm Optimization–Grey Wolf Optimizer (PSO–GWO)-based Maximum Power Point Tracking (MPPT) strategy with adaptive parameters for standalone photovoltaic (PV) systems. Maximizing energy extraction from PV panels by ensuring fast, accurate, and stable tracking of the Maximum Power Point (MPP) remains a critical challenge, especially under rapidly changing environmental conditions. To address the inherent limitations of conventional MPPT methods, such as the slow convergence and steady-state oscillations observed in the Perturb and Observe (P&O) algorithm, a novel hybrid approach is proposed. The core of the developed algorithm lies in the synergistic integration of the global exploration capability of PSO and the local exploitation strength of GWO. Furthermore, the strategy employs dynamically adaptive control parameters that automatically tune the search behavior in real time. This adaptive mechanism significantly enhances convergence speed during rapid transients while reducing power oscillations once the MPP is reached. The control scheme is thoroughly validated through detailed MATLAB/Simulink simulations on a standalone PV system comprising a 100 kW solar array and a DC–DC boost converter. Comparative results clearly demonstrate that the proposed hybrid PSO–GWO MPPT strategy with adaptive parameters achieves superior tracking speed, accuracy, and steady-state stability compared with the conventional P&O technique. Overall, the proposed adaptive hybrid controller provides an efficient and robust solution for maximizing energy yield in large-scale standalone PV systems..

Keywords: *Maximum Power Point Tracking (MPPT), Boost Converter, Hybrid PSO–GWO, Photovoltaic (PV) System, MATLAB/Simulink..*

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MEDITERRANEAN CLIMATE AND ATTIC IMPACT

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Abstract

This study investigates the influence of attic presence on the energy demand of a typical single-family house located in a Mediterranean climate, using the city of Algiers as a reference site. A thermal model of an experimental solar house, located at the Solar Equipment Development Unit (UDES) in Bou Ismail, was developed and validated using indoor temperature measurements. The modeling and simulations were carried out using TRNSYS, a dynamic thermal simulation software widely used in building energy analysis. The validated model was used to compare the energy performance of a dwelling with an attic to a reference configuration commonly found in Algeria—without attic, without thermal insulation, and with a flat reinforced concrete roof. The simulations focused on the city of Algiers, representative of the Mediterranean climate zone. The results show that during the winter season, the presence of an attic leads to an increase in heating energy demand of approximately 10% compared to the reference case. This rise is mainly due to thermal losses toward the unheated attic space. In contrast, during summer, the attic acts as an effective thermal buffer, resulting in a significant reduction in cooling energy demand of nearly 66%. This improvement is attributed to the attenuation of direct solar gains in the living spaces..

Keywords: *Building – Energy efficiency – Simulations – TRNSYST – Attic..*

NUMERICAL SIMULATION OF LIGHT-INDUCED DEGRADATION IN SILICON WAFERS BASED ON A SINGLE-DEFECT MODEL

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Abstract

This work presents a new kinetic simulation of light-induced degradation (LID) in boron-doped silicon wafers, a key phenomenon affecting photovoltaic material performance. The proposed model is based on a single-defect theory that describes the activation and deactivation mechanisms of boron–oxygen (BO) complexes responsible for both fast and slow degradation processes. Implemented in Python and solved using a system of ordinary differential equations, the model traces the temporal evolution of precursor and defect concentrations while accounting for the dissociation of Fe–B complexes under illumination and thermal treatment. The simulation results reveal the strong influence of thermal processing on defect kinetics and material degradation, providing a deeper understanding of the mechanisms governing the electrical behavior of silicon materials used in renewable energy applications. This original modeling approach offers a valuable numerical framework for improving the stability and performance of photovoltaic materials..

Keywords: *Numerical simulation; Defect kinetics; Thermal processing; Material behavior; Photovoltaic materials..*

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DESIGN AND IMPLEMENTATION OF AN IOT-BASED SOLAR ROUTER FOR INTELLIGENT PHOTOVOLTAIC ENERGY SELF-CONSUMPTION

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Abstract

Self-consumption of solar energy is a fundamental step toward a more sustainable energy system,enabling local production to meet the needs of small businesses. Stakeholders in solar energy play a crucial role in the efficient and intelligent use of this technology. This project focuses on the design and development of a smart monitoring system for photovoltaic solar energy, aimed at enhancing the selfconsumption of the energy produced. Voltage and current data from solar panels are collected and analyzed to calculate the energy generated in real time.

At the core of the system is a solar router equipped with Internet of Things (IoT) technologies. It uses an ESP32 microcontroller to collect electrical data, connected to a JSY-MK-194T sensor, a Robotdyn dimmer module to regulate excess power, LED modules, and a suitable power supply. The software is developed using the Arduino IDE, taking into account technical constraints such as measurement accuracy.

The data is transmitted via Wi-Fi to the ThingSpeak platform, which serves as a cloud server for data analysis and storage. This system enables users to monitor the solar power plant's performance in real time through an interactive web interface accessible from computers, tablets, and smartphones. This solution helps improve energy efficiency and provides a clear overview of production and consumption, thereby strengthening energy independence and reducing reliance on the traditional electricity grid..

Keywords: *Solar energy, solar router, ESP32, Thingspeak, Internet of things (IOT)..*

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ANALYSIS OF A MODIFIED PERTURBATION AND OBSERVE TECHNIQUE FOR MPPT UNDER NON-UNIFORM IRRADIANCE

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Abstract

This study analyzes a modified perturbation and observation (P&O) technique applied to the monitoring of the maximum power point (MPPT) for photovoltaic systems under non-uniform lighting. Conventional algorithms, including standard P&O, see their performance degrade under a partial shading, with the appearance of multiple local optimums on the power-voltage characteristic, leading to suboptimal energy extraction. The research characterizes the limitations of the classical algorithm in this context, particularly its inability to discriminate the global maximum of local optima and its pronounced residual oscillations. A modified P&O technique is therefore proposed and rigorously implemented under MATLAB/Simulink. The methodology uses a precise photovoltaic field model integrating heterogeneous irradiance profiles to faithfully simulate non-uniform conditions. Simulations demonstrate the higher efficiency of the modified approach. This allows to avoid local maxima, ensuring stable convergence towards the maximum available power. The quantitative comparative analysis reveals a notable improvement in tracking efficiency and a substantial reduction in steady-state oscillations compared to the reference algorithm. This study validates the potential of the modified technique to optimize the energy production of photovoltaic installations in variable real conditions, paving the way for an implementation on embedded controllers.

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Keywords: *MPPT, Perturbation and Observation, Partial Shading, Non-uniform Illumination, Photovoltaic System..*

SUSTAINABLE STRUVITE RECOVERY AND PHOSPHORUS RECYCLING FROM WASTEWATER

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Abstract

Agricultural residue recovery, which involves reintroducing certain mineral and organic elements into soils, is part of a green technology approach aimed at restoring natural cycles. Within this framework, the extraction of phosphorus from phosphate-rich effluents in the form of struvite (magnesium-ammonium phosphate) represents an innovative and promising solution that is attracting growing interest. As a fertilizer, struvite has the advantage of being more environmentally friendly, as it limits nitrogen losses through volatilization, a phenomenon frequently observed with nitrogen fertilizers such as urea.

However, struvite formation can sometimes be accompanied by the co-precipitation of heavy metals, raising concerns about its safety as an agricultural amendment. This study therefore aims to assess the quality of struvite obtained by precipitation from phosphate-laden urban and industrial wastewater. To achieve this, struvite samples from previous treatments were subjected to various analyses, including scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), and X-ray fluorescence (XRF). The latter method can detect the presence of co-precipitated heavy metals and assess the risk of contamination by trace metal elements (TMEs).

The results obtained show that the struvite precipitated in this study does not contain any heavy metal contamination and meets the quality criteria required for use in agriculture. Consequently, the recovery of struvite represents a real opportunity for more sustainable management of agricultural systems, by reducing the risk of groundwater pollution and limiting hazards to human health, particularly through the food chain.

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Keywords: *Ecotoxicology, Struvite, Crystallization, Valorization, Agriculture, Environment, Health..*

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MATERIALS FOR BIOFUELS AND BIOCATALYSIS: ALGAL BIOMASS, BIOCATALYSTS IMMOBILIZATION AND MATHEMATICAL MODELING

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Abstract

The primary elements involved in bioenergy and biocatalysis encompass a range of materials like biomass, including oil-dense algae, a promising source of biofuel feedstocks and other valuable products, alongside agricultural byproducts such as cellulose, sugarcane bagasse, and nanocellulose, which function as supports for biocatalysts immobilization. The integration of these approaches enables sustainable biochemical transformations with high selectivity, improving stability and the potential for reuse. The mathematical models employed, including kinetic modeling, response surface methodology (RSM), and artificial neural networks (ANNs), serve as essential instruments for optimizing and scaling up the process. The use of environmentally friendly biomass resources, biocatalysts, and mathematical modeling are essential for promoting a sustainable bio-based economy..

Keywords: *Materials; Biomass; Biofuel; Biocatalysis; Immobilization; Modeling..*

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Numerical Simulation of Aerosol Behavior in Indoor Environments

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Abstract

In this study, turbulent indoor airflows and particle dispersion within a chamber were simulated using a three-dimensional numerical model and validated against experimental data reported in the literature. The chamber was tested with two inlet velocities v= 0.025 m/s, 0.45 m/s and for two particle sizes PM 10, PM2.5. Airflow velocity and concentration were obtained in different places of the room. The Eulerian-Lagrangian approach was used to simulate and predict the dynamic properties of the air (continuous) phase and the particle (dispersed) phase, In the Lagrangian particle model, the effects of drag, lift, and Brownian forces were taken into consideration, The turbulent airflow field is modeled with the renormalization group (RNG) k–e turbulence model. The results showed a good agreement between numerical and experimental results..

Keywords: *indoor air quality, PM, Particle concentration, turbulence model..*

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OPTIMIZATION AND THERMOKINETIC STUDY OF PEM WATER ELECTROLYSIS

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Abstract

Proton Exchange Membrane (PEM) electrolysis is a promising technology for the production of high-purity green hydrogen with superior current density and dynamic response. This work presents a comprehensive kinetic and thermodynamic study aimed at optimizing the operational parameters of a laboratory-scale PEM electrolyzer equipped with a Nafion117 membrane and Ir-RuO2/Pt-C electrodes. A Box-Behnken experimental design was employed to evaluate the effects of applied voltage, temperature, and water type on hydrogen production and energy efficiency.

Experimental results obtained between 25 °C and 50 °C revealed a strong temperature dependence of the reaction rate, with a 5.5 fold increase in hydrogen generation rate. Kinetic modeling based on the Arrhenius equation yielded a low activation energy (Ea = 4.518 kJ/mol), indicating that the process is predominantly diffusion-controlled. Among the tested water types, osmosed water provided the best compromise between Faradaic yield, energy efficiency, and cost.

These findings enhance the understanding of proton transport phenomena in PEM electrolyzers and contribute to the optimization of operating conditions for efficient and sustainable green hydrogen production [1-3]..

Keywords: *PEM electrolysis, Green hydrogen, Chemical kinetics, Arrhenius law, Ionic diffusion, Experimental optimization, Thermodynamics..*

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HEAVY METAL LEVELS IN THE LEACHATE GENERATED BY THE CET EL HARIA LANDFILL, CONSTANTINE

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Abstract

Solid urban waste from the city of Constantine is deposited at the El Haria technical landfill site, located 40 km away. This situation has led to pollution of the surrounding area and caused harm to the population of the village of Khenaba, due to leachate being discharged into the environment, with or without treatment. The only cell at this landfill was in operation during the period 2010-2015, after which waste was deposited outside this site. In order to study the impact of these leachates on the external environment, we analyzed the presence of heavy metals such as lead, copper, chromium, zincs, cadmium, and nickel in these liquids. We found excessive concentrations of these metals in the liquids discharged outside after treatment by a lagooning system adopted on site. We recorded values of 0.0159 mg/l of copper, 0.0816 mg/l of lead, 0.5272 mg/l of chromium, 0.1781 mg/l of nickel, 0.3297 mg/l of zinc, and 0.0027 mg/l of cadmium. These values exceed Algerian standards for surface water, particularly for lead and chromium. It should be noted that the area below the landfill is a high-quality agricultural area..

Keywords: *leachate, landfill, heavy metals, dosage..*

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PHOTO-FENTON-LIKE DEGRADATION OF TRAMADOL HYDROCHLORIDE CATALYZED BY FERRIC CITRATE: MODELING AND OPTIMIZATION VIA ANN AND GENETIC ALGORITHMS

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Abstract

This study focuses on the mineralization of Tramadol hydrochloride (TR) under natural pH conditions, evaluated through Chemical Oxygen Demand (COD) removal, using a photo-Fenton-like process catalyzed by ferric citrate ($Fe(C_6H_5O_7)$). To improve modeling accuracy, a novel data generation approach based on the Box–Behnken design was implemented and coupled with Artificial Neural Networks (ANNs). This methodology enables a systematic investigation of degradation behavior while minimizing experimental effort and enhancing predictive and optimization efficiency.

Three main parameters Fe^{2+} concentration, citric acid concentration, and pollutant concentration were used to construct the dataset derived from a polynomial model. Twenty-four ANN architectures were tested by varying training algorithms and transfer functions. The best-performing model was a cascade-type ANN trained using the Levenberg–Marquardt algorithm with learngdm adaptation, a tansig hidden layer function, and a purelin output layer, achieving excellent performance (R^2 = 0.99; MSE = 9.7×10^{-7}).

Compared with the Box–Behnken model, the ANN exhibited superior predictive capability, with a performance factor of 0.00135. Optimization using ANN-GA, Box–Behnken-GA, and Box–Behnken-DF methods yielded identical optimal conditions ($[TR]_0$ = 0.033 mM, $[Fe^{2+}]$ = 0.2 mM, citric acid = 1.3 mmol L^{-1}), confirming the robustness of the genetic algorithm approach. Among these, the ANN-GA strategy demonstrated the fastest convergence and highest reliability, underscoring its effectiveness for optimizing photo-Fenton-like processes.

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Keywords: *Photo-Fenton-like process; Ferric citrate complex; Box–Behnken design; Artificial Neural Network (ANN); Levenberg–Marquardt algorithm; Genetic Algorithm (GA)..*

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Performance Evaluation of a Five-Level NPC and Stacked Multicell Converter-Based STATCOM for Power Quality Improvement in Modern Energy Systems

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Abstract

This paper presents the modeling and performance analysis of a NPC and five-level stacked multicell converter-based STATCOM designed to enhance power quality and system stability in modern energy infrastructures. The proposed structure is characterized by modular construction and reduced voltage stress on semiconductor devices, providing technological reliability and structural robustness suitable for high-power industrial applications. A Backstepping control strategy is developed to improve dynamic response and voltage regulation under variable load conditions. MATLAB/Simulink-based evaluations demonstrate that the proposed configuration achieves a unity power factor, reduced total harmonic distortion (THD < 2.5 %), and improved transient performance compared to conventional PI-based control. The results highlight the converter's suitability for integration into mechanical and industrial energy systems where reliability and power stability are critical..

Keywords: *Keywords: Backstepping Control, STATCOM, Multilevel Converter, Voltage Regulation, THD..*

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PARAMETRIC STUDY OF A MODERNIZED PVT MODULE FOR EFFICIENT DUAL-ENERGY PRODUCTION

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Abstract

A significant fraction of the solar radiation absorbed by photovoltaic (PV) panels is converted into heat, which increases the PV cell temperature and reduces electrical efficiency. To overcome this limitation, an experimental investigation of a hybrid photovoltaic/thermal (PV/T) collector, combining a conventional thermal absorber with a PV module, is carried out. The proposed design features a baffled water-cooled heat exchanger mounted on the rear side of the PV panel, enabling simultaneous electrical generation and thermal energy recovery from the same solar surface. Experimental tests were conducted under similar operating conditions to analyze the influence of water flow rate and inlet temperature on system performance. The results show that the cooling mechanism stabilizes the PV cell temperature below 46 °C while delivering hot water at approximately 30 °C. The highest electrical efficiencies were achieved at moderate flow rates of (5.5 l/ min and 4 l/min).

The findings confirm that hybrid PV/T collectors constitute efficient bi-energy systems. The optimal configuration depends on the trade-off between electrical and thermal efficiencies, energy consumption, and hydraulic pressure losses. Furthermore, the inlet water temperature was found to significantly influence the global performance of the system, highlighting the importance of thermal-fluid management in PV/T design and optimization.

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Keywords: *Hybrid PV/T system , Solar cell cooling , Bi-energy system, Electrical efficiency.*

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Modeling and Simulation of a Medical Oxygen Recovery System Based on Hydrogen Electrolysis: Case Study of the SONALGAZ Ras‑Djinet Power Plant

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Abstract

This paper presents a modelling and simulation study for recovering high‑purity medical oxygen as a by‑product of hydrogen production at the SONALGAZ Ras‑Djinet combined‑cycle power plant. The study develops a thermodynamic process model in Aspen HYSYS, validated against the plant data and operating assumptions from the Ras‑Djinet H2 station. Key unit operations—gasometer buffering, KOH scrubbing, cooling, high‑pressure compression and cylinder filling—are represented in the model. Parametric simulations assess oxygen purity, mass flow, compressor duty and cooler loads for typical operating scenarios. Results indicate that recovered oxygen can reach medical‑grade purity (~99.5% O_2) after KOH scrubbing and appropriate cooling/compression, while maintaining stable filling rates compatible with hospital supply needs. A techno‑economic sensitivity analysis shows that, for the Ras‑Djinet case, onsite recovery using existing electrolyzer infrastructure can be competitive with purchased cryogenic oxygen under certain electricity price and utilization assumptions. The paper concludes with recommendations for pilot deployment, safety considerations (ATEX, material compatibility) and further work to integrate renewable electricity and advanced PSA polishing..

Keywords: *Electrolyzer, Oxygen recovery, Hydrogen, HYSYS simulation, Medical oxygen, SONALGAZ Ras‑Djinet, PSA, KOH scrubbing.*

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PIPEPHASE 9.6 SIMULATION-BASED ASSESSMENT OF AN LPG TRANSPORT NETWORK'S RESILIENCE IN THE EVENT OF AN UNEXPECTED PUMPING STATION SHUTDOWN

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Abstract

Energy is a fundamental pillar of economic development and industrial activity. In Algeria, the National Oil and Gas Company (SONATRACH) plays a strategic role as the main producer and exporter of crude oil, natural gas, condensates, and liquefied petroleum gas (LPG). In response to the increasing national and international energy demand, the establishment of an efficient and resilient logistics strategy is essential to ensure the safe, reliable, and cost-effective transportation of production volumes. Within this framework, pumping stations constitute vital components of the transport infrastructure, ensuring flow continuity, pressure stability, and network operability. This study presents a numerical simulation approach based on experimental operational data applied to a 989 km LPG transportation network linking Alrar to Hassi R'mel. The primary objective is to guarantee uninterrupted transport performance under critical operating conditions, particularly in the event of an unexpected shutdown of a pumping station—a scenario that poses significant operational and economic risks.

The network is modeled using Pipephase 9.6, integrating both continuous variables (flow rates at nodes) and discrete variables (discharge pressures) to accurately capture the system's hydraulic behavior. The model comprises three pumping stations (SP0, SP1, SP2), three injection nodes (LR1, DLR1, ELR1), and sixteen production fields.

The simulation results, validated against experimental data, demonstrate the robustness, adaptability, and resilience of the transport system to maintain stable and efficient LPG flow even under adverse and critical operational scenarios. These findings highlight the strategic importance of dynamic modeling in optimizing energy transport networks and enhancing operational reliability within SONATRACH's infrastructure.

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Keywords: *LPG transport network, Pipephase 9.6, Numerical simulation, Pump station shutdown.*

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Green hydrogen integration in aluminum recycling

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Abstract

The integration of green hydrogen into the aluminum recycling process represents a promising pathway toward reducing the environmental footprint of the metallurgical industry. Traditional aluminum recycling methods rely heavily on fossil fuels, leading to significant CO_2 emissions during the melting and refining stages. In contrast, substituting conventional natural gas with hydrogen produced from renewable energy sources (electrolysis powered by solar or wind) offers a carbon-free alternative.

This study aims to evaluate the technical feasibility and environmental benefits of using green hydrogen as a reducing and heating agent in secondary aluminum production. Through thermodynamic modeling and energy balance analysis, the study demonstrates that hydrogen combustion generates sufficient thermal energy for melting aluminum while eliminating direct CO_2 emissions. Moreover, a life cycle assessment (LCA) indicates a potential reduction of up to 70% in greenhouse gas emissions compared to conventional recycling methods.

The results underline the potential of coupling renewable energy systems with recycling processes, thereby fostering a sustainable industrial transition toward carbon neutrality and aligning with the global decarbonization goals.

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Keywords: *Green hydrogen , Aluminum recycling, Renewable energy, Decarbonization, Sustainable industry..*

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DEVELOPMENT OF LOW-COST PARALLEL ROBOTS FOR ACCESSIBLE ROBOTICS AND MECHATRONICS EDUCATION

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Abstract

The integration of practical experiences is fundamental to an effective teaching of mechatronics and robotics, but financial barriers often limit students' access to comprehensive learning experiences. This article examines the use of low-cost hardware combined with accessible rapid prototyping technologies, including 3D printing and CNC machining, to develop affordable yet functional robotic platforms for engineering education. Through the analysis of three case studies of parallel robots developed in our laboratory, we demonstrate how these approaches significantly improve student learning outcomes while reducing costs. The results reveal that properly implemented low-cost platforms can maintain pedagogical effectiveness while improving accessibility, thereby promoting a deeper understanding of mechatronic principles through practical applications. This article provides educators with the building blocks to develop and deploy similar solutions in academic settings, supporting more inclusive and effective robotics and mechatronics education.

Keywords: *Educational platforms, low-cost hardware, parallel robots, design, rapid prototyping.*

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PREDICTIVE MAINTENANCE ASSISTED BY ARTIFICIAL INTELLIGENCE FOR THREE-PHASE ASYNCHRONOUS MOTOR BASED ON IOT AND PLC.

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Abstract

This work presents the design and implementation of an intelligent predictive maintenance system applied to a three-phase asynchronous motor, combining Internet of Things (IoT) and programmable logic controller (PLC) technologies. The main objective is to prevent breakdowns and optimize the lifespan of industrial equipment through continuous and intelligent monitoring of the motor's electrical and mechanical parameters..

Keywords: *predictive maintenance , three-phase asynchronous motor,programmable logic controller (PLC),Internet of Things (IoT).*

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SIMULATION STUDY ON THE IMPACT OF WELDING PARAMETERS ON ELECTRIC FIELD AND VOLTAGE IN TIG WELDING

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Abstract

The Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure. Due to its high welding quality, compared to other arc welding processes, Gas Tungsten Arc Welding (GTAW) also called Tungsten Inert Gas (TIG) is currently taking a leading position for specialist applications. In TIG welding high quality welds can be achieved due to high degree of control in heat input and filler additions separately. TIG welding can be performed in all positions and the process is useful for tube and pipe joint. Expensive materials, tight geometrical tolerances and the need to decrease product and manufacturing development time, cost and associated risks have motivated the development of models and methods for the simulation of manufacturing processes.This study reveals the effect of welding parameters on electric field and voltage, highlighting the impact of tungsten electrode radius curvature on voltage, electric fields, and space charge densities..

Keywords: *arc welding, GTAW process, electric fields, tungsten electrode, finite elements method, COMSOL Multiphysics..*

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IMPACT OF CORONA RING ON THE ELECTRIC FIELD BEHAVIOR OF CAP AND PIN INSULATOR PROFILE

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Abstract

The addition of a corona ring to a 5-element cap and pin high-voltage insulator significantly influences the electric field distribution along the insulator string. The primary effect is a reduction of the electric field intensity on the high-voltage side, where the corona ring is installed, lowering the risk of corona discharge and premature insulation failure. However, this reduction is accompanied by an increase in electric field intensity on the grounded side. This phenomenon aligns with the fundamental principle that the integral of the electric field along the insulator surface must remain equal to the fixed potential difference between line and ground. Within this distribution, the triple point—where the ceramic, air, and metal parts converge—remains a critical location due to localized field enhancement, affecting surface stresses and corona inception. Design parameters of the corona ring such as diameter, tube thickness, and vertical placement are essential in tailoring the electric field profile. Finite Element Analysis (FEA) and experimental studies confirm that an appropriately sized corona ring moderates peak field strengths on the energized end while redistributing fields toward the grounded end, thereby improving insulator endurance without altering the overall voltage difference. This balanced field management extends the operational life and reliability of the insulator string in high-voltage applications..

Keywords: *[Corona ring, Insulator reliability, Electric field distribution, Finite Element Analysis (FEA)]*.

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Comparative Analysis of Fault Detection and Diagnosis Techniques for Industrial Applications

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Abstract

in today's highly competitive industrial environment, ensuring high levels of quality, reliability, and performance is essential, as even minor process malfunctions can lead to significant operational and economic losses. Effective fault detection and diagnosis (FDD) systems play a crucial role in maintaining process stability and safety. However, the increasing complexity and diversity of modern industrial systems make the development of a universal diagnostic framework impractical. Consequently, numerous diagnostic approaches have been proposed, each exhibiting specific advantages and limitations depending on the application domain and system characteristics.

This paper presents a comprehensive classification of existing diagnostic methods and provides a comparative assessment of their performance. Furthermore, an academic case study is developed to illustrate the effectiveness of the analyzed approaches. The results emphasize the importance of selecting appropriate diagnostic strategies to enhance fault identification accuracy and ensure reliable operation in complex industrial environments.

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Keywords: *Fault Detection and Diagnosis (FDD); Diagnostic Methods; complex Systems; Reliability; System Monitoring.*

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Study and Numerical Simulation of Wavelength Division Multiplexing (WDM)

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Abstract

Wavelength Division Multiplexing (WDM) has become a key technology for increasing the capacity of modern optical communication systems. This study presents a detailed analysis and numerical simulation of WDM performance under various operational conditions. Using a simulation environment, several WDM configurations were evaluated to investigate the impact of channel spacing, signal power, fiber length, and dispersion on system quality. The results highlight the critical role of non-linear effects—such as Four-Wave Mixing (FWM), Self-Phase Modulation (SPM), and Cross-Phase Modulation (XPM)—on the degradation of the optical signal, particularly in dense WDM systems. Performance metrics such as Bit Error Rate (BER), Quality Factor (Q-factor), and eye diagrams were analyzed to assess system reliability. The findings provide practical insights into optimizing WDM networks for high-capacity, long-distance communication and offer guidelines for selecting appropriate design parameters to enhance overall system performance..

Keywords: *Wavelength Division Multiplexing (WDM), Optical Communication, Numerical Simulation, Fiber Optics, Signal Dispersion, Nonlinear Effects, BER, Q-factor, Optical Networks.*

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AN ENHANCED FUZZY BAYESIAN NETWORK PROBABILISTIC MODEL FOR LNG RELEASE DURING LOADING OPERATIONS IN AN ONSHORE TERMINAL

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Abstract

This paper's purpose is to present a risk assessment approach for analysing the LNG (Liquefied Natural Gas) release in onshore terminals during the loading process. This research adopted the Fuzzy Bayesian Network (FBN) procedure that predicts the likelihood of an LNG release and its consequences using a BN model combined with an FST (Fuzzy Set Theory), it calculates the percentage of major critical causes of LNG release in the loading process more accurately. First, the FST employing an enhanced SAM (Similarity Aggregation Method) to handle incertitude and incline the outcomes to the more credible experts is applied to obtain the probabilities of source causes. Then, the Bayesian Network (BN) is used to predict the possibility of LNG release and perform an accurate identification of its causes and consequences. The procedure is demonstrated with a case study of Algeria's LNG marine terminal. The results of this paper are the quantification of the risk of the top event, consequences, and update the prior risk occurrence possibility based on new evidence. In addition, sensitivity analysis has been established to validate the risk model. Overall, the methodology will be effective in helping safety professionals and decision-makers support safety management in the LNG loading process.

Keywords: *LNG Ship-Port Interface, Probabilistic Risk Assessment, LNG Release, Enhanced Similarity Aggregation Method, Fuzzy Bayesian Network.*

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CONTRIBUTION TO THE IMPROVEMENT OF THE OPERATIONAL SUSTAINABILITY OF A PRODUCTION LINE: CASE OF THE CHLEF CEMENT PLANT

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Abstract

A reliability study of a production line in a cement plant is a comprehensive analysis aimed at assessing the robustness and performance of a specific production process. Our work focuses on evaluating the reliability of a selected production line. By applying statistical analysis methods and probabilistic models, we identify the main causes of failures and propose improvements to enhance the overall reliability of the production line..

Keywords: *Keywords: Maintenance, Reliability, Stability, Availability, Production..*

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DIRECT INSTANTANEOUS TORQUE CONTROL OF SWITCHED RELUCTANCE MACHINE

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Abstract

This research paper focuses on the Direct Instantaneous Torque Control (DITC) method applied to a three-phase 12/8 reluctance switched machine (SRM). The machine exhibits pronounced nonlinearities in both its magnetic circuits and geometrical characteristics, particularly in the air gap, which vary with the rotation mode. To address these nonlinear effects, the finite element method (FEM) is used as a reliable modeling and problem-solving tool. Several torque ripple reduction techniques have been proposed in the literature on reluctance machines; among these, the control strategy examined in this study is direct instantaneous torque control and optimal operating angle selection. The paper presents the SRM torque controller, its behavior, and the corresponding modeling and simulation results. Analysis of the unit characteristics, supported by simulation results, confirms that torque ripple reduction can be achieved with optimized operating angles, validating the effectiveness of the proposed system design..

Keywords: *Direct Instantaneous Torque Control (DITC), Switched Reluctance Machine (SRM), Magnetic Circuits, Geometrical Characteristics, Finite Elements Method (FEM), Nonlinear magnetic properties.*

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A COMPARATIVE STUDY OF MULTI-OBJECTIVE OPTIMIZATION ALGORITHMS FOR RELIABILITY ENHANCEMENT IN ELECTROMECHANICAL SYSTEM.

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Abstract

This study investigates the application of two multi-objective (MO) optimization algorithms to address the reliability optimization problem, aiming to determine both the redundancy and reliability levels of individual system components. Traditionally, such problems are formulated as single-objective optimization tasks involving mixed (real–integer) variables and are subject to multiple design constraints. Classical solution methods have shown limitations in handling these complexities, prompting recent research to adopt nature-inspired optimization algorithms, a subfield of artificial intelligence (AI).

In this work, the problem is reformulated as a multi-objective optimization task and solved using two MO algorithms, the Non-dominated Sorting Genetic Algorithm II (NSGA-II) and Multi-Objective Particle Swarm Optimization (MOPSO). The results yield sets of optimal, non-dominated solutions, known as Pareto fronts, for each algorithm, which aid the decision-making process. The proposed approach is applied to an electromechanical system case study..

Keywords: *Reliability engineering, Multi-objective optimization, Electromechanical systems, Nature-inspired algorithms.*

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Modeling and Control of a Twin-Rotor Helicopter System

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Abstract

This paper presents the modeling and control of a twin-rotor helicopter system designed to replicate the complex dynamics of aerospace vehicles. The platform exhibits strong nonlinearities, coupled dynamics, and sensitivity to external disturbances, making it suitable for evaluating advanced control strategies. A Computed Torque Control (CTC) scheme is developed and compared with Linear Quadratic Regulator (LQR) controllers. The comparative analysis focuses on key performance metrics such as stability, tracking accuracy, and robustness under external disturbances. Simulation and experimental studies are conducted using the Quanser Aero platform to validate the control approaches. Results highlight the effectiveness and limitations of each control law, offering practical insights into the control of nonlinear and disturbance-prone aerospace systems..

Keywords: *Quanser Aero2, Computed Torque Control, PID, LQR..*

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Inverse Dynamics–Based Trajectory Control of an RRR Planar Robot under Joint Constraints

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Abstract

This paper investigates task trajectory control of an RRR planar robot to achieve precise end-effector positioning and smooth path tracking while satisfying joint constraints. The RRR planar configuration, consisting of three rotational joints operating in a two-dimensional workspace, is widely applied in high-precision industrial manipulation. A control strategy combining inverse dynamics and feedback regulation is developed to ensure accurate trajectory tracking under varying operating conditions. The robot's kinematic and dynamic models, incorporating joint position and velocity limits, are implemented in Simscape to enable high-fidelity simulation and analysis. The controller's performance is evaluated through simulation, emphasizing trajectory accuracy, error reduction, and constraint satisfaction. Results confirm the effectiveness of the proposed approach, highlighting its potential for implementation in automated and precision-oriented tasks. This study demonstrates the utility of simulation-based control analysis as a foundation for future experimental validation and real-world deployment..

Keywords: *RRR-Planar Robot, Trajectory Control, Simscape Simulation..*

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Development and Control of a SCARA Manipulator Model within Simscape Multibody

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Abstract

This paper presents the development and implementation of a complete kinematic and dynamic model of a Selective Compliance Articulated Robot Arm (SCARA) within the Simscape Multibody environment. Accurate modeling of robotic dynamics is essential for the analysis and design of advanced control strategies. A rigid-body model of the SCARA manipulator is constructed, including joint definitions, dynamic parameters, and coupling effects. A Computed Torque Control (CTC) scheme is then developed and integrated within Simulink, using the derived Simscape-based dynamic model to achieve precise trajectory
tracking. The approach combines high-fidelity modeling with nonlinear control implementation, enabling detailed performance evaluation in simulation. Results demonstrate that the proposed framework achieves accurate and stable motion control, validating the effectiveness of the CTC method and illustrating the capability of Simscape Multibody as a tool for robotic modeling and control validation..

Keywords: *SCARA Robot, Kinematic Modeling, Dynamic Modeling, Computed Torque Control..*

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Dynamic Inversion and QP-Based Control of Overconstrained Cable-Driven Parallel Robots

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Abstract

This paper presents a dynamic model–based control strategy for overconstrained cable-driven parallel robots (CDPRs), characterized by having more actuation cables than degrees of freedom. While such redundancy improves workspace range and load distribution, it complicates tension allocation and control stability. A full dynamic model is derived to capture the coupling between cable tensions, platform motion, and external forces. A dynamic inversion controller is designed to compute the desired cable forces for accurate motion tracking. To resolve actuation redundancy, a quadratic programming (QP) formulation is employed to distribute cable tensions subject to positivity and actuator constraints. Simulation results validate the effectiveness of the proposed control scheme, demonstrating accurate trajectory tracking and stable, feasible tension profiles across the robot's workspace..

Keywords: *Cable-Driven Robot, Quadratic Programming, Dynamic Inversion, Redundancy Resolution..*

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Improvement of the Shear and Plasticity Characteristics of a Low-Plasticity Calcareous Tuff by Incorporation of Coal Waste

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Abstract

The valorization of industrial waste in the field of geotechnics represents a sustainable solution for improving or adapting soil performance, particularly in Saharan regions. This study focuses on a low-plasticity calcareous tuff collected from the Béchar region (southwestern Algeria), into which various proportions of coal waste (3%, 6%, 9%, and 12% by weight) were incorporated. The tests performed include Atterberg limits, Proctor compaction, and direct shear tests.

The results show that the incorporation of coal waste leads to an increase in plasticity, which nevertheless remains within the range of low to medium plastic soils. Regarding shear behavior, an improvement is observed up to a substitution rate of 6%, which is considered the optimal threshold. Beyond this percentage, the shear properties (cohesion and internal friction angle) tend to decrease, indicating a progressive weakening of the mechanical strength of the mixture.

These results suggest that the 6% incorporation rate provides a satisfactory balance, achieving a moderate improvement in the geotechnical properties of calcareous tuff without deteriorating its shear behavior. The study highlights the potential of coal waste valorization as a geotechnical additive, while emphasizing the importance of controlling the incorporation ratio to prevent performance reduction. It thus contributes to promoting sustainable management of mining waste and the rational use of local materials in civil and road engineering projects.

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Keywords: *Calcareous tuff, Coal waste, Geotechnical properties, Plasticity, Shear strength.*

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Comparative study of prestress loss calculation codes

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Abstract

This study applies a developed shrinkage prediction model to evaluate prestress losses in prestressed concrete beams. Two I-shaped beams—one post-tensioned and one pre-tensioned—were analyzed using four international codes: BPEL 1991, Eurocode 2, ACI-318, and IS-1343. The losses considered include elastic shortening, creep, shrinkage, relaxation, anchorage slip, and friction. Results show that total prestress losses range from 818.78 MPa (Eurocode 2) to 865.73 MPa (ACI-318) in the pre-tensioned beam, and from 483.55 MPa (IS-1343) to 508.61 MPa (BPEL 1991) in the post-tensioned case. The ACI-318 code generally predicts the highest total losses due to larger estimated values of shrinkage (174 MPa), creep (399 MPa), and elastic shortening (175 MPa). In contrast, Eurocode 2 and BPEL 1991 give comparable but slightly lower results. The shrinkage values predicted by the proposed model result in slightly reduced total losses compared to those computed directly from the codes. These findings highlight that the mode of prestressing (pre- or post-tension) and the choice of code significantly influence the calculated long-term losses. Overall, the developed shrinkage model improves prediction accuracy and provides a more realistic assessment of time-dependent prestress losses in concrete structures..

Keywords: *Shrinkage prediction. Prestress Loss. post-tensioned. pre-tensioned..*

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DESIGN AND NUMERICAL MODELLING OF TUNNEL SUPPORT: CASE STUDY OF DJEBEL EL OUAHCH TUNNEL, CONSTANTINE

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Abstract

The objective of our work is to evaluate the geotechnical properties of the rock mass and recommend the optimal design for the support structure of the Djebel El Ouahch road tunnel (Constantine). Tunnel stability is a crucial issue in complex geological conditions, where inappropriate support structures can lead to excessive deformation. Previous studies have focused on empirical classifications, but integrating empirical methods with numerical modeling offers a more reliable design approach. The empirical analysis was performed using the Bieniawski (RMR) and GSI (geological strength index) methods. The section covered by this study is the area marked by points PK206+277 to PK 206+287. In addition, a 2D finite element method was performed using Phase 2 software to estimate the effectiveness of the support design, the size of the plasticized area, and the deformations around the excavation. The results obtained show that the entrance section presents unfavorable conditions with a very low RMR (13), indicating very poor rock mass requiring heavy support consisting of HEB260 arches spaced 0.75 m apart and a 35 cm layer of shotcrete. The simulation confirms that the proposed support will function properly, while highlighting significant deformations around the tunnel with a maximum displacement of 23 cm and a plasticized zone reaching a radius of 15.5 m, due to the combination of the structure's geometry and the poor geological conditions of the rock mass. In conclusion. The study proves that combining an empirical approach with numerical modeling offers a reliable solution for designing tunnel support systems..

Keywords: *Tunnel, RMR, Hoek Brown, Support, Numerical Modeling, Deformation.*

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Effect of Water Content on the Compressive Strength of an Expansive Soil Stabilized with Inert Additive

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Abstract

The swelling phenomenon of soils represents a major geotechnical issue, particularly common in arid and semi-arid regions. This phenomenon causes significant technical and financial impacts on civil engineering structures, highlighting the need for a thorough characterization of the affected soils in order to develop locally effective stabilization solutions.

The present study aims to evaluate the effect of adding marble waste powder on the strength of an expansive soil sampled from El Achour (Algiers). Mixtures of soil and marble powder were prepared at different proportions (ranging from 10% to 25% by dry weight of the soil) and at various water contents, then subjected to unconfined compressive strength tests.

The results reveal a significant increase in compressive strength with the addition of marble powder, particularly when the samples are compacted at a water content slightly lower than the optimum Proctor value..

Keywords: *Swelling soils, marble powder, stabilization, compressive strength, water content.*

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SELECTIVE OXIDATION OF N-ALKANES OVER POLYMER-SUPPORTED METAL CATALYSTS: TOWARD SUSTAINABLE VALORIZATION OF ALGERIAN CONDENSATE

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Abstract

In recent years, the controlled transformation of saturated hydrocarbons has become a subject of considerable interest, particularly in relation to the oxidation of light n-alkanes. Conversions such as those of n-hexane, n-heptane, and n-octane are highly relevant for the petroleum and chemical industries, as they provide sustainable pathways to value-added oxygenated products. To achieve these demanding transformations, polymer-immobilized transition metal catalysts have been extensively investigated. Compared with conventional systems, these heterogeneous materials offer several advantages, including lower toxicity, higher stability, and easier recovery from the reaction medium, which make them suitable for practical applications. This overview highlights the main advances, current trends and summarizes recent progress in the catalytic oxidation of n-alkanes with molecular oxygen, focusing on the development of heterogenized metal complexes. This approach also offers a promising route for the valorization of Algerian condensate through the selective oxidation of their alkane fraction. The reported results demonstrate that such catalysts are capable of promoting the selective oxidation of linear alkanes under mild conditions, thereby highlighting their potential for efficient and environmentally benign oxidation processes..

Keywords: *Algerian condensate, n-alkanes, polymer-immobilized transition metal catalysts, oxidation, oxygenated products..*

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IMPROVING BUILDINGS THERMAL COMFORT BY MODIFYING HVAC SYSTEMS TERMINAL UNITS

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Abstract

This work presents numerical study using the computational fluid dynamics (CFD) simulations, employing the commercial ANSYS Fluent software, aiming to improve the indoor thermal comfort in buildings by editing heating, ventilation and air conditioning (HVAC) systems terminal units. The purpose of this investigation is to evaluate and compare the thermal comfort obtained by ceiling multi-cone air diffuser, occupied with and without inclined inserted lobes, in an office room occupied with seated occupant, the thermal comfort was assessed in terms of percentage of dissatisfaction (PPD) and draft rate (DR) indices. This numerical study was validated using SST k-w turbulent model, the optimal mesh density was selected after testing four different mesh densities. The results showed noticeable improvement in thermal comfort after inserting inclined inserted lobes..

Keywords: *Thermal comfort, Buildings, Ceiling air diffuser, Inclined inserted lobes.*

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APPLICATION OF ADVANCED CONTROL IN QUADROTOR UAVS

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Abstract

This work focused on the control of a quadrotor Unmanned Aerial Vehicle (UAV) by first deriving its dynamic model using the Newton-Euler method and validating it with the Lagrange-Euler formulation for accuracy. A simulation function based on these equations was developed and tested in open-loop conditions with predefined control inputs to understand the system's dynamic behavior. Four control strategies were implemented and evaluated to regulate altitude, attitude, heading, and position: classical PID and PD controllers, a Linear Quadratic Regulator (LQR), and advanced nonlinear approaches including Backstepping Control and Sliding Mode Control (SMC). The controllers were implemented in MATLAB and rigorously tested through simulations to assess performance and stability. The comparative analysis showed that all controllers had similar rise time, settling time, and overshoot but exhibited unique traits. The PD controller was simple and fast but showed overshoot and minor steady-state error. Backstepping Control had good performance but required careful tuning due to parameter sensitivity. SMC achieved the lowest overshoot but had slower response and induced chattering that may harm actuators. LQR yielded the fastest response but with significant overshoot. This study highlights the importance of selecting control techniques matched to specific performance criteria. While classical methods are straightforward, advanced nonlinear and robust controls provide better precision and reliability for quadrotor UAVs under diverse conditions..

Keywords: *UAV, PID Controller, PD Controller, SMC, LQR, Backstepping..*

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3D RECURSTRUCTION USING PYTHON OPENCV

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Abstract

Reconstructing 3D shapes from a sequence of images is a challenging problem that requires precise knowledge of the camera's intrinsic and extrinsic parameters, which define its position and orientation relative to the scene. Point clouds, representing the spatial distribution of 3D points, are used to model the geometry and shape of objects. The higher the image resolution and the greater the number of viewpoints, the more accurate and detailed the reconstruction becomes.

Photogrammetry, the process of generating 3D models from overlapping 2D images using parallax, has become increasingly efficient with the advent of digital imaging and computer vision techniques. In this work, Python and OpenCV are employed for camera calibration, including the correction of radial and tangential distortions, to ensure geometric accuracy. Following multiple tests to optimize lighting and minimize shadow-induced distortions, point clouds were generated and converted into 3D models that closely resemble real objects. The results confirm that digital photogrammetry provides an effective approach for accurate and realistic 3D reconstruction..

Keywords: *3D Reconstruction, Photogrammetry, Python, OpenCV, Camera Calibration, Point Cloud..*

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SELECTIVE FIXED-BED ADSOPRTION OF TEXTILE DYES IN THE SINGLE AND BINARY SYSTEMS

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Abstract

Textile dyes are among the most commonly released pollutants into nature, in large quantities, which negatively affect human health and ecosystems. Several methods have been applied to treat and remove textile dyes. Dynamic adsorption is one of the simplest, most feasible, and industrially applicable processes. The aim of this work is to perform selective bio-adsorption in a fixed-bed column (using Cockle shells) to treat and reduce the toxicity of a simple system or a binary mixture of two dyes: Direct Red 81 (DR 81) and Cibacron Green H3G (CG-H3G).

The experiments were conducted at room temperature (22 °C) with the natural pH of the colored solutions. Dynamic adsorption was carried out by contacting a flow rate (Q = 7 mL/min) of solution (C_0 = 20 mg/L), either simple or as a binary mixture of dyes (DR 81, CG-H3G), with a bed of cockle shells (H = 5 cm). The experimental results are as follows:

-In the simple system: the adsorption capacity of the CG-H3G dye (1.39 mg/g) is higher than that of the DR 81 dye (1.11 mg/g). This result indicates that CG-H3G is more selective in the simple system.

-In the binary system: the adsorption capacity of the DR 81 dye (1.13 mg/g) is higher than that of the CG-H3G dye (0.77 mg/g). This finding indicates that DR 81 is more selective in the binary mixture.

-It can be concluded that cockle shells biomaterial can be used as a selective adsorbent to treat real textile effluents..

Keywords: *Cockle shells, Dynamic adsorption, fixed-bed, Textile dyes, Selectivity*.

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VOLCANIC ROCK-BASED GEOPOLYMERS: PROPERTIES AND MECHANICAL PERFORMANCE LITERATURE REVIEW

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Abstract

Geopolymers are innovative, low-environmental-impact materials synthesized by alkali activation of aluminosilicate-rich precursors such as metakaolin, fly ash, natural pozzolan, mining residues, and volcanic ashes and rocks. Recent interest in volcanic rocks (e.g., volcanic ash, scoria, perlite, pumice) as precursors has grown significantly. Using these natural or waste resources enables the production of geopolymers with high mechanical properties while promoting waste valorization and reducing CO_2 emissions. Their reactivity strongly depends on amorphous phase content, particle size, and chemical composition. For instance, A. Aziz et al. found that volcanic ash and acidic perlite can achieve high compressive strengths (up to 50 MPa) when properly formulated. Similarly, the study by Zheng Yanjin et al. demonstrates that a 50/50 mix of volcanic ash (VA) and blast furnace slag (BFS) allows N-A-S-H and C-(A)-S-H gels to achieve a synergistic effect, resulting in a homogeneous and dense microstructure with compressive strength exceeding 55 MPa. This study provides a literature review on the synthesis of volcanic rock-based geopolymers. Building on previous research, it highlights the key role of the mineralogical composition and reactivity of the precursors on the final material performance.

.

Keywords: *Geopolymers, Volcanic rocks, Synergistic effect, Mechanical performance, Alkaline activation..*

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EFFECT OF THE COMBINATION OF MINERAL ADDITIONS ON THE MODULUS OF ELASTICITY OF CONCRETE

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Abstract

This paper investigates the effect of mineral additions, namely limestone fillers, blast furnace slag, and silica fume, on the Young's modulus of concrete after 28 days of curing. These additions were incorporated into the concrete mix design by replacing 50% of the cement with a combination of two alternative materials, such as limestone fillers and blast furnace slag (LF–BFS), and limestone fillers and silica fume (LF–SF).

It was observed that the modulus of elasticity of concrete strongly depends on the nature and proportion of mineral additions, which influence the microstructure and density of the material. The reference concrete (RC), without any additions, exhibited a higher Young's modulus. The combination of silica fume with limestone fillers (LF–SF) produced notable results. Indeed, the obtained Young's moduli were relatively high, indicating good stiffness in the studied concretes. For example, the mix containing 10% LF and 40% SF showed a Young's modulus (E) of 37005 MPa. However, the E value of concretes combining 10% LF and 40% BFS was around 33803 MPa.

Although these values are slightly lower than that of the reference concrete, they remain within acceptable limits, providing greater flexibility while still meeting stiffness requirements for certain specific applications.

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Keywords: *Blast furnace slag, limestone fillers, silica fume, combination, the Young's modulus of concrete..*

PARAMETRIC NUMERICAL STUDY ON THE FLEXURAL BEHAVIOR OF FRP-STRENGTHENED RC BEAMS

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Abstract

Fiber-reinforced polymers (FRP) have become a widely adopted solution for strengthening reinforced concrete (RC) structures, primarily due to their superior mechanical performance and resistance to environmental degradation. Despite their effectiveness, the flexural behavior of FRP-strengthened RC beams is influenced by several parameters related to the constituent materials and reinforcement properties. In this study, a numerical investigation was conducted to analyze the flexural performance of RC beams externally strengthened with FRP plates. Previously published experimental results were used as a reference, and the numerical simulations were carried out using a cohesive zone model (CZM) to represent the nonlinear behavior. The study examines the influence of key parameters, such as the mechanical properties of the FRP, the compressive strength of concrete, and the elastic modulus of the epoxy adhesive, on the overall structural response. The numerical results show strong agreement with experimental findings and confirm that variations in material characteristics significantly affect the load–deflection behavior and flexural capacity of FRP-strengthened RC beams..

Keywords: *RC beams, FRP, CZM, ANSYS.*

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STUDY OF THE INFLUENCE OF THE TREATMENT TYPE OF DATE PALM STEMS ON THE PHYSICO-MECHANICAL BEHAVIOUR OF COMPRESSED EARTH BLOCKS

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Abstract

In the rural, arid and desert areas of Southern Algeria, constructions are often carried out with raw earth due to its wide availability, its low price and its ease of implementation. Unfortunately, these old buildings suffer from disorders and deterioration which appear in the form of cracks frequently caused by shrinkage and differential settlement. In this study, we are interested in the development of a new ecological, low-cost material of construction, adaptable to the hot and desert climate, which must meet the mechanical and durability requirements of earth constructions. It is made from raw earth as a matrix and date palm fiber (stems) (DPS) as reinforcement, moistened with water, then poured into a steel mold and after then statically compacted using a manual hydraulic press. The use of DPS falls within the framework of the valorization of date palm waste which can be used as a renewable natural reinforcement in construction materials which can lead to the improvement of these mechanical performances and durability. For this purpose, several formulations of compressed earth blocks (BTC) reinforced with different rates of untreated and treated DPS (0,5 ; 1 ; 1,5 and 2 %), lengths (1, 2 and 3 cm), and morphology (smooth, rough and mixed) were developed. The DPS having undergone three types of treatments namely treatment by boiling, autoclaving and hornification, in order to serve as reinforcement in the reinforced BTC then compared to the unreinforced BTC. The influence of the percentage, length, morphology and treatment of DPS on the physico-mechanical properties were performed and discussed.

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Keywords: *Key words : earth construction, compressed earth blocks, static compaction, date palm waste, natural reinforcement, physico-mechanical properties..*

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STUDY OF THE INFLUENCE OF THE TREATMENT TYPE OF DATE PALM STEMS ON THE PHYSICO-MECHANICAL BEHAVIOUR OF COMPRESSED EARTH BLOCKS

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Abstract

Abstract: This research aims to study the influence of the non linearity of barrettes subjected to lateral loads. For this purpose, numerical analyses were carried out using the Concrete model recently developed for the software PLAXIS 3D. The results revealed that the response of the barrette is strongly influenced by the nonlinear behaviour of its materials. Neglecting the nonlinear behaviour of the materials leads to an underestimation of the lateral load bearing capacity of barrettes..

Keywords: *Keywords: PLAXIS 3D, Concrete, Barrette, nonlinear behaviour, linear behaviour, cracking..*

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TOPOGRAPHY OPTIMIZATION OF AN ELLIPTICAL DOME: EFFECT OF THICKNESS

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Abstract

An elliptical shell is known for its efficient load distribution and smooth curvature, making it one of the most structurally and aesthetically efficient shapes in engineering. This study investigates an elliptical, reinforced concrete dome with fixed supports along its base. The dome was optimized through a topography optimization process to enhance stiffness and material efficiency. The dome was modeled as a shallow shell and subjected to a uniformly distributed load combined with its self-weight. Two thickness configurations were analyzed to evaluate the impact of shell thickness on the optimization's performance. The optimization aimed to minimize compliance. The results indicated substantial improvements in stiffness: the thicker shell achieved a compliance reduction of approximately 46%, while the thinner shell showed a smaller reduction of about 25%. Additionally, the optimization resulted in moderate mass savings, with the thicker shell demonstrating a reduction of approximately 2.31%, compared to 0.96% for the thinner shell. These results demonstrate that topography optimization effectively improves stiffness and material efficiency. Thicker shells benefit more in the case of elliptical dome structures..

Keywords: *elliptical dome, topography optimization, thickness, compliance.*

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ENGINEERING AND CHARACTERIZATION OF FIBER-REINFORCED COMPOSITES FROM DAM SEDIMENTS FOR SUSTAINABLE LINER APPLICATIONS IN CIVIL INFRASTRUCTURE

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Abstract

The mud extracted from the bottom of dams (MED) poses a major environmental challenge in terms of disposal, due to its increasing volume and the limited avenues for valorization. This study investigates the reuse of MED as a raw material for the production of compacted barrier systems, used as passive hydraulic barriers systems in landfills, mining tailing, and wastewater treatment applications.

To improve the mechanical and hydraulic performance of MED, fiber reinforcement was introduced using treated wheat straw fibers (natural, biodegradable). Composite mixtures were prepared with fiber contents of 0%, 0.3%, 0.6%, and 0.9% by dry weight. Standard geotechnical tests, including Proctor compaction, direct shear, oedometer consolidation and permeability, were conducted to assess compaction characteristics, strength behavior, and compressibility. Fourier-transform infrared spectroscopy (FTIR) was used to analyze chemical interactions within the fiber-MED matrix. Results show that both fiber improve mechanical behavior compared to unreinforced MED. However, Alkali treated wheat straw fibers demonstrate promising potential as a sustainable reinforcement alternative, offering acceptable performance while reducing environmental impact. This study highlights the feasibility of developing fiber-reinforced MED liners and contributes to ongoing efforts in sustainable geotechnical material design.

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Keywords: *Keywords: Mud Extracted from Dam, Hydraulic Barrier, Wheat Straw Fibers, Fiber Reinforcement, FTIR, Sustainable Geomaterials.*

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From Desert to Pavement: Effects of Fine Particles on the Compaction Behavior of Dune Sand for Subgrade Applications

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Abstract

In a global context of depletion of conventional natural aggregates, many countries have explored innovative strategies to valorize desert sands (dune sands) in civil engineering, particularly in road infrastructures for pavement subbase layers. This bibliographic review presents a critical analysis of the approaches adopted by different countries (China, United Arab Emirates, Saudi Arabia, etc.) to overcome the technical limitations of dune sands, characterized by their high uniformity and low bearing capacity. The techniques studied include treatment with hydraulic binders, the addition of industrial by-products (slag, fly ash), as well as chemical and mechanical stabilization methods. This contribution aims to identify best practices that can be transferred to the Algerian context, particularly in Saharan regions such as Djelfa, with a focus on sustainability, cost reduction, and the valorization of local resources.

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Keywords: *Dune sands, valorization, bibliographic review, stabilization, road infrastructures..*

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CARACTERISATION ET EVALUATION DE LA STABILITE DES ANTHOCYANES ISSUES DE LA ROSELLE

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Abstract

Roselle is a plant that is very rich in anthocyanins. Extracts from its flowers and calyces are used as natural colorants in several industrial and food applications. However, these pigments are sensitive to light, temperature, pH, and humidity. Therefore, studying the stability of Roselle anthocyanins under different storage conditions is necessary to expand their field of application. We examined the stability of anthocyanins extracted from Roselle flowers by first evaluating the impact of various factors such as temperature, pH, and storage conditions. The degradation of Roselle anthocyanin extract was studied at different pH values ranging from 1 to 4.5, stored under exposure to light, in the dark, or at 4°C for 60 days. The Roselle anthocyanin extract at low pH showed better stability.

The extract stored at a low temperature (4°C) and in darkness retained the highest anthocyanin content after 60 days of storage, followed by the one stored in darkness and then the one exposed to light. Anthocyanins degraded rapidly when subjected to heating for 120 minutes. The study of the stability of Roselle anthocyanin extracts could contribute to expanding their use as a potential source of natural pigments, serving as an alternative to artificial dyes for both food and non-food applications.

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Keywords: *Anthocyanins; Stability; Temperature; Storage; pH.*

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PROPERTIES OF CEMENTITIOUS ECO-COMPOSITES BASED ON CONSTRUCTION WASTE REINFORCED WITH HYBRID FIBERS

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Abstract

Brick waste from the red brick industry remains one of the underutilized by-products. A promising solution is to use it in the production of sustainable mortars capable of replacing traditional sand-based mortars.

Reinforcing construction materials, particularly mortars, through the addition of fibers is an increasingly common technique aimed at improving their mechanical properties. The objective of this study is to evaluate the performance of a mortar in which sand is partially replaced by brick waste at substitution rates of 10%, 15%, and 30%, while incorporating two types of fibers (steel and polypropylene) in varying proportions: steel fibers at 0.5%, 0.6%, and 0.7%, and polypropylene fibers at 0.1%, 0.2%, and 0.3%. The results show that the combined use of brick waste and steel or polypropylene fibers significantly enhances the mechanical properties of mortars, particularly compressive strength and tensile strength.

.

Keywords: *Keywords: Mortar, Brick waste, Steel fibers, Polypropylene fibers, Properties..*

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PHYSICO-MECHANICAL STUDY OF A NEW CEMENTITIOUS COMPOSITE BASED ON PLANT WASTE

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Abstract

This research is part of the general policy of energy conservation and environmental protection. It aims to study the influence of plant residues, particularly olive and date pits, on the characteristics of an eco-friendly mortar.The work involves collecting pits from the olive processing industry, which are generally discarded in nature, as well as date pits, and incorporating them into mortar production as aggregates by partially replacing sand with these wastes at different substitution rates: 5%, 10%, and 20% for olive pits, and 8%, 16%, and 24% for date pits. The results show that incorporating these organic wastes (olive and date pits) leads to a decrease in workability and compressive strength of the mortars. However, the thermal properties are significantly improved due to their addition. Thus, it is possible to develop new insulating construction materials that can be used in various building applications.

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Keywords: *Keywords: Cementitious composites, Plant waste, Olive pits, Date pits, Mechanical properties..*

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EFFECT OF VEGETABLE FIBERS ON THE WORKABILITY OF MORTARS BASED ON SLAG AND RECYCLED GLASS

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Abstract

Mortars based on slag and recycled glass represent a promising and sustainable alternative in modern concrete technology. In this study, vegetable fibers (VFs) were incorporated into mixtures containing glass powder and slag (GP/S). The primary aim was to evaluate the workability of GP/S mortars reinforced with different native Algerian plant fibers, Alfa (A) and Diss (D), while polypropylene fibers were used as a reference for comparison. Accordingly, six mortar formulations were developed: MC, MS, MSG, MSGA, MSGD, and MSGP. Flow tests were conducted to assess the fresh-state consistency of the mixtures. The results show a decrease in the flow of mortars based on slag and recycled glass when reinforced with vegetable fibers..

Keywords: *slag, glass powder, Alfa/Diss vegetable fibers, Polypropylene, workability.*

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Numerical Investigation of the Ultimate Bearing Capacity of Strip Footing on a Bilayer Slope

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Abstract

Implementation of geosynthetics in civil projects is increasing rapidly. To increase the Ultimate Bearing Capacity (UBC) of granular soils, to avoid the construction of expensive deep foundations (a cost-effective options) and decrease the foundation settlement, soil reinforcement by means of geogrid is an effective method. In this paper, a finite element simulation using PLAXIS 3D was carried out to investigate the ultimate bearing capacity of strip footings located near a geogrid-reinforced slope (sand overlying soft clay). The influence of different keys parameters on the load carrying capacity of the footing has been investigated. The parametric study focuses on the effect of the depth of replaced sand layer, the length of geogrid layers, depth of the topmost layer (u/B) of geogrid, and vertical spacing of geogrid layers (h/B). Relative density of sand on the ultimate bearing capacity also have been investigated. The Hardening Soil model with small-strain stiffness (HSs) implemented in Plaxis, is used in this study to simulate the non-linear stress-strain soil behavior. The results show that the ultimate bearing capacity increases with increase in depth of replaced sand layer and relative density of sand. The results indicates that there is a critical values for the embedment depth to footing width ratio (u/B), vertical spacing between reinforcement layers (h/B) and the length of geogrid layers..

Keywords: *Ultimate Bearing Capacity, Slope, Strip Footing, Geogrid Reinforcement, Numerical Analysis..*

EXPERIMENTAL STUDY OF THE HYGROTHERMAL AND MICROSTRUCTURAL PERFORMANCE OF MODIFIED GYPSUM

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Abstract

In this study, the effect of the progressive incorporation of an organic material into a gypsum-based matrix was evaluated through a series of physico-mechanical and microstructural tests. The formulations studied included different percentages of added GOS (Ground Olive Stones), and the resulting specimens were characterized in terms of open porosity, water absorption, thermal conductivity, and microstructural observation using Scanning Electron Microscopy (SEM). The results show a clear increase in open porosity and water absorption with higher addition rates, indicating a more aerated and permeable structure. At the same time, thermal conductivity gradually decreases, suggesting an improvement in the insulating performance of the composites, which is directly related to the increase in the porous fraction. SEM analyses confirm these observations, revealing a more heterogeneous microstructure characterized by interconnected voids. These findings highlight that the incorporation of organic matter, although it alters the compactness and water durability of the material, can be an effective strategy to enhance its thermal properties, thus opening interesting perspectives for applications in the field of sustainable and low-energy construction materials..

Keywords: *Gypsum, addition, open porosity, water absorption, thermal conductivity..*

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RSM FOR ECO-EFFICIENT ADSORPTION: TACKLING THE CHALLENGE OF RECALCITRANT CONTAMINANTS

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Abstract

The adsorption of recalcitrant contaminants represents a major challenge in water treatment. In this work, three model compounds – paracetamol, amoxicillin, and diclofenac were selected to evaluate the performance of activated carbon as an adsorbent. To translate experimental complexity into a reliable predictive model, the Response Surface Methodology (RSM), based on a Central Composite Design (CCD), was applied using Design-Expert 7.0 software. A total of 30 experimental runs, including six replicates at the central point, were conducted to investigate the influence of four key parameters: solution pH, contaminant concentration, contact time, and activated carbon dose. The results revealed that a second-order polynomial model accurately described not only the individual effects but also the interactions among these variables. This statistical approach highlights the relevance of RSM as an optimization tool to enhance adsorption efficiency and to support the development of advanced processes for sustainable water treatment..

Keywords: *[Recalcitrant contaminants, Response Surface Methodology (RSM), Central Composite Design (CCD), Water treatment, Activated carbon]*.

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FINITE ELEMENT SIMULATION OF REINFORCED CONCRETE BEAMS EXTERNALLY STRENGTHENED WITH CFRP MATERIALS.

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Abstract

In recent years, fiber reinforced polymer (FRP) is a promising material that is used for strengthening as well as repairing concrete structures. The current study presents a numerical investigation of flexural deficient reinforced concrete (RC) beams externally enhanced with attached Carbon Fiber Reinforced Polymers (CFRP). This work focuses on developing three-dimensional (3D) finite element (FE) models of a collection of experimentally proven beams reported in the literature that can successfully simulate and capture the behaviour and effectiveness of externally enhanced reinforced concrete (RC) beams implementing CFRP laminates/sheets under three-points loading. The numerical model takes into account constitutive material laws as well as the perfect behaviour of the concrete and improving system. The expected FE findings for the load-midspan displacement are verified with the experimental data. Throughout the loading process, there was a close agreement between the predicted and recorded findings for the evaluated specimens. Furthermore, the verified model was employed in a parametric investigation examining the impact of FRP type, and concrete compressive strength on the general performance of concrete beams externally emphasized with CFRP laminates/sheets. The conclusion is that the FE models that were developed can accurately predict and capture the response and failure mode of RC beams that have laminates/sheets added.

Keywords: *Fiber reinforced polymer (FRP), flexural deficient, reinforced concrete (RC), (3D) finite element (FE) models.*

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ASSESSMENT OF THE POTENTIAL USE OF RIVER SEDIMENTS AS ALTERNATIVE MATERIALS IN ROAD CONSTRUCTION

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Abstract

The use of river sediments as an alternative material represents a significant potential resource in civil engineering, particularly in road construction. However, the valorization of these sediments poses a major economic, technical and environmental challenge. Therefore, a thorough understanding of the various characteristics of these materials is essential, requiring a series of laboratory tests, including physico-chemical, geotechnical and mechanical tests.

This study fits within this framework and focuses on the experimental characterisation of sediments collected from the banks of the Oued Soummam river in the region of Bejaia. The main objective is to identify the composition of the material and assess its potential for use as a road construction material. The analysis of the constituent element contents is an essential parameter for assessing the direct suitability of sediments for construction, or for defining the treatments necessary to improve their physico-chemical, mineralogical and mechanical properties.

The experimental results obtained revealed that the material in its raw state does not meet the requirements for road use. However, treatment with varying percentages of hydraulic binder led to a significant improvement in the physico-chemical and geotechnical properties of the treated sediment, making it suitable for use in road construction.

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Keywords: *Sediment, Geotechnics, Hydraulic binder, Improvement, Road..*

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Investigation of Structural Dynamic Characteristics Using Shaking Table Experiments

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Abstract

Over the years, several countries have been affected by powerful earthquakes, causing severe human casualties and substantial structural damage. These naturals events have motivated researchers in earthquake engineering to develop various approaches focused on lessening seismic hazards and minimize seismic risks and the damages impacts. Given the inherent difficulty in accurately predicting the dynamic response of structures through analytical methods alone, experimental investigations have become essential for validating theoretical models. This research focuses on the dynamic characteristics of structures through scaled-reduced models. The main purpose of this work is to experimentally evaluate the dynamic response of a steel specimen using shaking table tests. The specimen is subjected to harmonic dynamic excitations to capture its dynamic response using the Setra 141 accelerometer. Based on these measurements, the dynamic characteristics of this specimen, such as its natural frequency and damping ratio, are determined. Based on finite element analysis, a numerical model of the specimen is then used to simulate its dynamic response. The comparison of these two approaches led to a high level of consistency between the experimental results and the numerical predictions. The specimen is further subjected to free vibration experiments, where the damping ratio is calculated using the random decrement method, relying on the temporal variation of the acceleration signals obtained during the tests. The findings highlight the fundamental role of dynamic characteristics obtained from experimental investigations in accurately assessing and comprehending the dynamic response of structures..

Keywords: *Shaking table, Dynamic characteristics, Natural frequency, Damping ratio, Random decrement method..*

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PREPARATION OF CELLULAR CERAMIC BASED ON LOCAL KAOLIN

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Abstract

The Tamazert kaolin (KT2), due to its low alumina content and excess silica, is generally considered unsuitable for ceramic fabrication. To compensate for this chemical imbalance, this study proposes the addition of aluminum slag to the KT2–limestone mixture in order to produce a cellular ceramic. The resulting mixture was ground and homogenized with distilled water before being cast into molds of the desired shapes. After demolding, water evaporation led to the formation of low-density porous samples. Thermal analysis (TG-DSC) was carried out to monitor the reactions occurring during heat treatment: two endothermic reactions were observed, followed by a noticeable exothermic reaction around 900 °C. Complementary X-ray diffraction (XRD) analysis of the samples sintered at 910 °C revealed the formation of two phases — a major "Gehlenite" phase and minor traces of calcium and aluminum silicate. Since the TG-DSC analysis up to 1250 °C did not show any additional reactions, sintering was performed at this temperature. The resulting cylindrical specimens exhibited a compressive strength of about 1 MPa and a porosity exceeding 60%. These physico-mechanical properties fall within the strength range of standardized lightweight construction bricks, indicating that the samples produced in this study could serve as a suitable substitute for lightweight civil engineering bricks..

Keywords: *Key words: kaolin, aluminum slag, Gehlenite, cellular ceramic..*

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THE IMPACT OF SOIL-STRUCTURE INTERACTION ON THE NONLINEAR DYNAMIC RESPONSE OF FOUNDATIONS

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Abstract

The analysis of foundation behaviour under dynamic loads has evolved considerably over the past four decades. The strict safety requirements imposed on the design of certain types of structures have played a particularly important role in this development. To understand the non-linear dynamic behaviour of foundations, a series of axisymmetric models were created using PLAXIS 3D finite element analysis software. Taking soil-structure interaction into account when analysing the dynamic behaviour of foundations enables the influence of the soil on its vibrations to be considered realistically. The rheological properties of different soil configurations will be studied, both linear and non-linear. Additionally, the propagation of vibrations to the surrounding soil will be examined. To reduce calculation time, only a quarter of the overall geometry is modelled using symmetry boundary conditions along the symmetry lines. Physical damping due to viscous effects is taken into account via Rayleigh damping. Additionally, geometric damping can be important in attenuating vibration due to the propagation of radial waves. Boundary modelling is a key consideration in dynamic calculations. To avoid parasitic wave reflections at the model's boundaries, special conditions must be applied to absorb waves that reach them .A comparative study was carried out between the two models, resulting in the drawing of conclusions. The results showed that considering the nonlinearity of the soil and soil-structure interaction is important for understanding the dynamic response of foundations..

Keywords: *Soil-structure interaction, Dynamic response, Non-linear, Foundations, Modeling.*

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VALORIZATION OF DREDGED SEDIMENTS AS BACKFILL MATERIAL

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Abstract

The increasing scarcity of natural materials used for earthworks has led to a growing interest in the recovery of dredged sediments as alternative resources. Although these sediments are often regarded as waste, they can be reused and represent a valuable alternative resource for civil engineering applications, particularly in road construction. Their management and valorization raise significant economic, technical, and environmental challenges for local communities. Transforming these sediments from polluting waste into high-value materials contributes to a more sustainable use of natural resources.

This study is part of a broader approach aimed at recovering and valorizing sediments from the Ighil Emda dam, located in the Kherrata region. It focuses on the physical and mechanical characterization of the material and assesses its potential use as a road embankment material. A series of laboratory tests was conducted to evaluate its performance. The results indicate that the sediment, in its natural state, does not meet the required standards for direct use as embankment material. Therefore, an improvement of its properties is necessary to achieve the strength and durability criteria expected for road construction materials.

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Keywords: *sediment, characterization, embankment, valorization, performance.*

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Mechanical Performance of Lime-Stabilized Compacted Earth Blocks

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Abstract

This study investigates the mechanical performance of compacted earth blocks (CEBs) stabilized with lime to enhance their strength and sustainability. Local silty soil was mixed with 4%, 8%, and 12% lime by dry weight, compacted under 5 MPa pressure, and cured for 28 days. The blocks were tested for compressive and tensile strength, as well as the wet-dry strength ratio. The results show a significant improvement in mechanical performance with lime addition. The dry compressive strength increased from 4.01 MPa for unstabilized blocks to 8.17 MPa at 8% lime and 10.79 MPa at 12%, while the wet compressive strength
rose from 1.8 MPa to 5.5 MPa and 8.63 MPa, respectively. The dry tensile strength also increased from 1.05 MPa to 1.5 MPa and 1.96 MPa. Although 12% lime achieved the highest strengths, 8% provided the best balance between performance and cost-effectiveness. These results confirm lime as an efficient, low-carbon stabilizer for sustainable masonry applications..

Keywords: *compressed earth blocks, lime, mechanical strength, strength ratio,*

sustainable construction.

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Evaluation of Waste Foundry Sand as a Sustainable Partial Replacement for Natural Sand in Mortar

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Abstract

The depletion of natural sand reserves and the environmental consequences of their extraction have intensified the search for sustainable alternatives in construction materials. This study examines the potential of waste foundry sand (WFS) as a partial replacement for natural sand in mortar, contributing to circular economy goals and resource efficiency. Six mortar mixes incorporating 0%, 10%, 20%, 30%, 40%, and 50% WFS by weight were prepared and tested for compressive and flexural strength at 7, 28, and 56 days, in accordance with EN 196-1 standards. The results indicate that a 10% substitution of natural sand with WFS maintains or slightly enhances the mechanical strength compared with the control mix. Beyond this level, both compressive and flexural strengths gradually decrease with increasing WFS content, likely due to the finer particle size and the presence of residual impurities affecting the mortar matrix. Overall, the findings demonstrate that a limited proportion of WFS can serve as a technically viable and eco-efficient fine aggregate in mortar production, reducing dependence on natural sand. Future work will investigate durability performance and microstructural characteristics to confirm the long-term applicability of WFS-based mortars in sustainable construction..

Keywords: *waste foundry sand; mortar; sustainable construction; compressive strength; flexural strength; alternative fine aggregate.*

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Wave propagation analysis of FG-CNT composite beams on elastic foundations

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Abstract

This paper investigates the propagation of waves in functionally graded carbon nanotube- reinforced composite (FG-CNTRC) beams resting on a Pasternak elastic foundation composed of a shear layer and Winkler springs. The reinforcement consists of single-walled carbon nanotubes (SWCNTs) with various uni-axially aligned distribution patterns, including a uniformly distributed (UD) configuration to assess the influence of nonlinear (NL) variations in CNT content. Based on the first-order shear deformation theory (FSDT) and Hamilton's principle, the governing equations are derived and analytical dispersion relations are established to evaluate wave frequencies and phase velocities. The results highlight the effects of CNT distribution type, volume fraction and foundation stiffness on the wave propagation characteristics..

Keywords: *Wave propagation ; (CNTRC) beams ; Hamilton's principle ; Dispersion relation.*

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THE BODY IS NOT JUST LIFE, IT IS A MECHANICAL MACHINE

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Abstract

Background: Understanding the human body's mechanical interactions is crucial for healthcare development and disease solutions. Biomechanics, a field combining material science, mechanics, and technology, is vital for developing assistive devices for over 2.5 billion people globally. However, progress in this field has been slow, highlighting the need for research into local factors and potential solutions.

Methods: This research is based on a review and analysis of previous experimental studies in the field of biomechanics. Among them is an American company specialized in the production of advanced plastics that acquired a factory specializing in precision molds, with the aim of expanding the production of medical components. This move is an industrial strategy that highlights the fact that the development of medical devices requires a strong industrial structure based on the manufacture of presised materials and components , mostly polymers, metals, alloys, and ceramics.

Results: The analysis shows that the study of the previous experiences of American companies, can contribute to the available capabilities in the field of mechanics and local manufacturing in Algeria.

This would enable the development of medical devices through the use of machines and robots, and the use of local factories employing innovative and integrated methods that enhance industrial efficiency and quality.Conclusion: Biomechanical testing plays a crucial role in the advancing medical devices, thereby enhancing patient outcomes and promoting health and well-being. Its impact extends beyond patients, offering opportunities for innovation that benefit customers, employees, and stakeholders in biomechanics by facilitating the integration of scientific research with industrial applications..

Keywords: *biomechanics,technology,mechanical interaction,device disign.*

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AN INNOVATIVE AND INTERPRETABLE HYBRID AI SYSTEM FOR AUTOMATED DIAGNOSTIC AND ENGINEERING APPLICATIONS

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Abstract

The integration of artificial intelligence into diagnostic engineering has enabled intelligent systems capable of automating complex medical assessments. This study presents an interpretable computer-aided diagnosis (CAD) framework for the early detection of Parkinson's disease using magnetic resonance imaging (MRI), emphasizing system optimization, computational efficiency, and innovation. The proposed approach combines a custom-designed Convolutional Neural Network (CNN) for hierarchical feature extraction with a Bayesian-optimized Random Forest (RF) classifier for robust decision-making. The system was validated on MRI data from 178 Parkinson's patients and 124 healthy controls from the Parkinson's Progression Markers Initiative (PPMI) dataset. The CNN–RF framework achieved 98.9% accuracy, 99.0% precision, and an AUC of 0.996. Beyond its biomedical application, this work demonstrates an innovative and scalable AI architecture capable of high-performance automated decision-making, offering potential for adaptation in diverse engineering and industrial systems..

Keywords: *Hybrid AI, computer-aided diagnosis, interpretable AI, engineering innovation.*

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AI-BASED RESIDUAL LEARNING FRAMEWORK FOR INTELLIGENT IMAGE-BASED DIAGNOSTICS

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Abstract

Artificial intelligence is reshaping healthcare through data-driven and automated diagnostic systems. This study presents an innovative AI-based residual learning framework, employing the ResNet18 architecture, for the early detection of Parkinson's disease (PD) from structural magnetic resonance imaging (MRI) data. Using the Parkinson's Progression Markers Initiative (PPMI) dataset, the model was fine-tuned across multiple MRI-derived images—gray matter (GM), white matter (WM), cerebrospinal fluid (CSF), and Jacobian determinant maps. Feature vectors extracted from ResNet18 were classified with a Bayesian-optimized Random Forest, enhancing generalization and interpretability. The Jacobian map features achieved the best performance, with 98.2% accuracy, 98.3% sensitivity, 98.2% specificity, 98.7% precision, and an AUC of 98.74%, while the GM-based model achieved 96.4% accuracy and 97.6% AUC. These results demonstrate the framework's ability to capture subtle morphological patterns linked to neurodegenerative changes. The proposed approach represents a computational innovation in image-based diagnostics, bridging intelligent systems research with practical healthcare technology applications..

Keywords: *Computational Innovation, Artificial Intelligence, Deep Residual Learning, Biomedical Imaging, Diagnostic Technology.*

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APPLICATION OF REVERSE OSMOSIS MEMBRANE TECHNOLOGY FOR TANNERY WASTEWATER PURIFICATION

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Abstract

One of the most common forms of pollution control in the world is wastewater treatment. Thus, wastewater reclamation has become a viable alternative to supplement water supplies in water-short areas. It is evident from the literature survey articles that ion-exchange, adsorption and membrane filtration are the most frequently studied for the treatment of heavy metal wastewater. In particular, membrane technology is being used for the large-scale reclamation of wastewater. Successes of this new technology depend on proper pretreatment, chemical control and reverse osmosis membranes that are resistant to fouling. Reverse osmosis is a process that industry uses to clean water, whether for industrial process applications or to convert brackish water, to clean up wastewater or to recover salts from industrial processes.

The Chromium is one of the most dangerous inorganic water pollutants.

The main objective of this study is to demonstrate the efficiency of reverse osmosis membrane for removal of trivalent chromium from aqueous solution. A reverse osmosis (RO) process was used to remove the contaminants of the tannery spent wash The feasibility of the membranes for treating wastewater from the tannery industry by varying the feed pressure (0–40 bar) and feed concentration was tested on the separation performance of thin-film RO membranes. Also, the influence of pH on the removal process has been studied.

The results obtained are encouraging and make it possible to propose that the reverse osmosis filtration process is by far the most effective for water purification.

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Keywords: *Reverse osmosis, Membrane, Recovery, Chromium, Wastewater..*

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IoT-Based Smart Wristband for the Early Detection of Fever in Children

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Abstract

The early detection of fever in children is very important to prevent further complications and for the early intervention of medical services. This paper describes the design and development of an IoT-enabled smart bracelet that can continuously monitor body temperature in real time. The developed system consists of a MAX30205 temperature sensor with an ESP32 microcontroller, powered by a rechargeable battery for autonomous working. If there is an increase in temperature beyond 38 °C, it will trigger a local alarm via a buzzer and will send a notification to the parents remotely through a mobile app developed on the Blynk platform. The IoT-based communication enables the immediate awareness and fast response of the parents regarding the potential fever episodes. This prototype demonstrates a low-cost and power-effective method, enhancing child health monitoring, especially in regions facing poor healthcare access. Future work will focus on the incorporation of additional biosensors and data analytics modules towards broader health diagnostics..

Keywords: *smart health, IoT, body temperature monitoring, ESP32, children's health, MAX30205 sensor*.

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