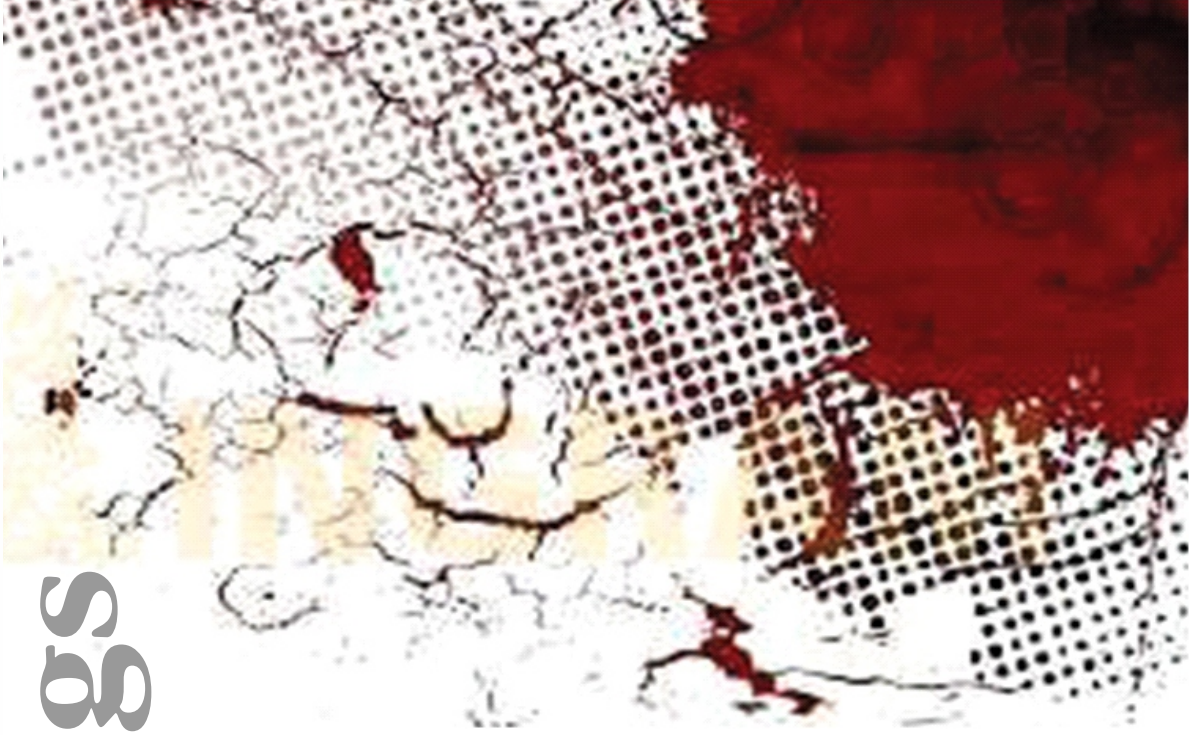

Proceedings

7th Tunisian Congress of Mechanics

COTUME'2025

7ème Congrès Tunisien de Mécanique

1 – 3 May / Mai 2025

Mahdia – Tunisia / Tunisie

CoTuMe'2025

Preface

The Tunisian Society of Mechanics (ATM) organizes, every three years, the Tunisian International Congress on Mechanics (COTUME). Its seventh edition is programmed on Mai 1st -3rd, 2025. The congress presents an important opportunity to meet and to exchange between researchers in mechanics, in its broadest sense. It is one of the ATM's tools to structure and dynamize the Tunisian mechanics community and to help it to make well known its scientific production. A particular encouragement is addressed to both PhD student and young doctors to present their research works. The participation of the industrial sector is also highly encouraged.

The COTUME'2025 congress will ensure, during the three days, plenary, paper and poster sessions. Round tables on mechanics in Tunisia will be organized.

Altogether, there are more than 150 papers submitted to the congress. 145 papers were accepted from which 130 for oral presentations and 15 for poster presentations. All contributed papers were subjected to a review process and have been published in a numeric proceedings.

We hope that everyone finds the technical program intellectually stimulating and their stay in Tunisia enjoyable.

A successful organization of such congress is a considerable task. First, we would like to thank all the authors for submitting their valuable contributions and meeting the deadlines. The commendable job done by all the members of the scientific committee is greatly appreciated.

Special thanks go also to the organizing committee for great job they did to organize this congress.

We would like to extend our warmest welcome to all attendees of the seventh Tunisian International Congress of Mechanics COTUME'2025.

Pr. Tarak BOURAOUI

COTUME'2025 Chair

7th Tunisian International Congress of Mechanics

COTUME'2025

Seventh Tunisian International Congress of Mechanics

01-03 Mai 2025

Mahdia – Tunisia

Organized by

Association Tunisienne de Mécanique (ATM)

Abstract Proceedings

https://www.cotume.tn

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Topics

Recent developments in the field of Mechanics. In particular, the following topics are addressed.

- Biomechanics
- Design Methodology & Robotics
- Dynamics and Vibrations of Structures, Modeling and Structures analysis
- Energy, Mass, Heat transfer and Fluid mechanics
- Industrial applications & advanced technologies
- Manufacturing processes & Additive Manufacturing
- Materials: Structure and behaviour
- Contact mechanics

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Venue:

Mahdia, Tunisia

SUMMARY

Plenary Sessions

Invited Speakers

Topic: Biomechanics

Topic: Design Methodology & Robotics

Topic: Dynamic and vibration of Structures, Modelling and Structures analysis

Topic: Energy, Mass, Heat transfer and Fluid mechanics

Topic: Industrial applications & advanced technologies

Topic: Manufacturing processes and additive manufacturing

Topic: Materials: Structures & Behavior

Posters

PLENARY SESSIONS

PROF. CHIHEB BOUDEN

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Ecole Nationale d'Ingénieurs de Tunis - Université de Tunis El Manar, Tunisie

PS1 : Hydrogène Vert : Quelle contribution est attendue du secteur de l'enseignement supérieur pour accompagner les objectifs de la stratégie nationale ?

Biography: *Chiheb BOUDEN est professeur à l'École Nationale d'Ingénieurs de Tunis (ENIT). Il a été à plusieurs reprises professeur invité et chercheur associé dans diverses universités en Europe et aux États-Unis. Il est diplômé en génie civil de l'ENIT (promotion 1984), titulaire d'un Diplôme d'Études Approfondies (DEA) en Énergie Solaire obtenu à l'Université Paris-Diderot en 1985, ainsi que d'un doctorat en Physique et Énergie de la même université, soutenu en 1989. Ses travaux de recherche portent principalement sur la conversion de l'énergie solaire et ses applications dans les domaines du bâtiment, de l'industrie et de l'agriculture. Il s'intéresse également au confort thermique humain dans les bâtiments, à l'hydrogène vert, à la planification énergétique ainsi qu'à l'optimisation des systèmes de production et de distribution d'énergie.Le professeur BOUDEN a dirigé de nombreux projets de recherche soutenus par le Ministère tunisien de la Recherche Scientifique, l'Agence Nationale pour la Maîtrise de l'Énergie, ainsi que par des partenaires industriels. Il a pris part à plusieurs projets de recherche collaborative à l'échelle internationale, en partenariat avec des universités de France, d'Espagne, du Royaume-Uni et de Grèce. Il a également coordonné les équipes tunisiennes dans au moins quatre projets financés par l'Union européenne (programmes FP6 et FP7), ainsi que dans des projets du programme ENI-CBCMED. Auteur et co-auteur de nombreuses publications scientifiques, ses travaux ont largement contribué à l'avancement de ses domaines de spécialité.Très engagé dans la vie associative, le professeur BOUDEN est membre de la Société Internationale de l'Énergie Solaire depuis 1986 et a siégé à son Conseil d'Administration entre 2004 et 2006. Il est également membre de l'Association Jeunes Science de Tunisie depuis 1977, au sein de laquelle il a occupé plusieurs postes de responsabilité, notamment celui de président de 2011 à 2023. De plus, il a été membre du conseil d'administration du Mouvement International pour le Loisir Scientifique et Technique (MILSET) de 1998 à 2002. En matière de gestion de l'enseignement supérieur, il a d'abord dirigé le Département de Génie Industriel de l'ENIT avant d'être nommé Directeur de l'École Nationale d'Ingénieurs de Tunis, poste qu'il a occupé de 2008 à 2014. En 2014, il a pris la direction générale de l'Enseignement Supérieur au sein du Ministère de l'Enseignement Supérieur et de la Recherche Scientifique, avant d'être nommé, en février 2015, Ministre de l'Enseignement Supérieur et de la Recherche Scientifique. Il a exercé cette fonction jusqu'en août 2016. years.*

PROF. MOHAMED HABIBI
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PS2 : Fabrication additive intelligente et matériaux réactifs : Catalyseurs de la transition vers le manufacturier 5.0

Directeur de l'Équipe de Recherche en Ingénierie Mécanique Avancée (ÉRIMA), et ingénieur senior membre de l'Ordre des ingénieurs du Québec.
Université. du Québec à Trois-Rivières

Biography: *Mohamed Habibi est professeur en génie mécanique et mécatronique à l'Université du Québec à Trois-Rivières (UQTR), directeur de l'Équipe de Recherche en Ingénierie Mécanique Avancée (ÉRIMA), et ingénieur senior membre de l'Ordre des ingénieurs du Québec. Ses travaux de recherche portent sur les matériaux fonctionnels avancés et les procédés de fabrication de pointe, avec un accent particulier sur La fabrication additive intelligente : développement de jumeaux numériques, intégration de l'intelligence artificielle pour l'optimisation en temps réel des paramètres de fabrication, reconstruction 3D en temps réel par IA générative et apprentissage machine, contrôle qualité automatisé et impression à grande échelle assistée par robotique industrielle. Les matériaux intelligents : impression 3D/4D de polymères à mémoire de forme, composites multifonctionnels et matériaux piézoélectriques, pour des applications dans les MEMS, la récupération d'énergie, la robotique, les capteurs anatomiques et les systèmes embarqués. M. Habibi est également membre chercheur au Centre national intégré du manufacturier intelligent (CNIMI), où il dirige l'axe de recherche en fabrication intelligente. Ses activités visent à optimiser les procédés de production, réduire les coûts industriels et favoriser l'adoption de solutions durables. Avant de rejoindre l'UQTR, il a mené un postdoctorat au Centre de recherche industrielle du Québec (CRIQ), suivi d'un poste de chercheur en bioéconomie et efficacité industrielle et environnementale, où il a piloté de nombreux projets d'innovation technologique et de transition durable pour l'industrie manufacturière. Il a ensuite rejoint Investissement Québec, à la Direction de l'innovation industrielle, en tant qu'expert en matériaux et procédés de fabrication avancés. Il a par la suite été nommé Directeur responsable de la valorisation de la recherche, de l'innovation et de l'entrepreneuriat scientifique chez Axelys, la société de valorisation de la recherche publique du Québec, où il a accompagné un portefeuille de plus de 800 chercheurs universitaires et collégiaux dans la région de la Mauricie et du Centre-du-Québec.*

PROF. MONCEF GABBOUJ
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PS3 : **Le Deep Learning et ses applications diverses**

Department of Computing Sciences, Tampere University, Tampere, Finland

Abstract: *Deep Learning is great as it has outperformed many traditional approaches in numerous fields. However, DL comes at a price of high computational cost and follows mostly a Blackbox approach. Striving towards shallower and more compact models, we will discuss Operational Neural Networks (ONNs) as more efficient alternatives to conventional Convolutional Neural Networks (CNNs). ONNs can perform any linear or non-linear transformation with a proper combination of "nodal" and "pool" operators. This is a great leap towards expanding the neuron's learning capacity in CNNs, which use of a single nodal operator for all synaptic connections for all neurons. This restriction has recently been lifted by introducing a superior neuron called the "generative neuron" where each nodal operator can be customized during the training to maximize learning. As a result, the network can self-organize the nodal operators of its neurons' connections. Self-Organized Operational Neural Networks (Self-ONNs) equipped with superior generative neurons can achieve high performance with a compact network model. We shall explore several applications of Self-ONN models equipped with the generative and the superior neuron ranging from anomaly detection in vibration signals to computer-aided medical diagnosis.*

PROF. AMANI CHARRAD
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PS4 : **Les opportunités des instruments "Widening" dans le programme Horizon Europe**

PCN "Widening",
UGPO - Horizon Europe, MESRS

Biography: *Amani MAHJOUBI CHARRAD is a Senior Officer at the National Agency for Scientific Research Promotion (ANPR), where she leads the Office of International cooperation and Support to research and innovation. She plays a key role in the design and management of numerous programmes and projects funded by the European Commission—including Horizon Europe, Horizon 2020, Dialogue 5+5, EuropeAid, PASRI, Tempus, Erasmus+, EMORI…—as well as by other international funders such as the World Bank.She is also part-time seconded to the Ministry of Higher Education and Scientific Research, serving as the National Contact Point (NCP) for Horizon Europe's "Widening Participation and Spreading Excellence" and for the "Joint Research Centre (JRC)." Additionally, she acts as the National Correspondent for COST (European Cooperation in Science and Technology) and is the coordinator of the EURAXESS North Centre in Tunisia. Amani is a reviewer for the "African Journal of Science, Technology, Innovation and Development" and the "African Centre for Economic Transformation". She also serves on the Steering Committee for Gender Inclusion, contributing to the development of a gender-sensitive budget within the Ministry of Higher Education and Scientific Research. Alongside her policy work, she was an online lecturer at the Virtual University of Tunis..*

PROF. ELHEM GHORBEL
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PS5 : **Impact des Matériaux sur le Réchauffement Climatique : Analyse par l'ACV pour une Efficacité Environnementale améliorée 4**

Université de Cergy-Pontoise, France

Abstract: *Face aux enjeux climatiques, la réduction de l'empreinte carbone du secteur de la construction constitue une priorité. La production de ciment Portland, fortement émettrice de gaz à effet de serre (GES), impose la recherche de matériaux alternatifs plus durables. Cette étude propose une évaluation environnementale comparative de deux solutions innovantes par l'analyse du cycle de vie (ACV) : (i) l'utilisation de bétons géopolymères incorporant des granulats recyclés issus de déchets de construction et de démolition (CDW), et (ii) la valorisation des déblais tunneliers du Grand Paris Express pour la production de mortiers thermiquement isolants, enrichis de fibres végétales. La méthodologie ACV adoptée sappuie sur le logiciel SimaPro 9, la base de données Ecoinvent et la méthode ReCiPe Midpoint (2016). Pour le béton géopolymère « BG », différentes proportions de granulats recyclés (10 %, 30 % et 50 %) ont été incorporés au BG. Les résultats obtenus ont été comparés à ceux d'un béton autoplaçant conventionnel (SCC) de même résistance équivalente en considérant une unité fonctionnelle de 1 m³. Une réduction significative du potentiel de réchauffement climatique (GWP) est observée : 93 kg CO_2/m³ pour un béton géopolymère avec 50 % de granulats recyclés, contre 332 kg CO_2/m³ pour le SCC. Sur les 18 catégories d'impact évaluées, 11 présentent des résultats favorables en faveur du géopolymère, notamment en matière de réduction des émissions de GES (72 %) et de préservation des ressources fossiles (81 %). Parallèlement, les déblais tunneliers ont été valorisés dans la formulation de mortiers pour panneaux muraux, intégrant 1,2 % de fibres de chanvre, 1 % de tannin et 5 % de ciment. Ces mortiers ont été comparés à des matériaux à base de fibres de kénaf ainsi qu'à de la terre crue. L'ACV révèle une diminution des impacts environnementaux de 52 % à 83 % selon les indicateurs étudiés, tout en garantissant de bonnes propriétés mécaniques, thermiques et hydriques. En comparaison avec la terre crue, les mortiers issus de marins tunneliers présentent des performances environnementales proches, tout en offrant des avantages en termes de durabilité et d'isolation. Ces résultats démontrent le potentiel des matériaux recyclés, biosourcés et géosourcés pour une construction durable. Ils soulignent également l'importance d'une approche multicritère afin de concilier réduction des émissions de GES, performance technique et limitation des transferts de pollution. L'intégration de ces solutions innovantes constitue une voie crédible pour atteindre les objectifs de neutralité carbone dans le bâtiment. Mots-clés : géopolymères, granulats recyclés, déblais tunneliers, analyse du cycle de vie (ACV), matériaux biosourcés, construction durable.*

INVITED SPEAKERS

Unravelling the interplay of structural and material properties of skin
PROF. GEORGES LIMBERT, UNIVERSITY OF SOUTHAMPTON, UK

Tool steels: New developments, Manufacturing techniques, Heat Treatment and Mechanical properties
PROF. RIADH ELLEUCH, IPEIS - UNIVERSITE DE SFAX

Biomécanique du disque intervertébral - vers un diagnostic de la dégénérescence discale
PROF. OLIVIER BOIRON, CENTRAL MEDITERRANEE, MARSEILLE - FRANCE

Expectations of advanced CAD systems in the era of Industry 5 and 6.0
PROF. NIZAR AIFAOU, IPEIM - UNIVERSITE DE MONASTIR

Recent Advances in Bulk Metallic Glasses for High-Performance Applications
PROF. TAREK BENAMEUR, ENIM - UNIVERSITE DE MONASTIR

Proposal for the manufacturing of personalized orthoses by 3D printing
PROF. SAMI CHATTI, ENIM - UNIVERSITE DE MONASTIR

Enhanced Water Quality Prediction
PROF. RIDHA ENNATTA, ENIG - UNIVESRITE DE GABES

Keynote 8 : Nitinol Architected Materials and Interpenetrating Phase Composites
PROF. WAEL ZAKI, KHALIFA UNIVERSITY - ABU DHABI (UAE)

Analyse numérique multi-échelles de la réponse des structures poreuses ou architecturées en alliages à mémoire de forme par les méthodes des éléments finis au carré et basées sur les données
PROF. TARAK BEN ZINEB, UNIVERSITE DE LORRAINE

Fatigue Performance and Predictive Modeling of 3D Printed PLA: Towards Reliable Additive Manufacturing of Polymers
PROF. HAYKEL MAROUANI, ENIM - UNIVERSITE DE MONASTIR

Turbulence Modeling: A Pillar of Fluid Mechanics
PROF. MOULDI CHRIGUI, ENIG - UNIVERSITE DE GABES

Sur une nouvelle stratégie d'identification des lois de comportement des matériaux métalliques
PROF. AMNA ZNAIDI, IPEIEM - UNIVERSITE DE TUNIS ELMANAR

[redacted]

Computational strategy for quasi-brittle fracture via phase-field modeling: toward multiphysics integration

PROF. SANA KOUBAA, ENIS - UNIVERSITE DE SFAX

[redacted]

Conception robuste en dynamique des structures mécaniques robust design in dynamics of mechanical structures

PROF. MOHAMED GUEDRI, ENSIT- UNIVERSITE DE TUNIS

[redacted]

Modélisation numérique du comportement hydrodynamique et des phénomènes de transfert thermosolutal induits dans un étang solaire

PROF. MOUNIR BACCAR, ENIS - UNIVERSITE DE SFAX

[redacted]

Advanced hybrid approaches for predictive maintenance 4.0: Integrating physics-based models and AI

PROF. NABIH FEKI, ISSAT - UNIVERSITE DE SOUSSE

[redacted]

Revêtements biomédicaux pour implants temporaires biodégradables en alliage de magnésium : Etude du comportement mécanique et biologique

PROF. KAOUTHAR KHELIFI, IPEIEM - UNIVERSITE DE TUNIS ELMANAR

[redacted]

Fabrication additive métallique par le procédé WAAM : de la conception au post traitement

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Complex channels flows: from the basic flow to coherent structures onest

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La robotique au service de la santé humaine

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BIOMECHANICS

ID 606548: Physico-chemical and mechanical properties of DC sputtered ZrO2 coatings prepared by oblique angle deposition

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Abstract: *The medical industry benefits greatly from the additive manufacturing (AM) technology used on customized products. Total knee arthroplasty (TKA) has been widely used however it has drawbacks of stress shielding and loosening due to the excessive daily routine of patients. The problem could be minimized by applying lattice structures to the implant and mimicking the actual density of human bone. A finite element analysis was used to investigate the mechanical behavior of uniform lattice structures as such body-centered cubic (BCC), gyroid, octahedral, face-centered cubic (FCC), and face-centered cubic + body-centered cubic (BCCFCC). The surface-to-volume ratio (SVR) is a crucial factor for the osseointegration of bone implants, especially for porous knee implants. A higher SVR typically enhances osseointegration by offering more attachment points for bone cells, leading to improved adhesion of these cells to the implant. The properties of various porous structures were compared to identify the optimal one. The H5e2 gyroid structure emerged as the most suitable choice, as it features a high elastic limit of 120 MPa, similar to that of human bone, and a lower Young's modulus of 55.220 GPa compared to the base material. Additionally, its surface-to-volume ratio of 2.41 mm• »¹ further supports its suitability, indicating that this structure would be more effective in promoting osseointegration.*

ID 611652: Impact of MS Particles and DLC Coatings on the Tribological Properties of MS-HDPE Biocomposites

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Abstract: *Energy harvesting harnessing ambient energy, has become of great importance nowadays. This paper presents a parametric study of a double pendulum energy harvester to evaluate its performance under free and forced excitations. The proposed design generates energy through the interaction of two coupled pendulums. The equations of motion are derived using Lagrange formulation, and simulations are performed to analyze the influence of the main pendulum parameters: the pendulum masses and the pendulum total length; on the pendulum oscillations and energy generation. Indeed, the study focused on how these parameters affect the pendulum behavior, in masses angular displacement and velocity, and energy production. Results indicate that the pendulum nonlinear dynamics is also to be considered since quasiperiodic and chaotic oscillations are possible. Besides, the study highlighted the potential of optimizing the double pendulum masses and length to enhance energy harvesting.*

ID 612896: Numerical Modeling and Simulation of the Human Trachea Post-Endoprosthesis Insertion

JAZIRI MARWA , LARBI BADREDDINE , TRABELSI OLFA , AYADI MAHFOUD

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Abstract: *The success and reliability of finite element welding simulations heavily depend on the constitutive law describing the thermo-mechanical behavior of welded materials. Among various models, the Johnson-Cook (JC) model is widely used in Friction Stir Welding (FSW) due to its ability to estimate material behavior across a broad range of strains, strain rates, and temperatures. However, the lack of standardization in JC material parameters poses challenges, as discrepancies in these constants can cause significant variations in predicted outcomes such as joint morphology, temperature, and heat generation. This study mitigates JC parameter uncertainty in Friction Stir Spot Welding (FSSW) simulations using a Design of Experiments (DOE) approach. AA6082-T6 aluminum is selected due to its distinct microstructural evolution and plastic behavior at high temperatures. The proposed DOE-based approach is validated through finite element and experimental results, enhancing numerical accuracy and reliability. .*

ID 615167: 3D pose estimation and REBA-based automated ergonomic risk assessment for industrial worker

ABIDI RAMZI , BENNOUR SAMI , KAMMOUN MOHAMED ALI , REZGUI TAYSIR , HAJEJ ZIED

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Abstract: *To ensure the safety guidelines of chemical industries, the composite pipes networks have to withstand the hostility of the transported solutions at wide range of temperature. Therefore, it is crucial to study the hygrothermal behaviour of composite pipes in an acid environment in order to guarantee the durability of these systems. In this context, the present study aims to investigate the diffusion kinetics of an acid solution into a glass fiber reinforced vinylester composite tubes. For this purpose, representative specimen have been aged in 10% hydrochloric acid solution at various temperature levels ranging from 25°C to 50°C and 85°C for six months. The mass uptake measurements were recorded over the immersion period at regular interval time. The diffusion kinetics were then modelled based on Fick's law. The results reveal that the diffusion kinetics are thermally activated in GFRP tubes. The increase in temperature induces a rise in the absorbed mass and in the diffusion rate. At room temperature, the diffusion kinetics of the hydrochloric acid solution in the test specimens follow the Fickian diffusion model. However, at high temperatures, the aged specimen's hygrothermal behaviour deviates from the Fickian kinetics due to several degradation mechanism.*

ID 620533: Design and Optimization of a Polycentric Prosthetic Knee Mechanism

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Abstract: *This paper sheds light on the nonlinear viscoelastic relaxation type behavior of mirror epoxy, recently applied on coating in the construction and civil engineering sector. The "3D epoxy" technology gives the interior a modern personalized look based on mirror epoxy, a two-component thermosetting liquid polymer. The ratio of hardener to resin is an essential factor with regard to the mechanical characteristics, and consequently reflects on the quality of the material in service. In this context, this study is concerned with the long-term viscoelastic behavior and the evolution of the Schapery model of pure mirror epoxy at 100:50 resin / hardener ratio. five constant strain relaxation tests at room temperature are performed to numerically determine the static nonlinearity factors h and h0 formulated in the Schapery model. A remarkable consistency between the variations of the experimental and numerical values of the model programmed on MATLAB allows to say that the Schapery model describes well and in a satisfactory way the real behavior of the epoxy mirror.*

ID 620607: Effect of Solvent on the Development of Graphene Oxide Coating as a Protective Layer on AZ31 Magnesium Alloy: In Vitro Biodegradation and Adhesion Behavior

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Abstract: *Anti-trichiral 3D-printed structures have diverse applications, notably in biomedical and industrial fields, due to their unique mechanical properties. However, their behavior under cyclic loading remains poorly understood. Understanding their cyclic response is crucial not only for optimizing their use in engineering applications but also for addressing challenges in the development of suitable constitutive models. To investigate this, we conducted cyclic tests on antichiral 3D-printed structures. The study began with tensile tests to determine the ultimate tensile strength (UTS). Subsequently, cyclic loading was applied at 40%, 60%, and 80% of the UTS, followed by load-discharge cycles. An F-N curve was plotted based on the obtained data, revealing highly promising results. These findings enhance the comprehension of cyclic behavior in anti-trichiral structures and contribute to the advancement of constitutive modeling for these materials.*

Design Methodology & Robotics

ID 607641: Metaheuristic robot-human disassembly tasks assignment optimization

BELHADJ IMEN , ZEDDINI MOHAMED ALI , BEN ABDALLAH MOHAMED AMINE , AIFAOUI NIZAR

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Abstract: *Convective (CV) drying kinetics of kaolin-based composites filled with expanded perlite (EP) was investigated. Incorporating EP into the kaolin matrix enhanced the resulting mechanical and physical properties of the proposed composites. CV drying experiments were conducted at 70 °C with 5% EP (wt.%) in the kaolinic matrix. The objective was to analyze the CV drying kinetics of the prepared composites and evaluate their mechanical properties, including compression and Flexural strength. The results indicate that EP content has a positive impact on the drying kinetics and mechanical properties of Kaolin-based composite materials.*

ID 611736: Fit Approximation of 3D Sphericity Errors using Radial Basis Functions

RADHOUAN ALI , GHALI MARWA , AIFAOUI NIZAR

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Abstract: *Parmi les simulations des procédés, la simulation numérique du soudage par résistance électrique par points offre l'avantage d'un calcul direct des sources de chaleur par couplage électromagnétisme. En revanche, la modélisation numérique des essaie de caractérisation d'un point soudée offre une prévision du comportement mécanique de ce point, tandis que la modélisation d'une structure soudée multipoints va élargir cette prévision de comportement mécanique et tenue Ã la rupture, encore mieux l'utilisation des nouveau méthodes numériques qui permet aux industriels des résultats validés expérimentalement et plus précis qu'aux méthodes conventionnelles. Des résultats expérimentaux et numériques sont enregistrés et validés au cours de cette étude.*

ID 620235: A comparative study of accuracy in Optimized and Non-Optimized Parallel Manipulators

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Abstract: *In this paper, the effect of modulation period on mechanical characteristics of the coating is discussed. Indeed, an improvement in the mechanical properties of the coating by reducing the modulation period is obtained. Nevertheless, when modulation period is reduced under a critical value these properties change. These results are explained by the inverse Hall-Petch effect. Furthermore, several numerical models with different modulation periods have been developed to justify the effect of varying the modulation period of the coating on the mechanical properties of the film-substrate system. The results show that for the*

film/substrate system with Young's modulus Es=210GPa, Ef1=210GPa, Ef2=100GPa and for a thickness of the film equal to 300nm, the maximum hardness is obtained for a critical modulation period of 10nm.

ID 629050: Development of a Cost-Effective Navigation System for Differential Drive Robots Using LowCost Sensors and Optimized Control Algorithms

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Abstract: *Dans ce papier, une étude numérique de l'écoulement laminaire dans un canal complexe, formé par un sous-canal rectangulaire muni d'une fente au milieu d'un de ces cÃ´tés latéraux, est présentée. En premier lieu, le modèle mathématique, obtenu Ã partir des équations de NavierStockes, décrivant le phénomène physique est présenté. Ensuite, la stratégie de résolution et la formulation éléments finis utilisée comme méthodologie numérique sont brièvement discutées. Le maillage est raffiné plusieurs fois afin de minimiser les erreurs de discrétisation et jusqu'Ã convergence des résultats numériques. Les résultats sont montrés en termes d'iso-contours et de profils de vitesse. Ces derniers confirment la présence de points d'inflexions dans les régions de jonction entre le sous-canal et la fente. Ces points d'inflexion sont, comme cela est établi, des conditions nécessaires quoi que non suffisantes pour l'apparition d'instabilités dans l'écoulement, ce qui ouvre la porte Ã l'étude de stabilité de l'écoulement.*

DYNAMIC AND VIBRATION OF STRUCTURES, MODELLING AND STRUCTURES ANALYSIS

ID 600805: Gradient plate with cosine porosity distribution: vibration study

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Abstract: *The main purpose of this work is to investigate vibrations of gradient plate including cosine porosity distribution by the means of 3D finite element model-based on four noded tetrahedron element. The mathematical modeling is established on the bases of 3D theory of elasticity and variational principle to derive the equations of motion. The through thickness component of stain and stress is considered and Lagrangian polynomial basis function are utilized. The mass and stiffness matrices are determined, in global level, for free vibration problem and the natural frequencies can be hence evaluated. The reliability of the model is checked via a comparison of the current values with data from literature, and the impact of length-to-width ratio on natural frequencies of functionally gradient (FG) porous plates is studied and shown.*

ID 609116: Effect of Al content on the elastoplastic properties of CrAlN coatings studied by means of nanoindentation and finite element-reverse analysis

BEN AMMAR YAMEN , BOUCHOUCHA FAKER , GASSARA ADNAN , AOUADI KHALIL , BESNARD AURELIEN , NOUVEAU CORINNE ,

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Abstract: *The demand for sustainable solutions has risen significantly as the environmental impact of industrial activities continues to grow. As a result, the Life Cycle Assessment (LCA) method has become a popular approach for evaluating the environmental performance of products and processes. This method integrates two key approaches: input-output (IO-LCA) and process-based (P-LCA) assessments. However, each technique has limitations, including data availability, boundary constraints, and computing complexity. By combining the advantages of both approaches, Hybrid Life Cycle Assessment (H-LCA) provides a more thorough solution. Artificial Intelligence (AI) and Machine Learning (ML), which handle data automatically, increase accuracy, and bridge temporal inconsistencies between P-LCA and IO-LCA, offer new ways to improve H-LCA as digital technologies advance. A unique AI/ML-driven H-LCA approach is presented in this research. Enhancing environmental impact assessments, streamlining data processing, and enabling more precise sustainability assessments are the goals of the suggested framework. By integrating AI/ML into H-LCA, this research contributes to advancing industrial sustainability, enabling more effective decision-making for reducing energy consumption and minimizing environmental degradation.*

ID 610098: Suspension of Heavy Trucks with Intelligent Control using Extended Adaptive Neuro-Fuzzy Inference System (EANFIS)

HAMZA ANIS , BOUSNINA KAMEL , DRIDI ISSAM , BEN YAHIA NOUREDDINE

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Abstract: *Accurate Understanding the mechanical behavior of the left ventricle (LV) is essential for advancing cardiovascular diagnostics and therapeutic strategies. This study presents a detailed static biomechanical model of the LV, focusing on the integration of orthotropic transverse hyperelastic material behavior and active contraction. The model was developed using MRI-derived geometric reconstruction, enabling accurate representation of the LV's anatomy. Passive myocardial behavior was described using a Fung-type transversely orthotropic hyperelastic model, while active contraction was incorporated through a thermal expansion framework aligned with fiber direction. Finite element simulations were performed under static loading conditions, replicating physiological pressures at end-diastole and end-systole. The results demonstrated realistic stress distributions, displacement fields, and ventricular pressure responses, validating the model against experimental data and prior studies. Stress concentration areas were identified near the endocardium, highlighting regions of significant mechanical activity. The study further provides visualizations of isostress contours and displacement fields, offering detailed insights into myocardial mechanics under static conditions. By integrating advanced constitutive modeling with precise geometric reconstruction, the proposed model establishes a robust framework for investigating cardiac biomechanics. This static approach lays the groundwork for future extensions to dynamic simulations and patient-specific analyses, contributing to the development of more effective diagnostic and therapeutic tools in cardiology.*

ID 610441: Oscillation coupling effect on a double pendulum energy harvester

SEIF EDDINE CHEBBI, CHARFEDDINE MRAD, FETHI ALOUI, RACHID NASRI

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Abstract: *Robotic disassembly plays a key role in achieving efficient and sustainable product lifecycle management. The focus is on conserving resources and reducing waste. However, the presence of the human operator is more than necessary to carry out tasks that the robot is not able to perform. This work deals with the planning of disassembly operations between the robot and the human while re-ducing energy losses. The main objective has been to improve the efficiency of disassembly processes through intelligent techniques for optimizing both robotic and human disassembly task allocation. At the heart of this research is the application of the Salps Swarm Algorithm (SSA), a metaheuristic optimization algorithm inspired by the natural behavior of salps. The mathematical model of the proposed method is developed. A fitness function that traduces a non-deterministic problem and reflects the problem of uncertainty is detailed. The SSA reaches the optimum solution of human and robot tasks*

allocation. A case study including the dismounting of gear box was used to validate the proposed approach. The advantages and limitations of the proposed approach will be outlined.

ID 610777: Modélisation numérique du procédé de soudage par résistance par la méthode SPG.

MOUSSA KAHRI , ROMDHANE OTHMANI , SHIRI SEDDIK

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Abstract: *Natural and organic-based composite materials are increasingly utilized across various industries due to their low cost, ease of recyclability, economic feasibility, and widespread availability. This study investigates environmentally friendly hemp-polypropylene (HPP) composites, where polypropylene (PP) is reinforced with 30 wt.% short hemp fibers (HF) as a natural filler. The composites were prepared using a twin-screw extruder, followed by injection molding to shape standard test specimens. To address the inherent incompatibility between the hydrophilic lignocellulosic fibers and the non-polar PP matrix, a coupling agent€"polypropylene-graft-maleic anhydride (PP-g-MA) was employed. The stuctural, and mechanical properties of the composites were evaluated through SEM, FTIR, tensile and scratch tests. Results revealed a significant improvement in fiber-matrix adhesion with the use of PP-g-MA, demonstrating enhanced interfacial bonding. The hemp fibers were uniformly dispersed within the PP matrix, resulting in a dense and homogeneous composite structure.The addition of 30 wt.% HF markedly increased the stiffness and tensile properties of the composites. The Young's modulus and tensile strength of the HPP composites reached 3804 MPa and 28.07 MPa, respectively, compared to 1523 MPa and 22.98 MPa for neat PP. Scratch testing further supported these findings, showing a notable reduction in penetration depth upon the inclusion of hemp fibers. The study highlights hemp-reinforced polypropylene composites for sustainable, high-performance applications. .*

ID 610885: Analyse de la stabilité d'un rotor mono-disque comprenant des anneaux en élastomère magnéto rhéologique

SAKLY FAIZA , CHOUCHANE MNAOUAR

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Abstract: *This paper aims to evaluate the effect of aluminium content on the elastoplastic properties of PVD CrAlN coatings. An optimization procedure, integrated with the finite element analysis, is used to extract the optimal elastoplastic properties of the coating based in the experimental nanoindentation load-displacement curves. The uniqueness issue of the inverse analysis is addressed by choosing initial guess parameters closer to the target values by means of the JÃ¶nsson and Hogmark (JH) model. The optimization results show good agreement between the simulated and the experimental nanoindentation load-displacement curves and as a result, the optimal elastoplastic properties of CrAlN coating for each*

aluminium contents is determined accurately. Results show that the hardness, Young's modulus and the yield stress of the CrAlN coatings increase when increasing the aluminium content which attributed to the solid solution hardening. These findings provide valuable insight for evaluating the elastoplastic properties of monolayered systems in order to optimize their structure.

ID 612693: Modeling and Analysis of a Piezoelectric Bimorph Energy Harvester with Honeycomb Sandwich Structures

MHIRI MOHAMED TAHA , LARBI WALID , GUERICH MOHAMED , CHOUCHANE MNAOUAR

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Abstract: *In this paper, we propose a production and inventory control policy for a manufacturing system composed of an imperfect process subject to random disturbances due to product quality degradation. This control policy allows, during the out-of-control state diversion, to continue producing during the restoration preparation phase and until the safety stock is filled. This policy is an extension of the one proposed by Dhouib (2016) and takes into account all possible capacities of the safety stock. Analytical models are proposed, and allow to describe the dynamic and stochastic behaviors of the manufacturing system. In addition, a numerical procedure and a simulation model have been developed to evaluate the total cost incurred per unit time of the proposed policy. The results show that the suggested approach has the potential to produce significant financial benefits.*

ID 616804: Overview of product and production process model integration in mechatronic system devel-opment using the MBSE approach

BOUZID WAFA, IMEN BELHADJ, FAIDA MHENNI, JEAN YVES CHOLEY, NIZAR AIFAOUI

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Abstract: *Optimizing drying methods is essential for reducing energy consumption while maintaining efficiency in processes. This paper presents an experimental analysis of energy consumption in a convective drying process that incorporates a phase change material (PCM). The goal is to evaluate the impact of PCM by comparing the system's energy consumption with and without its integration. Experimental measurements were conducted to monitor temperature changes, humidity levels, and energy consumption. The thermal inertia of PCM allows for a controlled and continuous heat supply, thus decreasing reliance on traditional energy sources. The results show that this approach improves thermal regulation and significantly reduces energy consumption while preserving the quality of the dried product.*

ID 616950: A multi-scale patch approximation for Poisson problems with a small inhomogeneous inclusion

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Abstract: *La modélisation des endoprothèses pour la trachée humaine est réalisée Ã l'aide de logiciels spécialisés tels que Mimics et ABAQUS. Ces outils permettent de convertir des images médicales en modèles 3D précis de la trachée. L'analyse biomécanique des stents permet d'étudier en détail les contraintes et les déformations subies par la trachée dans des conditions physiologiques normales. Cette analyse est réalisée en créant des modèles anatomiques précis Ã partir d'images DICOM. Ces modèles sont ensuite importés dans ABAQUS, oÃ¹ des simulations numériques évaluent les interactions entre le stent et la trachée. GrÃ¢ce Ã ces simulations, il est possible de prédire les performances des stents et de détecter les faiblesses potentielles. De plus, l'optimisation de la conception des stents trachéaux peut Ãªtre explorée en effectuant des analyses paramétriques afin de réduire le risque d'échec et d'améliorer leur efficacité Ã long terme.*

ID 618641: Optimization of the number and location of piezoelectric patches bonded on a rotor shaft surface using an iterative method

BRAHEM MARYEM , CHOUCHANE MNAOUAR

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Abstract: *The present study describes a computer simulation model for gas-gas ejector used to enhance the performances of absorption chiller. The 1D€“model is developed based on thermodynamic equations governing perfect gas flow correlations. Actual investigations deal with constant-pressure ejector flow model using steam as working fluid. An algorithm chart is developed in order to investigate the performances of the ejector. The model is first validated basing on data from the open literature and then used as tool to explore the behavior of the ejector, in particular its performance for varying operating conditions and ejector geometry. Results show that for fixed nozzle area ratio and constant secondary flow properties, the entrainment ratio increases with increasing primary flow pressure, reaches a maximum, and then decreases, when the backpressure is constant. For constant primary pressure, the entrainment ratio decreases with increasing backpressure. Further, the maximum nozzle area-ratio is determined by the secondary flow pressure. Choking of the gas in the constant area section of the ejector limits its performance. Maximum entrainment ratio is reached when the gas exiting the nozzle decelerates so that its Mach number equals that of the entrained secondary flow. For imposed primary and secondary flow pressures, the entrainment ratio increases with increasing ejector area ratio but the range of possible nozzle area ratios largely diminishes in parallel.*

ID 620270: Comparative Analysis of LQR and PI Control Strategies for Active Vibration Mitigation in Flexible Structures

MAYSSA TOUIL , BEN HASSEN DORRA , CHÃ,ARI RIADH , HADDAR MOHAMED

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Abstract: *In this study, we suggested using the affected depth (AD) approach to evaluate the fatigue of V-notched material under multiaxial loading. This technique is based on a critical depth parameter determined from analyzing of the stress distribution surrounding the notch. The V-notch is assumed to be a discontinuity of matter defined by its depth and sharpness. Stress field calculations around the notch have been done using Elastoplastic Finite Element (FE) Simulations in Abaqus. The Crossland criterion is adopted to apply the AD method and to determine the fatigue limit diagram. The experimental investigation made to the notched AISI 416 steel is analyzed so that the applicability of the affected depth parameter can be proven for the case of combined loadings fatigue. The predicted model provides interesting results.*

ID 620439: Influence of bonding layer and fiber thickness on the performance of Macro fiber Composites

MALLOULI MARWA , CHOUCHANE MNAOUAR

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Abstract: *The paper deals with the multi-scale approximation of the influence of a small inhomogeneity of arbitrary shape in an elastic medium. A new multi-scale patch method is introduced, whose caracteristic is to deal with a large scale problem without inclusion, a small-scale problem on a patch surrounding the inclusion defining a corrector and an iterative procedure between these two problems. Theoretical results of convergence of the iterations, a posteriori error estimate and comparison of the corrector with the asymptotic expansion are provided. The finite element approximation is also addressed together with some numerical tests.*

ID 629408: Intelligent control of active vehicle suspension systems using advanced reinforcement learning algorithms

DRIDI ISSAM , HAMZA ANIS , BEN YAHIA NOUREDDINE

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Abstract: *The evaluation of propeller performance is crucial for optimizing unmanned aerial vehicle propulsion systems. This study presents a CFD analysis of 1045 propeller to determine the static thrust generated at various rotational speeds*

The relationship between thrust and rotational speed is analyzed, compared with empirical models, and validated with experimental data. The results demonstrate that the thrust varies quadratically, enabling better performance prediction and system design. .

ID 629439: Numerical and Experimental Investigation of Propeller 1045 Thrust

LOTFI LAKHDHAR, ABDALLAH BOUABIDI , ALI SNOUSSI

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Abstract: *This study performs a parametric analysis using the Box-Behnken design to evaluate the influence of the main printing parameters on the mechanical properties of PLA parts produced by the fused deposition modelling (FDM) process. The parameters examined were nozzle temperature, bed temperature, layer thickness and extrusion rate. The mechanical properties evaluated are tensile strength, Young's modulus and Poisson's ratio. In addition, a neural network-based predictive model has been developed to estimate these properties as a function of selected printing parameters, providing a valuable tool for optimising printing parameters and improving part performance.*

ID 636661: Synthesis of flexible multibody systems using SALP Swarm Algorithm Optimisation

KHEMILI IMED, BELHADJ IMEN, BEN ABDALLAH MOHAMED AMINE, AIFAOUI, NIZAR

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Abstract: *In this paper, SALP Swarm algorithm optimization is used for the dynamic synthesis of flexible multibody systems. Based on its dynamic responses, the system elements dimensional design variables and the material characteristics are identified. Multi-objectives optimization synthesis based on these responses taken all together have been presented. Flexible four bar mechanism and flexible slider crank mechanism are considered as illustrative application examples. The optimization efficiency has been proved through numerical simulations carried on MATLAB software.*

ENERGY, MASS, HEAT TRANSFER AND FLUID MECHANICS

ID 602393: Simulation on optical and thermal performance of a cylindrical cavity receiver in a parabolic dish collector system

HOUDA ZAGROUBA, ALI SNOUSSI

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Abstract: *TiO,, nanotubes were synthesized via anodization on titanium substrates and subsequently decorated with lead sulfide (PbS) nanoparticles using the SILAR method, varying the number of deposition cycles. The morphological and structural properties of the coatings were analyzed using scanning electron microscopy (SEM), transmission electron microscopy (TEM), and X-ray diffraction (XRD). The results revealed a homogeneous distribution of PbS nanoparticles, forming small spherical structures whose size and crystallinity increased with the number of cycles, thereby influencing the overall morphology and organization of the TiO,, nanotubes. The electrochemical properties of the coatings were evaluated to assess their corrosion resistance. Electrochemical impedance spectroscopy (EIS) revealed that TiO,, nanotubes decorated with PbS after 15 cycles exhibited the highest corrosion resistance, attributed to a dense and uniform layer that formed an effective barrier against oxidation and electrochemical degradation. The charge transfer resistance (Rct) and absorption capacitance (Qab) values, measured at 4.49 „¦.cm² and 0.9 F.s• »¹.cm• »², respectively, confirmed the coating's superior protective performance. These findings highlight the potential of PbS-decorated TiO,, nanotubes for advanced biomedical implants, offering enhanced mechanical durability and superior anticorrosion properties, making them promising candidates for applications in demanding physiological environments.*

ID 611353: Parametric study of assisted solar absorption chiller

ABED AMANI , BOUKHCHANA YASMINA , FELLAH ALI

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Abstract: *Punching is a widely used process in cold forming field due to its simplicity, its performance and product quality. However, this process is a bit complicated since choosing its parameters remains a difficult task to achieve. Obtaining a high-quality product essentially involves a validated choice of punching parameters. In this work, shear zone height was studied to judge punched part quality. The finite element method using Johnson Cook model was used to show some punching parameters effect on shear zone height depending on punch shaft shapes. Results highlighted that punching tool having a pointed shape has an almost constant distribution by varying punching parameters which leaves it considered as optimal.*

ID 611599: Magnetohydrodynamic Natural Convection in a Square-Curved Corners Enclosure: The Effect of Thermal Arrangements in Multi-Inner Pipes of Heat Exchangers

HASSAN ASIRI WEDAD , ABDULKADHIM AMMAR , IBRAHIM ELSAEEDY HALEMAH , MAHJOUB SAID NEJLA

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Abstract: *Energy harvesting consisting on producing green energy, has gained huge interest recently. This paper presents an investigation on the performance of a double pendulum energy harvester operating under free excitation then under forced excitation, with an emphasis on nonlinear dynamics and energy generation. The studded double pendulum was presented, was modeled, and the governing equations were presented. The coupled double pendulum is compared to the uncoupled double pendulum in displacement, velocity, and energy production. The pendulums angular displacement and velocity are important since they give information about oscillations, while the energy production is essential since the purpose is to harvest energy. The coupled pendulum is found neatly superior to the uncoupled pendulum, showing rich dynamics and higher energy production, which confirms the oscillation coupling positive effect on energy harvesting. The forced regime and the free regime were also compared, the forced regime energy generation is sustained and promising.*

ID 612700: Experimental Investigation of Energy Consumption during Convective Drying Using Phase Change Materials

BEN MUSTAPHA NOUR EL HOUDA , HACHEM HOUDA , MIHOUBI DAOUED

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Abstract: *This study presents a numerical investigation into the combustion behavior of a diesel engine, focusing on testing the bowl profile of the engine model. The simulation model is used to analyze the combustion process under predefined conditions, with the bowl profile serving as a key parameter. Emissions such as carbon monoxide (CO), carbon dioxide (CO,,), nitrogen oxides (NO, NO,,), and particulate matter (soot) are evaluated based on the simulation results. The findings emphasize the influence of the bowl profile on combustion characteristics and emissions. This work lays the groundwork for future investigations, including the testing of biodiesel combustion in the engine model, offering a basis for optimizing engine performance and emissions when using alternative fuels*.

ID 612909: Absorption cooling system investigation for tri-generation Application: industrial case study

SIOUD DONIAZED, RAOUDHA GARMA, AHMED BELLAGI

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Abstract: *Cette étude évalue la performance d'un refroidisseur Ã absorption alimenté par énergie solaire Ã travers une analyse paramétrique réalisée Ã l'aide du logiciel Engineering Equation Solver (EES). L'analyse porte sur les principaux paramètres de fonctionnement afin d'optimiser l'efficacité du système et d'évaluer la faisabilité de l'utilisation de l'énergie solaire dans les systèmes de réfrigération Ã absorption. Les résultats mettent en évidence les avantages potentiels de l'intégration des énergies renouvelables pour améliorer la performance et la durabilité des machines frigorifiques Ã absorption.*

ID 613272: Theoretical Investigation Of Steam Ejector Design For Performance Optimization

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Abstract: *Water scarcity is a major global challenge, particularly in arid regions with limited freshwater resources. This study evaluates the performance of a pyramidal solar still (PSS) as a sustainable desalination solution. An experimental investigation was conducted in Gabès, Tunisia, to analyze the thermal behavior of a conventional PSS (CPSS), and the results were validated using Computational fluid dynamics (CFD) simulations. Once validated, a numerical optimization was performed by incorporating fins on the absorber plate to enhance heat transfer. The optimized design led to a notable temperature increase, reaching a peak of 71°C at 1:00 PM, thereby improving the overall efficiency of the system. The strong agreement between experimental and numerical results confirms the accuracy of the CFD model and underscores the potential of geometric modifications in enhancing solar still performance. .*

ID 613393: Mechanical and Thermal Characterization of Composite Materials Based on Clay, Fired Clay Waste, and Sand: Effects of Firing and Composition Parameters

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Abstract: *In terms of industrial applications, the surface quality represents essential criteria determining the work-piece functionality. Equally, its profit is directly related to the productivity rate. For thus, in this paper, an experimental study is carried out focuses on both effects of cutting parameters and combined optimization of quality-productivity during turning of Inconel 718. Otherwise, the ANOVA analysis and the RSM methodology are retained respectively in order to study the sensitivity of the studied performances (surface integrity Ra and material removal rate MRR) to the process parameters (nose radius r (mm), cutting speed Vc (m/min) and feed rate f (mm/rev)) and to develop the prediction model that addresses the optimization procedure. As results, the surface roughness is mainly affected by r (33%) followed by Vc (30,3%) and f (30%) but the productivity is depended on Vc (61%), f*

(36%) and Vc Ã—f (3%). Moreover, a 3D surface topography visualization is presented showing in details the effects of different cutting parameters.

ID 618171: Optimal sites selection for green hydrogen production in Senegal from solar photovoltaic power plant using a GIS-AHP-based approach

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Abstract: *La fabrication additive (FA) a progressé rapidement, grÃ¢ce aux progrès des procédés, des matériaux et des méthodologies de conception. Cette technologie offre des avantages substantiels, notamment la capacité de créer des géométries complexes, une flexibilité améliorée et des temps de production réduits par rapport aux techniques de fabrication conventionnelles. Néanmoins, les technologies de fabrication additive rencontrent des difficultés, notamment pour obtenir une qualité de surface supérieure et des caractéristiques mécaniques adéquates. Ces contraintes sont particulièrement importantes dans les applications médicales, oÃ¹ la qualité de surface et la rugosité sont des facteurs essentiels. Diverses techniques de post-traitement sont utilisées pour améliorer les propriétés de surface des composants de fabrication additive. Cette étude a porté sur des composants AISI 316L produits par fusion laser sur lit de poudre (LPBF) qui ont été soumis Ã un martelage Ã la brosse métallique avec différents nombres de passes : 5, 7, 10 et 15. La qualité de surface résultante a été soumise Ã des mesures de rugosité et de microdureté. Les résultats révèlent une significative des propriétés de surface après le traitement. La rugosité de surface a diminué de manière significative, de près de 50 %, d'une mesure initiale de 14 Î¼m Ã 6,5 Î¼m. La microdureté s'est considérablement améliorée, augmentant de 102 %, de 202 Hv Ã 408 Hv, affectant ainsi positivement la résistance Ã l'usure et Ã la corrosion. De manière significative, après 10 passages, les données se sont stabilisées, ce qui signifie que la substance a atteint un point de saturation.*

ID 618569: Enhancing Building Energy Efficiency: A Pathway to Sustainable Development

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Abstract: *This paper addresses the challenge of optimizing a production line while considering different ergonomic requirements across workstations. The varying physical demands of workstations impact operator well-being and productivi-ty, necessitating an approach that balances ergonomic risks with operational efficiency. To tackle this issue, we propose a joint dynamic ergonomic job ro-tation strategy that adapts operator assignments based on real-time fatigue monitoring. Instead of predefined rotation intervals, the proposed*

model initi-ates reassignment only when an operator's fatigue level exceeds a specified threshold, ensuring recovery while maintaining performance. This strategy is integrated into an optimal production plan to enhance productivity and satisfy demand while respecting service levels, preventing inventory shortages and minimizing production costs. The results demonstrate that the proposed ap-proach effectively aligns ergonomic considerations with production efficien-cy, contributing to sustainable manufacturing practices within the industry 5.0 framework.

ID 619518: Effect of the Bionic Scapharca Shell Piston Shape of a Gaseous Engine Efficiency

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Abstract: *Metal additive manufacturing processes, such as Wire Arc Additive Manufacturing, have already demonstrated their effectiveness in producing parts with intricate geometries, and advancements continue to be made in this field. This study introduces an innovative computer-vision approach for the real-time detection and assessment of porosity defects in the WAAM process, utilizing an advanced YOLOv8x deep-learning algorithm. The primary aim of this study was to evaluate the effectiveness of YOLOv8x in identifying porosity, a critical defect that can significantly compromise the structural integrity of WAAM components. To achieve this, a dataset of SS308L weld beads deposited on 304 L stainless steel substrates using the Cold Metal Transfer process was created and annotated. Although variations in welding speed (WS), wire feed rate (WFR), and gas flow rate (GFR) were introduced to generate a range of bead qualities, the emphasis remains on vision-based classification and quantification of defects. The YOLOv8x algorithm demonstrated an average accuracy (mAP) of 99% for regular beads and 96.68% for irregular beads, with a detection accuracy ranging from 76% to 83% for porosity identification. Overall, it exhibited high accuracy in assessing porosity levels, with defects reaching 58% in the most defective samples. These findings underscore the substantial potential of AI-based systems to enhance quality control in WAAM by facilitating the rapid, accurate, and non-invasive detection of potential defects in the construction process.*

ID 620268: Using Laser Bessel beams to measure fluid flow velocity

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Abstract: *This paper presents an experimental investigation into the mechanical, physical, and thermal properties of a new construction material composed of plaster and almond shell powder (AS). The goal is to enhance the insulation potential of plaster. Initially, Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), and Thermogravimetric Analysis (TGA-DTG) were conducted for the preliminary characterization of Almond shell powder. This was done to understand its chemical properties and resistance to high*

temperatures. Additionally, we tested the particle size distribution, density, thermal conductivity, and diffusivity of the AS powder. Composite samples were then prepared using 7.5 wt.% of AS. We evaluated the thermal conductivity and mechanical properties, including compressive and flexural resistance, of the resulting samples. The findings indicate that adding AS to the plaster matrix improves its thermal resistance while reducing its mechanical strength. Furthermore, moisture diffusivity was measured at various temperatures to estimate the material's activation energy. The results suggest that incorporating 7.5 wt.% of AS decreases the activation energy of the material by approximately 19%.

ID 620293: POD-based reduced order model for transitional flow dynamics in a stenotic vessel

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Abstract: *In response to the increasing needs of customers, modern products have become increasingly complex. The product design, including both functional and logical structure, along with three-dimensional renderings, and development planning, today requires the use of various methodologies and formats. It is necessary to manage the relationships and consistency between these models and their corresponding data to ensure that a product meets basic cost, time, and quality requirements. The resolution of such issues innately necessitates the employment of a consistent approach toward design creation related to products. The minimum elements involved in that process are the realization of the production of the product and how it connects to manufacturing, need, design, and related activities. Model-Based Systems Engineering (MBSE) allows one to address such problems effectively. It has been based on the concurrent design and planning sequence modeling and simulation of a product, incorporating considerations of workstations, mechanisms, substances, and data routes so that the product development lifecycle will be integrated and smoothed. In this paper, a methodology that integrates SysML and MBSE in mechatronic systems is proposed and discusses some challenges faced with the solutions based on real case study.*

ID 628562: Etude numérique de l'écoulement de base dans des canaux complexes

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Abstract: *Dans ce papier, une étude numérique du processus de fusion d'un matériau Ã changement de phase (MCP) dans une enceinte rectangulaire différentiellement chauffée est effectuée. Les simulations sont réalisées avec le logiciel commercial ANSYS-Fluent. L'objectif principal de cette étude est d'intégrer des éléments de MCP dans des matériaux de construction pour les bÃ¢timents passifs. On remarque que letaux de fusion du MCP est dominée par la conduction dans les premiers temps du processus de fusion. Le transfert de*

chaleur par convection ralentit le mouvement de l'interface solide-liquide puisque la fusion du MCP est concentrée uniquement dans la partie supérieure de la cavité.

ID 629423: Influence of Intake Temperature on Spray Vaporization in Methanol Diesel Dual-Fuel Engines

HAMDI FATHI , HAMDI TAKWA , HERNÃ¡NDEZ JUAN J. , CHRIGUI MOULDI

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Abstract: *This experimental study investigates transitional flow dynamics in silicone straight vessel with a stenosis of 50% reduction in diameter in a flow configuration of iliac artery. Unsteady flow was analysed at a heart rate of 60 beats per minute, with flow velocities measured using Particle Image Velocimetry (PIV). Proper Orthogonal Decomposition (POD) was applied to identify the most energetic modal contributions and extract the spatial structure of the corresponding modes. Experimental results revealed pulsed flow characteristics in the velocity fields, with POD modes exhibiting paired structures corresponding to the downstream convection of flow features. These findings provide valuable insights into the hemodynamic behaviour of stenosed arteries, offering a foundation for improved diagnostic and therapeutic strategies in cardiovascular disease.*

ID 629425: A case Study on Diesel Engine Combustion Behavior: Numerical Simulations and Insights

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Abstract: *Laser metal welding of Ti-6Al-4V, a titanium alloy widely used in aerospace, automotive, and biomedical industries, presents significant challenges due to its high reflectivity, rapid oxidation, and susceptibility to residual stresses and distortions. This study focuses on the simulation of the laser welding process for Ti- 6Al-4V plates using finite element analysis (FEA) to predict and optimize key welding outcomes. A thermo-mechanical model was developed, incorporating material properties, meshing strategies, and boundary conditions to accurately simulate temperature distribution, residual stresses, and distortion. The effects of critical welding parameters such us laser power, welding speed, and spot diameter were systematically analysed to identify optimal conditions. This work provides a robust computational framework for simulation of laser welding processes, reducing the need for costly experimental trials, and enhancing the quality of welded Ti-6Al-4V components in critical applications. .*

ID 629429: Optimization of Pyramid Solar Still Performance Through Fins: Experimental and CFD Analysis

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Abstract: *Solar heat pump systems have been widely implemented in heating applications due to their sustainability and operational stability. However, their efficiency requires further improvement through advanced technologies such as energy storage using phase change materials (PCM). Consequently, a solar heat pump system coupled with a PCM-based heat exchanger was numerically studied to analyze the effect of integrating latent thermal storage on the heat pump's coefficient of performance (COP). The simulation software used to model the variations in inlet and outlet temperatures of the heat exchanger was ANSYS Fluent, while TRNSYS was used to simulate the overall system. The results showed that the system could effectively meet the daily heating demand, and the integration of the PCM-based heat exchanger had a significant effect on the system's overall performance. The addition of a PCM-based heat exchanger to the system increased the average COP by 9.2% and reduced electricity consumption by 10.45%. .*

ID 629443: The impact of integrating latent heat storage (LHS) on the performance of a solar-assisted heat pump (SAHP) system used for greenhouse heating

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Abstract: *his study investigates the effect of post-processing heat treatment on the microstructure and mechanical properties of additively manufactured AISI 316L stainless steel. Samples were fabricated using selective laser melting process, with a volumetric energy density of 167 J/mm3. Subsequently, they underwent a heat treatment consisting of annealing at 1050°C for 2 hours in a protective argon atmosphere, followed by furnace cooling. Results revealed that the as-printed AISI 316L exhibited a columnar grain structure, extending across melt pools, and consiste mainly of austenite (Î³) with small amounts of ferrite (Î´). Cellular-dendritic microstructures, typical of additive manufacturing, were observed within these grains. After heat treatment, the melt pool boundaries disappeared, resulting in a homogeneous microstructure. Concurrently, both tensile strength and yield stress decreased, shifting from 690 to 590 MPa and 505 to 330 MPa, respectively. Furthermore, the surface microhardness decreased from 230 to 190 Hv. The applied heat treatment achieved near-complete stress relief, reducing tensile residual stress from 575 MPa to approximately -56 MPa. .*

ID 629444: Numerical and experimental study of an innovative heat exchanger design with phase change materials for enhanced latent heat thermal storage

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Abstract: *The successive ionic layer adsorption reaction (SILAR) technique was employed to deposit Cu2O nanosheets onto anodized TiO2 nanotubes across various deposition cycles, specifically at 4, 8, 15, and 20 cycles. The tribological behavior€"including friction, wear, and energy loss€"along with scanning electron microscopy (SEM), transmission electron microscopy (TEM), and X-ray diffraction (XRD) techniques were utilized to characterize the Cu2O/TiO2 coatings. This analysis aimed to investigate how the number of deposition cycles influences the morphological and structural properties of the samples. The adhesion of the coating was evaluated through the critical loads obtained from the scratch test. The Cu2O/TiO2 coating with 15 cycles demonstrated higher critical loads, indicating improved adhesion. Additionally, this sample exhibited a lower wear volume compared to others, although it experienced greater energy loss due to the low shear strength of copper oxide. Given that these coatings are intended for orthopedic and dental implant applications, their corrosion resistance was also assessed. The results were outstanding for the 15 cycles Cu2O-NPs/TiO2-NTs, as these coatings significantly enhanced corrosion resistance compared to the other samples. .*

ID 629446: Geometric design optimization for improved thermal performance in a solar air collector

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Abstract: *The surface morphology of parts manufactured by Selective Laser Melting (SLM) plays a crucial role under mechanical stress and chemical environments. This study investigates the influence of laser processing parameters on the porosity and density of titanium samples produced through additive manufacturing. The analyzed parameters include laser power, scan speed, hatch spacing, and volumetric energy density (VED). The results indicate that porosity is primarily influenced by VED, with lower energy density promoting a better surface quality by minimizing fusion defects and reducing the accumulation of porosity in overlap zones of melt tracks. A clear correlation between processing parameters and surface quality was observed, demonstrating that optimized parameter adjustments can effectively reduce porosity and lead to a denser and more homogeneous structure. .*

ID 629447: Enhancing Darrieus Rotor Performance with Innovative Deflector Integration

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Abstract: *Material instability for fiber-reinforced hollow cylinders is examined under radial inflation. Three compatible standard incompressible transversely isotropic hyperelastic models are considered. The transverse isotropy is due to a single family of fibers distributed throughout the cylinder, oriented either in the radial or circumferential direction. The onset*

of failure is associated with the loss of ellipticity of the equilibrium equations. The loss of ellipticity was related to fiber kinking and fiber splitting, depending on the direction of fiber reinforcement. .

ID 630043: CFD Study of a Wind Catcher-Evaporative Cooling System for Poultry Climate Control

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Abstract: *This study explores recent advances in restorative dentistry and highlights nanoparticle-doped polymethyl methacrylate (PMMA) nanocomposites as an innovative material. Copper oxide (CuO) nanoparticles of specific sizes were synthesized and then incorporated into a PMMA resin matrix sold to dentists to produce a multifunctional nanocomposite. The surface morphology was analyzed using scanning electron microscopy and energy dispersive spectroscopy (SEM-EDS). Tensile strength tests were performed to determine the mechanical properties of the prepared nanocomposites. The synthesized nanoparticles (NPs) were then tested for their antimicrobial activity. Microstructural studies using SEM/EDS showed that the nanoparticles (NPs) were successfully dispersed in the PMMA matrix. Mechanical studies showed that the tensile strength increased by 79.5% with the addition of CuO NPs in PMMA resin. This result confirms that PMMA/CuO nanocomposites can overcome the mechanical limitations of conventional dental restorative materials. Antibacterial tests showed that the synthesized copper oxide nanoparticles exhibited successful antibacterial effects. In fact, the combination of mechanical and antibacterial effects paves the way for more effective and durable tooth restorations.*

ID 630045: Thermal Energy Storage Potential of Desert Sand: Experimental Analysis and Performance Evaluation

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Abstract: *Thermal Energy Storage (TES) is vital for meeting increasing energy demands and integrating renewable sources. This study investigates the TES potential of Sahara sand from Douz, Tunisia, considering its thermal properties, availability, and cost-effectiveness. An experimental setup was developed, comprising a cylindrical parabolic solar collector that heats a cubic sand battery, insulated with sandwich panels with the aim of providing adiabatic coverage. Heat is transferred via a closed-loop water circuit inside a copper coil .Temperature sensors monitor both the sand and fluid temperatures. During the 10-hour charging phase, sand temperature reached 46 °C with uniform heat distribution. Over 24 hours of discharge, the temperature gradually declined to 35 °C. The cooling rate varied: 0.41 °C/h in the first six hours and 0.168 °C/h in the next ten hours, confirming slow and steady heat dissipation. The overall rate ranged from 0.25 to 0.4 °C/h, demonstrating high*

thermal retention. These results confirm the feasibility of sand-based TES as a cost-effective and sustainable energy storage solution. Sand's ability to store and release heat gradually makes it a promising material for improving energy efficiency and supporting the transition to renewable energy.

INDUSTRIAL APPLICATIONS & ADVANCED TECHNOLOGIES

ID 607761: Heuristic-Based Pathfinding in FreeCAD: Length, Energy and Hybrid Optimization

NHOUCHI AHMED , SALMA BEN SAID , BEN ABDALLAH MOHAMED AMINE , AIFAOUI NIZAR

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Abstract: *Ti6Al4V alloy is widely used in biomedical implants due to its excellent biocompatibility and corrosion resistance; however, it poses risks of aluminum and vanadium ion release in the body. Hydroxyapatite (HAP), a bioceramic with a structure similar to natural bone, is considered an ideal candidate for coating materials. This study investigates the enhancement of adhesion and microstructural properties of hydroxyapatite (HAP) combined with chitosan (CS) nanocomposite coatings on a Ti6Al4V alloy substrate, fabricated by laser powder bed fusion, through electrophoretic deposition (EPD). The coated samples were characterized using X-ray diffraction (XRD), and scanning electron microscopy (SEM) to evaluate the phase composition and microstructure of the coatings. The coatings' adhesion and durability were evaluated through scratch test. This study demonstrates the potential of HAP/chitosan coatings for improving the performance and the biocompatibility of Ti6Al4V implants in biomedical applications.*

ID 613186: Dynamic Ergonomic Job Rotation Based on Cumulative Fatigue Levels for Optimized Production Planning and Ergonomic Risk Mitigation

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Abstract: *According to ISO 17450-1, extraction operations from real parts are derived from the integration of a set of points from measured data. They are followed by a feature association after filtering process. Least-Squares and Minmax criterions are widely used for surface estimation and conformity checking. Data are generally assumed to be well distributed. In addition to improving the production process for spherical parts, describing the characteristics of these surfaces using best-fit methods can help provide accurate information on the shape of features extracted from measurement data. This paper presents an approach for best fitting spheres to noisy measured data. The proposed approach is based on spherical basis functions used to approximate noisy data. In this work, Wendland functions are applied as a support for shape error interpolation. Tikhonov regularization method is indeed applied to reduce the effect of noise and improve the smoothness of the solution. A case study is presented to illustrate the proposed approach. The results are compared with the commonly used Gaussian kernel approximation and showed robust results in terms of quality of fit scattered data.*

ID 618568: Advancing sustainable performance in Green Logistics through Industry 4.0 innovations

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Abstract: *This study investigates the tribological behavior of Zr-based metallic glass alloys, specifically Zr59Cu17Ni9Al7O6, using advanced micro-scratch testing and characterization methods. High-purity amorphous alloy ribbons were synthesized via rapid solidification techniques, including melt spinning and copper mold casting, under controlled inert atmospheres to minimize oxidation. Micro-scratch experiments were conducted to evaluate frictional behavior, critical load thresholds for wear initiation, and surface damage mechanisms. Detailed analysis of scratch track morphologies using Scanning Electron Microscopy (SEM) provided key insights into the alloy's deformation and wear processes. The findings offer valuable contributions to the development of surface engineering strategies for metallic glasses in high-performance applications.*

ID 620549: An efficient many-objective heuristic approach for constrained engineering design

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Abstract: *To effectively combat climate change, it is crucial to find sustainable alternatives to fossil fuels. Hydrogen, owing to its unique properties, has potential as a primary energy source. Many countries are focusing on developing green hydrogen industries, making it essential to accurately assess this potential. This study utilized a Geographic Information System (GIS) alongside the Analytic Hierarchy Process (AHP) within a Multicriteria Decision-Making (MCDM) framework to evaluate green hydrogen potential in Senegal, identifying optimal sites for production using photovoltaic solar energy. Criteria were categorized as technical, including irradiation, temperature, and terrain slope, and economic, focusing on proximity to roads, settlements, water sources, and high-voltage lines. Irradiation was the most critical factor, accounting for over 41% of the weightings, while proximity to settlements was least significant at 2.47%. The northwest region of the country is the most suitable for green hydrogen production, spanning 3,943.53 km². The photovoltaic output is estimated at over 91 GWh/km²/year, translating to 1,742.73 kg of hydrogen produced annually per km². Production costs in these areas are projected to range from $4.54/kg actually to $2.21/kg in 2050.*

MANUFACTURING PROCESSES AND ADDITIVE MANUFACTURING

ID 598405: Modeling the Influence of Vibration and Welding Parameters on Spot Weld Resistance Using PSO-ANN

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Abstract: *The strength of 304L stainless steel spot welds was studied using a combined method to estimate and optimize their performance. This method is based on the integration of the PSO-ANN algorithm with the genetic optimization algorithm. The paper focuses on the effect of vibration and welding parameters on the strength of spot welds. To analyze the importance of input factors on the obtained response, statistical tests, including P values and PC% contributions, were performed. It turns out that the vibration frequency is the dominant factor, influencing the displacement by 47.20%. The results demonstrate the remarkable efficiency of the PSO-ANN model to accurately relate the predictions to the experimental data.*

ID 603524: Energy Consumption prediction of AM-FDM isovolumetric components using the ANN and GPR models

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Abstract: *This study investigates the Poly(2-acrylamido-2-methyl-1-propanesulfonic acid-co-acrylonitrile)/Î²-Galactosidase complex, focusing on coacervate formation. We employed UV-visible spectroscopy and Image Dynamic Light Scattering (IDLS) to characterize the complex. Turbidity measurements, obtained from spectroscopy, precisely identified the critical pH values for complex formation (pHC=8.4, pHÏ†1=6.6, pHopt=5.3, and pHÏ†2=3.7). IDLS was used to thoroughly examine the g2(t) correlation function and the size of coacervate droplets within the liquid-liquid phase separation. These analyses revealed that the growth of coacervate droplets, which reached a maximum hydrodynamic radius RH of 2.43 Î¼m at pHopt, is primarily driven by attractive electrostatic interactions between the components within the complex.*

ID 603736: Robust Design Optimization of Compressive Strength of HPC- specimens using the Static RDPP-SF method

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Abstract: *This study presents the development of a detailed simulation method for modeling the cylindrical cavity receiver in a parabolic dish concentrator (PDC) system. Computational Fluid Dynamics (CFD) was utilized to replicate the complex photo-thermal conversion processes within the system. The conversion process was examined in two stages: in the first*

stage, solar energy is absorbed by the receiver walls and transformed into thermal energy, while the second stage involves transferring this thermal energy to the heat transfer fluid (HTF) and the ambient air. The thermal performance during the second stage was evaluated using the Finite Volume Method (FVM), with the solar flux on the receiver walls represented as a source term. The simulation results were validated against experimental data. Various operating parameters, such as HTF mass flow rate, solar irradiation levels, and HTF inlet temperature, were analyzed to determine their impact on the outlet temperature of the HTF and the overall thermal performance of the system.

ID 605929: Contribution of the potential of additive manufacturing technologies to the performance of orthopedic implants

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Abstract: *The study implements the Robust Design of Products and Processes using the Stochastic Frontier method (RDPP-SF) to optimize the compressive strength of High-Performance Concrete (HPC). The compressive strength of HPC was modeled using a mixture of seven quantitative parameters i.e., cement (x1), blast furnace slag (x2), fly ash (x3), water (x4), superplasticizer (x5), coarse aggregate (x6), fine aggregate (x7), and curing period (x8). The RDPP-SF method is used to find out the ingredient mixture, which yields the minimum variation in 1030 HPC specimens. The robust formulation is of nbr. 46 and corresponds to the following setting: x1=427.5Kg/m3, x2=47.5Kg/m3, x3=0.0Kg/m3, x4=228.0Kg/m3, x5=0.0Kg/m3, x6=932.0Kg/m, x7=594.0Kg/m3, x8=7 days, and a compressive strength of 35.08MPa.*

ID 606698: Enhanced Surface Quality and Mechanical Properties of Ti-6Al-4V Alloy via Brushing and Electropolishing Post-Treatments in L-PBF Additive Manufacturing

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Abstract: *Oblique Angle deposition (OAD-PVD) was used to synthesize a ZrO2 thin film with different substrate/Zr target angle (15,30,45,60°) and orientation phi 180°. The main objective of this work is to develop and characterize new biocompatible coatings for hip prosthesis implants that have a « complex » 3D spherical form. The OAD deposition method facilitates the deposition of thin films on this geometry and improves the understanding of the influence of the particle's incidence angle on the surface morphology and microstructure of Zirconium oxide thin films (ZrO2). This study is based on both an experimental approach (DC magnetron sputtering) and a multi-scale numerical approach (Monte Carlo codes SRIM, SIMTRA and NASCAM). Structure, texture and growth of the ZrO2 coatings are studied by XRD. The microstructure and surface morphology were observed by SEM while EDS provided coating composition. We will measure the mechanical properties of ZrO2 thin films*

on titanium alloy substrates on a nanometric scale by the nanoindentation test. The experimental and numerical results complement each other and provide a better understanding of the phenomena that occurred during this study. The simulation by SIMTRA software reproduces well what happens experimentally; higher the number of particles, higher the coatings thickness. Also, the thickness of the ZrO2 thin films is the smallest the highest substrates inclination angles. The microstructure of ZrO2 thin films varies with the substrate inclination angle. It revealed that coated substrates outperform their uncoated counterparts.

ID 607978: Numerical Modeling of Local Mechanical Behavior in the Surface Layer During and After EDM

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Abstract: *Enhancing the mechanical properties and surface quality of Ti-6Al-4V alloy parts produced by selective laser melting (L-PBF) is a major challenge in additive manufacturing. This study explores the impact of post-fabrication treatments rarely studied for this alloy: brushing, mechanical polishing, and electropolishing. The results show that the combination "Brushing + Electropolishing" achieves exceptional surface roughness (Ra ‰ˆ 0.23 µm) while significantly increasing surface hardness, reaching 550 HV after ten brushing passes. Comparing these treatments with other post-fabrication approaches, such as mechanical polishing alone or conventional techniques, it is evident that the "Brushing + Electropolishing" method offers significantly superior performance in terms of surface quality and mechanical properties. These results highlight the relevance of these treatments in demanding sectors such as biomedicine and aerospace, where component quality and durability are essential.*

ID 611139: Production Planning and control of a Production cell prone to random degradation

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Abstract: *Automotive manufacturing is experiencing great development in many areas by developing many systems such as protection and stability control. Electronic control of the suspension and steering system has become one of the most important techniques for simultaneously improving comfort, luxury and protection. The suspension system is considered to be one of the most important components of automobiles as it is responsible for the stability and balance of the vehicle on the roads to ensure the comfort of the passengers. This research introduces a new design for Neuro Fuzzy controller called Extended Adaptive Neuro Fuzzy Inference System (EANFIS) for suspension systems. MATLAB used to simulate the proposed controller under different types of disturbances. In addition, a comparison between EANFIS controller, Fuzzy controller and passive suspension carried out with different types of disturbances in order to evaluate the performance of the proposed model.*

The controller showed excellent performance in terms of robustness, travel reduction, speed and acceleration.

ID 611717: New Approach to creating customized products using 3D printing

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Abstract: *A numerical modeling of diesel-methanol is provided. This study explores diesel spray pattern in methanol region. Simulations are performed on dual fuel Compression Ignition (CI) engine. Three cases are adopted with different intake temperature of T=25°C, 35°C, and 45°C. Results are reported on an engine speed of 1600 rpm and 5 Indicated Mean Effective Pressure. The spray breakup is followed using the Kelvin Helmholtz-Rayleigh Taylor break up model. RosinRammler distribution is used to specify sizes of children drops after a parent drop breakup. Simulations are performed using the RANS framework where k-Îµ RNG model governs turbulence. The Discrete Multi-Component (DMC) model serves fuel vaporization. The results show temperature of T=35°C is adequate in delivering considerable vapor length.*

ID 611861: Experimental study of cutting parameters effects and combined optimization of quality-productivity during turning of Inconel 718

WASSILA FRIFITA, SAHBI BEN SALEM, ABDELKRIM HADDAD, MOHAMED ATHMANE YALLESE

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Abstract: *Copper oxide (CuO) films have garnered significant interest for their potential as effective agents against viruses and bacteria, including their application in combatting COVID-19. This research focuses on the development, deposition, and characterization of CuO films.*

Microstructural analysis was performed using SEM/EDS (Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy), revealing a dense and uniform structure. Mechanical properties were evaluated through Vickers hardness and scratch tests, demonstrating a hardness of approximately 11.14 ± 0.04 GPa and high scratch resistance with a critical load (LC) of about 1.89 ± 0.02, alongside a friction coefficient of 0.093. Antiviral efficacy was assessed, confirming the CuO film's ability to deactivate HSV-2 virus, highlighting its potential as a robust antiviral coating. .

ID 612376: Surface Roughness in PBF-LB/M Additive Manufacturing: A first investigation into the Role of Design and Thermal Factors

VEZIRIAN ANTOINE , ABROUG FOUED , BAILI MAHER , ARNAUD LIONEL

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Abstract: *The objective of this work is to study the fatigue life of specimens with a rough cross-section of the ALSi10Mg alloy, obtained by additive manufacturing and containing defects. The defect was modelled by a semi-spherical void on the surface of a specimen subjected to cyclic loading. The finite element (FE) method was used to calculate the stresses around the defect. Application of the affected depth approach, using the Crossland criterion, enabled us to determine the purely alternating tensile fatigue limit of the AlSi10Mg alloy for several defect sizes. The calculated fatigue limits were used to make Kitagawa diagrams. The results obtained are in good agreement with the experimental data*.

ID 612474: Additive Manufacturing : Performance Evaluation for Sustainable and Efficient Production

HAJJI AMEL , DHOUIB KAREM , GHARBI ALI

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Abstract: *This paper deals with an analysis of the stability of a single-disk rotor supported by adaptive bearings. These bearings incorporate magneto-rheological (MR) elastomer rings as smart materials with controllable mechanical characteristics that can be reversibly modified under the effect of a magnetic field. An analytical approach based on the finite element method is developed to model the rotor-bearing system with MR elastomer rings. In this paper, the effect of using MR elastomer rings on the instability threshold of the rotor-bearing system is studied in both passive and semi-active modes. Simulation results show that the use of MR elastomer rings in passive mode leads to an improvement in the stability of the rotor-bearing system. In semi-active mode, when the MR elastomer is subjected to a magnetic field, the instability threshold of the rotor-bearing system decreases.*

ID 615616: Detection and evaluation of porosity defect in 308L beads using the YOLOv8x computer vision model

OUSSAMA TRAD , KHALFALLAH SOUHAILA , BEN KHALIFA ATED , ZEMZEMI FARHAT , HAMDI HEDI

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Abstract: *Metal additive manufacturing, particularly laser powder bed fusion (PBF-LB/M), enables the creation of complex parts, introducing an entirely new level of complexity to the part design and fabrication fields. However, the surfaces of these parts often exhibit specific defects and high roughness, which degrades their mechanical properties and complicates the treatment of internal surfaces. Therefore, understanding and predicting the roughness*

influencing factors is essential for improving part quality and guiding users in their choices. To identify and categorize the factors influencing roughness, a detailed analysis of surface defects specific to additive manufacturing was conducted. Test specimens were designed to highlight these defects. A plate made of AlSi10Mg was printed using a Renishaw® AM400 machine, and the surfaces were analyzed using an Alicona® focus variation microscope. Various roughness parameters, such as Sa, Sq, Sp, Sv, Sz, S10z, Sku, SSk, Sdq, and Sdr%, were considered for a comprehensive evaluation of the surface states. Preliminary results on the aluminum alloy show due to its high thermal conductivity low roughness variability and minimal heat dissipation issues. This research will provide valuable guidance to designers for anticipating and improving the surface states of PBF-LB/M parts.

ID 615871: Robust Design of the Friction Stir Welded HDPE using the RDPP-SF method

MOHAMED-ALI REZGUI, ALI TRABELSI, MARWEN AMDOUNI, SALAH BEJAOUI, KHALED HAMROUNI

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Abstract: *Additive Manufacturing, or 3D printing, is widely used for creating complex designs directly from digital models, reducing material waste and improving design flexibility. However, AM faces challenges, including defects in printed parts, which can affect performance. Rework techniques can help address these issues. This paper analyzes AM performance by modeling, assessing, and exam-ining the impact of machine's failures and repairs, and product's quality through scrapping and reworking non-compliant ones. Key performance metrics like throughput, efficiency, defective rate, and the number of required raw ma-terials are evaluated, and simulation models are developed to validate the accu-racy of the proposed analytical formulations.*

ID 618691: Machine Learning Prediction of Mechanical Properties of PA12/CF Parts Based on FDM Parameters

SOUDAN MOHAMED AMINE , TIMOUMI MOHAMED , BARHOUMI NAJOUA , LAMNAWAR KHALID

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Abstract: *AZ31 Magnesium alloys have gained significant attention in the biomedical field due to their excellent biocompatibility, and biodegradability. The biodegradability of AZ31 offers several advantages over traditional metallic implants. As the implant degrades, it is gradually replaced by newly formed bone tissue, eliminating the need for a second surgical procedure to remove the implant. However, the rapid degradation rate of AZ31 can also be a limitation, as it may lead to premature loss of mechanical integrity and potential adverse effects. To address this issue, researchers are actively investigating various strategies to control the degradation rate and optimize the mechanical properties of AZ31 for specific applications. In this study, graphene oxide (GO) coating was synthesized using an improved Hummers' method and subsequently deposited onto biodegradable AZ31 Mg alloy for further*

analysis. GO suspensions were prepared in various solvents, including deionized water and ethanol, using ultrasonication. Spin coating was employed to apply GO suspensions onto the AZ31 Mg alloy. Surface morphology was analyzed via Scanning Electron Microscopy, Energy Dispersive Spectroscopy (SEM-EDS) and Fourier transform infrared (FTIR) spectroscopy. Adhesion of GO film to the magnesium alloy substrate was evaluated using a scratch tester. Biodegradation of GO coating was then assessed in simulated body fluid (SBF) in vitro at 37°C. The results demonstrated that the solvent influences the morphological, adhesion, and corrosion behavior of GO thin films. The findings demonstrated that the critical load (Lc) of the GO-ethanol coating (1.6 ± 0.08 N) was significantly higher than that of the GO-water coating (0.41 ± 0.02 N). Furthermore, in vitro SBF immersion testing showed promising outcomes, with the GO-ethanol coating effectively reducing the biodegradation rate and enhancing the corrosion resistance of AZ31.

ID 618921: Heat source model calibration for the simula-tion of LSC-GMAW additive manufacturing Process of SS 316L

BOUZGAROU KAMAR , MZALI FOUED , BEN KHALIFA ATED

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Abstract: *This study investigates the mechanical and thermal characterization of composite materials made from clay, fired clay waste, and sand, highlighting the influence of firing conditions (temperature, firing time, heating rate) and initial composition (mass percentage of each component). Samples were prepared with varying proportions of these constituents (5, 15, 25, and 35 wt.%) and subjected to firing cycles at different temperatures. The analysis of thermal and mechanical properties revealed that increasing firing temperature reduces thermal conductivity while enhancing compressive strength. The results enable the optimization of formulations to design more efficient building materials, contributing to the sustainable use of natural resources and industrial waste. The study also identified the optimal percentages for incorporating fired clay waste powder and construction sand. Experiments showed that incorporating 5 wt.% fired clay waste results in a mechanically strong material, with a compressive strength (Rc) of 20 MPa when fired at 900°C for 15 minutes.*

ID 620550: Mechanical Performance of Additively Manufactured Polylactic Acid Parts

BOUDABBOUS MOHAMED ISKANDER , BELHADJ ASMA , SLAMA SALMA , ZIADIA ABDELHAMID , HABIBI MOHAMED

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Abstract: *The world of logistics is undergoing a radical change during this era, known as Industry 4.0. Deviating from traditional ways, logistics is becoming more advanced with the help of various digital technologies. The supply chain systems are now IoT enabled, using big data, artificial intelligence, and blockchain technology. The latest integrations are enhancing processes, allowing decisions to be made much faster and increasing visibility across the*

supply chain. The technologies of Industry 4.0 can also be holistic by managing resources sustainably, reducing waste, and lowering carbon emission throughout the entire supply chain system. This paper analyzes the issue of new technologies embraced in green logistics. In particular, it examines the construction of such systems from the point of view of energy saving, waste elimination, and the movement towards the principles of the circular economy and everything in between. It also discusses the green and economic aspects of these changes, providing a broader understanding of how the logistics industry can make use of Industry 4.0 along with meeting broader sustainability objectives.

ID 620592: Surface characterization of abrasive waterjet-machined composites: Contribution of 3D topography analysis

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Abstract: *This research investigates the nanomechanical properties of Zr-based bulk metallic glass (BMG) using experimental methods and numerical simulations. Mechanical characteristics such as elastic recovery ratio (hr/hm), reduced modulus (Er), hardness (H) and contact depth (hc) were evaluated by nanoindentation at different depths. A finite element modeling (FEM) was used to capture the experimental results, with the aim of providing a comprehensive analysis of the mechanical properties of Zr-based BMG, revealing insights into the mechanical behavior and stress distribution of the material under nanoindentation test. Contact-mode AFM friction measurements were used to analyze the surface sample. The AFM analysis indicated the presence of low-density defects on the tested surface. The experimental load-unload curves also display phenomena such as €œpop-in€• during deformation, which is characterized by sudden changes in load response. The results reveal that BMG hardness decreases significantly with increasing penetration depth during indentation testing. Furthermore, the finite element simulations show a strong correlation between the experimental and calculated loading and unloading curves, allowing the pop-in phenomenon to be included during the loading phase. This correlation underlines the reliability of the simulation approach in modeling the mechanical properties of BMGs. The indentation profiles revealed the formation of distinct pile-up around the indenter edges, indicating elasto-plastic behavior during the loading and unloading phases. More significantly, the simulated hr/hm values are similar to those obtained experimentally. This result supports a potential method for analyzing the mechanical performance of BMGs.*

ID 629413: AI/ML-Driven Hybrid Life Cycle Assessment for Greening Manufacturing Systems

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Abstract: *We previously demonstrated a new optical technique to measure solid surface velocity using one Laser zero-order Bessel beam. This technique, called Laser Bessel*

velocimetry (LBV), resembles the Laser Doppler Velocimetry and is based on the frequency change of the light scattered from particles crossing the fringes of the Bessel beam. In this investigation, we aim to apply this technique to measure fluid flow velocity. One of the challenges of this technique is its poor spatial resolution compared established techniques such as Laser Doppler Velocimetry (LDV). We use Durnin's circular slits with large width, which results in a reduced depth of field and effective diameter of the beam based on the visible fringes, and resulting in improving the spatial resolution. We report measurement of a fully turbulent water pipe flow and discuss the limitations and potential advantages of this technique.

ID 629420: Slug impact on punching quality in case of various punch-die clearance and velocity

ZEIDI ABDELWAHEB , BAHRI AMIR , ELLEUCH KHALED

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Abstract: *This paper proposes an effective method for determining the shear properties of woven reinforcements. Digital image correlation (DIC) is used to analyze the distribution of shear angles and verify the slip hypothesis. Though limited in some respects, the shear-extension test remains a simple and reliable approach to determining the locking angle of the fabric. .*

ID 629436: Experimental study on surface roughness in end-ball milling of inclined Toolox 33 steel surfaces

LOTFI DAHMANI, BOUJEMAA HADJ BRAHIM , SLIMEN ATTYAOUI, MOHAMED NASSER

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Abstract: *In this paper, an efficient version of imperialist competitive optimizer (ICO), named many-objective improved ICO (MICO) was proposed and explored to solve many-criteria engineering design issues. An enhanced technique for colonies movement towards imperialists, named enhanced assimilation step (EAS), is employed to improve the MICO effectiveness in terms of convergence and global search capability. In order to let this optimizer to handle challenges with numerous conflicting functions, the pareto domination approach is integrated into ICO. To assess the MICO efficiency, convergence and diversity performance metrics are used. The obtained results illustrate that for many-criteria engineering issues, the MICO optimizer outperforms other well-known methods and literature results.*

ID 629442: Finite Element Simulation of Laser Welding for Ti-6Al-4V Titanium Alloy Plates

JABLAOUI NOUR , FRIJA MOUNIR

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Abstract: *L'optimisation des caractéristiques mécaniques et de l'adhérence de l'alliage de magnésium AZ31 est essentielle pour son utilisation dans le secteur biomédical, en particulier pour les implants bio-résorbables. Durant cette étude, des revÃªtements de carbone amorphe hydrogéné ont été déposés sur la surface de l'alliage de magnésium AZ31 dans le dessein d'optimiser ses propriétés mécaniques et son adhérence. Le dépÃ´t du revÃªtement a-C=H a été réalisé en utilisa une technique industrielle de dépÃ´t chimique en phase vapeur assisté par plasma (PECVD). L'analyse de la morphologie de la surface due au film de carbone amorphe hydrogéné a été effectuée en recourant Ã la microscopie électronique Ã balayage (MEB) et Ã la spectroscopie Ã dispersion d'énergie (EDS). De plus, une analyse de l'adhérence du revÃªtement de carbone amorphe hydrogéné sur les surfaces des alliages de magnésium a été menée Ã l'aide d'un équipement de test de scratch spécialisé. Par ailleurs, il a été observé une augmentation significative de la force d'adhésion entre le film a-C=H et le substrat de magnésium, d'environ 6,4 N, indiquant une liaison solide qui présente une résistance Ã la délamination lorsqu'elle est soumise Ã une contrainte mécanique.L'alliage de magnésium AZ31 revÃªtu d'a-C=H est prometteur pour les applications biomédicales en raison de l'amélioration de ses caractéristiques mécaniques et de son adhérence accrue, en particulier pour la fabrication d'implants biodégradables performants. .*

ID 629445: Optimization of Laser Metal Welding Process Parameters of Ti-6Al-4V Plates.

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Abstract: *Cette étude présente une analyse expérimentale des essais Ã simple recouvrement pour une combinaison, aluminium/acier. L'influence de divers paramètres tels que le couple de serrage, la température et le temps de maintien sur la résistance mécanique et la déformation maximale a été examinée. Les résultats permettent d'identifier les paramètres les plus influents et de comprendre les mécanismes de défaillance associés Ã chaque configuration. Un couplage entre les paramètres mécaniques et thermiques est également discuté pour mieux interpréter les tendances observées.*

ID 629449: Effect of Laser Processing Parameters on the Porosity and Density of Ti-6Al-4V Parts Produced by Selective Laser Melting SLM

SELMI NARJESS, KAOUTHER KHLIFI

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Abstract: *This study concerns the buckling behavior of T-shaped stiffened composite panels reinforced with a new concept of curvilinear grid sub-stiffening under uniaxial compression loading. First, the simulated buckling response of the T-shaped stiffened composite panel is validated against experimental results from the literature. Subsequently, curvilinear T-shaped sub-stiffeners are introduced into the design of the T-shaped stiffened composite panel. An optimization design framework is proposed to optimize laminates sequence of skin, ply*

orientation angles, and distribution of the curved sub-stiffeners, as well as the curvature of the sub-stiffeners of the proposed curved grid sub-stiffened composite panels, aiming to achieve higher buckling performance without additional weight. Results reveal that introducing curvilinear grid sub-stiffeners into the T-stiffened composite panel significantly improves buckling performance by 254.42%, highlighting the exceptional design potential of curvilinear grid sub-stiffeners. This study offers valuable insights into the design of sub-stiffened composite panels for improving structural performance, offering significant advantages for industries such as aerospace that require lightweight structures yet are resistant to buckling.

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Materials: Structures & Behavior

ID 595776: Effect of coupling agent on mechanical properties of HDPE composites reinforced with higher content reed fiber obtained by injection moulding

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Abstract: *This paper investigates the influence of high content reed fibers (Phragmite australis) on the mechanical characteristics of High Density Polyethylene composite (HDPE). The natural fiber reinforced composites were produced by melt compounding injection. Their mechanical and thermal properties were investigated. It was found that the presence of high concentration reed fibers had no effect on the thermal stability of polymer matrix, but may be increase the crystallinity of the polymer matrix. As for the mechanical properties, a substantial enhancement in module was observed, as compared to that of neat matrix. When the coupling agent €œOverac€• was added, the Young's modulus is significantly decreased. This decrease can be may be related to poor dispersion of fiber bundles in the matrix. It was also observed that tensile strength increase at max in the presence of the €œOverac€• in composites HDPE reinforced with reed fibers. This is explained by a better interfacial adhesion between the fibers and the matrix allowing an improvement in the transfer of stress from the HDPE matrix to the reed fibers.*

ID 600929: Tribological and mechanical studies of irradiated SnO2 thin films

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Abstract: *Gamma-irradiated SnO2 thin films are studied in this work. Over recent trends, these films have been used in various applications exposed to gamma rays, which has had a negative impact on their mechanical properties. The spray pyrolysis method was used to produce these thin films, which are deposited on a glass substrate preheated to 450°C. The influence of gamma irradiation on tin oxide coatings has been studied. XRD analysis of pure and gamma-irradiated SnO2 thin films shows considerable changes in their crystal structure. Nanoindentation results show that gamma irradiation increases hardness and Young's modulus. On the other hand, the scratch test reveals deterioration in substrate adhesion and wear resistance. Meanwhile, the friction test shows an increase in the coefficient of friction. Scanning electron microscopy shows that the surface morphology of gamma-irradiated SnO2 thin films changes. They become smoother. However, the surface has not been damaged by this change in morphology. Although SnO2 films are subject to various changes when irradiated with gamma rays, they can still be used successfully in a wide range of applications. This applies to gamma-ray doses below 60 kGy. Beyond that, variations in characteristic parameters such as structure, hardness, wear, friction and adhesion are random. Thus, a dose of 60 kGy represents a limiting condition for the application of SnO2 in high-irradiation environments.*

ID 601553: Investigation of Poly(2-acrylamido-2-methyl-1-propanesulfonic acid-co-acrylonitrile) /Î²-Galactosidase complex structure by Image Dynamic Light Scattering

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Abstract: *This study aims to assess the structural integrity of 3-layer Laminate Shells by integrating machine learning (ML) to predict its resistance, under varying material properties, geometric parameters, and loading conditions. A synthetic dataset of 86,400 configurations was generated by varying layer thickness, Young's modulus, and applied normal force. The Tsai-Hill failure criterion was applied to determine the failure threshold of the central layer. To address class imbalance, the Synthetic Minority Oversampling Technique (SMOTE) was employed. Five ML algorithms were evaluated to predict the central layer's failure value: Linear Regression, Decision Tree, Random Forest, Gradient Boosting, and XGBoost. Performance was assessed using mean squared error (MSE) and R-squared (R^2) metrics. Results indicate that ensemble methods, particularly Random Forest (MSE = 0.04, R^2 = 0.9998), outperform others due to their ability to capture nonlinear relationship between Failure criterion and structure's geometry and material properties. These findings demonstrate the potential of the ML to enhance innovative composite design by providing accurate predictions of mechanical behavior and failure. Future work could explore hybrid approaches that integrate physical model based with data-driven methods for more reliable predictions in complex structures. .*

ID 605551: Experimental Investigation of the Mechanical Properties of Cement Mortar Incorporating Recycled Polyurethane Particles

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Abstract: *This research investigates the application of model-free reinforcement learning (RL) algorithms for real-time adaptive control of vehicle suspension systems. Departing from traditional model-based approaches, we leverage the inherent adaptability of RL to address the challenges of real-world driving scenarios characterized by unpredictable road disturbances and varying driving conditions. Specifically, we explore the performance of Deep Deterministic Policy Gradient (DDPG) and its variants, including Twin Delayed DDPG (TD3) and Soft Actor-Critic (SAC), in optimizing suspension damping forces to minimize body accelerations, improve ride comfort, and enhance vehicle stability. A high-fidelity simulation environment incorporating realistic road profiles and vehicle dynamics is developed to evaluate the performance of these RL agents. Results demonstrate the efficacy of RL-based control in achieving superior ride quality and improved handling compared to conventional passive and active suspension systems, highlighting the potential of this approach for next-generation intelligent vehicles.*

ID 606287: Advanced Modeling of Fatigue Behavior in SMCs Under Tempered Moisture Aging Conditions

ABDESSALEM ABIR , SAHBI TAMBOURA , FITOUSSI JOSEPH , BEN DALY HACHMI

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Abstract: *This study aims to develop sustainable materials that minimize environmental impact by investigating bio-composites reinforced with date palm fibers. These fibers, abundant in North Africa and the Middle East, offer a promising alternative for ecological and high-performance materials. Experimental results indicate that incorporating palm fibers significantly alters the structural properties of bio-composites. For instance, at a fiber content of 4% by weight, the theoretical density is 1.097 g/cm³, while the measured density is 1.085 g/cm³, with a void volume fraction of 1.093%.Increasing the fiber content to 10% results in a theoretical density of 1.092 g/cm³, a measured density of 1.072 g/cm³, and a void fraction of 1.831%. These findings highlight the potential of palm fiber composites for applications in automotive, construction, and aerospace industries, where lightweight and sustainable materials are increasingly sought after.*

ID 606395: Comparison of the performance of liquid and gaseous nitriding on the wear resistance and surface properties of 42CrMo4 material

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Abstract: *Using waste materials instead of natural resources helps preserve them for the future and supports a circular economy. In this context, this study aims to gradually replace sand with recycled polyurethane (PU) particles by varying the PU volume percentage (0%, 33%, 50% and 100%). Compressive and bending tests were conducted to show the effect of the inclusion of PU on the mechanical properties of mortar. The results show that the compressive strength remains the same as the reference mortar (mortar without PU) but decreases when all the sand is replaced with PU. In addition, increasing the percentage of PU modifies the damage behavior of the mortar. However, the bending strength improves as the PU percentage increases. As a result, 50% of the sand can be replaced with recycled PU particles without impacting the mortar's mechanical properties.*

ID 606579: Effect of firing temperature and materials particle size distribution on the mechanical performances of Clay composite filled with Expanded Perlite

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Abstract: *The durability of sheet-moulding compound (SMC) composite mate-rials was explored through a series of temperedfwater immersion experiments. The tests were undertaken in distilled water at 25, 50, 70 and to 90 degrees Celsius over a range of time periods. The results appear to support the theory proposed by Kibler and Carter. In their theoretical model, Kibler and Carter put forth the idea that the diffused moisture molecules could be classified intoftwo categories: mo-bile or bound. In theypresent study, we have considered the two aforementioned types separately in order to predict the water uptake. It would seem that the amount of sorbed moisture has a considerable effect on the mechanical performance. The results appear to indicate that humid conditions may potentially lead to a reduction in fatigue behaviour, namely the number of cy-cles to failure (Nr). Furthermore, a new and efficient methodology was put forth for predicting the fatigue behaviour of hydrothermal-aged SMC composites.*

ID 606606: Drying kinetics and Mechanical performances of a Kaolin-based composite filled with expanded Perlite

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Abstract: *The strengthening behavior of inorganic fillers in composite materials depends to a great extent on the interfacial interaction between the polymer matrix and the filler. Due to their multiple applications and low cost, particle- filled polymer composites are becoming more popular. In addition, highly desirable functional properties may be added to the composite material via the use of modified nanometric fillers. The aim of the present study was to investigate the effect of adding nano- zirconia particles on the properties of Smart Set GHV gentamicin bone cement. The nanozirconia powder was obtained by the use of high energy ball milling and added to the bone cement in the weight percentages of 0.7, 1.2, and 1.7. Samples were prepared from these hand- lay nanofiller €“ polymer mixtures and shaped by casting in a mould. The nano zirconia powder characterization was carried out via X-Ray Diffraction (XRD) and Fourier Transform Infra €“ Red Spectroscopy (FTIR) techniques. The mechanical behaviour of the composite samples was studied using tests included tensile and impact testing. The XRD results showed that the crystallite size was successfully reduced to the required nanosize of 37 nm. The FTIR demonstrated that milling to the nanosize had an influence on the level of interfacial interaction between the filler and the bone cement matrix as evidenced by the observed enhanced strength at a content of 1.7 wt % nano zirconia. However, there was a decrease in the impact property of the zirconia reinforced composites as compared with the non €“ reinforced pure samples. .*

ID 610093: Microstructural Evolution and Damage Mecha-nisms in SMC Composites: A Detailed Micro-scopic Study Before and After Accelerated Wet Aging

ABDESSALEM ABIR , TAMBOURA SAHBI , BEN DALY HACHMI , FITOUSSI JOSEPH

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Abstract: *This study evaluates the performance of a pyramidal solar still as a sustainable and efficient desalination technology. An experimental investigation was conducted in GabÃ¨s, Tunisia, to assess the thermal performance of a conventional pyramidal solar still, with results validated through Computational Fluid Dynamics simulations. Following validation, numerical optimization was performed to enhance system performance. Additionally, the study examines the impact of glass cover geometry, specifically the inclination angle, on distillate yield. ANSYS Fluent simulations were conducted for three inclination angles (30°, 34°, and 38°) to identify the optimal configuration for maximizing performance. The results indicate that the glass cover tilt significantly influences heat absorption and condensation rates within the still. Among the tested angles, the 34° inclination achieved the highest thermal efficiency and absorber temperature. These findings contribute to the optimization of pyramidal solar still designs, enhancing freshwater production in arid regions. .*

ID 612665: Bi-directional deflections of functionally graded plates: 3D FEM approach

SOUHIR ZGHAL , HADRICH AYMAN , KARMI AHLEM , BOUAZIZ ZOUBEIR

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Abstract: *This paper focuses on the vibration control of a rotor system using adaptive bearings in order to reduce the vibrations amplitudes especially in the vicinity of critical speeds. These bearings include magneto-rheological (MR) and electro rheological (ER) elastomers rings as a smart material whose mechanical characteristics can be controlled under the effect of a magnetic or electric field. An analytical approach based on the finite element method is developed to model a rotor-bearing system with MR and ER elastomers rings. The effect of the use of MR and ER elastomers rings on the unbalance vibration response of the rotor system is investigated. The simulation results showed the effectiveness of MR and ER elastomers in controlling the vibration of the rotor-bearing system. The use of MR and ER elastomers in passive mode leads to a reduction in the vibration responses. These two types of MR and ER elastomers have practically the same effect on the reduction of the maximum vibration amplitude. In the semi-active mode, when the MR and ER elastomers are subjected to a magnetic or electric field, the vibration amplitudes increase at the resonant speeds. Nevertheless, it has been shown that the vibration response can be reduced at other rotating speed range when a magnetic or electric field is applied.*

ID 612989: Effects of duplex carburizing-PVD treatments on the tribological behavior of Hardox 400 steel

KHALDI ABIR , GHANEM ABDELKARIM , TERRES MOHAMED ALI

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Abstract: *This study aims to evaluate the surface quality during abrasive waterjet (AWJ) cutting of glass/vinylester laminates. A 3D topographical analysis was carried out to characterize the irregularities of machined surfaces under the influence of various process parameters, including abrasive flow rate, traverse speed, pressure and standoff distance. The*

results showed that optimizing these parameters significantly improves surface quality by reducing topographical defects and ensuring more homogeneous cutting. In addition, 3D roughness analysis enabled more precise characterization of irregularities than 2D roughness, providing a better understanding of erosion mechanisms. These findings underline the importance of a three-dimensional approach to the control and optimization of machining processes, particularly for applications requiring high precision and excellent surface integrity.

ID 616354: Effect of modulation period on mechanical properties of multilayered protective nanostructured coatings

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Abstract: *Traditional plastic materials, although widely used for their cost and ease of shaping, pose major challenges in terms of recycling and environmental impact. Faced with these challenges, researchers are turning to the development of biodegradable composite materials, reinforced with natural fibers such as jute and raffia, to reduce pollution and improve durability. The aim of this work is to conduct a comparative study between two biodegradable bio-composite materials based on PLA as matrix and jute fabric and raffia fibers as reinforcements. The results showed that the bio-composite reinforced with jute fabric exhibited more significant tensile strength than those reinforced with raffia fibers.*

ID 616640: Characterization and Sustainability Assessment of Plaster/Amend Shell Powder Composites for Thermal Insulation Applications

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Abstract: *The limitations of batteries have led to the investigation of energy harvesting methods, particularly vibration-based harvesting with piezoelectric transduction, which shows potential for replacing batteries in powering small electronic devices. However, current piezoelectric energy harvesters exhibit a lower power-to-weight ratio than batteries. To enhance the power density (power-to-weight ratio) and improve the sustainability of the harvester, this paper presents an investigation into the modeling and analysis of a piezoelectric bimorph cantilever with base excitation. The bimorph consists of two piezoelectric layers bonded to a substrate. The substrate is modeled as a lightweight honeycomb sandwich structure constituted of two face sheets attached to a honeycomb core. The developed model is validated using 3D numerical simulation. The obtained results show that replacing the continuous substrate solid with a honeycomb sandwich substrate generates higher power density and reduces stress concentration on the clamped side. This leads to an increase in the life cycle of the piezoelectric layers and enhances the sustainability of the energy harvester. Furthermore, the results indicate that adding face sheets to the honeycomb core can significantly increase power density.*

ID 616678: Multiaxial Fatigue Limit of V-Notched AISI 416 Steel based on Affected Depth approach

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Abstract: *This study investigates the optimization of piezoelectric nanogenerators based on BaTiO,f-P(VDF-HFP) composite thin films through the systematic analysis of particle size, sonication parameters, and computational modeling. Two distinct BaTiO,f particle sizes ((20%, 30%, and 40%) were evaluated to understand their effects on both energy harvesting capabilities and mechanical properties. The solution casting method was employed to fabricate the composite films, with particular attention given to the processing conditions' impact on performance. Finite element analysis using representative volume elements was conducted to model the composite behavior and investigate electric field enhancement phenomena between particles. Results demonstrate that nanogenerators fabricated with fine grain size.*

ID 617761: Mechanical and thermal characterization of Plaster-based composites reinforced with expanded perlite and/or leather waste

BOUMNIJEL IBTISSEM , KAIBA CHAIMA , BEN FRADJ SAFOUEN , DAOUED MIHOUBI

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Abstract: *Superalloys are categorized as difficult-to-cut materials. These superalloys such as Inconel 718 have poor machinability. So that, the improvement of the surface quality and productivity of our material workpiece become crucial to reduce the risk of premature failure and tool wear. Therefore, an enhanced tool life and higher productivity are achieved. The present study investigates to choose the optimal cutting parameters on material removal rate (MRR) and surface roughness (Ra) through an experimental study using three MCDM methods (MARCOS, TOPSIS and PIV) based on the signal to noise (S/N) ratio in order to achieve the best technological parameters to obtain the best quality and the high productivity*.

ID 618040: Characterization of Viscoelastic Behavior in Relaxation and Evolution of the Shapery Model for mirror epoxy

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Abstract: *The present study focuses on improving wear resistance, using two types of duplex surface treatments, chromium nitride (CrN) and diamond-like carbon (DLC), deposited on Hardox 400 steel carburized by the gas carburizing process. The two thin films were deposited by physical vapor deposition (PVD). A scratch test evaluated the studied layers' adhesion and wear resistance. The results obtained were compared with those of the Hardox*

400 steel without treatment and revealed the gains made on the adhesion; such as a significant improvement was shown at the level of critical loads and the absence of the third damage mode was noted in the case of CrN duplex treatment. Concerning the wear resistance, multipass scratch tests were used to analyze the friction coefficient, wear volume, and dissipated energy. The results reveal that both treatments record lower friction coefficients and wear volumes. Still, the CrN duplex layer remains the most efficient, such as it records a wear volume of approximately 1.02 10^6 Î¼m^3 for an applied load of 15N.

ID 619173: Nanomechanical Properties of Zr-Based Bulk Metallic Glass: Insights from Experimental and Numerical Nanoindentation Prediction

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Abstract: *This study presents a novel automated ergonomic risk assessment system using 3D posture estimation, in order to improve the Rapid Entire Body Assessment (REBA) scoring methodology. By employing two synchronized smartphones and Direct Linear Transformation (DLT), the system accurately reconstructs 3D human joint positions. An automated REBA algorithm is then used to analyse 3D posture data, enabling detailed ergonomic risk assessment for industrial workers. The approach demonstrates significant advantages over traditional methods, including a high level of accuracy, low-cost setup, and non-intrusive data collection, aligning well with Industry 5.0's human-centric philosophy. The validation showed an 88.66% alignment between manual and automated scoring, with the discrepancies mainly due to joint occlusions, calibration inaccuracies, and subjective manual scoring. To mitigate identified high-risk postures, the system suggests potential ergonomic interventions such as workstation adjustments, assistive lifting aids, and job rotation. This automated system provides a robust solution for mitigating work-related musculoskeletal disorders (WMSDs), supporting data-driven interventions to improve worker well-being and workplace safety.*

ID 620445: A decoupled homogenization methodology for fibre-reinforced composites with fibre-bending stiffness

GAMRA ANWAR , MANSOURI KHALIL , RENARD YVES , ARFAOUI MAKREM , HOMOLLE THOMAS

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Abstract: *Accurately predicting fatigue life is crucial for the design of aerospace components. This study investigates the use of machine learning (ML) models to predict the fatigue life of AA2024-T351 aluminum alloy under a fixed strain amplitude of 1.2%. Experimental fatigue data were used to train and evaluate various ML models, including Linear Regression, Polynomial Regression, Random Forest, Support Vector Regression (SVR), and Artificial Neural Networks (ANN). The performance of these models was assessed using metrics such as Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE) and R-squared*

(R^2). Among the tested models, the Random Forest demonstrated superior predictive accuracy. This work underscores the potential of ML to reduce the reliance on expensive and time-consuming experimental fatigue testing while maintaining high predictive reliability.

ID 620505: Numerical Analysis of the Mechanical Behavior of Date Palm Fiber-Reinforced polylactide Bio-composite

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Abstract: *The present study aims to experimentally evaluate the efficiency of incorporating Expanded Perlite (EP) and/or Leather Waste (LW) in plaster-based composites for construction applications. Several EP and/ or LW- reinforced composites were prepared by partially replacing the plaster with varied percentages of EP (0-5% wt.) and/or LW (0-5% wt.). After being dried, mechanical and thermal characterization of these reinforced composites were performed. The results show that the thermal conductivity decreased for all the proposed composites, especially for the proportion of reinforcement of 5% LW with a reduction of 23.17% with regard to the reference sample; its thermal diffusivity was assessed as 0.33mm2/s, proving the efficiency of LW, as an organic fibrous material, to limit heat transfer. Nevertheless, considering the porous structure of the EP, its presence in the plaster matrix has improved the thermal conductivity; while slightly increasing the thermal diffusivity. The improvement in the thermal properties of plaster-based composites was attributed to the low thermal conductivity of the LW fibers and EP. Regarding mechanical properties, the compressive strength, and Flexural force decreased with the addition of EP and LW compared to the reference sample. Despite the reduction in the mechanical properties, P-0%EP-5%LW met the requirements for use as an insulating material in building construction. Finally, this study contributed to the valorization of EP and/or LW. The results encourage handling plaster-based composites reinforced with LW and EP in the construction field towards eco-friendly buildings.*

ID 620584: Laser welding joining of glass fiber reinforced thermoplastic composite and DP600 steel dissimilar joint

BOUKHADRA KHAOULA , JENDLI ZOUHAIER , WALRICK JEAN CHRISTOPHE , KOUADRI-HENNI AFIA

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Abstract: *Zinc oxide (ZnO) nanocoating has attracted attention for its potential antiviral and antibacterial properties, including its ability to combat COVID-19. This study focuses on the synthesis and characterization of a zinc oxide (ZnO) nanocoating. The examination of the microstructure and the composition of the coating was conducted using SEM/EDS (Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy). The Vickers hardness and scratch experiments were carried out to evaluate the mechanical properties of coated surfaces. Results demonstrated a hardness of about 8.93 ± 0.02 GPa. Additionally, scratch tests revealed a high scratch resistance with a critical load LC of about 1.04 ± 0.02*

accompanied by a friction coefficient of 0.12. In addition, this study revealed that the ZnO nanocoating had excellent antimicrobial capacity Staphylococcus aureus ATCC 29,213.

ID 620599: Hygrothermal behaviour of composite tubes exposed to acid solution

BRAHEM NESRINE , ATED BEN KHALIFA , LAGACHE MANUEL , BRAIEK SONIA , MONDHER ZIDI

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Abstract: *This study aimed to evaluate how enzymatic treatment influences the morphology of date palm fibers and its impact on the physical and mechanical behavior of composites incorporating both untreated and treated fibers. Five different extraction techniques were examined, including the use of xylanase and pectinase individually, their combined application, as well as sequential treatments where xylanase was applied before pectinase and vice versa. Morphological analyses were performed on both raw and treated fibers, while the resulting composites were evaluated through tensile testing and water absorption assessments. The results demonstrated that the combined enzymatic treatment was particularly effective in eliminating non-cellulosic components and enhancing fiber defibrillation. Composites reinforced with surface-modified fibers demonstrated a 30% increase in rigidity, improved tensile strength, and exhibited a slower water absorption rate compared to those containing untreated fibers.*

ID 629047: Vibration performance of a lightweight natural fiber reinforced composite footbridge

HELAILI SOFIENE , REZGUI TAYSIR , NAJAR FEHMI , CHAFRA MOEZ

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Abstract: *Computer Aided Design (CAD) systems are crucial in mechanical engineering, enabling precise design, modeling, and simulation of complex parts. Mastering these tools is essential for students and professionals to stay competitive and meet industry demands. Efficient and quick learning of CAD systems is key to developing practical skills, boosting productivity, and fostering innovation in the field. To support teachers in delivering effective training and conducting accurate evaluations, an automated tool is essential for assessing CAD models during training sessions. This work presents a CAD Model Automated Assessment (MAA) tool designed for use in mechanical engineering courses. The proposed tool is based on a developed model that incorporates different aspects of modelling, such as geometric, feature-based and parametric modelling. To ensure accurate evaluation of a given part compared to a known reference, the proposed framework utilizes adjustable coefficients. They are determined by the teacher and can be adapted according to the teaching strategy or the specific objectives of the course. The proposed framework employs adjustable coefficients determined by instructors based on their pedagogical strategies or coursespecific objectives.*

ID 629053: Etude Expérimentale des Assemblages a Simple Recouvrement : Influence des Paramètres du Processus sur la Résistance Mécanique

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Abstract: *Ball-end milling is essential in mold and die machining for several reasons. It allows complex shapes to be machined with a better surface finish and reduces the need for post-machining polishing. In this work, an experimental study was conducted to analyze the influence of cutting parameters, cutter overhang length and surface inclination angle on roughness in the case of finish milling of Toolox 33 steel. The average value of the arithmetic roughness (Ra) of the surface measured in three different directions was used to evaluate the surface quality. The first direction is the feed direction, the second direction is along the radial pass direction and the third direction is along the line inclined at 45° to the feed direction. The Taguchi L27 experimental design method was used. The results found show that radial depth of cut (ae) and machining strategy have the greatest impact on surface quality. The found mathematical roughness model has a high roughness prediction capability and constitutes a database for preventing roughness of inclined surfaces.*

ID 629054: Prediction of 3-layer Laminate Shells Failure: A Comparative Study of Machine Learning Algorithms

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Abstract: *A multi-objective optimization approach based on the prediction of error bounds through interval analysis combined with genetic algorithms was developed to enhance the performance of parallel robots. Using this optimization, a comparative study was conducted between the optimized and non-optimized mechanisms. For a test trajectory, several parameter vectors were evaluated, and the accuracy improvements were quantified. The results revealed improved performance and highlighted the effectiveness of the proposed method.*

ID 629056: Electrochemical Properties of PbS Decorated TiO2 Nanotubes Via SILAR for Biomedical Applications

GHOZLANI JABEUR , DHIFLAOUI HAFEDH , HAJJAJI ANOUAR , TERRES MOHAMED ALI

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Abstract: *Advances in Additive Manufacturing (AM), particularly Fused Deposition Modelling (FDM), are attracting increasing interest from healthcare professionals worldwide. Although this process is widely used across various industrial sectors, it is becoming increasingly important in the medical field, particularly with regard to the*

manufacture of medical devices, instruments and implants. This article provides a comprehensive review of the literature on the use of FDM process, which is adopted in the medical field for its ability to offer customized solutions. FDM technology is characterized by its flexibility, allowing for the use of a wide range of plastic materials, particularly polymers. However, selecting the appropriate material for each application can pose challenges. To assess the relevance of the materials used, it is essential to analyze their mechanical properties. This review thoroughly examines recent research on the application of FDM in the medical sector, studying the influence of printing parameters on the mechanical properties of materials. Additionally, it identifies existing research gaps and underscore the need for a more targeted approach to optimize the use of this technology in developing customized medical devices. .

ID 629419: Sustainable Polypropylene Composites Reinforced with Natural Fillers: An Analysis of Mechanical and Wear Performance

BARHOUMI NAJOUA , ATTIA-ESSAIES SAMEH , SAMET AMEL , KHLIFI KAOUTHER , MAJID FATIMA

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Abstract: *The development of cost-effective, and accurate navigation systems for differential drive robots (DDR) is essential to enhance accessibility in robotics, since current advanced systems require costly sensors and computational resources. This study aims to implement a hybrid approach for PID controller tuning, combining the Ziegler-Nichols method with Particle Swarm Optimization (PSO), to reach desired trajectory tracking with acceptable balance between computational performance and control performance. In this study, kinematic and dynamic models of a DDR were developed, followed by PID tuning through an estimation using ZN algorithms, which serve as initialization for PSO optimizer. A sensor fusion via Kalman Filter was developed using a low-cost encoder and an IMU. All algorithms were implemented using Python and a DDR prototype was used for real-world tests. As result, our hybrid approach achieved zero overshoot and a 25 ms setting time, outperforming ZN estimates. For real tests, the navigation error is estimated to be below 2 cm. Hence, our PID tuning method confirms the possibility of obtaining high-performance navigation with cost-effective components and presents an adapted solution for robotics implementation in resource-constrained environments. .*

ID 629424: Enhancing Viral Protection and Scratch Resistance of Stainless Steel Surfaces with Copper Oxide Coating

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Abstract: *Piezoelectric Macro Fiber Composite (MFC), known for its great flexibility, has increasingly been employed in several modern applications including energy harvesting. The heterogeneous structure of the MFC, composed of piezoelectric fibers embedded in an epoxy*

matrix, complicates its study. Homogenization technique is used to describe the equivalent piezoelectric properties of the MFC patch. In this study, two MFCs are assembled using a bonding layer to create a bimorph structure. The tensile properties of these composites are heavily influenced by the bond characteristics between the MFCs patches and the bonding layer. Few studies have examined the MFC/bonding layer interface. However, there is a lack of study characterizing the effect of the bonding layer thickness on the generated power. This work presents linear analytical approaches to predict the energy harvested from an MFC bimorph cantilevered beam. To improve the structure of the bimorph MFC, fiber thickness and bonding layer thickness are adjusted to maximize the output power. It has been observed that an increase in the fiber thickness or the bonding layer thickness, compared to a reference configuration, results in a decrease in output power.

ID 629426: Enhancing Predictive Accuracy in FSSW Simulations Using Design of Experiments on Johnson-Cook Parameters

HANNACHI NASRA , KHALFALLAH ALI , LEITÃ£O CARLOS , RODRIGUES DULCE

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Abstract: *We present a two-scale decoupled homogenization scheme for the numerical approximation of large elastic deformations in fiber-reinforced layers. This methodology integrates micromechanical and macro-mechanical frameworks to leverage their respective advantages while mitigating their limitations. The approach applies to periodic microstructure materials exhibiting hight anisotropy, characterized by a huge difference between longitudinal and transverse responses. The macroscopic deformation gradient tensor and its gradient are prescribed on a microstructural representative volume element (RVE), enabling the incorporation of bending stiffness and capturing non-uniform macroscopic deformation fields at the microscale. Each microstructural constituent is modelled as a classical continuum, and the RVE problem is formulated based on equilibrium equations and appropriate boundary conditions. The macroscopic stress tensor and the double stress tensor are derived from the solution of the microstructural boundary value problem through an extended Hill€“Mandel condition. A second-order continuum theory is employed at the macroscale. Numerical simulations validate the accuracy and robustness of the proposed framework, demonstrating a 4% discrepancy between heterogeneous and homogenized layers in various bending tests. This methodology effectively captures complex deformation mechanisms while reducing computational costs compared to fully coupled homogenization strategies.*

ID 629431: Analytical Study of Stress Distribution in MWCNT Nanocomposite Films on Flexible Substrates under Residual Stresses and Unidirectional Loading

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Abstract: *This study numerically investigates the heat transfer performance of a helical coil heat exchanger (LCHX) used in latent heat thermal storage (LHTS). A 3D model was developed using ANSYS Fluent and validated against experimental charge and discharge data. The novelty of this work lies in repurposing the helical coil heat exchanger as a container for phase change material (PCM), specifically designed for solar-powered LHTS systems. Parametric analyses were conducted to evaluate the effects of heat transfer fluid (HTF) inlet temperature and flow rate on charging and discharging performance. Simulation results provided deeper insights into the thermal behavior inside the LCHX, overcoming experimental limitations. Notably, increasing the HTF flow rate from 0.03 to 0.07 kg/s significantly reduced both charging and discharging times. Similarly, increasing the temperature difference between HTF and PCM accelerated the melting and solidification processes. .*

ID 629432: Effects of Particle Size and Sonication Parameters on the Mechanical and Energy Harvesting Performance of BaTiOâ‚ƒ-P(VDF-HFP) Composite Nanogenerators

NAIFAR SLIM , BENBRAHIM FATMA , AYADI MOHAMED DHIA , KANOUN OLFA

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Abstract: *The mechanical properties of bio-composites made from polylactide (PLA) reinforced with date palm fibres (DPF) are investigated using numerical analysis in this study. The focus is on comprehending the impact of processing parameters and fibre content on the mechanical properties of the material. A finite element model was used to simulate the stress-strain behaviour, deformation modes and failure behaviours of these bio-composites. The behaviour of the bio-composites at different fibre loads of 10€“40 wt. % was evaluated under various loading conditions. It was found that the optimal mechanical properties were obtained at 30 wt. % of fibre content, where the tensile strength was improved by 45% as compared to the neat PLA. The results of the numerical analysis indicated that fibre orientation and distribution are the most important factors affecting the mechanical properties of the composite. Moreover, the study showed that the interface between DPF and PLA matrix is crucial in the load transfer mechanisms. This paper offers important conclusions regarding the mechanical properties of DPF-PLA bio-composites and their potential applications in sustainable engineering materials.*

ID 629433: Improvement of Mechanical Properties and Antibacterial Behavior of 316L Stainless Steel through Zinc Oxide Nanocoating for Biomedical Applications

KHLIFI KAOUTHER , MANNAI ZIED

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Abstract: *The optimization of laser metal welding parameters is crucial for ensuring high-quality welds in Ti-6Al-4V plates, a widely used titanium alloy in aerospace, biomedical, and*

automotive industries. This study focuses on identifying the optimal welding parameters, including laser power and welding speed, to achieve minimal defects, reduced residual stresses, and enhanced mechanical properties. A comprehensive numerical approach is employed, utilizing finite element simulations and response surface methodology (RSM) to analyse the effects of process parameters on weld bead geometry and mechanical performance. The results demonstrate the significance of process optimization in controlling heat input, minimizing distortion, and improving joint integrity. The study provides valuable insights into parameter selection for achieving defect-free and high-performance welds, contributing to the advancement of laser welding technology for titanium alloys. .

ID 629434: Investigation of Physical and Mechanical Characteristics of Palm Fiber Reinforced Composites

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Abstract: *In this work, a detailed numerical study on the thermal performance of a solar air collector with a helical duct is presented. The study involved the development of four configurations of Solar Air Collectors (SACs), with thicknesses ranging from 50 mm to 125 mm. A numerical model based on ANSYS Fluent 2021 software was developed. The discrete ordinate (DO) radiation model was used to study the effect of radiation. The k-Îµ turbulence model was used to analyze the turbulent flow. In terms of the results, the numerical model is validated by 3% error compared with the experimental results. The temperature contours indicated better heat transfer for h = 125 mm. For a mass flow rate of 0.01 kg/s, the air temperature reached 81°C. In terms of pressure drop, the 50 mm thickness shows a high value of 1190 Pa for a flow rate of 0.025 kg/s. However, the pressure drop remained relatively low for h = 100 mm at 513 Pa and h = 125 mm at 446 Pa. Therefore, an increase in thickness enhances heat exchange while reducing pressure losses. Thus, the configuration with h = 125 mm appears to be the most suitable configuration. .*

ID 629441: Investigations of in-plane shear properties of Â±45 Carbon Fabrics using Bias-Extension Test and Optical Measurement

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Abstract: *Strategies to improve power extraction from renewable sources are essential for meeting global energy demands sustainably. Wind energy, one of the fastest-growing alternative energy industries, holds significant potential, with Darrieus turbines known for their high efficiency. However, these turbines face a notable limitation in their self-starting capability. To address this issue, the present study proposes a novel upstream deflector designed to enhance the turbine's power coefficient (Cp). Computational fluid dynamics (CFD) simulations, conducted using ANSYS Fluent, were employed to evaluate the aerodynamic performance of the proposed design. The analysis focused on optimizing wind flow interaction with the rotor, aiming to improve energy capture and overall efficiency. The*

results demonstrated that incorporating this deflector significantly improved the Cp, indicating its effectiveness in overcoming the self-starting limitation of the Darrieus turbine. .

ID 629448: Adhesion Behavior of Hydrogenated Amorphous Carbon (a-C=H) Film Deposited on AZ31 Magnesium Alloy for Temporal Implant Applications

BESKRI ALI, MOHAMED SALAH ATALLAH, AKILA KHLIFI, KAOUTHER KHLIFI, MASOUD ATAPOUR

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Abstract: *Ces dernières années, les alliages de magnésium, en particulier l'AZ31, ont suscité beaucoup d'intérÃªt dans les applications biomédicales en raison de leur excellente biocompatibilité et biodégradabilité. Cependant, leur résistance limitée Ã l'usure, leur mauvais comportement face Ã la corrosion et leurs propriétés mécaniques dans des conditions physiologiques restent des défis majeurs. Cette étude se concentre sur l'amélioration des propriétés tribologiques et mécaniques de l'alliage de magnésium AZ31 en développant des revÃªtements composites Ã base de chitosane (CS) et d'oxyde de graphène (GO) avec des applications biomédicales potentielles. Le chitosane, un biopolymère aux propriétés antibactériennes et biocompatibles, est associé Ã l'oxyde de graphène, un matériau connu pour son excellente résistance mécanique. Le revÃªtement a été préparé Ã l'aide d'un procédé simple et peu coÃ»teux, et ses propriétés structurelles ont été analysées par microscopie électronique Ã balayage (MEB). Les propriétés tribologiques ont été évaluées en termes d'usure et de frottement Ã l'aide de tests de rayures. Les résultats ont montré que le revÃªtement composite Chitosan/Oxyde de graphène a un coefficient de frottement plus faible (0,11) et un volume d'usure plus faible (0.3 ˆ— 106Î¼.*

ID 629450: Material instabilities in an incompressible transversely isotropic hyperelastic hollow cylinder under radial inflation

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Abstract: *Wind catchers, a wind-powered ventilation system, are being explored for improving airflow and cooling poultry houses, especially in hot climate regions, thereby reducing energy consumption. This study explores the incorporation of a passive €• wind catcher€• system with a downward evaporative cooling apparatus in poultry housing. Computational Fluid Dynamics (CFD) modeling along with empirical validation are used to examine the effectiveness of this integrated system. The results clearly show that it can improve the environmental conditions within the chicken house. Specifically, the investigation reveals a remarkable reduction in air temperature, plummeting from 35°C to a comfortable 23°C. Concurrently, there's a noteworthy elevation in relative humidity, ascending from 25% to an optimal 50%, all achieved under a modest wind speed of 1.5 m/s. The results highlight the strong efficacy of our developed technology in cooling poultry homes. The suggested system provides notable improvements in regulating the climate of chicken houses, increasing*

energy efficiency and economic feasibility in comparison to traditional cooling techniques. The study emphasizes the flexibility and capacity for growth of this method, making it applicable to different chicken house setups and weather circumstances, thereby promoting its broad application. The results indicate other paths for future research. The activities include enhancing the placement of cooling nozzles, studying various droplet sizes, and assessing the long-term economic feasibility of this new cooling system. This study makes a substantial contribution to the ongoing discussion on cooling methods for chicken houses. Demonstrating the practical effectiveness and benefits of combining €• wind catchers€• with evaporative cooling can lead to significant breakthroughs in poultry farming methods that support sustainability goals and meet industrial needs. .

ID 629452: Enhanced Tribological Properties of AZ31 Magnesium Alloy with Chitosan/Graphene Oxide Composite Coating

MOHAMED SALAH ATALLAHA , AKILA KHLIFI , ALI BESKRI , KAOUTHER KHLIFI , NAJOUA BARHOUMI

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Abstract: *The field of lightweight structures has witnessed significant innovations in modern industrial manufacturing in recent years, playing a key role in improving efficiency and reducing environmental impact. One effective approach to achieving climate targets is the development of hybrid metal-plastic composites structures, which combine the strength of metals with the lightweight and design flexibility of polymers. This study focuses on laser welding as a thermal joining technique to create strong and durable metal-polymer bonds. Specifically, a thermoplastic composite (PA6GF47) and dual-phase steel (DP600) both widely used in the automotive industry are investigated. The quality and performance of the laser-welded joints are evaluated through tensile-shear testing and microscopic analysis, providing insights into their structural integrity and potential industrial applications.*

ID 630042: Design and optimization of curved grid sub-stiffened composite panels

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Abstract: *This study presents a comprehensive analysis of the internal conditions of a soilless greenhouse in Tunisia through a combination of numerical modeling and experimental observations. The primary objective is to predict the influence of tomato crops on the microclimate of the Manouba soilless greenhouse. To achieve this, computational fluid dynamics (CFD) simulations are performed using ANSYS FLUENT 16.2 to assess the effects of tomato crops on airflow, heat transfer, and mass exchange. Simulations are conducted both with and without crops to quantify their impact on the greenhouse environment. The results reveal that the presence of tomato crops significantly alters temperature distribution, leading to a 9 K increase above the crop canopy at 13 h. These findings provide valuable insights into*

optimizing climate control strategies for improved greenhouse efficiency and crop productivity.

ID 631556: Dynamic Characterization of the Fe-28Mn-6Si- 5Cr Iron-Based Shape Memory Alloy via Impact Testing

MEGDICHE MALEK , FTOUTOU EZZEDDINE , HELLARA MYRIAM , BOURAOUI TARAK

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Abstract: *Iron-based shape memory alloys (Fe-SMAs) have gained increasing interest due to their unique combination of shape memory effect, superelasticity, and damping properties. These materials offer promising applications in structural engineering, vibration control, and damping systems. In this study, we investigate the damping behavior of an Fe-SMA alloy Fe-28Mn-6Si-5Cr through an impact hammer test. The dynamic response of the material is analyzed using three approaches: (i) the exponential envelope method to extract the damping coefficient, (ii) frequency analysis via Fast Fourier Transform (FFT) to determine the dominant natural frequency, and (iii) an energy dissipation analysis to quantify the total energy dissipated during vibration. The results show a damping coefficient of approximately 0.18 using the exponential envelope method, while frequency analysis identifies a dominant natural frequency of 35.6 Hz. The energy-based approach provides additional insight into the material's ability to absorb mechanical energy. This study contributes to the understanding of Fe-SMAs' damping performance, paving the way for their optimized use in engineering applications.*

POSTERS

ID 606642: Impact of chitosan on microstructural properties and adhesion of hydroxyapatite coatings on Ti6Al4V alloy via electrophoretic deposition

KAMMOUN JASSEM , DHIFLAOUI HAFEDH , BEN MOUSSA NAOUFEL

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Abstract: *This study evaluates the effects of different nitriding treatments (liquid, gaseous) on the surface properties of 42CrMo4 material. Scratch tests were conducted to measure the critical loads (LC1, LC2, LC3), tangential force, penetration depth, and coefficient of friction under different normal loads (5N, 10N, 15N, and 20N). The results show that liquid nitriding indicates superior resistance to high loads, whereas gaseous nitriding shows increased vulnerability to failure under high loads. Gaseous nitriding exhibits the highest values of the coefficient of friction, while liquid nitriding shows the lowest values. These results provide valuable information for optimizing nitriding processes for specific industrial applications, thereby improving the performance and durability of materials.*

ID 606730: A Comprehensive Biomechanical Model of the Left Ventricle: Integration of Orthotropic Transverse Hyperelasticity and Static Simulation

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Abstract: *Clay composites filled with Expanded Perlite (EP) were prepared. After firing, their mechanical properties, specifically flexural and compressive strength, were evaluated. The impact of the key parameters, namely, firing temperature, particle size distribution of the materials, and EP content, on the mechanical performances of the final ceramic product was examined to assess their influence on producing high-quality ceramic materials. The results showed that variations in EP content, materials granulometry, and firing conditions significantly affected the compressive and flexural strengths of the Clay/Expanded Perlite (C/EP) composites. Experimental findings revealed that composites with 5% EP content and a 160 µm particle size distribution exhibited the optimal Flexural and compressive strengths balance. These composites were found to be most suitable for enhancing the mechanical properties of ceramic clay materials, making them ideal for construction applications*.

ID 610443: Operating parameters effect on a double pendulum energy harvester

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Abstract: *This study investigates the application of heuristic-driven pathfinding methods, particularly the A* algorithm, within the FreeCAD environment to optimize 3D static design and assembly workflows. By integrating this algorithm, the research addresses the early*

detection of design issues and enhances the planning of assembly operations. Three distinct heuristics are compared: one focused on minimizing path length, another prioritizing energetic cost and a hybrid heuristic combining both criteria. A case study demonstrates the simulation and evaluation of these approaches in a 3D static controlled FreeCAD's environment, providing insights into their respective efficiencies and trade-offs. The results highlight the potential for such integrations to improve the predictive and problem-solving capabilities of Computer-Aided Design (CAD) tools.

ID 610895: Réduction des vibrations d'un rotor mono-disque comprenant des anneaux en élastomères magnéto et électro rhéologique

SAKLY FAIZA , CHOUCHANE MNAOUAR

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Abstract: *The effect of environmental factors on the deterioration of structural components manufactured with fiber-reinforced polymers over extended periods is a concern that remains subject to ongoing research. Exposure to both elevated temperatures and moisture has been demonstrated to induce degradation of the composite. In this study, glass/polyester composites were subjected to accelerated aging under temperature conditions ranging from 25°C to 90°C in 100% relative humidity. The evolution of the material's characteristics was examined using Scanning Electron Microscopy (SEM). The results of the qualitative and quantitative studies demonstrated a contin-uous increase in damage with both time and temperature during the aging process. The damage was initially detected in the voids within the polymeric matrix during the early stages of aging. As the aging process progresses, the damage evolves, manifest-ing predominantly as fiber/matrix interfacial debonding.*

ID 616260: Optimal Sensor Placement for a Truss Structure Using a Modified Genetic Algorithm

MOUSSA HATHEMI, NAJEH BEN GUEDRIA

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Abstract: *Polymer nanocomposite thin films deposited on flexible substrates have emerged as promising materials for advanced sensors. In strain sensor applications, performance depends critically on minimizing residual stress caused by coefficient of thermal expansion (CTE) mismatches between film and substrate during deposition. This residual stress can lead to crack formation and film delamination, compromising sensor functionality. This study presents a dual-component model for quantifying stress distribution in MWCNT/epoxy nanocomposite thin films on polyimide substrates. The first component predicts the CTE and mechanical properties of the nanocomposite thin film, incorporating multi-walled carbon nanotube (MWCNT) concentration. The second component extends Hsueh's improved shear lag model to determine both residual stress and film stress under unidirectional strain conditions. Our model accounts for multiple parameters, including MWCNT concentration, film and substrate thicknesses, and deposition temperature. Results demonstrate that residual*

stress develops in the film center, with stress distribution being affected by MWCNT concentration and processing conditions. The Young's modulus increases with increasing MWCNT content, while the CTE decreases, confirming the reinforcement effect of the nanotubes. Maximum residual stress shows strong dependence on processing temperature. .

ID 616456: Detection of Instability Criteria for Conventional Rigid Journal Bearings Using a Nonlinear Hydrodynamic Force Model

AMAMOU AMIRA , AMAMOU AMANI

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Abstract: *The paper presents a 3D finite element approach for studying deflections of bi-directional FGM plates. In this approach, the mechanical characteristics of the plate vary along both the axial and longitudinal directions. For the analysis purpose, a four noded tetrahedral finite element formulation is established and the governing equations are derived by the weak form of equilibrium. In the first step, the validation of the model is conducted in the case of unidirectional FGM plate showing a good agreement with existing data in the literature. In the second step, the deflections of Bi-FGM plate are provided considering the change of gradient exponents in x and y directions. It is demonstrated that the change in these directions leads to unsymmetric distribution of the deflection responses in regard of the mid-plane surface and the raise of gradient index in x-direction enhance the flexural rigidity of the plate and thereby the diminution of plate deflections.*

ID 617524: Machine Learning models for predicting fatigue life of the aluminum alloy AA2024-T351 in Low Cycle Fatigue

KHADIMALLAH AYMEN , ZNAIDI AMNA , HFAIEDH NAILA , PETIT JOHANN

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Abstract: *In this paper a tri-generation plant is studied. The system produces electrical power via a generator and hot water via heater and chilled water via a vapor compression refrigeration system. Currently a vapor compression refrigeration system provides the 810 kW cold necessary to cool production and buildings air conditioning during the summer. The objective is to substitute the vapor compression refrigeration system by absorption cooling system. That's why, the system produces electrical power by using initially natural gas feeding a generator with an internal combustion engine and which yields absorption cooling. This cooling absorption system is activated by making use of exhaust hot water that has been used for cooling the electricity generator. The aim of this study is to evaluate the possibility of replacing the current vapor compression refrigeration installation with an absorption machine is activated by hot water used from between 70 and 90°C, released from the engine. A configuration was studied based on commercialized machines using water libr at the needed temperature and producing high capacity of cooling water equal to 810Kw. EES simulation and Aspen model were conducted. Parametric study was investigated. Results showed a COP of cycle about 0.7. This absorption system is used to substitute the convention*

systems already installed in the building. The cooling systems actually used is the vapor compression machine.

ID 620233: CFD simulation of melting process of Phase Change Material (PCM) in rectangular capsule

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Abstract: *Optimal Sensor Placement (OSP) is a key challenge in Structural Health Monitoring (SHM), aiming to strategically position sensors to maximize dynamic data capture while minimizing sensor count. This study formulates OSP as a discrete optimization problem, using integer variables to represent sensor locations and minimizing off-diagonal elements of the Modal Assurance Criterion (MAC) matrix to enhance modal identification. Three modified Genetic Algorithm (MGA) variants Roulette Wheel Selection (MGA-RWS), Tournament Selection (MGA-TS), and Random Universal Sampling (MGA-RS) are proposed and evaluated. In addition, new adapted crossover and mutation operators are also proposed. A reduced-order model, generated via the Iterated Improved Reduced System (IIRS) method, computes the system's dynamic characteristics. The algorithms are tested on a 12-bar plain truss, with MGA-RWS outperforming others in convergence speed, solution quality, and robustness. A parametric analysis explores the influence of crossover and mutation probabilities on MGA-RWS performance. Results show that a 10- sensor configuration provides the most accurate modal separation, emphasizing the importance of objective function formulation and optimization algorithms in achieving optimal sensor placement. This research advances SHM by offering a reliable and efficient OSP methodology for complex structures.*

ID 620250: Hydrodynamic Behavior of Offset Jets Under Various Situations

MOHAMMED AWDAH B ALSHEHRY, AMANI AMAMOU, ALI ASSOUDI, MOHAMMED HADI AL-GHAMDI, NEJLA MAHJOUB SAID

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Abstract: *Rotors supported by hydrodynamic journal bearings may become unstable with increasing speed of rotation and may exhibit several phenomena due to self-excited vibrations induced by the oil whirl instabilities. For a successful application of rotor bearing system, the prediction of the stability boundaries and other nonlinear phenomena observed near the stability limits such as stable and unstable limit cycles, hysteresis and jumping phenomena is of a major importance. In the present work, a perfectly balanced symmetric rigid rotor supported by two identical hydrodynamic journal bearings is considered and its vibrations behavior is analyzed. The continuation method for periodic solutions is used to determine the stability boundaries separating the region of instability from that of stability as well as the existence of supercritical or subcritical bifurcations depending on the bearing characteristics.*

ID 620587: Numerical Investigation of the Airflow Surrounding Tomato Crops in a Soilless Greenhouse

ZGHAL OLFA , ABID HASNA , KETATA AHMED , DRISS ZIED

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Abstract: *Additive Manufacturing (AM) has revolutionized industries such as healthcare by enabling cost-effective, rapid prototyping and patient-specific components. Fused Deposition Modeling (FDM) is particularly valued for its accessibility and material efficiency, yet optimizing process parameters remains critical to achieving superior mechanical performance. Polyamide 12 (PA12) and its carbon fiber-reinforced counterpart (PA12-CF) exhibit high strength, thermal stability, and biocompatibility, making them promising for medical applications. However, optimizing FDM settings for PA12-CF is challenging due to complex nonlinear interactions. Traditional optimization approaches are time-consuming and limited in modeling intricate parameter-property relationships. Machine Learning (ML), particularly ensemble techniques like XGBoost, offers a data-driven alternative for predictive accuracy and process control. This study presents an XGBoost-based ML model to predict the mechanical properties of PA12-CF FDM-printed parts, focusing on tensile strength, flexural strength, and surface roughness. Trained on a dataset from Almuflih et al. (2024), the model achieved outstanding performance despite a limited dataset of 51 trials. It attained R^2 values of 0.99 for surface roughness and tensile strength and 0.98 for flexural strength, with low mean squared error (MSE) values of 0.13, 0.73, and 2.02, respectively. These results highlight the model's robustness and generalization ability, demonstrating the potential of ML-driven optimization to enhance FDM parameter selection and improve mechanical performance in medical-grade PA12-CF applications.*

ID 629418: CFD Analysis: Glass Angle Variation in Solar still

DHAOUI SIRINE , MEKKI NABIHA , BOUABIDI ABDALLAH

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Abstract: *Vibrations in flexible structures like cantilever beams can cause performance degradation, fatigue, and damage over time, necessitating active vibration control for stability. This paper evaluates the effectiveness of LQR and PI control strategies in suppressing vibrations in a smart beam. The study focuses on reducing tip deflection under sinusoidal and random excitations, representing real-world dynamic loads. Numerical results demonstrate that the LQR controller outperforms the PI controller in minimizing tip deflection, showcasing superior accuracy, robustness, and optimal control capabilities. The comparison provides insights into selecting effective control strategies for vibration mitigation in flexible structures. This work aids in choosing the right controller and optimizing its gains for enhanced performance, highlighting LQR's potential to improve the durability of dynamically loaded structures and encouraging future research into advanced optimization techniques for vibration control.*

ID 706261: Towords an improving Cutting Tool Life through CFD Driven Design of Internal Cooling Channels

OUSSEMA BEN REJEB, IBTIHEL MAALAOUI, HATEM KANFOUDI, GHAZI BELKHAL, TAREK MABROUKI, TEMEL VAROL

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Abstract: *This project aims to develop innovative cutting tool inserts and tool holders with integrated cooling channels using Selective Laser Melting (SLM). By replacing conventional multi-step fabrication methods with metal-based additive manufacturing, the approach reduces energy use, production costs, and material waste. The project is a collaboration between Turkish and Tunisian institutions under the TÜBİTAK-MHESR call, focusing on advancing materials science through sustainable manufacturing solutions.*

ID 706262: Numerical Investigation of a Spiral-Shaped Solar Air Heater under Varying Solar Flux

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Abstract: *The study focuses on a spiral-shaped solar air heater, employing a numerical model developed. The Discrete Ordinates radiation model and the k-ω SST turbulence model were used to evaluate heat transfer and turbulent flow characteristics. The numerical model is validated with experimental data from prior research. The study explores the effects of varying solar radiation intensities on the system's performance. Findings indicate system performance depends on solar radiation intensity. The highest temperature gradients and peak air temperatures are achieved under a solar flux of 1056 W/m². The maximum thermal efficiency observed in the study reaches 52.4%.*

ID 629435: Automated Solution for 3D CAD Model Assessment

AMENI ELTAIEF, SABRINE BEN AMOR, BORHEN LOUHICHI

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Abstract: *Optimizing the design of a lower limb knee prosthesis is essential for restoring both functional and aesthetic aspects of amputee movement. This study focuses on optimizing a crossed four-bar mechanism (CFBM) to accurately replicate the complex flexion-extension motion of the human knee in the sagittal plane. Using the Multi-Objective Imperialist Competitive Algorithm (MOICA), the optimization process aims to minimize the tracking error of the Instantaneous Center of Rotation (ICR), ensuring better biomechanical compatibility with natural knee kinematics. The obtained results demonstrate the effectiveness of the proposed optimization framework, achieving a Traking Error (TE) of 0.5 mm. Furthermore, the optimized CFBM successfully tracks the reference walking trajectory with a maximum angular deviation of 2.3°, leading to improved gait fluidity, reduced compensatory movements, and enhanced weight distribution.*

ID 706265: Sustainable approach: using agricultural waste to reinforce biodegradable polymers in the circular economy

WAFA KHMIRA, SAMEH ATTIA-ESSAIES, MEHDI ISMAIL, NAJOUA BARHOUMI, KAOUTHER KHLIFI

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Abstract: *The increase in the production of agricultural waste represents a major environmental challenge, but it also offers significant opportunities for the development of sustainable materials. In this context, the use of plant fibres derived from this waste is proving to be a promising solution for the manufacture of bio-composites, particularly those based on biodegradable polymers. By incorporating these fibres into polymeric matrices, it is possible to improve the mechanical properties and durability of materials while helping to reduce waste. In Tunisia, large quantities of residues from pearl millet (Pennisetum glaucum) production, in particular the stalks and thatch, are generally neglected, even though they represent a potential source of plant fibres. These fibres, incorporated into biodegradable polymer matrices, could improve the mechanical performance of biocomposites while reducing the environmental footprint of conventional materials, benefiting both the environment and local economies, thereby promoting a sustainable circular economy [1]. This study explores the physico-chemical properties of fibres derived from pearl millet agricultural waste in Tunisia, and demonstrates their potential as a sustainable alternative for the development of high-performance biodegradable polymers.*

ID 613018: Post-Additive Manufacturing Surface Enhancement: Effect of Wire Brush hammering on Surface Integrity and Roughness

MANNENA SAHRAOUI , YAHYAOUI HOUDA , BEN MOUSSA NAOUFEL , HABIBI MOHAMED

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Abstract: *This study investigates the tribological properties of MS-HDPE biocomposites (0, 5 and 10 wt.% MS) in contact with coated and uncoated metal balls, in a potential application for hip prostheses. Biocomposites were manufactured by hot compression molding and tested against 316L stainless steel balls, coated or uncoated with DLC, DLC-Si and DLC-W:H, using a ball-on-disc tribometer. The results show a positive correlation between the coefficient of friction and the wear rate, confirming that reducing friction helps to limit wear. The addition of MS particles improves the tribological performance of HDPE, with a significant reduction in friction and wear. These results suggest that the use of MS-HDPE biocomposites combined with DLC coatings could be a promising alternative for orthopedic implants, limiting metal corrosion and the formation of wear debris.*

ID 620566: Numerical Study of the Mechanical Behavior of FDM-Manufactured Parts

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Abstract: *To address natural resource depletion and climate change, the global community is prioritizing sustainable construction in the building sector. Construction works account for considerable resource consumption and greenhouse gas emissions. Therefore, it is crucial to improve energy efficiency in buildings. In France, additional actions were taken in the implementation of the Energy Transition Law. These actions included the elimination of mandatory energy audits and the addition of financial penalties and incentives. This study analyses the provided measures as they relates to increasing energy efficiency in residential buildings, as well as the barriers that may be facing this improvement. An energy audit of the residential building of 145 m2 was done by BAO Evolution software. Initially, the building's primary energy consumption was 499 kWhEP/m2/year with a CO2 emission rate of 77.8 kg/m2. After conservative energy efficiency measures reccomended by the energy audit, energy consumption decreased to 101.8 kWhEP/m2/year, while CO2 emission dropped to 3.04 kg/m2. This data reveals the beneficial effect targeted energy interventions have on the environment, as well as the positive advancement for sustainable building practices.*

ID 620580: Impact of the post processing heat treatment on the microstructure and mechanical properties of SLMed AISI 316L stainless steel

YAHYAOUI HOUDA , BEN MOUSSA NAOUFEL , HABIBI MOHAMED , BARKIA BASSEM , BRAHAM CHEDLY

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Abstract: *Piezoelectric patches have gained significant attention in the field of engineering due to their capability to convert electrical energy into mechanical strain, positioning them as ideal candidates for vibration control applications. This study explores the integration of piezoelectric patches with a Linear Quadratic Regulator (LQR) controller and sensors to actively control vibrations in a Jeffcott rotor bearing system. The patches were strategically mounted on the rotor shaft, and conventional iterative methods were employed to determine the optimal number and placement of the patches, with the objective of maximizing vibration suppression effectiveness. To simulate the dynamic behavior of the rotor system, Finite Element Analysis (FEA) was utilized, providing essential insights into patch positioning and load distribution. By leveraging FEA, the researchers could forecast the system's response under various conditions and pinpoint the most effective locations for the patches, thereby ensuring efficient energy transfer and enhanced vibration control. The combination of piezoelectric patches with an LQR controller demonstrated significant improvements in reducing unwanted vibrations, establishing this method as a promising solution for industries requiring precise vibration management, such as turbomachinery, aerospace, and industrial*

machinery. The study concludes that the synergy of advanced control algorithms and piezoelectric technology presents a versatile and effective strategy for enhancing the performance of rotating systems, particularly in environments where stability and precision are paramount. This approach may also contribute to increased durability and efficiency in high-performance engineering applications.

ID 629438: Fused Deposition Modeling for medical application: a literature review

GHANMI INES, ASMA BELHADJ, SALMA SLAMA, IDRIS CHENINI, TAREK MABROUKI

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Abstract: *The present study performs a parametric analysis using the Box-Behnken design to evaluate the influence of the main printing parameters on the mechanical properties of PLA parts produced by the fused deposition modelling (FDM) process. The examined parameters included nozzle temperature, bed temperature, layer thickness and extrusion rate. The mechanical properties evaluated include tensile strength, Young's modulus and Poisson's ratio. Furthermore, an artificial neural network-based predictive model has been developed to estimate these properties as a function of selected printing parameters, providing a valuable tool for optimising printing parameters. Indeed, a maximum strength of 55 MPa and a Young's modulus of 3399.9 MPa were predicted for a specimen manufactured with a nozzle temperature of 210 °C, a bed temperature of 65 °C, a bed temperature of 0.3 mm and an extrusion rate of 0.98. This outcome aligns with experimental results, which yielded a maximum strength of 55.36 MPa and a Young's modulus of 3382 MPa, employing the predicted parameters.*

ID 605422: Investigation of palm fiber composites : Experimental approch

ISSAMI IKRAM , LTAIF LAMMERI , SANA BEN KHALIFA

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Abstract: *In additive manufacturing (AM), energy consumption is crucial to establish a long-term balance between energy consumption and environmental deterioration. The study uses Gaussian Process Regression (GPR) and Artificial Neural Networks (ANN) models to estimate the energy consumption of AM-FDM processes. The learning rate, momentum, number of hidden nodes, proportions of training and test sets, and activation function are the six graded-level factors, which are used in a numerical factorial design to compare the model performances. The study also examined the ANN and GPR performances based on hypercube sampling of 25%, 50%, and 75% of randomly chosen subsets. In every scenario, the GPR model outperforms the ANN, even though, the GPR model is more attractive since it predicts the energy consumption with uncertainty.*

ID 610884: Fatigue Study of AlSi10Mg Alloy as-built

CISSE IBRAHIM KALIL , NASR ANOUAR

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Abstract: *This study presents an advanced numerical approach to investigate the local mechanical behavior of the surface layer during and after an electrical discharge in the EDM process. The primary aim is to enhance the numerical prediction of residual stresses and strain hardening induced by this complex thermomechanical phenomenon. A robust thermomechanical model was developed using ABAQUS/Explicit, incorporating the GrÃ¼neisen equation of state for hydrodynamic behavior and the Johnson-Cook plasticity model to account for material deformation under extreme conditions. Improvements in modeling parameters, including refined loads, boundary conditions, and a uniform heat flux distribution, were introduced to increase prediction accuracy. The numerical simulations demonstrated two key findings: (1) the uniform heat flux distribution model efficiently predicts the residual stress profile, aligning well with experimental data, and (2) the plasma-induced pressure significantly influences strain hardening in the affected surface layer.*

ID 613073: Characterization of amorphous metallic alloys through scratch tests

NARJES SELMI , KAOUTHER KHLIFI

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Abstract: *Reverse engineering is an important approach to creating customised products using 3D printing. Its application in healthcare and biomedical has become an integral part of this manufacturing process, mainly for complicated shapes or surfaces. CAD systems using SolidWorks provide tools for 3D reconstruction of the model from cloud point and for topological optimisation of the resulting model to ensure high accuracy. In this paper the author introduces a general algorithm of the proposed approach process for converting a scan data into a useful 3D model, creating the prototype and ensuring the comfort and manufacturability of the required parts. This paper also focuses on material choice. In addition, it also takes into account the strategy of 3D printing. The author focuses on the implementation of the developed algorithms in SolidWorks using the API to generate a user interface that allows the designer to transform a scan data into a customised useful object.*

ID 620116: Analysis of 3D-Printed Anti-Trichiral Structures under uniaxial Cyclic Loading and Unloading

KHATERCHI HOUDA , ALLEGUE LAMIS , BEN KHALIFA ATED , NASRI MONDHER , ZIDI MONDHER

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Abstract: *The paper seeks to address the robust design of friction stir welded joints made of high-density polyethylene (HDPE). The objective is to allow the joints to have the best*

mechanical performances while desensitizing the manufacturing process to endogenous and exogenous noises. The friction stir welding of thermoplastics is different from that of metals because of their unique physical characteristics. Moreover, mechanical testing, the in-situ application of the friction stir welding process of thermoplastics, and the multiple sources of variation that contaminate the process pose significant challenges. The impact of processing factors on weld mechanical properties has frequently been studied using statistical techniques, but these methods have fallen short of distinguishing between predictable and unpredictable sources of variation. The Robust Design of Products and Processes using the Stochastic Frontier model (RDPP-SF), a robust design optimization technique, is employed to apprise random and nonrandom variation in the friction stir welding process and determine the robust design solution.

ID 620591: Mechanical and antibacterial properties of denture base resins containing copper oxide nanoparticles

BEN AISSA CHOKRI , BARHOUMI NAJOUA , KHLIFI KAOUTHER , KARKOUCH INES , WIEM BOUSSLAMA , BEN SGHAIER RAFIKA

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Abstract: *A 316L stainless steel welding seam was deposited on a 304L stainless steel plate using Gas Metal Arc Welding (GMAW) with Low Spatter Control (LSC) technology. The simulation, performed with Simu-fact 2023.4, used a 3D heat transfer model that included filler metal addition, heat release during solidifi-cation, and heat losses from radiation and convection. The heat source was modeled using a Goldak double ellipsoid function, which is essential for ac-curate simulation results. To improve the accuracy of the heat source, a facto-rial design of experiments was used to adjust and optimize its parameters. A validation of the parameter results was conducted using experimental data to ensure simulation accuracy. These results will support future research on welding process optimization and simulation improvements.*

ID 620601: Development and Characterization of two Biodegradable Biocomposite Material Reinforced with Jute Fabric and Raphia Fibers

TOUNSI AMER , SLIMANI FAOUZI , RABHI NEJI , GHANMI SAMIR , GUEDRI MOHAMED

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Abstract: *Inspired by the Scapharca shell, which features a unique surface topography that enhances aerodynamic performance, we propose a bionic piston shape for gas engines. This design aims to achieve robustness in aerodynamic performance for the piston, ensuring optimal flow dynamics within the combustion chamber. We use computational fluid dynamics (CFD) simulations to analyze the flow characteristics of both the original piston geometry and the bionic design, which incorporates specific parameters derived from the shell's geometry, such as groove depth (d) and groove width (w). The comparative analysis focuses*

on key performance metrics, including turbulence generation and in-cylinder flow dynamics. Our findings reveal that the bionic piston design significantly enhances flow characteristics performance and swirl within the combustion chamber compared to the initial geometry. This study underscores the potential of bionic approaches to improve gas engine efficiency and performance through innovative design modifications.

ID 629051: Impact of CuxOy-NPs/TiO2-NTs on Anti-Corrosion and AntiWear Applications for Implants

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Abstract: *Lightweight composite materials are increasingly used as main loadbearing materials in the design of pedestrian bridges. As an example of such bridges, Fiberline Bridge in Kolding, Denmark, was constructed in 1997 using 12 different pultruded profiles, all made of GFRP composites material. The composites made of footbridges are typically characterized by high strength and relatively low mass and stiffness. These properties could lead to excessive vibration response under wind and human-induced dynamic loading. This paper studies natural frequencies, mode shapes, and damping ratios of a natural fiber composite made footbridge. The mechanical properties and dumping of the alfa reinforced composite are identified by numerical homogenization and experimental mesures. Thes identified properties are then used in vibration models. The same footbridge made from steel is studied, and results are compared and discussed. .*

ID 706264: Uniaxial and Biaxial characterization of PLA biocomposites films: Application of 3D-DIC for thickness instability detection

FAKHER KHARRAT, MOHAMED KHLIF, MOHAMED HABOOUSSI, CHEDLY BRADAI

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Abstract: *The bulge test is a versatile mechanical characterization method widely utilized in biomedical engineering, materials science, and mechanical engineering to analyze both material and structural behavior. In this study, a neat polylactic acid (PLA) blown film and a biocomposite film composed of with 2 wt.% date palm leaf powder (PLA_2%) were examined using the bulge test, and its mechanical properties were compared to those obtained from uniaxial tensile testing. To enhance measurement accuracy, three-dimensional digital image correlation (3DDIC) was employed, enabling precise strain field analysis while simultaneously detecting defects such as thickness instability. The 3D-DIC analysis during the bulge test provided insights into the evolution of strain distribution within the film, confirming isotropic deformation in the elastic region. This was evidenced by the uniform isodisplacement lines observed on the bulged film bubble, as well as the comparable maximum and mean deformation values along both the transverse direction (TD) and the machine direction (MD). However, as deformation progressed, the film exhibited anisotropic*

behavior, with the initially spherical bubble gradually adopting an elliptical shape due to plastic deformation. Further analysis using 3D-DIC demonstrated that, although the average deformation in both directions remained similar under identical loading conditions, strain concentration was significantly higher in the TD. These strain concentrations appeared as localized bands running parallel to the blown direction, indicating regions of reduced thickness.

ID 706263: Automated Solution for 3D CAD Model Assessment

AMENI ELTAIEF, SABRINE BEN AMOR, BORHEN LOUHICHI

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Abstract: *Computer Aided Design (CAD) systems are crucial in mechanical engineering, enabling precise design, modeling, and simulation of complex parts. Mastering these tools is essential for students and professionals to stay competitive and meet industry demands. Efficient and quick learning of CAD systems is key to developing practical skills, boosting productivity, and fostering innovation in the field. To support teachers in delivering effective training and conducting accurate evaluations, an automated tool is essential for assessing CAD models during training sessions. This work presents a CAD Model Automated Assessment (MAA) tool designed for use in mechanical engineering courses. The proposed tool is based on a developed model that incorporates different aspects of modelling, such as geometric, feature-based and parametric modelling. To ensure accurate evaluation of a given part compared to a known reference, the proposed framework utilizes adjustable coefficients. They are determined by the teacher and can be adapted according to the teaching strategy or the specific objectives of the course. The proposed framework employs adjustable coefficients determined by instructors based on their pedagogical strategies or coursespecific objectives.*

ID 595425: The impact of glass fiber orientation in polyamide 6,6 on the friction coefficient during short dry sliding

MISSAOUI SAMI , AUTAY RIADH , DRISS ZIED

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Abstract: *Glass fibre reinforced polyamide 6,6 (PA66) composites are often utilized in applications that require great strength while remaining lightweight. In this context, it is particularly important to determine how much the friction coefficient of glass fiber-reinforced polyamide 6,6 composites can be increased by fiber direction orientation. Experiments were conducted to compare the performance of reinforced PA 66 with three different ratios of short glass fiber (10, 20, and 30% weight fractions) in two distinct directions (0° and 90°). It has been demonstrated that proper orientation can significantly enhance the friction coefficient of PA66 reinforced with short glass fibers.*

ID 595429: The effect of varying the contact face on the friction coefficient of glass fiber-reinforced polyamide 66 (PA66) composites against a steel surface

MISSAOUI SAMI , AUTAY RIADH , DRISS ZIED

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Abstract: *A study was conducted to investigate the influence of specimen face contact on the friction coefficient of short glass fiber-reinforced Polyamide 66 composites with weight fractions of 10%, 20% and 30%. Four types of specimens, unreinforced Polyamide 66 and reinforced Polyamide 66 with three different ratios of short glass fiber were tested under identical materials and operating conditions. According to the obtained experimental results, it was discovered that the contact face had no effect on the coefficient of friction.*

ID 595441: Experimental Investigation of the Coefficient of Friction in Short Glass Fiber-Reinforced Polyamide 66 Matrix Composites

MISSAOUI SAMI , AUTAY RIADH , DRISS ZIED

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Abstract: *The coefficient of friction of unreinforced polyamide 66 and polyamide 66 reinforced with different weight fractions of short glass fiber (10 wt%, 20 wt%, and 30 wt %) is investigated under dry sliding conditions without lubrication. Friction tests are conducted at two different normal loads and at room temperature. The results show that the reinforcement significantly affects the coefficient of friction and that the normal load also influences the friction behavior. Increasing the weight fraction of glass fiber leads to a decrease in the coefficient of friction.*

INDEXATION

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COTUME'2025

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7th Tunisian Congress of Mechanics

The Tunisian Society of Mechanics (ATM) organizes, every three years, the Tunisian Congress on Mechanics (Cotume). Its seventh edition is programmed on May 1st -3rd, 2025. The congress presents an important opportunity to meet and to exchange between researchers in mechanics, in its broadest sense. It is one of the ATM's tools to structure and dynamize the Tunisian mechanics community and to help it to make well known its scientific production. A particular encouragement is addressed to both phd student and young doctors to present their research works. The participation of the industrial sector is also highly encouraged.The COTUME'2025 congress will ensure, during the three days, plenary, paper and poster sessions. Round tables on mechanics in Tunisia will be organized.