BOOK OF ABSTRACTS

CCFA9

The 9th International Conference on:
Composites Characterization
Fabrication Application

Iran University of Science and Technology
&
University of Tehran

December 18-19, 2024

Co-Chairs:
M.M. Shokrieh
M. Safarabadi

In the name of Allah

CCFA 9

The 9th International Conference on Composites: Characterization, Fabrication and Application

18-19 Dec. 2024

School of Mechanical Engineering
Iran University of Science and Technology
Tehran, Iran

School of Mechanical Engineering
College of Engineering
University of Tehran
Tehran, Iran

IUST
Iran University of Science and Technology

Iran Composites Institute

Iran Composites Scientific Association

Chair of Composite and Nanocomposite Materials and Structures

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Preface

The ***ninth International Conference on Composites: Characterization, Fabrication, and Application (CCFA-9)*** was held on December 18-19, 2024, in Tehran, Iran. It successfully brought together engineers and researchers in the field to review and discuss the recent practical and theoretical methods/approaches to addressing composite characteristics and manufacturing processes. The conference focused on state-of-the-art material science and the mechanics of composites and nanocomposites.

Applications of composites are progressively growing in various industries. The extensive use of engineering composites over such a range of applications, plus the cost involved with manufacturing processes, has resulted in an increasing awareness of the importance of research in composite materials. Different applications of composites expose them to various environmental and service conditions. Each service condition dictates several technical requirements and questions, which might be answered by engineers. All these complexities change the science and technology of composites revolutionarily. New methods of design, manufacturing, and material characterization of composites are needed to enable us to find novel and reliable solutions for new questions.

Out of 167 submissions, this proceeding presents two-page extended abstracts that were accepted for CCFA-9. This book includes different subjects of Microstructures, Physical and Mechanical Properties, Deformation, Deflection and Damage, Creep, Thermal Effect and Properties, Buckling and Plate Deformation Theory, Vibrational Analysis, Dynamic Response, Concrete, Modeling, Simulation, Optimization, Fatigue and Fracture, Nanocomposites, Impact, Environment, Recycle and Waste, Numerical Analysis, Design and Fabrication and Composite Applications.

The organizing committee of *CCFA-9* wishes to thank the members of the international and national advisory committees for their great involvement in reviewing papers. Many thanks also go to the national and private sectors for their support. Support through the Islamic World Science Citation Center (ISC) and Civilica is highly appreciated.

Sincere thanks also go to the participants and authors for their great participation. The members of the executive committee are highly thanked for their tireless and uninterrupted efforts.

Lastly, we thank Almighty God for granting us the ability to comprehend the subject matter.

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The 9th International Conference on Composites: Characterization, Fabrication and Application

Dec. 18-19, 2024, Tehran, Iran

Online!

Final Program

December 18, 2024						
8:00 - 8:15	**Welcoming Session:**	**Prof. M.M. Shokrieh,** Conference Chair *Opening Talk*				
8:15 - 9:00	**Plenary Talk:**	**Prof. M.M. Aghdam**, Amirkabir University of Technology, Tehran, Iran *Homogenization Methods: From Classical Models to Advanced Multiscale Techniques*				
9:00 - 9:45	**Plenary Talk:**	**Prof. S. Schmauder**, Institute for Materials Testing, Materials Science and Strength of Materials (IMWF), University of Stuttgart, Germany *Multiscale Modelling of Fatigue of Metals*				
9:45 - 10:00	**Break**					
Oral Presentations						
10:00 - 12:00	**Session Title**	**3D Printing**	**Coatings and Surface Enhancements**	**FML and Metallic Composites**	**Green and Bio-Based Composites**	
	Session Chair	Dr. Mohammad Heidari-Rarani Dr. Siavash Kazemirad	Dr. Hossein Toozandehjani Dr. Mohammad Hossein Bayati	Dr. Majid Jamal-Omidi Dr. Abolhassan Imani	Dr. Hadi Khoramishad Dr. Hamed Saeidi Googarchin	
12:00 – 13:30	**Pray & Lunch**					
13:30 - 14:15	**Keynote Talk:**	**Prof. B. Pourabbas**, Sahand University of Technology, Tabriz, Iran *Additive Manufacturing: your Permission to Catch the Future through 3D Printing*				
14:15 - 15:00	**Keynote Talk:**	**Prof. R. Rafiee**, University of Tehran, Tehran, Iran *On the long-term behavior of composite pipes*				
Oral Presentations						
15:00 - 17:00	**Session Title**	**Advanced Materials, AI, and Optimization**	**Impact Behavior and Energy Absorption**	**Nanocomposites: Electromagnetic-chemical Characterization**	**Sandwich, Cylindrical and Thin wall Composites**	**General Topics 1**
	Session Chair	Dr. Mojtaba Haghighi-Yazdi Dr. Mahnaz Zakeri	Dr. Alireza Daneshmehr Dr. Mohammad Javad Ashrafi	Dr. M. Masoud Seyyed Fakhrabadi Dr. Nabi Mehri-Khansari	Dr. Roham Rafiee Dr. Reza Eslami-Farsani	Dr. Fathollah Taheri-Behrooz Dr. Ali Maleki

December 19, 2024						
8:15 - 9:00	**Keynote Talk:**	**Prof. M. Baniassadi**, University of Tehran, Tehran, Iran *Design and Manufacturing of Thermo-Mechanical Metamaterials*				
9:00 - 9:45	**Keynote Talk:**	**Prof. M. Baghani,** University of Tehran, Tehran, Iran *4D printing of shape memory polymers through materials extrusion additive manufacturing*				
9:45 - 10:00	**Break**					
Oral Presentations						
10:00 - 12:00	**Session Title**	**Battery and Electronics Technologies**	**Biomechanical and Biomedical Composites**	**Hole, Crack, and Cohesive Properties in Composites**	**Fabrication and Material Properties**	**General Topics 2**
	Session Chair	Dr. Hadi Rezghi Maleki Dr. Majid Baniassadi	Dr. Afshin Zeinedini Dr. Mohammad Haghpanahi	Dr. Siavash Kazemirad Dr. Mohammad Hossein Bayati	Dr. Hadi Khoramishad Dr. Mohammad Fasihi Dastjerdi	Dr. Nabi Mehri-Khansari Dr. Mohammad Reza Farahani
12:00 – 13:30	**Pray & Lunch**					
13:30 - 14:15	**Keynote Talk:**	**Prof. S.M.R. Khalili**, Khajeh Nasir University of Technology, Tehran, Iran *Impact Behaviour of Lightweight Smart Composites*				
14:15 - 15:00	**Keynote Talk:**	**Prof. H. Steeb,** Institute of Applied Mechanics (CE), University of Stuttgart, Stuttgart, Germany *Porous Media - From Imaging to Physical Characterization*				
Oral Presentations						
15:00 - 17:00	**Session Title**	**Damage, Failure, and Fracture in Composite**	**Characterization and Non-Destructive Testing**	**Nanocomposites: Properties, Fabrication and Applications**	**Vibration and Thermal Analysis of Composites**	
	Session Chair	Dr. Fathollah Taheri-Behrooz Dr. Zahra Daneshjoo	Dr. Afshin Zeinedini Dr. Reza Mosalmani	Dr. M. Masoud Seyyed Fakhrabadi Dr. Omid Rafeie	Dr. Hadi Rezghi Maleki Dr. Mahdi Moghimi Zand	
17:15 - 17:30	**Dr. M. Safarabadi,** Conference Chair *Conference closing session*					

Wednesday18th December (28th Azar) (Morning)

Plenary Speeches

Time	Title	Presenter
8:00 - 8:15	Welcoming Session	**Prof. M.M. Shokrieh**, *Opening Talk,*
8:15 -9:00	First Plenary Talk	**Prof. M.M. Aghdam**, *Homogenization Methods: From Classical Models to Advanced Multiscale Techniques*
9:00 -9:45	Second Plenary Talk	**Prof. S. Schmauder**, *Multiscale Modelling of Fatigue of Metals*
9:45 -10:00	Break	

Oral Presentations

Session Title		3D Printing	Coatings and Surface Enhancements	FML and Metallic Composites	Green and Bio-Based Composites
Session Chair		Dr. Mohammad Heidari-Rarani Dr. Siavash Kazemirad	Dr. Hossein Toozandehjani Dr. Mohammad Hossein Bayati	Dr. Majid Jamal-Omidi Dr. Abolhassan Imani	Dr. Hadi Khoramishad Dr. Hamed Saeidi Googarchin
Session Assistant		Mr. Ali Rahimi-Lenji	Ms. Niloufar Bagheri	Mr. Amirhossain Teymouri	Mr. Arang Pazhouheshgar
10:00 – 10:15	Code	A-10-1888-1	A-10-1851-1	A-10-1908-1	A-10-1879-1
	Title	Feasibility of the manufacturing process of joint stabilizers using 3D printing	Investigating the microstructure and hardness coating of HA on Mg-Zn alloy by sol-gel method	Effect of stainless steel 309 (SS) reinforcing particles addition on the microstructure, porosity and hardness of Al 6061/SS composites	Green Bead Foams of Poly(lactic acid) in Thermoplastic Starch Matrix Reinforced with Expanded Graphite
	Authors	Morteza Golestani, Mohammad Karimi, Mojtaba Haghighi-Yazdi	Erfan Fatehi, M. Salehi, Anahita Hajkarim	Zeynab Mohammadi Firooz, Farshad Akhlaghi	Danial Abbassi, Pedram Bahrami, Farkhondeh Hemmati, Jamshid Mohammadi-Roshandeh
10:15 – 10:30	Code	A-10-1868-5	A-10-1884-1	A-10-1937-1	A-10-1876-2
	Title	Enhancing 3D Printed PLA Filaments with Nanoclay: Impact on Thermal Stability and Mechanical Performance	Study of corrosion rate of Co-CeO2 composite for SOFC interconnect application	Effect of carbon and boron addition on physical and mechanical properties of aluminum metal matrix composite, a simulation study	Preparation and properties of biodegradable PBAT/CaCO3 composite modified with chain extender
	Authors	Alireza Ramezani, Amir Hossein Akbari, Mohammad Sina Edrisian, Goolia Nikravan	Saba Dehghan, Hadi Ebrahimifar, Hamid Reza Nejadgholamali, Mohammad Sefidbakht	Ehsan Rahimi, Omid Ashkani	Sedigheh Bagheri Kazemabad, Mohammadreza Arghavani, Atefeh Shegeft
10:30 – 10:45	Code	A-10-1869-1	A-10-1865-1	A-10-1907-1	A-10-1895-1
	Title	Modeling the impact of flame retardants on burning behavior of 3d printed polymer chair	Effect of aluminum hydroxide/epoxy coating on the flammability indexes of cotton/epoxy laminated composites	Effect of sintering temperature on the microstructure and hardness of Al 6061 matrix composites reinforced with AlFeCuCrNi high-entropy alloy	Plant-Based Biocomposites of Poly(lactic acid)/Rice Straw/Soybean Oil: Effect of Eco-friendly Boric Acid Pulping and Compatibilization on Properties
	Authors	Soheil Dariushi, Ehsan Naderi Kalali	Reza Piri Hosseinabadi, Masoud Kazemi, Afshin Zeinedini	Amirhosein Ghadimyari, Farshad Akhlaghi	Reyhane Shahpouri, Amir-hamzeh Golbaz, Farkhondeh Hemmati, Jamshid Mohammadi-Roshandeh
10:45 – 11:00	Code	A-10-1838-1	A-10-1884-2	A-10-1935-1	A-10-1867-1
	Title	Experimental study of tensile properties of 3D-printed Titanium-reinforced ABS	Decrease of Cr2O3 growth at presence of Co-La2O3 composite coating	Novel Experimental Approach to Enhancing the Tensile Properties of GFRP Laminates through Steel Wire Reinforcement	Environmentally-Friendly Strategies for Tailoring Interfacial Adhesion and Performance of All-green Biocomposites Based on Thermoplastic Starch/Kenaf Fiber
	Authors	Mohammad Heidari-Rarani, Farah Tibni	Saba Dehghan, Hadi Ebrahimifar, Hamid Reza Nejadgholamali, Mohammad Sefidbakht	Saman Ghoddousi, Maziar Shamsali, Majid Safarabadi, Mehdi Ganjiani	Ali Matin, Amir-hamzeh Golbaz, Farkhondeh Hemmati, Jamshid Mohammadi Roshandeh
11:00 – 11:15	Code	A-10-1951-13	A-10-1880-1	A-10-1857-1	A-10-1917-1
	Title	Comparative analysis of re-entrant honeycomb and star-shaped auxetic meta-structures: energy absorption and Poisson's ratio performance	Improved mechanical properties of epoxy composite via modified and functionalized short carbon fibers by LT560	A numerical investigation into the crashworthiness of bio-inspired aluminum/CFRP tubes under lateral loading.	Bio-composites of Cellulose Nano-crystals and Sodium Alginate for Removal of Heavy Metal Ions
	Authors	Ali Rahimi-Lenji, Mahmood M. Shokrieh	Afagh Panahi Moghadam, Kourosh Shirvani	Farhad Latifzadeh, Ali Keshavarzi, Hamed Saeidi Googarchin	Yeganeh Mousavi, Masoud Frounchi
11:15 – 11:30	Code	A-10-1946-1	A-10-1884-3	A-10-1936-1	A-10-1857-2
	Title	A case study for mechanical behavior of lattice reinforced cementitious composites under uniaxial compression	Effect of Co-Y2O3 composite coating on oxidation activation energy of AISI 430 steel	Comparative Experimental Study of Open Hole GFRP and Aluminum Plates under Tensile Loading	Bio-Inspired Hybrid Energy Absorbers: Enhancing Crashworthiness and Weight Efficiency in Vehicles
	Authors	Sara Golbabapour, Mohammad Zaman Kabir	Saba Dehghan, Hadi Ebrahimifar, Hamid Reza Nejadgholamali, Mohammad Sefidbakht	Maziar Shamsali, Saman Ghoddousi, Majid Safarabadi	Alireza Baratian Sani Devin, Ali Keshavarzi, Hamed Saeidi Googarchin
11:30 – 11:45	Code	A-10-1963-1	A-10-1845-1	A-10-1924-1	A-10-1843-1
	Title	Nature-inspired pattern for improvement in-plane compression of honeycomb structures	Investigating the orientation of short carbon fibers on surface hydrophobicity using flocking electrostatic method	Examining Internal Defects in 3D FML Composites with Cork Core Using Active Thermography	Tailored Plasmonic Microspheres: Fabrication, Characterization and Harvesting Visible Light for Photocatalytic Removal of Organic Pollutants
	Authors	Afshin Zeinedini, Abolfazl Gholami, Abolfazl Hajatpour	Farshad Farajnezhad, Abolhassan Imani, Mahdi Maleki	Hussein Naghdi Varnosfaderani, Mohammad Reza Farahani, Benyamin Shahsavar, Puya Parvande	Sogand Rajaei Farid, Mohammad Amin Habibi, Azadeh Ebrahimian Pirbazari, Fatemeh Esmaeili Khalil Saraei
11:45 – 12:00	Code	A-10-1965-1	A-10-1887-1	A-10-1892-1	A-10-1902-1
	Title	A chiral-based topology for improvement the mechanical properties of auxetic structures	Effect of PCA addition on the hardness and shear strength of A0.25CoCuMnNi high entropy alloy	Investigating the effect of interphase region on the elastic modulus of metal/graphene nanocomposites	Comparison of buckling capacity in CFRP composite plate and Hemp-Epoxy composite plate
	Authors	Afshin Zeinedini, Delnia Sangsefidi, Amir Hossein Farzipour	Soroosh Mohammadi, Farshad Akhlaghi	Javad Payandehpeyman, Mahdi Hedayatian, Mojtaba Mazaheri	Arsalan Nojavan Kohnehshahri, A. Javadzadeh Khoei, Hasan Biglari, M.R. Khoshravan Azar

Wednesday18th December (28th Azar) (Afternoon)

Keynote Speeches

Time	Title	Presenter
13:30 -14:15	First Keynote Talk	**Prof. B. Pourabbas**, *Additive Manufacturing: your Permission to Catch the Future through 3D Printing*
14:15 -15:00	Second Keynote Talk	**Prof. R. Rafiee**, *On the long-term behavior of composite pipes*

Oral Presentations

Session Title		Advanced Materials, AI, and Optimization	Impact Behavior and Energy Absorption	Nanocomposites: Electromagnetic-chemical Characterization	Sandwich, Cylindrical and Thin wall Composites	General Topics 1
Session Chair		Dr. Mojtaba Haghighi-Yazdi Dr. Mahnaz Zakeri	Dr. Alireza Daneshmehr Dr. Mohammad Javad Ashrafi	Dr. M. Masoud Seyyed Fakhrabadi Dr. Nabi Mehri-Khansari	Dr. Roham Rafiee Dr. Reza Eslami-Farsani	Dr. Fathollah Taheri-Behrooz Dr. Ali Maleki
Session Assistant		Mr. Shahabeddin Garshasbi	Ms. Niloufar Bagheri	Mr. Arang Pazhouheshgar	Mr. Amirreza Amirinejad	Mr. Hossein Sabzchi
15:00 – 15:15	Code	A-10-1921-1	A-10-1900-2	A-10-1942-2	A-10-1953-1	A-10-1915-3
	Title	Optimization of the laminated composite beam with box section under pure shear load	The Experimental Investigation of Low-Velocity Impact on Sandwich Structures with a Cork Core and Basalt Face Sheets	A novel polymeric nanocomposite based on MXene toward EMI shielding material: a Review paper	Quasi static indentation of fully polypropylene sandwich panel	Nondestructive Testing of PCTFE panels using Infrared Thermographic Signal Reconstruction and image processing
	Authors	Rahele Anvari, Aryan Dehdashti, Mahsa Soheil Shamaee, Ahmadreza Ghasemi	Hadi Rezghi Maleki, Puya Parvande, Dursun Metric, Hasan Gidikli	Maedeh Jalilpour, Omid Rafeie, Saeed Zeinali Heris, Sanaz Saeedpour	Hadi Vahidi, Hamed Ahmadi, Gholamhossein Liaghat	Seyed Mobin MosaviFard, Mohammadreza Farahani, Sepehr Jahangiri
15:15 – 15:30	Code	A-10-1881-1	A-10-1931-1	A-10-1905-1	A-10-1951-6	A-10-1949-1
	Title	Optimization of Antisymmetric Angle-ply composite laminates under transverse and thermal loads	Design and stress analysis of the protective rod of a rail-car bogie cradle made of hybrid metal and carbon/epoxy composites under low-velocity impact	Development of MXene/PEDOT: PSS nanocomposite for electrochemical applications	Numerical study of low-velocity impact on GLARE laminates based on elasticity concepts	Investigation of the effect of shape memory alloys on Pressure capacity of polymer composite Pipes
	Authors	Aghil Yousefi-Koma, Mahmood Mansuri Poor, Mostafa Sohankar	Mohammad Moshaveri, Mahmood M. Shokrieh	Mohammad Sepehr Eshtiaghi, Seyed Mohammad Hasan Mousavi, Fatemehsadat Pishbin, Shokoufeh Hassani, Bahram Ramezanzadeh	Amirreza Amirinejad, Siavash Kazemirad, Mahmood M. Shokrieh	Ali Reza Pourmoayed, Mohammadali Ranjbar, Morteza Seyednejad
15:30 – 15:45	Code	A-10-1938-1	A-10-1900-3	A-10-1875-1	A-10-1952-1	A-10-1912-1
	Title	A novel Taguchi-based tabular neural network (TabNet) algorithm for simultaneous anticipation of elastic properties of anisotropic short fiber reinforced composites	Low Velocity Impact Behavior of Glass- and Basalt-Reinforced Vinyl Ester Composites	Melting of Holy Boron - Nitride nanosheet using molecular dynamics simulation	Mechanical characterization of thin-walled Al-honeycomb core sandwich structures reinforced thin-ply carbon-glass fiber facings	Design of glass/epoxy composite stacking using machine learning algorithms
	Authors	Mohammad Hossein Nikzad, Mohammad Heidari-Rarani, Mohsen Mirkhalaf	Hadi Rezghi Maleki, Puya Parvande, Mohammad Ebrahimi, Masoud Rostaei	Rogayeh Ghaffari Arsoun, Hamed Aghajari, Jamal Davoodi	Reyhanehsadat Kazemian, Seyed Mohammad Saleh Mousavi Bafrouyi	Milad Shahsavari, Mohammad Reza Zamani, Hosein Parsa, Jafar E. Jam
15:45 – 16:00	Code	A-10-1951-15	A-10-1955-1	A-10-1873-1	A-10-1957-1	A-10-1940-2
	Title	Influence of Printing Parameters on 4D-Printed Samples	The Impact of Projectile Velocity on the Ballistic Performance of Layered Composites Consisting of Aluminum, Glass Epoxy Composite, and Alumina-Reinforced Elastomer	A magnetic nanocomposite based on graphene oxide nanosheets and Zn-Fe layered double hydroxide as a highly efficient adsorbent for the removal of dye from aqueous environment	Localized impulsive response of aluminum three-layered sandwich cylinders with auxetic core	Analysis of Energy Absorption in Composite Sandwich Panels with Different Core Structures Under Impact Loading
	Authors	Sina Farahifar, Dominik Fauser, Holger Steeb, Mahmood M. Shokrieh	Shahide Jannesari, Gholamhosssein Liaghat, Hamed Ahmadi	Maryam Mohammadi, Mohsen Babamoradi, Reza Eivazzaheh-Keihan, Ali Maleki	Ali Davar, Reza Azarafza	Mohammad Erfan Ezzati, Jaafar Ghanbari
16:00 – 16:15	Code	A-10-1940-1	A-10-1900-1	A-10-1850-2	A-10-1852-2	A-10-1951-1
	Title	Optimization and Simulation of Energy Absorption in Composite Propeller Under High Speed Impact	Low-energy impact response of rubberised cork sandwich structures with glass face sheets	Corrosion Behavior of Nano- and Micro-Composite Materials	Comparative study of the flexural properties of fiber-metal laminates subjected to extreme freeze-thaw cycles	Design and stress analysis of the protective rod of a rail-car bogie bolster made of hybrid metal and carbon/epoxy composites under low-velocity impact
	Authors	Mohammad Erfan Ezzati, Jaafar Ghanbari	Hadi Rezghi Maleki, Masoud Roustaei, Puya Parvande	Mohammad Mehrdar	Moslem Najafi, Jafar Eskandari Jam	Mohammad Moshaveri, Mahmood M. Shokrieh
16:15 – 16:30	Code	A-10-1837-1	A-10-1951-10	A-10-1918-1	A-10-1852-1	A-10-1941-1
	Title	Shape Reversibility and Thermomechanical Transformations in Shape Memory Alloys	A numerical investigation of Newtonian and non-Newtonian fluid-filled nested hyperelastic structures under low-velocity impact loading	Adsorption of Methyl Orange from Aqueous Solution Using Polypyrrole/Andalusite Nanocomposite	Effects of aging on compressive properties of a multilayered hybrid cored-sandwich panel stiffened by composite grid structure	Experimental Study on Foam Density Influence in 3D-Printed Foam-Filled Sandwich Beams Under Flexural Loading
	Authors	Osman Adiguzel	Niloufar Bagheri, Abbas Moradi, Mahmood M. Shokrieh	Seyed Mohammadreza Sarbaz Roohani, Ahmad Dadvand Koohi	Moslem Najafi, Reza Eslami-Farsani	Amirreza Vakil Yakhforvazan, Saman Ghoddousi, Majid Safarabadi
16:30 – 16:45	Code	A-10-1951-8	A-10-1876-1	A-10-1843-2	A-10-1853-1	A-10-1948-1
	Title	Statistical analysis of fatigue life of laminated composites using artificial intelligence	Development of Lightweight PP/Talc Composites Reinforced with Hollow Glass Microspheres	Next-Generation of Photocatalytic Antibacterial Nanocomposite: Cutting-Edge Strategy for Effective Inactivation of Pathogenic Bacteria	Numerical analysis of composite cylinder with metal liner under combined internal pressure and thermal transient loading	Fabrication of Nanocomposites Based on PANI and P3HT by Crystallization Method
	Authors	Amirhossain Teymouri, Arang Pazhouheshgar, Mahmood M. Shokrieh	Sedigheh Bagheri Kazem Abad, Ali Khosravani, Hasti Bizhani	Sogand Rajaei Farid, Mohammad Amin Habibi, Azadeh Ebrahimian Pirbazari, Fatemeh Esmaeili Khalil Saraei	Amir Kermajani, Hamid Fazeli, Hosein Mehmannavaz	Saleheh Abbaspoor
16:45 – 17:00	Code	A-10-1951-7	A-10-1951-9	A-10-1951-3	A-10-1957-2	A-10-1898-1
	Title	Evaluating Shape Memory Properties of Recycled PET and HDPE vs PET with Carbon Fibers	The effect of grid-box material on energy absorption of shear thickening fluid-filled hyperelastic structure: A numerical study	Anisotropy of thin metal foils used in flexible electronics	Parametric stability of fiber metal laminate cylindrical shells under harmonic axial loads	Investigation of the Effect of TiO2 NPs and PEG on the Performance of PAN Nanocomposite Ultrafiltration Membranes
	Authors	Shahabeddin Garshasbi, Sina Farahifar, Mahmood M. Shokrieh	Niloufar Bagheri, Abbas Moradi, Mahmood M. Shokrieh	Arang Pazhouheshgar, Mahmood M. Shokrieh	Ali Davar, Reza Azarafza	Fateme Pishagahi, Mohammad Reza Mehrnia

Thursday19th December (29th Azar) (Morning)		
Keynote Speeches		
Time	**Title**	**Presenter**
8:15 -9:00	**First Keynote Talk**	**Prof. M. Baniassadi**, *Design and Manufacturing of Thermo-Mechanical Metamaterials*
9:00 -9:45	**Second Keynote Talk**	**Prof. M. Baghani,** *4D printing of shape memory polymers through materials extrusion additive manufacturing*
9:45 -10:00	**Break**	

Oral Presentations						
Session Title		**Battery and Electronics Technologies**	**Biomechanical and Biomedical Composites**	**Hole, Crack, and Cohesive Properties in Composites**	**Fabrication and Material Properties**	**General Topics 2**
Session Chair		**Dr. Hadi Rezghi Maleki Dr. Majid Baniassadi**	**Dr. Afshin Zeinedini Dr. Mohammad Haghpanahi**	**Dr. Siavash Kazemirad Dr. Mohammad Hossein Bayati**	**Dr. Hadi Khoramishad Dr. Mohammad Fasihi Dastjerdi**	**Dr. Nabi Mehri-Khansari Dr. Mohammad Reza Farahani**
Session Assistant		Mr. Pezhman Najafi	Mr. Mohammadhossein Emami	Mr. Hasan Ramezani	Mr. Abbas Moradi	Mr. Javad Khosravi
10:00 – 10:15	**Code**	**A-10-1951-11**	**A-10-1850-1**	**A-10-1869-2**	**A-10-1942-1**	**A-10-1983-1**
	Title	Design and fabrication of a flexible battery fatigue tester to investigate the effect of geometrical parameters on electrochemical performance	Degradation and Biocorrosion of Composite Materials in Biomedical Implants: A Comprehensive Review of Mechanisms and Applications	Analysis of delamination propagation in open-hole GFRP composite under 3point-bending fatigue loading	Study on The Prevention of Laminated UPVC Profiles from Deformation by Simultaneous Decrease in Heat Buildup (HBU) and Enhancement of Their Heat Deflection Temperature (HDT): A Review Paper	An Experimental Investigation of the Creep Behavior of Single-Lap Adhesive Joints with PMMA Sheets
	Authors	Mohammadhossein Emami, Arang Pazhouheshgar, Mahmood M. Shokrieh	Mohammad Mehrdar	Nahal Barzegar Bagheri, Soheil Dariushi, Farbod Bijari	Masoud Naserifard, Omid Rafeie, Seyed Jamaleddin Peighambardoust	Ali Moradi-Bayati, Mohammad Rahim Nami, Mohammad Rahim Hematiyan
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Session Chair		**Dr. Fathollah Taheri-Behrooz** **Dr. Zahra Daneshjoo**	**Dr. Afshin Zeinedini** **Dr. Reza Mosalmani**	**Dr. M. Masoud Seyyed Fakhrabadi** **Dr. Omid Rafeie**	**Dr. Hadi Rezghi Maleki** **Dr. Mahdi Moghimi Zand**
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	Authors	Faezeh Mohammad Zaheri, Fathollah Taheri-Behrooz, Bijan Mohammadi	Parsa Dadashi, Ghodratollah Hashemi Motlagh	Alireza Ramezani, Hourieh Emadi, Hossein Nazockdast	Mohsen Kouhi, Shabnam Ebrahimi
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	Authors	Peyman Majnoun, Mohammad Reza Khoshravan Azar, Farid Vakili Tahami	Mojtaba Abedini Nodoushan, Rezvan Abedini, Mohammad Ali Zamani	Ali Matloubpasand, Mohammad-Amin Tayefeh Hassani Gholmansarai, Pegah Ezzati Nasab, Farkhondeh Hemmati, Hossein Ali Khonakdar	Mahdi Ahmadi, Hassan Fattahi, Mehrzad Mortezaei
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	Authors	Nazarian, Y., Mosalmani, R., Shishehsaz, M.	Safie Teymourinejad Touli, Ahmad Dadvand Koohi	Mohammad Reza Salehloo, Maisam Jalaly, Mohammad Khalesi Hamedani	Seyyed Mohammad Javad Mirbagheri, Hassan Fattahi, Mehrzad Mortezaei
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	Authors	Mohammad Ali Zamani, Rezvan Abedini, Hadi Ghorbani	AmirAli Basiri, Mojtaba Haghighi-Yazdi	Alireza Ramezani, Hourieh Emadi, Shervin Ahmadi	Daniyal Borooshkeh, Samaneh Mahmoudi-Qashqay, Mohammad-Reza Zamani-Meymian

Thursday19th December (29th Azar) (Afternoon)		
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17:15 -17:30	Conference Conclusion	**Dr. M. Safarabadi,** *Closing Talk*

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Plenary Speech

Homogenization Methods: From Classical Models to Advanced Multiscale Techniques

Professor Mohammad Mohammadi Aghdam

Solid Mechanics, Dep. of Mechanical Engineering, Amirkabir University of Technology, Tehran, Iran

Abstract

Homogenization techniques are fundamental approaches to predict the macroscopic behavior of heterogeneous materials based on their constituent properties and microscopic structures. These techniques primarily aim to derive overall material and structural properties from the characteristics of individual constituents. In most multiscale modeling frameworks, however, simultaneous interactions between various levels of materials is considered in the computational models.In this presentation, a brief review of the relatively extensive history of the homogenization theories from early models of simple Voigt (1928) and Reuss (1929) to more advanced formulations, including the Hashin-Shtrikman bounds (1963) and asymptotic homogenization (1978) will be discussed. While these methods effectively address periodic or presumed periodic media, stochastic homogenization (1979) has broadened the scope to include random materials. Furthermore, nonlinear homogenization also addresses complex behavior of materials such as plastic deformation and damage in which multiscale modeling would be necessary. In this area, with the rise of computational methods, the multiscale FEM (1997) and the generalized multiscale FEM (2009) offered more efficient multiscale tools. Recently, machine learning techniques have also been integrated into the homogenization to accelerate multiscale computations (2020) and predict effective material properties directly from data (2023). An overview of the possible future directions in the homogenization methods to further advancements in nonlinear, multiphysics systems through AI-driven approaches will be discussed.

Plenary Speech

Multiscale Modelling of Fatigue of Metals

Professor Siegfried Schmauder

Institute for Materials Testing, Materials Science and Strength of Materials (IMWF),
University of Stuttgart, Stuttgart, Germany

Abstract

Recently, Multiscale Materials Modelling (MMM) has grown in importance and simultaneously became a central idea in understanding present-day complex and advanced materials. As a part of MMM, considerable emphasis has been put at our institute in developing numerical models for predicting also fatigue lifetime of metallic materials. At the microstructural level, the physically-based Tanaka-Mura model (TMM) has been extended to elevated temperature conditions and microstructural characteristics such as porosities and proves to be a very promising model to estimate the number of cycles for a fatigue crack to be initiated. One of the parameters of the model is the critical resolved shear stress (CRSS) on a slip plane, which is of particular interest since it can be obtained by means of micro-pillar tests or alternatively by Molecular Dynamics simulations on the nanoscale. Concerning the macro scale and long crack growth predictions, there exist numerous established models that produce acceptable results, e.g., the well-known Paris law and its numerical realization. The present work comprises several fatigue problems of metals for which the modelling framework has been successfully applied, including the numerical determination of fatigue life (S-N, Wöhler) curves for materials and for components as well as elucidating the influence of the CRSS on these curves. This physically based multiscale approach presents a breakthrough in the field of fatigue research and opens the door to fast and inexpensive virtual materials development as well as fatigue resistant component design for fatigue application, e.g., under large deformation conditions.

Keynote Speech

Additive Manufacturing: your Permission to Catch the Future through 3D Printing

Professor Behzad Pourabbas

Dep. of Polymer Engineering, Nanostructured Materials Research Centre, Sahand University of Technology, Tabriz, Iran

Abstract

For decades, it has been like a dream in technology trend to reach out to the development millstone of touching real 3D printed objects directly from the computer screens, the CAD models, instead of just getting satisfied by having only the dramatic phantoms on a paper sheet. Now, the dream is in reality world, for years, and is rising fast being considered a mature technology. One may comment on the statement that such technologies, Selective Laser Sintering SLS methods, for instance, have been available for many years, and nothing would be considered as an exciting matter with this. To response yes, 3D printing techniques have been developing during the years however, it is available in quite wide range of accessibilities, in moderate to cheap cost and advanced technological specifications. Nowadays, selection list of 3D printers is in commercial products that can provide high output printing rate in very low resolution (< 20 micron) and using standard or functional materials which are emerging everyday by different producers all around the world. Among the other names DLP and mSLA printing technologies, due to versatility, rate of printing and lower cost of printing in addition to other economic aspects, have been developed widely and is being used for many different applications in research and industrial centers. Though polymeric materials are definitely the major reason for the diversity of 3D Printing technologies, they have been and are being considered as the most practically important part of the successful printing in SLA and DLP. The latter techniques build the 3D-printed object directly from a photosensitive mixture of polymeric materials or resins. By changing the resin properties, one can have 3D printed objects with different functionalities of the desired application. High strength, high modulus, chemically resistive, high temperature, transparent, biocompatible, electrically conductive, high resolution, investable, flexible, transparent and many other properties are only examples of the properties that a printing can result in. The aim of the talk will be all around the mSLA and DLP printing techniques with cons and pros around the techniques and current applications in addition to prospects that are now open for scientists and engineers to define target research projects.

Keynote Speech

On the long-term behavior of composite pipes

Professor Roham Rafiee

Faculty of New Science & Technologies, University of Tehran, Tehran, Iran

Abstract

Dictated by international rules and regulations, composite pipes are supposed to sustain their missions for 50 years as the service lifetime of the infrastructure industry. Therefore, composite pipes are required to be designed in accordance with the long-term design constraints as the most challenging design requirements. The long-term performance of a composite pipe is examined under two different expensive and cumbersome experimental programs for a period of more than two years. These experimental programs should be carried out for any new layup configuration as the approval of the pipe design configuration. The very long duration of the costly certification procedure is hindering industrial producers from developing new products. Thus, it is vital to predict the long-term behavior of composite pipes at early design stages and prior to mass production. Two computational modeling procedures are developed to predict the remaining properties of composite pipes for two different load cases of internal pressure and compressive transverse loading after 50 years. The developed modeling procedures require limited experimental data through short-term tests. Validated through an extensive experimental program on industrial-scale composite pipes, the developed modeling techniques are able to estimate the remaining properties of the pipes on a long-term basis with a very high level of accuracy. Moreover, the modeling procedure is extended to take into account the influence of water absorption, fulfilling the requirements of the normative standard for analyzing the long-term behavior under wet conditions. Despite the development of sophisticated computational methods for estimating the long-term response of composite pipes, the conducting of qualification tests cannot be waived. Consequently, an alternative testing program is proposed to reduce the duration of the experimental program to three months as the final step.

Keynote Speech

Design and Manufacturing Thermo-Mechanical Metamaterial

Professor Majid Baniassadi

College of Engineering, Dep. of Mechanical Engineering, University of Tehran, Tehran, Iran

Abstract

Mechanical metamaterials, also known as engineered materials or metamaterials with tailored mechanical properties, have emerged as an attractive field of research in materials science and engineering due to their ability to exhibit extraordinary mechanical properties not found in nature. Inspired by intricate natural structures, these materials are meticulously designed to possess counterintuitive mechanical characteristics, such as negative Poisson's ratio, tunable stiffness, and high strength-to-weight ratio not found in nature. We have developed a variety of thermo-mechanical metamaterials that demonstrate outstanding responses to both thermal and mechanical stimuli. During this presentation, we will discuss the fundamental principles underlying the design and manufacturing of metamaterial, as well as the experimental and numerical characterization of these structures. We will also explore the state-of-the-art techniques and technologies that allow us to push the limits of what is achievable in metamaterial development. Our primary focus is designing and developing an additive manufacturing approach to produce these advanced materials. We have developed different devices for the characterization of metamaterials.

Keynote Speech

4D printing of shape memory polymers through materials extrusion additive manufacturing

Professor Mostafa Baghani

College of Engineering, Dep. of Mechanical Engineering, University of Tehran, Tehran, Iran

Abstract

4D printing extends the capabilities of 3D printing by incorporating intelligent functions that enable printed parts to dynamically change shape over time. This transformation is achieved by integrating smart materials, particularly shape memory materials (SMMs), into the printing process. Applications of 4D printing include self-assembly, self-adaptation, sensing, and actuation of complex geometries and multi-material structures. The foundation of 4D printing lies in three key components: 3D printing technology, smart materials, and external stimuli. Among 3D printing methods, fused deposition modeling (FDM) is widely used due to its efficiency, cost-effectiveness, and suitability for thermoplastic polymers. The versatility of 3D printing allows for the design and fabrication of intricate structures and personalized equipment, particularly in medical applications. Smart materials, including shape memory polymers (SMPs), play a central role in 4D printing. SMPs are favored for their low density, high strain recovery, adaptability, and biodegradability. Heat-activated SMPs, a prominent subgroup, exhibit the shape memory effect (SME), where they recover their original shape upon heating. This effect results from specific polymer properties, including morphology, molecular structure, and deformation history. The programming process, involving heating/loading, cooling/unloading, and recovery, ensures the material's shape fixity and recovery. Recent advancements involve adding magnetic or electric fillers to enable indirect activation. Magnetic-sensitive composites, particularly those using iron oxide nanoparticles (Fe_3O_4), are notable for remote activation capabilities, which have significant potential in medical and industrial applications. To advance 4D printing for industrial use, it is essential to strengthen the integration of structural design, material development, and programming techniques. Achieving harmony among these components will unlock the full potential of 4D structures across diverse fields.

Keynote Speech

Impact Behaviour of Lightweight Smart Composites

Professor S. Mohammad Reza Khalili
Faculty of Mechanical Engineering, K.N. Toosi University of Technology, Tehran, Iran

Abstract

With the knowledge of composite materials from the last half century and its various applications in the industry from the last three decades, the science of these materials and structures in the construction of light weight structures and increasing the safe design capability for engineers due to the possibility of simultaneous design of materials and structures has gone gradually increased in such a way that scientists have gone towards the use of these light materials in special applications such as impact loading. With the understanding of smart materials and their unique features and the ability to make and use them in composite structures, practically new attitudes have been formed in the design, mechanics and also the behavior of these structures in different loads and their use in important applications. In this review research work, the behavior of smart composite lightweight structures under impact loading is investigated. In this research, after introducing composite materials and smart materials and how to combine these two together to achieve lightweight smart composite structures, the effect of various parameters on the behavior of these structures is investigated and discussed. Studying the integrity of the structure and their resistance against these loadings, as well as examining their failure behavior, helps to make the design of such structures more acceptable, reliable, operational, and practical for design engineers. In this research, the effect of one of the smart materials, i.e. shape memory alloys, has been used to improve the properties of laminated fiber composites under impact conditions. Also, on improving the behavior of the structure in impact, other smart technology is used with the name of self-healing composites. In this presentation, the processes, the materials, the tests, and the results and behavior of such structures will be examined.

Keynote Speech

Porous Media - From Imaging to Physical Characterization

Professor Holger Steeb

Institute of Applied Mechanics (MIB), Chair of Continuum Mechanics, University of Stuttgart, Stuttgart, Germany

Abstract

Effective material properties of porous media like concrete, natural rock and further porous materials strongly depend on the properties of morphology of the porous structure. Unfortunately, we are not able to classify the 3-dim pore space as those materials are in general intransparent. Therefore, we are using X-Ray Computed Tomography (XRCT) to make concrete "transparent" and to characterize the pore space. Within our in-house developed XRCT device, we are able to combine "imaging" and "physical" experiments, like (multi-axial) mechanical testing or multi-phase flow tests. Additionally, the high-resolution 3D CT-scans are for us the image-based sources for further and subsequent numerical investigations, i.e. multi-scale simulations for the determination of effective physical properties of porous media. Within this talk, results of those investigations of porous materials with inherent (fluid-saturated) fractures and fracture networks will be discussed. It will be shown how fractures can be visualized and how effective dispersive properties can be obatined. Furthermore, a hybrid-dimensional framework for deformable fractures in porous media will be discussed.

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A-10-1831-1

Investigation detachment of 2024-T3 Aluminum Alloy plates bonded by cohesive elements and cohesive surfaces

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[1]M.Sc. Student, [2]Professor
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Abstract

In the upcoming research, the difference between utilizing the cohesive element and the cohesive surface when separating two Aluminum plates has been investigated and their force-displacement diagrams have been compared. The results of the numerical analysis with Abaqus/CAE software for the cohesive element were validated with the experimental results, The force-displacement diagram for the cohesive element was compared with the experimental diagram of the Double Cantilever Beam (DCB) test. The maximum amount of force was measured at the point of displacement exerted, its value had a difference of 0.48% with the results of experimental tests. The maximum magnitude of force for the cohesive element was 730.322 N, on the other hand, it was calculated as 896.2 N for the cohesive surface. The magnitude of Von Mises stress was calculated for both analyses. The numerical analysis results indicate a 12.41% difference in Mises stress between the simulation of cohesive elements and cohesive surfaces.

Keywords: DCB test, cohesive element, cohesive surface, Aluminum alloy, Abaqus/CAE

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Core-shell $CoFe_2O_4$-ZnO nanocomposite for electromagnetic waves absorption application

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Abstract

The rapid advancements in electromagnetic communication and electronic technology have intensified challenges related to electromagnetic interference (EMI) and radiation, necessitating the development of efficient electromagnetic wave (EMW) absorbing materials. This study explores the synthesis and characterization of cobalt ferrite@zinc oxide ($CoFe_2O_4$@ZnO) core-shell nanocomposites, produced via hydrothermal and co-precipitation methods. The structural, morphological, and EMW absorption properties were analyzed using X-ray diffraction (XRD), vibrating sample magnetometry (VSM), transmission electron microscopy (TEM), scanning electron microscopy (SEM), and vector network analysis (VNA).The nanocomposites' microwave absorption performance in the X-band range (8–12 GHz) was evaluated using the transmission line method. Key parameters, including sample thickness and core-to-shell ratio, were optimized to enhance absorption efficiency. Results demonstrated optimal absorption at a $CoFe_2O_4$:ZnO ratio of 2:1 and a 1.0 mm thickness, achieving a maximum reflection loss of −11.0 dB and a broad effective bandwidth across the X-band. This superior performance is attributed to the synergy of dielectric and magnetic losses, increased interface polarization, and enhanced electromagnetic wave reflection and scattering within the nanocomposite structure. The findings highlight the potential of $CoFe_2O_4$@ZnO nanocomposites in addressing EMI challenges.

Keywords: Electromagnetic wave absorption, Cobalt ferrite, Reflection loss, Core-shell, Nanocomposite

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The influence of tin addition on the microstructure and properties of ZrO_2-Al_2O_3 reinforced aluminum composites

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Abstract

This research evaluated the impact of tin addition on the particle-matrix interface, wear properties, and hardness of A356 aluminum alloy reinforced with Al_2O_3 and ZrO_2 particles. Initially, 0.5 wt% Sn was added to the A356 alloy using a semi-solid stirring casting method. Subsequently, a weighed amount of Al_2O_3 and ZrO_2 particles was added to the molten alloy while rotating at 600 rpm. After 10 minutes, the melt was cast into a graphite mold. Microstructural analysis was conducted using a scanning electron microscope. The results showed that tin was rejected to the particle-matrix interface region during cooling, which resulted in better interface bonding. Pin-on-disk tests showed that the composite's wear resistance increased, and the friction coefficient decreased with the addition of Sn. The wear mechanism changed from adhesive to adhesive-abrasive, which was in good agreement with the increase in hardness of the composite according to Archard's relation.

Keywords: Aluminum composite, Tin, Microstructure, Wear, Hardness

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A-10-1834-3

Mechanical properties of epoxy-based nanocomposite reinforced with alumina nanorods

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Abstract

Polymer-based nanocomposites represent a vial category of composites, serving a wide range of industries, from high-end sectors such as aircraft part manufacturing to more low-end applications. In the present research, gamma alumina nanorods were synthesized using a hydrothermal method. The materials were characterized through X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and Fourier-transform infrared (FTIR) spectroscopy. The nanocomposite was fabricated using an epoxy resin matrix reinforced with alumina at varying weight percentages (0.5, 1, and 2 wt.%) to identify the optimal reiforcement content. The sample with 0.5 wt.% alumina filler exhibited the highest tensile strength, showing an improvement of about 19% compared to the unreinforced sample (21 MPa). The tensile strength results for the samples with 0.5, 1, and 2 wt.% alumina were 25, 21, and 19 MPa, respectively. The improvement of tensile strength can be attributed to several factors, including the effective distribution of alumina nanorods and activation of mechanisms that inhibit crack propagation, such as crack bridging and crack deviation within the epoxy resin, as evidenced by the images of the fracture surface of the samples.

Keywords: Alumina nanorods, Nanocomposite, Epoxy resin, Tensile strength

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Shape Reversibility and Thermomechanical Transformations in Shape Memory Alloys

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Abstract

Shape memory effect is a solid-state phenomenon and initiated with thermomechanical treatments by cooling and deformation and performed thermally on heating and cooling Therefore, this behavior can be called thermoelasticity, and governed by thermomechanical transformations, thermal and stress induced martensitic transformations, with which ordered parent phase structure turns into twinned and detwinned martensite structures. These alloys exhibit another property, called superelasticity, which is performed with stressing and releasing. Copper based alloys exhibit this property in metastable beta-phase region. Lattice twinning is not uniform in these alloys and cause the formation of complex layered structures. In the present contribution, x-ray and electron diffraction studies were carried out on copper based CuAlMn and CuZnAl alloys. X-ray diffraction profiles and electron diffraction patterns exhibit super lattice reflections. The specimens were aged at room temperature, and x-yay diffraction angles and intensities changed with aging duration. This result refers to disordering.

Keywords: Martensitic transformation, thermoelasticity, superelasticity, twinning, detwinning

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Experimental study of tensile properties of 3D-printed Titanium-reinforced ABS

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Abstract

This research examines the tensile properties of titanium (Ti) powder-reinforced acrylonitrile butadiene styrene (ABS) composites fabricated via fused deposition modeling (FDM). Three weight-percentage (wt%) compositions of Ti-reinforced ABS were investigated: 6, 13, and 20 wt%. Tensile specimens were 3D-printed and compared with neat ABS. The tensile properties obtained after tensile testing are the elastic modulus (E), ultimate tensile stress (UTS), and elongation at failure. Experimental results revealed that the E and UTS improved by about 28 % and 18 % respectively by adding 6 wt% Ti. The elongation at failure decreased by 12.84%, indicating reduced ductility and increased brittleness. However, higher Ti contents led to reduced UTS, likely caused by particle agglomeration and stress concentrations.

Keywords: Three-dimensional (3D) printing, Composites, Fused deposition modeling, Titanium, Acrylonitrile butadiene styrene, Tensile properties

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A new mixed mode I/II fracture criterion for arbitrary cracks in orthotropic materials considering fracture process zone effects

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Abstract

In this paper, a new mixed mode I/II fracture criterion for orthotropic materials is presented based on the development of the minimum strain energy density concept and considering the absorbed energy in the fracture process zone (FPZ). It is assumed that the arbitrary crack can be in any orientation relative to the fibers. The concept of reinforcement isotropic solid is used to describe the stress state at the crack tip in orthotropic materials. T-stress effects have also been included due to the crack's non-zero orientation to the fibers. To evaluate the accuracy of the criterion, the fracture limit curves for different crack-fiber angles are compared with available experimental data. The good agreement with experimental data compared to other existing criteria demonstrates the superiority of the new proposed criterion.

Keywords: Mixed-mode I/II fracture criterion, Orthotropic materials, Arbitrary crack, Fracture process zone, Minimum strain energy density

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Tailored Plasmonic Microspheres: Fabrication, Characterization and Harvesting Visible Light for Photocatalytic Removal of Organic Pollutants

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Abstract

Developing efficient photocatalysts is crucial for mitigating environmental pollution. This study synthesized zinc sulfide microspheres (ZSMs) via a hydrothermal process and functionalized them with plasmonic silver/silver phosphate nanoparticles (AAs) through a one-step deposition-precipitation method. Structural characterization using Powder X-ray Diffraction (PXRD) confirmed the zinc blende cubic phase of ZSMs and the body-centered cubic structure of AAs. Fourier Transform Infrared Spectroscopy (FTIR) validated the deposition of AAs on ZSMs by identifying key chemical bonds, while Field Emission Scanning Electron Microscopy (FESEM) demonstrated the uniform distribution of AAs. Exploiting silver's plasmonic properties, the ZSMs/AAs nanocomposite exhibited enhanced photocatalytic performance under both visible light and ultraviolet (UV) irradiation. It efficiently degraded common organic pollutants, such as tetracycline antibiotics and methyl orange dye, under these conditions. This study highlights the ZSMs/AAs nanocomposite as a promising and sustainable photocatalyst for environmental remediation.

Keywords: ZnS Microspheres, Ag/Ag_3PO_4 Nanoparticles, Photocatalytic Performance, Visible Light, UV Irradiation, Organic Pollutants

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A-10-1843-2

Next-Generation of Photocatalytic Antibacterial Nanocomposite: Cutting-Edge Strategy for Effective Inactivation of Pathogenic Bacteria

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Abstract

The proliferation of antibiotic-resistant bacteria underscores the urgent need for novel antibacterial materials. Herein, we report the synthesis of zinc sulfide (ZnS) modified with plasmonic silver/silver phosphate (Ag/Ag_3PO_4). Powder X-ray Diffraction (PXRD) confirmed the successful formation of ZnS with a zinc blende cubic structure, while Ag/Ag_3PO_4 exhibited a body-centered cubic phase. Field Emission Scanning Electron Microscopy (FESEM) revealed the homogeneous decoration of Ag/Ag_3PO_4 on the ZnS surface, creating a hybrid nanostructure with potent antibacterial properties. The antibacterial activity of the nanocomposite was evaluated against Gram-positive Staphylococcus aureus and Gram-negative Escherichia coli using Minimum Inhibitory Concentration (MIC), Minimum Bactericidal Concentration (MBC), and Disk Diffusion assays. The results demonstrated significant inhibitory and bactericidal effects against both bacterial strains, positioning the $ZnS/Ag/Ag_3PO_4$ nanocomposite as a promising candidate for photocatalytic antibacterial applications in healthcare and environmental settings.

Keywords: ZnS-based Nanocomposite, Ag/Ag_3PO_4, Photocatalytic Antibacterial Activity, Staphylococcus Aureus, Escherichia Coli

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Production of ultra-pure lithium hydroxide, lithium composites and completing the chain of lithium compounds from its halide salt by membrane electrolysis method

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Abstract

This study investigates the use of a PFSA cation exchange membrane for the production of ultrapure lithium hydroxide from halide salts. Lithium hydroxide is a critical component in the manufacture of lithium-ion batteries, dental composites, industrial greases, and lithium carbonate, all of which significantly impact battery performance and lifespan. Traditional production methods for lithium hydroxide are energy-intensive and involve complex steps. In contrast, membrane electrolysis offers a highly efficient alternative with reduced environmental impact. This research explores the membrane electrolysis process in detail, highlighting its advantages, including lower energy consumption, improved product quality, and minimized environmental issues. The findings underscore the method's potential to produce ultrapure lithium hydroxide efficiently, addressing the growing demand driven by the expanding lithium battery market. As demand for high-performance batteries increases, the study emphasizes the importance of innovative, sustainable production methods to meet industrial and environmental requirements.

Keywords: Lithium Hydroxide, Membrane Electrolysis, Proton Exchange Membrane, Halide Salts, High-Purity Production, Energy Efficiency

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A-10-1845-1

Investigating the orientation of short carbon fibers on surface hydrophobicity using flocking electrostatic method

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Abstract

This study addresses drag reduction in the maritime sector to enhance fuel efficiency and lower operational costs by mitigating fluid-solid interactions. A textile engineering approach, the electrostatic flocking technique, was employed to develop superhydrophobic coatings using diverse fibers for engineering applications. The process involved applying a hydrophobic coating onto an epoxy resin substrate with short carbon fibers, followed by surface modification with boron nitride nanoparticles to achieve superhydrophobicity.The water contact angle of the coating increased from 94.5° initially to 153.9° after Polydimethylsiloxane (PDMS) treatment and further to 160° upon incorporating boron nitride nanoparticles. These enhancements are attributed to a lotus leaf-like surface topography featuring micrometer-scale roughness and nanometer-scale ridges. Scanning electron microscopy (SEM) images revealed the vertical alignment of fibers and nanoparticle distribution, while Fourier transform infrared spectroscopy (FT-IR) confirmed the functionalization of carbon fibers after PDMS treatment. This approach highlights the potential of engineered superhydrophobic coatings for maritime applications.

Keywords: Flocking electrostatic, Superhydrophobicity, Surface modification, Short carbon fibers, BN nanoparticles

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Chemi-resistive behavior of polyaniline/anatase TiO_2 nanocomposite: application in sensing devices

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Abstract

Polyaniline (PANI) is an intrinsically conductive polymer that has attracted much attention as a potential candidate for sensing devices. Adding metal oxide semiconductors (MOSs) such as TiO_2 can enhance its sensing performance and reduce the operating temperature. Literature shows that divergent research has been carried out about the sensitivity of the PANI/TiO_2 nanocomposite to some vapors and gases. The current report considers the chemi-resistive behavior of the mentioned advanced material toward a wide range of organic and inorganic chemical compounds, and toxic gases including ethanol, methanol, acetone, acetylene, ethylbenzene, methane, ammonia, carbon dioxide, nitrogen dioxide, nitric oxide, hydrogen sulfide, sulfur dioxide, chlorine, and hydrogen. In this regard, the hydrothermal technique was employed to manufacture the samples with different levels of TiO_2 content. X-ray diffraction (XRD), Fourier transform infrared (FT-IR) spectroscopy, and atomic force microscopy (AFM) were also used to analyze the nanostructure and surface morphology of the samples. The results demonstrated that PANI/TiO_2 nanocomposite showed remarkable sensitivity to ammonia compared with other compounds and gases. The detection limit and reliability evaluations also revealed that the mentioned material could be used to manufacture the ammonia-sensing devices.

Keywords: Thin Films, Nanocomposite, PANI/TiO_2, Chemi-resistive Behavior, Reliability

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Degradation and Biocorrosion of Composite Materials in Biomedical Implants: A Comprehensive Review of Mechanisms and Applications

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Abstract

This review explores the transformative role of composite materials in advancing biomedical implants by addressing the dual challenge of biodegradability and sustained functionality. Polymer-matrix composites and magnesium-based alloys emerge as leading candidates for orthopedic and dental applications, combining biocompatibility with controlled degradation properties. The review examines the mechanisms of degradation and biocorrosion, highlighting the influence of structural reinforcements, surface treatments, and the incorporation of nano-fillers and bioactive glasses on material performance. Recent advancements in magnesium-based composites and bioabsorbable polymers have demonstrated significant potential for optimizing degradation rates while enhancing cytocompatibility and hemocompatibility. Through in vitro and in vivo studies, the review provides a comprehensive synthesis of these materials' behavior in biological environments, focusing on their corrosion resistance, mechanical stability, and tissue interactions. Key parameters affecting performance are analyzed, offering insights into the design of next-generation implants. This work underscores the need for continued research to fine-tune material properties, ensuring they meet the stringent requirements of medical applications while enabling safer, more effective implant designs.

Keywords: Biocorrosion, Biomedical Implants, Composite Materials, Magnesium-based Alloys, Biodegradable Polymers

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A-10-1850-2

Corrosion Behavior of Nano- and Micro-Composite Materials

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Abstract

Nano- and micro-composites are emerging as transformative materials for enhancing corrosion resistance, offering superior strength, durability, and performance compared to traditional materials. This review investigates their corrosion behavior, with applications spanning aerospace, automotive, and biomedical industries. Key factors influencing corrosion resistance are analyzed, including particle size, distribution, and reinforcements like SiC, Al2O3, and carbon nanotubes. Nano-scale reinforcements are shown to improve mechanical properties and mitigate microgalvanic corrosion by strengthening interfacial bonding. Special focus is placed on magnesium, aluminum, and copper-based composites, whose nano-particulate dispersions significantly alter corrosion mechanisms and rates. The role of fabrication methods such as stir casting and electrochemical deposition in shaping microstructure and enhancing corrosion resistance is also examined. Synthesized findings from electrochemical impedance spectroscopy and potentiodynamic polarization tests reveal the composites' ability to withstand harsh environments effectively. This review underscores the importance of optimizing composite formulations to maximize their protective capabilities, paving the way for future advancements in corrosion-resistant materials.

Keywords: Nano-composites, Micro-composites, Corrosion Resistance, Magnesium Alloys, Electrochemical Behavior

A-10-1851-1

Investigating the microstructure and hardness coating of HA on Mg-Zn alloy by sol-gel method

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Abstract

Research into the microstructure and hardness of hydroxyapatite (HA) coatings on Mg-Zn alloys via the sol-gel method reveals significant advancements in enhancing mechanical and biomedical properties. HA, celebrated for its biocompatibility and bioactivity, improves the integration of Mg-Zn alloys with bone tissue, making it ideal for medical implants. HA coatings not only enhance surface hardness but also significantly bolster corrosion resistance and wear durability, addressing key challenges in magnesium alloy applications. The sol-gel method emerges as a pivotal technique, offering precise control over coating composition and thickness while preserving the substrate's integrity through low-temperature processing. Composite coatings, such as HA/TiO2, further elevate corrosion resistance, cytocompatibility, and antibacterial properties. Similarly, forsterite coatings applied via sol-gel exhibit enhanced bioactivity and corrosion protection. Studies highlight HA coatings on anodized Mg and ZK41 alloy surfaces, which achieve superior microhardness, adhesion strength, and corrosion resistance compared to uncoated substrates, alongside promoting cell viability. These findings underline the transformative potential of HA-based ceramic coatings in biomedical applications, paving the way for more durable, biocompatible implants.

Keywords: Mg-Zn alloy, HA coating, Sol-gel, Microstructure, Hardness

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Effects of aging on compressive properties of a multilayered hybrid cored-sandwich panel stiffened by composite grid structure

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Abstract

This research explores the impact of accelerated hygrothermal aging on the compressive properties of an innovative multilayered hybrid cored-sandwich panel, stiffened by a composite grid structure. The proposed sandwich configuration was engineered for marine applications, wherein the core material, comprising two agglomerated cork layers, serves as an effective barrier against water ingress in the internal polyurethane (PU) foam core. This feature is of paramount importance within marine environments, significantly enhancing the durability and structural integrity of composite materials. Following the aging process, a comparative analysis was performed to evaluate the compressive properties of the hybrid sandwich panel against those of a conventional monolithic PU foam core. The results demonstrate that the hybrid sandwich panel exhibits a remarkably low propensity for water absorption, leading to only a marginal decline in compressive properties after aging. This study contributes to the expanding body of knowledge regarding advanced sandwich panels, emphasizing their potential for superior application in challenging marine conditions.

Keywords: Multilayered hybrid cored-sandwich panel, Composite grid structure, Hygrothermal aging, Compressive properties

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A-10-1852-2

Comparative study of the flexural properties of fiber-metal laminates subjected to extreme freeze-thaw cycles

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Abstract

Freeze-thaw cycles pose significant challenges in materials science, particularly for aerospace applications where composite materials endure extreme environmental conditions. These cycles can adversely affect the mechanical properties and durability of fiber-metal laminates (FMLs), which are widely used in aerospace structures for their exceptional fatigue resistance and high strength-to-weight ratio. Despite their importance, the impact of FML constituents on freeze-thaw performance remains underexplored. This study examines two types of FMLs composed of aluminum sheets and fiberglass/epoxy composites, differing only in the epoxy resin used, which exhibits distinct mechanical properties. Subjected to rigorous freeze-thaw cycles at -20 °C and boiling water—conditions exceeding typical aerospace environments—the laminates' flexural properties were evaluated. Results demonstrate a significant link between the shear strength of the epoxy resin and the laminates' resistance to freeze-thaw degradation. These findings underscore the critical role of material selection in enhancing the durability and performance of FMLs in extreme aerospace conditions.

Keywords: Freeze-thaw cycles, Flexural properties, Fiber-metal laminates (FMLs), Epoxy resin

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Numerical analysis of composite cylinder with metal liner under combined internal pressure and thermal transient loading

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Abstract

This research aims to replace an all-metal cylinder with a composite cylinder featuring a metal liner, prioritizing weight reduction while maintaining structural integrity under transient internal pressure and thermal loads. Using numerical simulations, the transient behavior of metal and composite cylinders was compared, with validation performed against previous studies. Following verification, simulations of cylinders with various stacking sequences were conducted to design an optimal composite cylinder. The proposed model achieves a weight reduction of approximately two-thirds and offers a higher reliability factor than the all-metal counterpart. The findings indicate that for composite cylinders with metal liners, increasing the composite-to-liner thickness ratio reduces liner stress up to a threshold, beyond which the maximum liner stress remains constant. Excessive composite thickness, however, may elevate the maximum cylinder stress under combined loading, a phenomenon absent when thermal loading is excluded. Additionally, composite layers reduce radial displacement and elevate maximum temperatures compared to the all-metal cylinder, demonstrating their potential for improved performance under complex loading conditions.

Keywords: Cylindrical shell, Composite, Combined pressure and heat, Numerical simulation, Finite elements

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A-10-1854-2

Simulation of layup effects on the residual stresses and deformations of layered composite structures caused by the curing process

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Abstract

Residual stresses which are created in composite structures during the curing process are the main reason for the parts' distortions and warpage. In this research, these residual stresses and deformations in polymer-based laminated composites were simulated using viscoelastic structural relations. This model has been implemented and validated using subroutines such as UMAT and UEXPAN in ABAQUS software. Furthermore, for a laminated composite plate, effects of layup on residual stresses and deformations have been investigated. The obtained results have been compared to each other. The results show that the maximum residual stress in the composite structure is created during the cooling process and the residual stresses are concentrated along the free edges.

Keywords: Laminated Composite, Residual Stresses, Curing Process, Viscoelastic Model

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Nonlinear Vibration Analysis of Simply Supported Euler-Bernoulli FGM beam under forced excitation

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Abstract

This research focuses on the analysis of forced vibrations in a Euler-Bernoulli beam. The presented model is a simply supported beam with FGM. Utilizing non-local theory and Hamilton's principle, the equations of motion for the studied model are derived. Additionally, the weighted residual method (Galerkin's method) is employed to discretize the equations of motion. Numerical methods are utilized to solve the resulting equations. Furthermore, to validate the obtained results, a comparison is made between the outcomes of the present study and those of previous investigations.

Keywords: Vibration analysis, FGM beam, Hamilton's principle, Numerical methods

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A numerical investigation into the crashworthiness of bio-inspired aluminum/CFRP tubes under lateral loading.

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Abstract

This study conducts a numerical investigation into the impact of various factors, including composite ply angles and the number of layers, on the energy absorption characteristics of an adhesively bonded bio-inspired composite/aluminum hybrid structure under quasi-static lateral loading. By employing numerical simulations that incorporate a cohesive zone model (CZM) for the adhesives and a well-established damage model for the composites, the research emphasizes the effectiveness of adhesive bonding in uniting aluminum and composite materials. The aim is to achieve optimal energy absorption prior to failure at the joint, while minimizing heterogeneous deformation in the structure, particularly given the inherent limitations of composite materials.In this study, a novel hybrid structure inspired by the tendon was designed and subjected to numerical analysis. The composite tubes were modeled using five different stacking sequences [0], [45], [90], [0/90], and [90/0] with 2, 4, or 8 layers. The findings indicate that increasing the number of composite layers enhances energy absorption. However, due to the delamination failure mode observed in the composite layers, the configuration with 8 layers is not optimal. Instead, the configuration with 4 layers demonstrated the best performance. Additionally, the [0/90] ply angle was identified as the most effective for energy absorption.

Keywords: bio-inspired AL/CFRP, hybrid structure, adhesive bonding, lateral loading

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Bio-Inspired Hybrid Energy Absorbers: Enhancing Crashworthiness and Weight Efficiency in Vehicles

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Abstract

With the growing number of vehicles and increasingly stringent environmental regulations, composites are being incorporated into energy absorbers to improve both energy efficiency and overall performance. This study investigates bio-inspired energy absorbers designed to enhance vehicle crashworthiness and reduce structural weight. Specifically, it examines the energy absorption behavior of an adhesively bonded aluminum-composite hybrid structure inspired by the deep-sea sponge Euplectella aspergillum under 10-degree quasi-static compression loading. The performance of this bio-inspired hybrid (HBIO) structure is compared to that of conventional multi-cell structures. The findings demonstrate that the HBIO structure outperforms all other designs in terms of energy absorption, specific energy absorption, and crushing force efficiency, establishing it as the most effective solution for crashworthiness. While multi-cell structures exhibit competitive results, simpler designs, such as pure aluminum (SPA) and adhesive joint (SAJ) structures, prove less efficient. These results highlight the HBIO structure's exceptional potential for advanced crashworthiness applications.

Keywords: Bio-inspired, AL/CFRP, Crashworthiness, Energy absorption

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Synthesis and Characterization of a novel trifunctional cycloaliphatic epoxy resin and preparation of its composite

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Abstract

Due to their flexible structure, cycloaliphatic epoxy resins have attracted more attention than aromatic epoxy resins for making many high-performance composites. The molecular structure of these resins improves chemical, physical and electrical properties in epoxy systems. Using cycloaliphatic structure in epoxy resin with high functional group can simultaneously improve strength, modulus and toughness. The aim of this research is to synthesize and identify trifunctional cycloaliphatic epoxy resin of diglycidyl-4,5-epoxy-cyclohexane-1,2-dicarboxylate by a new method and then make its composite. To achieve this goal, tetrahydrophthalic anhydride was used as the raw material and then the allylation step with allyl bromide and the epoxidation step with 3-chloroperoxybenzoic acid (m-CPBA) were performed. The synthesis method was investigated and confirmed using FT-IR analysis, and to check the final properties of the composite, the synthesized resin was cured with m-PDA and analyzed by interlayer shear strength analysis (ILSS). The composite made with this trifunctional resin has a high interlayer shear strength (76 MPa) compared to common resins. The presence of aliphatic ring and the potential ability to change its conformation or change its shape can repel the impact energy and applied stress.

Keywords: Composite, Resin synthesis, Epoxy, Cycloaliphatic, Trifunctiona

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An experimental study on fracture assessment of rigid nanocomposite foams weakened by a crack

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Abstract

In this study, fracture of rigid foams reinforced with three different weight percentages of nanoclay (i.e., 1, 2, and 3 wt. %) has been experimentally investigated for the first time. The sample with 2 wt.% of nanoclay has exhibited the best performance in the uniaxial tensile tests, showing an increase of 9.2% in elastic modulus and 35.7% in tensile strength compared to the pure sample. Additionally, Mixed-Mode I/II fracture tests have been conducted on Asymmetric Edge Notch Disc Bend (AENDB). The results have shown that the fracture toughness in pure mode I and pure mode II for the 2 wt.% of nanoclay sample has increased by 11.1% and 14.3%, respectively, relative to the pure sample. Furthermore, the maximum increase in the fracture load for the 2 wt.% of nanoclay sample compared to the 0 wt.% of nanoclay sample in the Mixed-Mode I/II fracture tests was approximately 32%. It is noteworthy that the samples with 3 wt.% of nanoclay has the worst mechanical properties among all. This finding can confirm the nanoclay agglomerations in the higher percentages of nano-reinforced composites.

Keywords: Rigid foam, Nanocomposite, Crack, Mixed-Mode I/II

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Synthesis and characterization of spinel-based catalyst for sonocatalytic removal of ciprofloxacin antibiotics

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Abstract

This study addresses the removal of ciprofloxacin (CIP), an essential antibiotic classified by the WHO, from pharmaceutical pollutants using spinel-based catalysts via sonocatalytic degradation. Spinel ZnCo2O4 was synthesized using the hydrothermal method and integrated with graphene nanoplatelets (GO/ZnCo2O4) through sonochemical and hydrothermal techniques. PXRD patterns confirmed the primary diffraction peaks of ZnCo2O4, though the GO diffraction peak at 2θ=11.98° was not detected, likely due to its low quantity and high crystallization. FESEM micrographs and EDS/Elemental-mapping analyses verified the presence of graphene nanoplatelets and elements Zn, Co, O, and C in the samples. Photoluminescence (PL) analysis revealed reduced electron-hole recombination in GO/ZnCo2O4, while DRS analysis demonstrated enhanced visible light absorption due to graphene oxide's presence.Performance evaluations showed that GO/ZnCo2O4 exhibited superior CIP removal efficiency under sonocatalytic conditions compared to ZnCo2O4 alone, emphasizing the catalytic enhancement imparted by graphene oxide. These findings position the GO/ZnCo2O4 catalyst as a promising candidate for water purification applications, leveraging its high activity in sonocatalytic processes to effectively degrade pharmaceutical contaminants.

Keywords: $ZnCo_2O_4$, Graphene nanoplatelets, Ciprofloxacin, Sonocatalytic degradation

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Effect of aluminum hydroxide/epoxy coating on the flammability indexes of cotton/epoxy laminated composites

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Abstract

In recent years, natural fiber laminated composites are extensively applied to fabricate various structures. Despite the numerus advantages of natural fiber laminated composites, flammability is one of the limitations to use them in different applications. Hence, this paper focused on the evaluation of the effect of additives on the flammability index of natural fiber laminated composites. An epoxy-based coating reinforced by different loadings of aluminum hydroxide was used on the surface of cotton/epoxy laminates. The fire behavior of the epoxy-based coating was characterized by a cone calorimeter device. The results manifested that by increasing the amount of aluminum hydroxide, the thermal properties of laminated composites will be enhanced.

Keywords: Natural fiber, laminated composites, flammability, aluminum hydroxide

A-10-1867-1

Environmentally-Friendly Strategies for Tailoring Interfacial Adhesion and Performance of All-green Biocomposites Based on Thermoplastic Starch/Kenaf Fiber

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Abstract

The growing global population has led to an increase in consumer goods production, resulting in millions of tons of waste annually. Plastic, widely used due to its low cost, poses environmental challenges due to its resistance to biodegradation. In response, researchers have focused on developing sustainable, biodegradable polymers from renewable resources. Biopolymers, while abundant and stable, have drawbacks such as poor mechanical properties, hydrophilicity, and processability. Starch is a widely used biodegradable material, yet it suffers from poor mechanical and thermal properties, high permeability, and low resistance to water. To address these limitations, the inclusion of lignocellulosic fibers, such as kenaf, has been explored to improve the mechanical properties and permeability of biodegradable polymers. In this study, kenaf fibers were treated using a solvent pulping method with tartaric acid as a compatibilizer to enhance the interface between the fibers and thermoplastic starch, creating environmentally friendly biocomposites with improved properties. The solvents used pose minimal environmental and safety risks.

Keywords: Biocomposite, Kenaf Fiber, Thermoplastic Starch

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Extrusion Foaming of Poly(lactic acid)/Poly(butylene adipate-co-terephthalate) in the Presence of Spherical Nanosilica and Reactive Compatibilizer

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Abstract

Plastic pollution and the depletion of petroleum resources have prompted the search for sustainable alternatives. Biodegradable polymers like poly(butylene adipate-co-terephthalate) (PBAT) and poly(lactic acid) (PLA) are promising due to their environmental benefits and strong mechanical properties. PLA, a commonly used biopolymer, can be processed into various products but faces challenges in the foaming process due to low melt strength and slow crystallization. Adding nucleating agents such as PBAT or nanoparticles can improve PLA's foamability. This study investigates the effects of hydrophilic and hydrophobic silica nanoparticles on the properties of PLA/PBAT foams, processed through extrusion. The foams were prepared using a chemical foaming agent (AZD) and activator (ZnO). Nanoparticles influence foam morphology by affecting crystallization, nanoparticle dispersion, and bubble nucleation. Results showed that foams with hydrophobic nanoparticles had the lightest structure and highest void fraction. Chain extenders also improved foam properties, with PBAT enhancing their effectiveness. Overall, the study demonstrates the potential for light, biodegradable PLA/PBAT foams, suitable for industrial-scale production, by optimizing the foaming process and using nanoparticles and chain extenders to enhance structural properties.

Keywords: Poly lactic acid, Poly butylene adipate-co-terephthalate, Nanosilica, Foam, Nanocomposite, Biodegradable Plastic

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Enhancing Polyamide 6 and 6.6 Properties with Nanofillers: A Study on Graphene, CNTs, Carbon Fibers

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Abstract

Polyamide 6 (PA6) and polyamide 6.6 (PA66) are essential engineering polymers, valued for their strong mechanical properties, thermal stability, and durability. Recent developments in polymer nanocomposites have shown that adding nanofillers like graphene, carbon nanotubes (CNTs), carbon fibers, and titanium dioxide (TiO_2) can significantly improve these polymers. Graphene, in particular, stands out due to its remarkable ability to enhance mechanical, electrical, and thermal properties, even at very low concentrations. As a result, graphene-polyamide (G-PA) nanocomposites have attracted a lot of attention for their potential use in high-performance applications. In the case of PA66, combining carbon fibers with acyl chloride-functionalized graphene oxide (AGO) and CNTs has led to notable improvements in tensile strength, shear strength, and stiffness. These enhancements come from the strong interfacial bonding between the materials, better dispersion of fillers, and efficient load transfer. Furthermore, integrating TiO_2 and graphene oxide (GO) into polymer membranes has shown great promise in separation processes, improving key factors like hydrophilicity, salt rejection, and oil rejection. These advancements highlight the potential of nanocomposites to create versatile, high-performing materials for various industrial uses.

Keywords: Polyamide nanocomposites, Graphene, Carbon nanotubes (CNTs), Mechanical properties, Titanium dioxide (TiO_2)

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A-10-1868-3

Sonochemical Synthesis of Copper Ferrite-Chitosan Nanocomposites for Electrochemical Sensing and Biomedical Applications

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Abstract

The synthesis of composite nanoparticles with specific functional and morphological goals involves combining materials at the nanoscale to create unique properties not found in individual components. In this study, copper ferrite nanoparticles are synthesized via a sonochemical method in the presence of chitosan, a biopolymer, to develop a highly sensitive and stable electrochemical sensor. Ultrasonic wave parameters, such as power and frequency, played a critical role in determining the nanoparticles' size and structure. The synthesized nanoparticles were characterized through various techniques, including electron microscopy and X-ray diffraction, revealing their potential in biological applications. Specifically, they were used to detecting oxidative stress biomarkers like 8-hydroxylamine in serum samples with high accuracy and a broad detection range, making them suitable for medical diagnostics. Furthermore, metal nanoparticles such as copper, gold, and silver are known for their antimicrobial properties and biocompatibility, making them valuable in medical treatments and antimicrobial coatings. Combining nanoparticles with organic or inorganic materials enhances their properties, offering diverse applications such as in water treatment, biosensors, and magnetic catalysts.

Keywords: Nanocomposites, Sonochemical synthesis, Copper ferrite nanoparticles, Chitosan, Electrochemical sensor

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A-10-1868-4

Synthesis of Cellulose Hydrogels for Drug Delivery Applications: Short Review

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Abstract

Nanocellulose, a sustainable nanomaterial, has gained attention for its low toxicity, biocompatibility, and biodegradability, making it a promising material in drug delivery systems (DDS). There are three main types: bacterial nanocellulose, nanocrystals, and nanofibers. These materials, along with hydrogels and crosslinking agents, have shown potential for controlled drug release, with release times ranging from minutes to days depending on conditions. Hydrogels, which are three-dimensional polymer networks, are highly biocompatible and can encapsulate therapeutic agents for targeted, sustained release, making them useful in drug delivery, wound dressings, tissue engineering, and more. Nanocellulose-based hydrogels, due to their high porosity and hydrophilicity, are particularly promising for advanced DDS. They can be physically or chemically crosslinked to enhance their drug-carrying capacities. Hydrogels also protect labile drugs from degradation and minimize systemic toxicity, offering advantages over conventional drug delivery systems. These features make hydrogels key candidates for various biomedical applications, including cancer therapy and chronic disease management. Future research will likely explore new hydrogel designs and applications in diverse medical fields.

Keywords: Nano-cellulose, Drug Delivery, Hydrogels, Biodegradability

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Enhancing 3D Printed PLA Filaments with Nanoclay: Impact on Thermal Stability and Mechanical Performance

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Abstract

This study investigates the use of polylactic acid (PLA) filaments reinforced with layered silicate nanoparticles in 3D printing. The focus is on how printing temperature affects the mechanical and thermal properties of PLA/nanoclay composites. PLA was combined with 4 wt% Cloisite 30B nanoclay and extruded to produce filaments, which were then 3D printed using fused deposition modeling (FDM) at different temperatures. Thermal and mechanical characterizations were performed using thermogravimetric analysis (TGA), dynamic mechanical analysis (DMA), differential scanning calorimetry (DSC), and tensile tests. Results indicated that adding nanoclay improved the thermal stability and mechanical performance of the PLA filaments. Specifically, the presence of nanoclay increased the storage modulus and acted as a nucleating agent, enhancing the material's structure. The behavior of 3D printed nanocomposites varied with temperature, showing improved elastic modulus compared to pure PLA. These enhanced properties make PLA/nanoclay composites a promising material for advanced applications in 3D printing, such as creating durable and functional components like surgical tools, wearables, and other biomedical devices, where both mechanical strength and thermal stability are crucial.

Keywords: Poly lactic acid, 3D Printing, Filaments, Nanoclay Reinforcement, Mechanical Properties, Thermal Stability

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A-10-1868-6

Nanoclay-Reinforced PLA/TPU Blends: A Study on Mechanical, Thermal, and Morphological Improvements- Short Review

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Abstract

This study explores the mechanical, thermal, and morphological properties of polymer composites based on Polylactic Acid (PLA) and Thermoplastic Polyurethane (TPU), reinforced with nanoclay particles. PLA, a promising bio-based polymer, has limitations like low thermal resistance and slow crystallization, which can be addressed by incorporating nanofillers such as Cloisite 30B nanoclay. In this research, PLA/TPU blends (70/30 ratio) were combined with varying amounts of nanoclay (1-5 wt%) and a Joncryl chain extender to enhance mechanical properties. Morphological analysis using SEM and TEM confirmed uniform dispersion and interfacial localization of the nanoclay, improving the droplet morphology of TPU in the PLA matrix. Mechanical tests revealed that the addition of 3 wt% nanoclay significantly enhanced strength, while 5 wt% provided the highest toughness and hardness. Dynamic Mechanical Thermal Analysis (DMTA) was used to assess storage modulus, loss modulus, and shape memory properties, which improved with increasing nanoclay content. XRD and FTIR spectroscopy confirmed the exfoliation and distribution of nanoclay without chemical reactions between the components. Overall, the incorporation of nanoclay improved the composite's mechanical performance and shape memory characteristics, demonstrating that PLA/TPU nanocomposites are viable, scalable materials for industrial applications requiring durability and toughness.

Keywords: Polylactic Acid (PLA), Thermoplastic Polyurethane (TPU), Nanoclay, Nanocomposite

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Modeling the impact of flame retardants on burning behavior of 3d printed polymer chair

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Abstract

Additive Manufacturing (AM) emerges as a promising technique for furniture creation, particularly for unique, customized, and lightweight pieces. Advancements in 3D printing technology and materials science are expected to drive the prevalence of AM furniture and broaden its application scope. The flammability of popular polymeric materials raises concerns for furniture in homes and businesses. The present study addresses this issue by exploring the effectiveness of flame retardant additives in 3D printed polymeric furniture. The fire behavior of two 3D printed chairs, one made of pure PLA and the other with intumescent flame retardants (IFR) containing 78.8% of PLA, 17% of ammonium polyphosphate, 3% of alkaline lignin, and 1.2% acidified clay, was modeled using PyroSim software. PyroSim is a computational fluid dynamics software based on the Fire Dynamics Simulator (FDS). The addition of IFR to PLA results in a particulate composite that exhibits enhanced fire resistance. The results demonstrate that composite chair with IFR additives exhibited significantly reduced smoke release compared to pure PLA chairs. This is crucial, as smoke propagation in a fire can be highly dangerous, leading to rapid spread, reduced visibility, and potential suffocation. Additionally, peak temperatures within the modeled environment were demonstrably lower in the presence of IFR additives, and the time required to reach peak temperature was considerably extended with the inclusion of IFR additives.

Keywords: Polymer Composite, 3D Printing, Modeling, Fire Dynamics Simulator (FSD), Intumescent Flame Retardant

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Analysis of delamination propagation in open-hole GFRP composite under 3point-bending fatigue loading

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Abstract

The most widely used method for joining composite materials is mechanical fastening with screws and bolts, which necessitates drilling holes in the composite. However, these holes create stress concentrations that can weaken the material and increase the risk of failure, particularly through delamination. This study investigated the initiation and propagation of damage in open-hole glass fiber-reinforced polymer (GFRP) composites subjected to bending fatigue. Numerical analysis was performed using ABAQUS software to simulate delamination propagation under 3-point bending fatigue loading. The study employs a combination of the continuum damage model (CDM) and cohesive zone model (CZM), along with the Hashin failure criteria, to accurately simulate delamination around the hole. These methods can help achieve reliable error margins in analysis. Additionally, the fatigue behavior was modeled using a user-defined material (UMAT) subroutine. The simulation results were validated against experimental data reported in the litrature to ensure the accuracy of results. The results of this study demonstrated a strong correlation between the simulation and experimental findings, highlighting the reliability of the numerical approach for predicting the damage progression in GFRP composites under fatigue loading.

Keywords: Delamination, Continuum Damage Model (CDM), UMAT, Cohesive Zone Model (CZM), Bending Fatigue

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A magnetic nanocomposite based on graphene oxide nanosheets and Zn-Fe layered double hydroxide as a highly efficient adsorbent for the removal of dye from aqueous environment

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Abstract

The magnetic GO/Zn-Fe layered double hydroxides (MGLDH) nanocomposite was effectively synthesized and utilized as an adsorbent for the removal of Methylene Blue (MB) from aqueous environment.The nanocomposite characteristics have been performed using different characterization techniques such as XRD, FTIR,VSM, FESEM, and BET analysis to evaluate its effectiveness in removing MB from solution.The BET analysis of the data indicated a surface area of 64.57 m^2/g, which is adequate for effective pollutant removal. As a result, the highest adsorption percentage of 84.17% at a concentration of 100 ppm (maximum adsorption capacity (qm) of 280 mg/g) obtained from the experimental test, so it shows that this nanocomposite prepared by this method has excellent dye adsorption ability. Additionally, an examination of different adsorption isotherms revealed that the Langmuir isotherm provided the best fit, while kinetic studies indicated that the adsorption of the dye followed a pseudo-second-order mechanism, with an R^2 value of 0.99. The findings suggest that the MGLDH nanocomposite possesses significant potential for the adsorption of cationic dyes.

Keywords: Adsorption, Methylene Blue, Nanocomposite, Layered double hydroxides, Cationic dye

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Melting of Holy Boron - Nitride nanosheet using molecular dynamics simulation

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Abstract

In this study, we used the software package LAMMPS for investigating the melting of Boron Nitride nano plate with holes. The potential energy between Boron Nitrogen atoms is the cohesive potential energy. The adaptive intermolecular reactive empirical bond order (Tersoff) potential is used to describe the interactions among the carbon atoms and also between layers. We apply periodic boundary conditions in the X and Y directions, and we apply boundary conditions with a distance of several Angstroms for the Z direction. Also, all systems are equilibrated in the canonical ensemble (NPT) at the ambient condition. The results show that the structure starts to melt as the temperature increases. The melting point and the beginning of the phase change process is almost at 3600 degrees Kelvin.

Keywords: Boron Nitride nano plate with holes, Melt, Molecular Dynamics simulation

A-10-1876-1

Development of Lightweight PP/Talc Composites Reinforced with Hollow Glass Microspheres

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Abstract

Hollow glass microspheres (HGMs) are low-density, water-resistant, and chemically stable additives made from soda-lime-borosilicate glass. Their spherical structure and low density allow for significant weight reduction in polymeric composites, making them advantageous for industries such as automotive and aerospace. Besides weight reduction, HGMs can enhance properties such as thermal expansion and dimensional stability, and potentially reduce injection molding cycle times, depending on processing conditions. In this study, hybrid PP/Talc/HGM composites were developed through melt blending using a co-rotating twin-screw extruder. HGMs were incorporated at varying loadings of 5.0 and 10 wt.% while maintaining a constant total reinforcement content (Talc + HGM) of 20%. The effects of HGM addition on the density, thermal behavior, and mechanical properties of the composites were investigated and compared to the properties of PP/Talc (70/20 wt%) composite, widely used in the automotive industry. The results indicated that increasing HGM content led to a 3-10% reduction in the composite's density with only a minor impact on mechanical properties. By partially substituting talc with HGMs, the composites achieved a favorable balance between reduced weight and retained mechanical performance. Furthermore, optimized processing techniques minimized HGM breakage, ensuring uniform dispersion and enhanced final properties. These findings suggest that hybrid PP/Talc/HGM composites are a promising solution for developing lightweight materials without compromising structural integrity, suitable for applications where weight reduction is crucial.

Keywords: Hollow Glass Microspheres (HGM), Polypropylene, Talc, Composites, weight reduction

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Preparation and properties of biodegradable PBAT/$CaCO_3$ composite modified with chain extender

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Abstract

The huge amount of plastic waste generated in the environment has significantly increased attention to biodegradable materials, especially for use in short-term and disposable applications such as packaging and films. Poly (butylene adipate-co-terephthalate) (PBAT) is a biodegradable polyester suitable for producing packaging films, compostable bags, and agricultural mulch films. However, PBAT suffers from high prices and relatively low mechanical properties that limit its vast applications. Incorporation of inorganic fillers such as $CaCO_3$ and talc into PBAT can resolve these limitations to some extent. In this study, composites consisting of PBAT and $CaCO_3$ with and without chain extender were prepared via melt blending in a twin-screw extruder. The effects of the chain extender on the mechanical, thermal, and morphological properties of the composites were investigated. The results showed that the incorporation of the chain extender increased tensile modulus and elongation at the break of the PBAT/$CaCO_3$ composite indicating reasonable interaction between both materials. The SEM images also confirmed a uniform dispersion of the $CaCO_3$ in the matrix, in the presence of the chain extender. As illustrated by the DSC test results, incorporating the chain extender increased the crystallization temperature, crystallinity, and melting temperature of PBAT. This work provides a simple, effective, and economical route to make biodegradable composite films of PBAT and $CaCO_3$.

Keywords: PBAT, Biodegradable, $CaCO_3$, Composite, Chain extender

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Nanocomposites of Toughened Poly(lactic acid) with Ethylene-Vinyl Acetate Copolymer: Effects of Nanoclay Type on Mechanical, Structural and Biodegradation Properties

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Abstract

To improve the properties of bio-based plastics, nanofillers are incorporated into polymeric matrices. In this work, the blends of poly(lactic acid) (PLA) and ethylene-vinyl acetate copolymer (EVA) were extruded in the presence of a chain extender. The effects of two types of nanoclay, i.e. pristine nanoclay (PNC) and organically-modified nanclay (ONC), on the performance of PLA/EVA blends were investigated. The structural, mechanical, and rheological properties of the nanocomposites were studied, along with the soil biodegradation behavior. In the presence of 2.5 phr of ONC, the nanocomposite exhibited good dispersion of nanolayers in the polymeric matrix, with higher viscoelastic properties and longer relaxation time. Regarding the mechanical properties, an increase in the nanoclay loading, especially PNC, significantly dropped the mixture's strain at break. However, incorporating nanofillers into the system doubled the Young modulus when 5 phr of nanofillers were added. Moreover, using 1 phr of nanofillers resulted in a high tensile strength, but gradually increasing the nanofiller percentage led to a decrease in strength, particularly for nanocomposites with PNC nanofiller. The biodegradation results showed that extended PLA/EVA blends have the highest biodegradation rate with 2.8% weight loss in 120-day.

Keywords: Nanocomposite, Blend, Poly(lactic acid), Nanoclay

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Polymorphism-Driven Performance Enhancement in Lightweight Polypropylene Composites

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Abstract

Self-reinforced polymer composites (SRPCs) are a novel category of materials that leverage the homogeneity between the reinforcing fibers and the polymer matrix to achieve superior mechanical properties and enhanced recyclability. This study focuses on the development of self-reinforced polypropylene (PP) composites through a combination of melt spinning and film-stacking technique, exploiting the polymorphic nature of PP to optimize the mechanical performance of the final composite. A critical step involved the use of differential scanning calorimetry (DSC) to determine the optimal processing temperature window. DSC analysis allowed for the precise identification of the melting and crystallization temperatures of PP, ensuring the correct balance between partial melting of the matrix and the preservation of fiber orientation during compression molding. X-ray diffraction (XRD) analysis was performed to assess the orientation of the polymer chains within the composite. XRD confirmed the alignment of the PP fibers, which contributed to the enhanced mechanical properties by improving load transfer between fibers and matrix. The resulting self-reinforced PP composites exhibited significant improvements in mechanical properties, while maintaining a significantly lower density. The intrinsic lightweight nature of the composites, coupled with the enhanced mechanical properties, renders them particularly suitable for applications in the automotive and aerospace industries, where weight reduction is crucial. The successful exploitation of PP's polymorphism through melt-spinning process and film-stacking highlights the potential of these composites to serve as sustainable alternatives to conventional multi-material composites.

Keywords: Self-Reinforced Composites (SRC), All Polypropylene Composite, Polypropylene, Polymorphism.

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Green Bead Foams of Poly(lactic acid) in Thermoplastic Starch Matrix Reinforced with Expanded Graphite

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Abstract

The increasing concerns about plastic waste and depletion of fosseil fuel resources encourage the researchers to find alternatives for synthetic plastics. One the plastic applications is lightweight foams, which are widely used in packaging and insulation applications. In the present work, biodegradable and renewable bead foams based on poly(lactic acid) (PLA), thermoplastic starch (St), and expanded graphite (EG) were prepared. The beads of foams consisted of PLA, poly(ethylene glycol) (PEG) plasticizer and EG reinforcement agent. The matrix of foams included St and glycerol plasticizer. The mechanical, structural, and physical properties of foams were investigated. The foams showed ductile mechanical behavior in tensile stress-strain tests. The incorporation of EG in PLA beads and St matrix caused a reduction in the foam density up to 0.728 g/cm^3 and an increment in the foam void content up to 33.5%. These close-cell foams can be used in disposable packaing and thermal insulation applications instead of bead foams based on polyethylene and polystyrene.

Keywords: Bead foams, Expanded graphite, Nanocomposite, Biopolymers

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Improved mechanical properties of epoxy composite via modified and functionalized Short Carbon Fibers by LT560

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Abstract

The surface modification technology of short carbon fiber (SCF) reinforcements improves the interface properties of polymer matrix, including epoxy resin. Therefore, due to the lack of active functional groups on the surface of SCF led to the weakened interface properties with matrix. In addition, the difference in the surface properties of the reinforcement causes nonuniform distribution of particles and also their weak surface interaction with matrix. The purpose of this study is to assess the effect of silane coupling agent (LT560) on the surface properties of SCFs and therefore the mechanical properties of Alumina/epoxy-based composite. For this purpose, carbon fibers were first desized using different solutions. After converting the carbon fibers to SCFs, the surface of SCFs was modified by LT560. As a result, FTIR analyses confirm desizing treatment by HNO_3 solution can remove sizing agents and also FTIR analyses after using silane coupling agent show that successful grafting onto SCFs. Mechanical tests demonstrate enhancements in hardness and bending properties of Alumina/SCF/epoxy composite. Silane coupling agents (LT560) contain epoxy ring that led to a improving in the network structure and so this regular network structure results in an increase of bending strength.

Keywords: Surface modification, Short Carbon Fibers (SCFs), Silane coupling agent (LT560), Epoxy composite, Mechanical Properties

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Optimization of Antisymmetric Angle-ply composite laminates under transvers and thermal loads

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Abstract

In this study, the single-objective and multi-objective optimization of composite laminates under Transverse Loads and thermal loads are presented. the Bee Algorithm (BA), a nature inspired search algorithm, has been developed for non-linear problems with discrete variables and implemented successfully for multi-objective design optimization of Antisymmetric Angle-ply laminate under four kind of transverse loading with simply supported. The design of optimal layup in single-objective is based on maximizing the allowable load of laminate. The multi-objective optimization is formulated with multiple objectives of maximizing the allowable load, minimizing weight, minimizing the total cost of composite component and minimizing the maximum deflection of plate. The four kinds of loading that applied to the laminate are uniform load, point load, line load and Hydrostatic load. Classical lamination plate theory and Navier solution is used to obtain stresses and deflection of the plate. The optimization variables are the number of layers, stacking sequence and thickness of each layer. Finally, to verify the performance of BA, the results are compared with that of particle swarm optimization (PSO) and the result of multi-objective optimization of KUR function. The results presented in current paper can be important because the designer can have more flexibility in selecting the layup of composite laminates.

Keywords: Multi objective optimization, Bee algorithm, Antisymmetric composite laminates

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Study of corrosion rate of Co-CeO_2 composite for SOFC interconnect application

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Abstract

Corrosion resistance of solid oxide fuel cells (SOFCs) interconnects can be improved by use of a protective, effective, relatively dense and well adherent composite coating. In this study the Co-CeO_2 composite coating was fabricated through the electrodeposition method onto AISI 430 ferritic stainless steel. Isothermal oxidation and cyclic oxidation were applied to evaluate the corrosion rate (kp). The formation of Co oxides during oxidation improved corrosion and oxidation resistance. The experimentally obtained k_p of the Co-CeO_2 composite coated AISI 430 alloy in cyclic oxidation was 2.57×10^{-13} $g^2\,cm^{-4}\,s^{-1}$, which was lower than that of the uncoated one ($k_p = 8.35\times10^{-12}$ $g^2\,cm^{-4}\,s^{-1}$). Also in cyclic oxidation the Co-CeO_2 composite coated samples exhibited a good resistance against spallation and cracking and it resulted to the lower values of corrostion rate (2.61×10^{-13} $g^2\,cm^{-4}\,s^{-1}$) compared to uncoated samples(8.23×10^{-12} $g^2\,cm^{-4}\,s^{-1}$). The Co-CeO_2 composite coated samples demonstrated lower kp in each test and it indicate that the Co-CeO_2 composite coating coating layer has acted as a mass barrier against the outward diffusion of cations specially Cr.

Keywords: Solid oxide fuel cell (SOFC), Co-CeO_2 composite, Corrosion rate, AISI 430 steel

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Decrease of Cr_2O_3 growth at presence of Co-La_2O_3 composite coating

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Abstract

Most current research has concentrated on solid oxide fuel cells (SOFCs) to resolve the contact resistance and cathode-chromium-poisoning problems associated with application of ferritic stainless steels as interconnects. In this study Co-La_2O_3 composite coating was fabricarted onto AISI 430 ferritic stainless steel through electrodeposition method. Isothermal oxidation and cyclic oxidation were applied to evaluate the oxide layer thickness which was created during these tests. Results showed Co-La_2O_3 composite coating improved oxidation resistance. The oxide thickness for Co-La_2O_3 composite coated and uncoated specimens was obtained ~ 0.73 µm and ~ 3.46 µm respectively after 100 h oxidation at 800 ºC. The obtained thickness after 50 cycles of oxifation for Co-La_2O_3 composite coated and uncoated specimens was obtained ~ 0.57 µm and ~ 3.32 µm respectively. The lower values of oxide layer thickness in each test emphasize that Co-La_2O_3 composite coating layer could have acted as a protective barrier against oxidation by limiting the outward diffusion of Cr cation and inward diffusion of oxygen onion.

Keywords: Co-La_2O_3 composite coating, Solid oxide fuel cell (SOFC), Cr_2O_3, AISI 430 steel

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A-10-1884-3

Effect of Co-Y_2O_3 composite coating on oxidation activation energy of AISI 430 steel

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Abstract

The formation of oxide scales is one of the critical issues for applying Fe–Cr alloys in solid oxide fuel cells (SOFCs). One of the most effective approaches to improve the interconnect properties is to apply composite coatings to provide better conductivity, reduced scale growth and Cr volatility. In this study, Co-Y_2O_3 composite coating was fabricated onto AISI 430 steel. Oxidation resistance of Co-Y_2O_3 composite coated and uncoated samples was studied at 800 ºC for 100 h. The corrosion resistance was remarkably reduced by the application of composite coating. The bare substrate had a weight change of 0.507 mg.cm^{-2} after 100 h of isothermal oxidation, while the coated samples had a weight change of 0.193 mg.cm^{-2}. The coating effectively protected the substrate from the corrosion at high temperatures. In order to measure the oxidation activation energy of Co-Y_2O_3 composite coating, uncoated and coated samples were subjected to isothermal at 800 °C, 900 °C and 1000 °C for 20 h. Activation energies were calculated 121 and 48 kJ mol^{-1}h for uncoated and Co-Y_2O_3 composite coated specimens, respectively. The lower activation energy for the Co-Y_2O_3 composite coated samples would imply that oxide formation is easier during isothermal oxidation.

Keywords: Co-Y_2O_3 composite coating, Oxidation, AISI 430 steel

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Investigation of flexural modulus of cyanate ester/carbon fiber composite at high temperature

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Abstract

The advent of space exploration and high-speed civil transport has prompted the development of polymeric materials that can endure extreme environments. Cyanate esters (CEs) form a family of thermosetting resins whose performance characteristics, make them attractive competitors to many current commercial polymer materials for many advanced applications. CEs are characterized by many attractive physical, electrical, thermal and processing properties required of an ideal matrix resin. Moreover, they generally exhibit high glass transition temperature (T_g) and high flexural modulus. In this research work, bisphenol A-based cyanate ester resin was was synthesized and characterized by different techniques including FT-IR, ^{1}H-NMR and ^{13}C-NMR. The synthesized resin was used for preparation of cyanate ester/carbon fiber composite by manual layering method. The obtained composite was examined by DMTA technique to evaluate the flextural modulus in the temperature range of 25-250°C. The DMTA results showed a modulus of 15.13 GPa for cyanate ester/carbon fiber composite. The modulus decrease of the composite at 250°C was approximately 15%. This shows that the cyanate ester/carbon fiber composite can retain it's modulus at high temperatures as high as 250°C and so can be used for preparation of advanced composite parts specially for those working at high temperatures.

Keywords: High Temperature Resins, cyanate ester, Thermal Stability, Mechanical Properties, carbon composite

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Effect of PCA addition on the hardness and shear strength of A0.25CoCuMnNi high entropy alloy

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Abstract

High entropy alloys (HEAs) are a new class of materials composed of at least four elements in equiatomic or near-equiatomic ratios, offering remarkable mechanical, physical, and chemical properties across various compositions. In this study, the Al0.25CoCuMnNi HEA was processed using powder metallurgy and spark plasma sintering (SPS). Powder samples prepared without process control agent (PCA) addition and sintered at 1000°C exhibited a single-phase FCC structure, with high hardness (295 Hv) and shear yield strength (200 MPa). To enhance the mechanical properties of this soft FCC alloy, 0.5 wt.% stearic acid was introduced as a PCA during the final 3 hours of milling. This minor modification changed the powder morphology from elliptical to plate-like, resulting in a significant increase in Vickers hardness (90% improvement to 560 Hv), though shear yield strength decreased by 25% to 150 MPa. X-ray diffraction (XRD) and scanning electron microscopy (SEM) with electron backscatter diffraction (EBSD) revealed finer grain sizes in PCA-added samples. This demonstrates that PCA addition is an effective and cost-efficient strategy for tailoring the hardness and microstructure of HEAs.

Keywords: High entropy alloy, Al0.25CoCuMnNi, PCA addition, Spark plasma sintering, Hardness, Shear strength

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Feasibility of the manufacturing process of joint stabilizers using 3D printing

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Abstract

Fractures in different parts of the body are among the unfortunate cases that individuals may encounter more or less in their lives. Plaster casts are commonly used to treat fractures, but current plasters have disadvantages, including being heavy, causing skin problems upon removal, and losingstrength when exposed to moisture. 3D printed plaster is a promising alternative to traditional plaster that can address these issues. In order to prepare a 3D printed plaster, it is first necessary to prepare a 3D scan of the desired area. Then, the scanned file should be thickened on the outside surface, hollowed out, its surface defects should be removed, and the place of the thorn, which can be a place for glue, should be placed on the model. Subsequently, using finite element software such as Abaqus, optimization is performed on the model and necessary perforations are generated. Finally, the model is produced using 3D printing machine. It was shown in this study that the 3D printed plaster shows capabilities of replacing conventional plasters in the near future.

Keywords: Plaster, 3D scanning, finite element model, optimization

A-10-1889-1

Thermo-mechanical properties of carbon/phthalonitrile composite at high temperatures

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Abstract

Phthalonitrile resins are promising materials as matrix for advanced composites. In this work bisphenol A-based phthalonitrile resin was synthesized and characterized by different techniques including FT-IR, ^{1}H-NMR and ^{13}C-NMR. The synthesized resin was utilized for preparation of carbon/phthalonitrile composite by hot press method using aromatic amine as curing agent. The modulus of composite was determined by dynamic mechanical thermal analysis (DMTA) techniques in the temperature range of 25-250°C. DMTA results showed 10.5 GPA modulus for for prepared carbon/phthalonitrile composite which is a high modulus for a polymer/carbon composite. Moreover, DMTA results revealed that composite samples postcured at elevated temperatures (375°C) do not exhibit a glass transition temperature (T_g) up to 250°C and also retain 87% of their initial modulus at high temperatures as high as 250°C. The results showed that the prepared carbon/ phthalonitrile composites can be used for preparation of advanced composite parts specially for parts which may be used at high temperatures.

Keywords: High Temperature Resins, Phthalonitrile, Thermal Stability, Mechanical Properties, carbon composite

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Effect of loading rate on the intralaminar fracture toughness of glass/epoxy laminated composites

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Abstract

Glass/epoxy laminated composites are widely utilized in different industries due to their lightweight and superior mechanical properties. One of the most important mechanical parameters that determine the performance of materials against failure is fracture toughness. The intralaminar fracture toughness of these composites at different loading rates is examined in this study. The samples were fabricated by 24 layers of glass/epoxy material. ASTM D5045 standard was employed for measuring the intralaminar fracture toughness. The samples were tested under four loading rates of 1, 10, 100, and 500 mm/min. In the load-displacement curves, it was observed that at all loading rates, the behaviour of the samples was linear and elastic at the beginning of loading, and after passing the yield point, plastic and nonlinear behaviour was observed. Analysis of the results shows that the intralaminar fracture toughness in glass/epoxy composites is directly affected by the loading rate. The findings indicate that the mode I intralaminar fracture toughness decreases as the loading rate enhances.

Keywords: Fracture toughness, glass/epoxy, intralaminar, loading rate

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Investigation of Interphase Cohesive Properties in Single-Fiber Glass/Epoxy Composite Using Tensile Test and FEM

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Abstract

The adhesion characteristics of the interphase in composite materials are critical, as this region is typically the site where damage mechanisms and failure propagation initiate. This study presents a single-fiber specimen experiment designed to examine the adhesion between the fiber and matrix in a glass/epoxy composite. The tensile test results of a single-fiber composite specimen are compared with finite element modeling (FEM) results of an identical specimen, incorporating three distinct phases. The modeling is performed in two scenarios: one with a distribution function applied to vary the Young's modulus along the thickness of the interphase, and another using the cohesive zone model (CZM) equation. Tensile test results are validated through image processing, and the parameters for the cohesive zone model of the interphase are selected to match the elastic modulus of the modeled sample with that of the experimental sample. The findings indicate that the cohesive zone model, with a fracture toughness of $0.04\,mJ/mm^2$, strength of 40 MPa, and stiffness of $10\,E6\,MPa/mm$, provides a better correspondence with the elastic behavior of the experimental sample compared to the model where the interphase is treated as a homogeneous material with varying Young's modulus. This discrepancy arises from the consideration of the interphase's softening behavior under loading conditions close to the failure surface of the composite, effectively modeling the initial damage in the interphase before final failure at the elastic stress levels of the fiber and matrix.

Keywords: Single-Fiber Composite Specimen, Interphase, Cohesive Zone Model (CZM), Finite Element Method (FEM), Young's Modulus

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Investigating the effect of interphase region on the elastic modulus of metal/graphene nanocomposites

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Abstract

The strength of metal nanocomposites is significantly influenced by the interaction between the filler and the matrix. Previous research indicates that when the filler is embedded in the matrix phase, it is surrounded by an interphase region. The geometric and mechanical properties of this interphase region greatly impact the composite's overall mechanical characteristics. This study investigates how the thickness and elastic modulus of the interphase region affect the elastic modulus of metal/graphene nanocomposites. Graphene particles, modeled as ellipsoids with a high aspect ratio, are dispersed within the matrix and encased by an interphase layer. Initially, equations for a single particle are derived and then extended to the entire composite using mean field theory. The mechanical properties of the interphase region are estimated through a mathematical model, and the composite's elastic modulus is determined for various filler volume fractions. The findings reveal that the interphase region plays a crucial role in determining the nanocomposite's elastic modulus.

Keywords: Interphase region, Elastic modulus, Metal/graphene nanocomposites, Mean fileld theory

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Prediction of elastic modulus of polymer/carbon nanotube nanocomposites by mean field method

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Abstract

Accurately predicting the elastic modulus of polymer/carbon nanotube nanocomposites is essential for effective composite design. Traditional numerical methods often require extensive and intricate calculations due to the detailed modeling involved. This study presents an analytical approach to determine the average elastic modulus of polymer/carbon nanotube composites. By modeling a carbon nanotube particle as a long cylinder and applying Maxwell's laws, we derived equations for a single particle. These equations were then extended to the entire composite system using the mean field method, resulting in the overall elastic modulus of the composite. We investigated key parameters, including the length, diameter, and elastic modulus of the filler, as well as the thickness and elastic modulus of the interphase region and the matrix. Our findings demonstrate that this analytical method effectively and efficiently assesses the influence of these fundamental parameters on the nanocomposite's properties. This approach not only simplifies the prediction process but also provides clear insights into the role of each parameter, facilitating more informed composite design decisions.

Keywords: Interphase region, Elastic modulus, Polymer/carbon nanotube nanocomposites, Mean fileld theory

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Plant-Based Biocomposites of Poly(lactic acid)/Rice Straw/Soybean Oil: Effect of Eco-friendly Boric Acid Pulping and Compatibilization on Properties

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Abstract

This study investigates the effects of the eco-friendly boric acid pulping method on rice straw (RS) fibers for the fabrication of biodegradable poly(lactic acid) (PLA) biocomposites. RS fibers, an agricultural waste, were utilized as the reinforcement agent in the PLA matrix without and with boric acid treatment. The RS pulp fibers (BR) were melt-compounded with PLA in the presence or absence of soybean oil (S) and epoxidized soybean oil (ES) using an internal mixer. Biocomposite samples were prepared by compression molding, and their impact properties were evaluated. The results show that the reactive ES additive acts as chain extender and reactive compatibilizer in virgin PLA and PLA/BR biocomposite, respectively. These roles lead to an increment in the impact strength of samples.

Keywords: : Natural fibers, Eco-friendly pulping, Poly(lactic acid), Biocomposite

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A-10-1898-1

Investigation of the Effect of TiO_2 NPs and PEG on the Performance of PAN Nanocomposite Ultrafiltration Membranes

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Abstract

Nanocomposite membranes have emerged as promising candidates in membrane technology due to their superior characteristics, such as high permeability, appropriate selectivity, and resistance to fouling. In this study, the performance enhancement of polyacrylonitrile nanocomposite ultrafiltration membranes was investigated by incorporating nanoparticles and a pore-forming agent. Titanium dioxide (TiO_2) nanoparticles were added to improve hydrophilicity and surface interactions, while polyethylene glycol (PEG) was employed to control pore size and distribution. These two components were introduced to the membranes both individually and in combination to assess their effects on membrane performance. The results demonstrated that both TiO_2 nanoparticles and PEG, when used separately, enhanced water flux and bovine serum albumin (BSA) protein removal. However, their simultaneous incorporation led to a decrease in membrane performance, likely due to adverse competitive interactions during the phase inversion process. Among the modified membranes, the one containing 0.4% TiO_2 nanoparticles exhibited the highest water flux and protein rejection rates. These findings provide insights that could help optimize nanocomposite membranes for separation processes in the water and wastewater treatment industry.

Keywords: PAN Nanocomposite membranes, Titanium dioxide, Polyethylene glycol, BSA sepration

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A-10-1899-1

Cyclodextrin-Metal–Organic Framework (CD-MOF) as efficient carrier for sustained drug delivery

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Abstract

Metal-Organic Frameworks (MOFs) have garnered significant attention as nanocarriers in various fields. This study explores the application of these nanocomposites as carriers for drug delivery in cancer treatment. Considering the ability for drug entrapment, easy preparation and controlled release, this class of material allows potential applications in drug delivery systems. By leveraging the unique properties of MOFs, we aim to enhance the efficacy and targeted delivery of therapeutic agents, ultimately contributing to improved outcomes in cancer therapy. Herein CD-MOF was synthesized with Fe metalas. Curcumin (CUR) is a natural polyphenol extracted from turmeric. Numerous studies have demonstrated that CUR is an effective anticancer drug that works by modifying different intracellular signaling pathways. CUR's therapeutic utility is severely constrained by its short half-life in vivo and potential for gastrointestinal discomfort with high oral doses. One of the most practical solutions to the aforementioned issues is the development of targeted drug delivery systems on nanomaterials. The longer controlled release was verified for Fe-CD-MOF, with a maximum of 69% released in 12 h.

Keywords: Metal-Organic Frameworks (MOFs), Drug Delivery, Cyclodextrin, Nanocarriers, Anticancer

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Low-energy impact response of rubberised cork sandwich structures with glass face sheets

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Abstract

The use of viscoelastic materials, like cork, in sandwich composite structures significantly reduces weight and enhances impact and acoustic performance. In this study, the low-velocity impact behavior of rubberised cork sandwich structures with glass face sheets was investigated. The samples were tested using a drop weight impact machine to evaluate the effect of impact energy on contact force, displacement, and absorbed energy. The results showed that impacted samples experience various types of fracture and fiber breakage. The findings suggest that glass/cork sandwich structures demonstrate adequate resistance and energy absorption capacity under increased impact energy. This study provides valuable experimental insights into the mechanical behavior of these structures under low-velocity impact, which could contribute to the improved design of impact-resistant sandwich structures.

Keywords: Low-velocity impact, Sandwich structures, Glass, Rubberised cork, Energy

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The Experimental Investigation of Low-Velocity Impact on Sandwich Structures with a Cork Core and Basalt Face Sheets

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Abstract

There is growing interest in the utilization and development of materials derived from renewable sources for various structural applications. Among these, cork-based structures have attracted considerable attention due to their potential for industrial use, particularly in safety equipment, protective devices, and other applications that demand efficient energy absorption. The results indicated that as impact energy increases, both the contact force and displacement of the samples rise significantly. The findings indicate that basalt/cork sandwich structures offer superior impact energy absorption capabilities and exhibit varying responses based on the impact conditions. This research can contribute to the improvement of design and enhancement of the safety of structures based on cork core and basalt fiber in various industrial applications.

Keywords: Basalt, Cork, Low-velocity impact, Sandwich Structure, Impact energy

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A-10-1900-3

Low Velocity Impact Behavior of Glass- and Basalt-Reinforced Vinyl Ester Composites

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Abstract

This work aims to study the effects of fiber type on the low-velocity impact response of composite materials. Two types of composite laminates were investigated: glass fiber-reinforced vinyl ester composites (GVEC) and basalt fiber-reinforced vinyl ester composites (BVEC), both fabricated using the hand lay-up technique. Impact tests were conducted at various energy levels to obtain the force–time, force-displacement, and absorbed energy-time curves. The study emphasizes the potential of GVEC and BVEC in engineering applications demanding robust impact resistance and highlights opportunities for further optimization of composite materials.

Keywords: Low velocity impact, Composite materials, Glass, Basalt

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A-10-1902-1

Comparison of buckling capacity in CFRP composite plate and Hemp-Epoxy composite plate

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Abstract

Buckling in composite plates is a significant phenomenon that can significantly affect the integrity of the structure and the performance of composite materials used in various structures. This study investigates the buckling capacity of carbon fiber reinforced polymer (CFRP) composite plates compared to Hemp-Epoxy composite plates, focusing on their structural performance under compressive load. CFRP composites are known for their mechanical properties, including high stiffness and strength, which make them a suitable and popular choice in various industries. On the other hand, Hemp-Epoxy composites using natural fibers have good strength, and sufficient mechanical performance, and are a suitable and environmentally friendly alternative. This research examined composite plates with two different materials but with the same layup [0/+60/-60/0] and with the thickness of each layer of 0.3 mm. In this analysis, the Numerical method was used to obtain the buckling capacity for each composite plate in six different modes, and then the shape of buckling was determined in each of the modes. Finally, this study highlights the importance of considering the mechanical performance of composite panels under buckling and environmental effects when selecting materials for various structural applications.

Keywords: Composite material, buckling capacity, CFRP, Hemp-Epoxy, FEM

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Estimation of burst pressure of type IV composite pressure vessels using various damage crtiteria for different composite layup

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Abstract

Fossil fuels, due to their significant pollution, pose a threat to the environment. Therefore, the use of alternative fuel sources such as hydrogen is essential, and its storage is of paramount importance. Hence, to store hydrogen, the use of Type IV composite hydrogen storage vessels has been proposed due to their lightweight nature, ability to withstand high pressure, and resistance to corrosion and other potential damages. Type IV composite vessels consist of an inner polymer liner, metal flanges, and composite layers. To improve the performance of these vessels for use in vehicles, they are used in the pressure range of 35-70 MPa. In this research, using the ANSYS software and the ACP module, the effect of composite layering on the burst pressure estimation of vessels using various damage detection criteria has been investigated. Based on this research, the effect of selecting the number of composite layers and appropriate fiber orientation angles with increasing internal pressure of the vessel from 0-200 MPa in different composite layers has been analyzed to estimate and increase the burst pressure of the vessel, considering different damage detection criteria and comparing the results obtained by these criteria.

Keywords: Composite pressure vessels, burst pressure, type IV, damage criteria , fiber orientation, ANSYS

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Development of MXene/PEDOT:PSS nanocomposite for electrochemical applications

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Abstract

In this study, we present the synthesis and characterization of MXene/PEDOT:PSS nanocomposites, highlighting their electrochemical properties and potential applications in sensing technologies. Scanning Electron Microscopy (SEM) images confirm the synthesis of the layered structure of MXene, and the successful formation of a composite MXene/PEDOT:PSS film. The results indicate that incorporation of MXene into the PEDOT:PSS matrix enhances the electrical conductivity of the composite. Electrochemical Impedance Spectroscopy (EIS) and Cyclic Voltammetry (CV) analyses reveal that the MXene/PEDOT:PSS nanocomposite exhibits significant electrochemical performance, characterized by improved charge transfer kinetics and peak augmentation in CV. These findings suggest that the nanocomposite could serve as an effective material for electrochemical sensing, providing a robust platform for detecting various analytes. Overall, this work underscores the promising role of MXenes in enhancing the performance of conductive polymers for electrochemical applications.

Keywords: MXene-PEDOT:PSS-Nanocomposite-Electrochemical Properties

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A-10-1906-1

Mixed-Mode (I/II) Fracture of Glass/PA6 Thermoplastic Composites Using Image Based Correlation Methods

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Abstract

Conventional methods for predicting crack propagation in composite materials often face challenges due to the complex nature of these materials, which can result in considerable inaccuracies when assessing crack initiation and growth. Given the widespread use of composite materials in various industrial sectors, employing Digital Image Correlation (DIC) for evaluating fracture properties emerges as a promising alternative that can provide both practical and dependable results. The DIC technique effectively captures data on heterogeneous deformations, such as localized damage accumulation, crack propagation, and stress concentration, without the need for traditional sensors or strain gauges. This study seeks to explore the fracture behavior of Glass/PA6 Thermoplastic Composites under mixed-mode (I/II) loading conditions using an image-based correlation method. In this methodology, displacement values within the material will first be recorded through a series of captured images, which will then be analyzed using advanced image processing techniques.

Keywords: Glass/PA6, Thermoplastic, composites, mixed mode fracture, digital image correlation (DIC)

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Effect of sintering temperature on the microstructure and hardness of Al 6061 matrix composites reinforced with AlFeCuCrNi high-entropy alloy

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Abstract

In this study, the effect of different sintering temperatures on the properties of AlFeCuCrNi high entropy alloy (HEA) reinforced Al6061 matrix composites processed via powder metallurgy was investigated. The produced samples were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD), macro hardness test, and density measurement. Microstructural observations showed that while for the sample sintered at 510°C the HEA reinforcing particles almost retained their integrity, sintering of the composite compacts at more this temperature resulted in the transformation of the HEA particles into some intermetallic phases. XRD results confirmed the presence of various phases in the Al-5%HEA sample sintered at 610°C. The lowest amount of porosity was observed in the sample sintered at 550°C, exhibiting a 50% reduction compared to the sample sintered at 510°C. The increased sintering temperature from 510°C to 610°C, resulted in a continuous increase in the macro hardness of the samples gaining a 33.6% improvement in hardness.

Keywords: Aluminium matrix composites, High entropy alloy, Intermetallic phases, Macrohardness, Porosity

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Effect of stainless steel 309 (SS) reinforcing particles addition on the microstructure, porosity and hardness of Al 6061/SS composites

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Abstract

In the present study, the effect of stainless steel 309 (SS) reinforcing particles addition on the porosity and hardness of Al6061/SS composites synthesized via powder metallurgy has been investigated. For this purpose, powder mixtures of Al6061 containing 5, 8, 10, and 12 vol.% of SS particles milled for 90 min subjected to cold pressing and sintering. The reference sample with no SS addition as well as the composites were characterized by using scanning electron microscopy, optical microscopy, hardness testing and density measurement. The results showed that addition of up to 12 vol.% of SS results in continuous increase of the porosity of samples. The increased up to 10 vol.% of SS resulted in increased hardness of composites leading to 18% improvement in the macrohardness of the Al/10vol.%SS composite as compared to that of the reference sample. However, further increase of the SS content resulted in decreased hardness. These results were attributed to the harmful effect of high porosity in Al/12vol.%SS composite that overcome the beneficial effect of SS particles addition on increasing hardness.

Keywords: Al6061 Matrix Composites, Stainless Steel Reinforcing Particles, Powder Metallurgy, Microstructure, Porosity, Hardness

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Using nanocompsoites in the heat transfer system of li-ion battery packs of electric vehicles

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Abstract

The aim of this research is to increase thermal conductivity of thermoplastic polymers by adding conductive and cost-effective nanoparticles. The obtained nanocomposite is supposed to replace the previous aluminum version as the microchannels (cooling fluid passages) used in the battery pack of Amper Innovation Factory. In this research, firstly, the microchannel used in Amper Innovation Factory's battery pack and its physical propeties, and also specifications of other components inside the battery pack including 21700 li-ion battery cells and TIMs (Thermal Interface Materials) are introduced, and the advantages of using nanocomposite in the desired application are explained. In the following, the background of research is mentioned on increasing the thermal conductivity of polymers by adding suitable nanoparticles in other industrial applications such as electronic devices etc. Then, appropriate nanoparticles and polymers for this research have been selected according to the existing criteria in this research and the preferences of the project employer. After that, the required thermal properties of the nanocomposite in the heat transfer equations are obtained, which include thermal conductivity, specific heat capacity, and density, in order to be used in future research for use in the heat transfer simulations of the lithium ion battery pack.

Keywords: Li-ion Battery Pack, Nanocomposites, Microchannels, Cost-effective Nanoparticles, Heat Trasnfer Equations

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A-10-1912-1

Design of glass/epoxy composite stacking using machine learning algorithms

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Abstract

Design of laminate composites, which are widely used in various industries, has many complexity due to the directionality of the materials. The number and angle of the layers in the stacking of these structures is very important, which forms the final properties of the structure. In this study, design of glass/epoxy composite stacking has been investigated using machine learning algorithms. For this purpose, a extensive database of various stacking configurations has been prepared, for which finite element analysis has been used, and experimental test has been conducted to ensure the answers obtained from the model. After the training process, the artificial intelligence model can suggest a suitable stacking for the considered failure load, and the results show that the prepared model has a suitable accuracy in lay-up design. The method presented in this research offers a novel approach for composite structure designers so that they can go through the design process with high speed and proper accuracy.

Keywords: Composite, Stacking, Machine learning, Angle, layers

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Morphological Evaluation of Conductive Polymer Blends By EIS measurments

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Abstract

In this study, EIS method is used to evaluate morphology of polymer blends. Polypropylene/Ethylene vinyl acetate (PP/EVA) containing conductive carbon black (CB) is prepared with different volume fractions of PP/EVA, specifically 60/40, 70/30, 80/20, and 90/10 vol%. A cocontinuous morphology was observed for the 60/40 vol% blend, while a dispersed-matrix morphology was observed for the 70/30 vol% blend. During the transition between the cocontinuous morphology (60 vol%) and the sea-island morphology (70 vol%), a discontinuity in the impedance versus frequency was observed. This is attributed to the second dielectric relaxation of the phase-segregated structure. This method offers an opportunity to use this measurement test instead of traditional morphological assessments like FE-SEM, which are local methods.

Keywords: Polymer blends, EIS, conductive polymer composites, morphology, microstructure

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Defects detection in PTFE using VMD analysis and Infrared Thermography

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Abstract

In this study, Variable Mode Decomposition (VMD) and infrared thermography was employed to enhance the detection of defects in PTFE samples. PTFE sheet with 25 simulated flat-bottomed holes of varying diameters depths were prepared . Initial thermal images exhibited low contrast and high noise, making defect detection difficult. VMD, the thermal signals were decomposed into multiple intrinsic modes, which significantly increased the contrast between healthy and defective areas. As a result, the detection capability improved from 48% in raw images to 96% after VMD application. This method made it possible to detect smaller and deeper defects by increasing the contrast between healthy and defective areas and removing noise. In addition, VMD was able to overcome challenges such as non-uniform heating and low signal-to-noise ratio that existed in traditional methods. These results show the importance of using advanced image processing methods, especially VMD, in improving the quality and accuracy of non-destructive testing.

Keywords: PTFE (Polytetrafluoroethylene), Infrared Thermography, Non-destructive evaluation, VMD (Variational Mode Decomposition).

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Nondestructive Testing of PCTFE panels using Infrared Thermographic Signal Reconstruction and image processing

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Abstract

In this study, the thermographic signal reconstruction (TSR) method was used to evaluate the ability to detect defects in PCTFE plates. The results showed that TSR was able to increase the quality of thermal images and the accuracy of defect detection. After applying TSR, the ability to detect defects increased from 56% to 88%. This method made it possible to detect smaller and deeper defects by increasing the contrast between healthy and defective areas and removing noise. In addition, TSR was able to overcome challenges such as non-uniform heating and low signal-to-noise ratio that existed in traditional methods. These results show the importance of using advanced image processing methods, especially TSR, in improving the quality and accuracy of non-destructive testing.

Keywords: PCTFE (Polychlorotrifluoroethylene), Infrared Thermography, Non-destructive evaluation, Thermographic Signal Reconstruction (TSR).

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A-10-1917-1

Bio-composites of Cellulose Nano-crystals and Sodium Alginate for Removal of Heavy Metal Ions

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Abstract

Industrial pollutants, especially heavy metals, pose a significant risk to aquatic ecosystems, highlighting the need for effective wastewater treatment. This study explores the development of bio-composites made from sodium alginate and cellulose nanocrystals for the adsorption of copper and nickel from wastewater. The findings show that increasing the cellulose nanocrystal content enhanced the bio-composite's swelling ratio, while higher alginate content improved the composite's structural stability and resistance to dissociation. A particle size of 2 mm provided optimal adsorption, with further reduction leading to dissociation. Absorption measurements were conducted using optical spectrum analysis, Fourier-transform infrared spectroscopy (FTIR) for structural analysis, and scanning electron microscopy (SEM) to assess surface porosity. Adsorption tests indicated that higher pH and extended contact time increased adsorption capacity until equilibrium was reached. The adsorption data followed Langmuir isotherm and pseudo-second-order kinetic models, with maximum copper and nickel adsorption reaching 186 mg/g and 144 mg/g, respectively, demonstrating the effectiveness of the bio-composites for heavy metal removal.

Keywords: Bio-composites, Cellulose nano-crystals, Alginate, Absorption, Metal ions

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Bio-composites of Polylactic acid/Polyethylene glycol/ Cellulose Nanocrystals for Drug Release Applications

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Abstract

Composites of polylactic acid, polyethylene glycol and cellulose nanocrystals were prepared in the form of nanoparticles. The nanoparticles were embedded in agar gels. The composites were biocompatible and could be considered for multiple medical applications. In this study we investigated the suitability of these nanoparticle composites as drug carriers and ciprofloxacin, an antibiotic, was selected as a model drug. The average size of nanoparticles was about 9 nm as measured by dynamic light scattering. The shape of nanoparticles was almost spherical as observed by scanning electron microscopy. The nanoparticles were loaded with ciprofloxacin and the release rate was measured in phosphate-buffered saline solution at pH = 7.4 by UV-visible light spectroscopy. The release profiles of the composites were adjusted by the variations on the compositions of the polylactic acid, polyethylene glycol and cellulose nanocrystals in the composites. It was found that the addition of polyethylene glycol and cellulose nanocrystals enhanced the flexibility and porosity of the composites and accelerated the drug release as a result. Antibacterial activity of the released drug was assessed by inhibition zone measurements that demonstrated a direct correlation between the rate of drug release and antibacterial efficacy. The drug release profiles of the composites were examined by various kinetic models.

Keywords: Bio-composites, Polylactic acid, Cellulose nano-crystals, Polyethylen glycol, Nanoparticles, Drug release

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A-10-1918-1

Adsorption of Methyl Orange from Aqueous Solution Using Polypyrrole/Andalusite Nanocomposite

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Abstract

This research presents an eco-friendly adsorbent derived from andalusite, a natural zeolite, modified with pyrrole and cetyltrimethylammonium bromide (CTAB) (An/Ppy/C-TAB) for efficient methyl orange (MO) adsorption. The structure of the modified adsorbent was confirmed using various techniques including FTIR spectroscopy, Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), Energy Dispersive X-ray Spectroscopy (EDX), and BET analysis. The modification with CTAB and pyrrole increased the surface area and introduced effective functional groups, significantly enhancing the adsorption capacity for MO. SEM analysis revealed that the surface roughness of An/Ppy/C-TAB was reduced after MO adsorption. The results showed that increasing pH improved the adsorption capacity, with the optimal pH for adsorption determined to be 11. The equilibrium time was 30 minutes, and the optimal adsorbent amount was 0.15 g. Adsorption followed the Langmuir isotherm and pseudo-first-order kinetic models, with a maximum adsorption capacity of 45.2 mg/g at 45°C. The process was found to be endothermic, with a standard enthalpy (ΔH°) of 9.1 kJ/mol and standard entropy (ΔS°) of 0.28 J/mol K.

Keywords: Adsorption, Polypyrrole, Composite, Methyl Orange, C-TAB, Andalusite

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A-10-1918-2

Adsorption of Crystal Violet Dye from Aqueous Medium Using Alginate/Acrylamide/Graphene Oxide Composite Hydrogel

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Abstract

Graphene-based composite hydrogels have emerged as effective materials for adsorbing toxic pollutants due to the incorporation of graphene nanosheets within a hydrogel matrix. This research focuses on using an alginate-cl-poly(acrylamide)-graphene oxide hydrogel (Alg/AA/GO) to adsorb crystal violet (CV) dye, which is harmful to both humans and the environment. The hydrogel was synthesized by grafting acrylamide onto a natural alginate backbone via free radical polymerization, using N,N′-Methylenebisacrylamide (MBA) as a crosslinking agent and ammonium persulfate (APS) as an initiator under microwave irradiation. The structure and morphology of the hydrogel were analyzed using FTIR spectroscopy, Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), Energy Dispersive X-ray Spectroscopy (EDX), and BET analysis. The results indicated that the optimal adsorbent amount was 2 g, with equilibrium reached in 180 minutes. The Alg/AA/GO hydrogel exhibited high adsorption capacity, following the pseudo-second-order kinetic model and Langmuir adsorption isotherm, with a maximum adsorption capacity of 345 mg/g. Thermodynamic analysis showed that the adsorption process is endothermic and spontaneous, as indicated by negative Gibbs free energy values, confirming the efficiency and desirability of CV adsorption onto the hydrogel surface.

Keywords: Adsorption, Alginate, Graphene Oxide, Acrylamide, Crystal violet, Composite

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Optimization of the laminated composite beam with box section under pure shear load

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Abstract

This study optimizes the buckling load in composite beams with box sections under pure shear load. A combination of finite element methods and optimization techniques was employed to develop an optimal model. A beam with a one-sided boundary condition, a ten-layer carbon-epoxy configuration was modeled to achieve this. The buckling load under shear force with critical limitations such as material, ply angles from 0 to 90 degrees, the number of wall layers, and the thickness of all section walls are considered in this study. We model this problem as an optimization one tackled by two population-based metaheuristics. The one is the well-known genetic algorithm and the other is the Bayesian Optimization which is powerful when computing the values of the objective function on the candidate solutions that are expensive or unavailable. In the case of applying the genetic algorithm, the mathematical formulation of the objective function is molded as the regression task. In contrast, in the case of applying the Bayesian optimization technique, we do not need any mathematical formulation of the objective function, and use the Abaqus simulator instead. The findings of this research showed that by changing the configuration of the layers, the buckling load capacity after optimization with 100 simulation calls can increase up to 1.5 times compared to the initial values under shear for asymmetric configurations.

Keywords: Buckling load, lay-up composite, finite element analysis, Genetic algorithm, Bayesian optimization, Box Section

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A-10-1922-1

Surface entrapment of hydroxyapatite on 3D printed polylactic acid interference screws for biomedical application

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Abstract

Fixation of biological grafts using interference screws is a common procedure for treating anterior cruciate ligament injuries. This research focuses on designing and manufacturing polylactic acid (PLA) interference screws via the fused deposition modeling (FDM) method, followed by surface modification using hydroxyapatite (HA) for enhanced bioactivity and hydrophilicity. A 5% chitosan solution in 0.1 M acetic acid was prepared, with 1% hydroxyapatite added to create a milky-colored solution. PLA scaffolds were immersed in this solution, and their surface morphology and microstructure before and after immersion in simulated body fluid (SBF) were examined using scanning electron microscopy. The hydrophilicity of the surface was measured by the contact angle, and cell viability was assessed via the MTT assay after two days. Results showed that after four weeks of immersion in SBF, a layer of spherical and needle-shaped hydroxyapatite formed on the scaffold surface, indicating excellent bioactivity. Additionally, the reduced contact angle with HA-coated samples enhanced cell proliferation, confirming the potential of PLA scaffolds coated with hydroxyapatite for accelerating cell growth and promoting the healing process.

Keywords: Interference screws, Polylactic acid, Fused deposition modeling, Hydroxyapatite

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A-10-1924-1

Examining Internal Defects in 3D FML Composites with Cork Core Using Active Thermography

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Abstract

Fiber Metal Laminates (FMLs) are popular materials in aerospace, automotive, and marine instruments. During the preparation and manufacturing process, defects such as matrix damage, fiber breakage, and delamination between fibers and the matrix can easily occur, which can pose a threat to the quality, performance, and operational safety of the equipment utilizing these materials. This research investigates defects that are vertically aligned with one of the surfaces, acting as barriers to heat propagation within the structure. This phenomenon leads to variations in the surface's thermal field, which can be clearly observed and evaluated through the thermal differences between various points on the surface. The defects are detectable using thermography, a non-destructive testing method. In this technique, halogen lamps are employed as an active heat source, radiating energy perpendicularly to the surface, and a sequence of infrared images is captured using a FLIR camera. The defects are visible and interpretable in the output images generated by the related software.

Keywords: 3D FML, Thermograghy, Defect Detection, Non-destructive evaluation, Thermal conductivity

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A-10-1925-1

Rheology and Viscoelastic Behavior of MWCNT-Reinforced EPDM/SBR Nanocomposites

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Abstract

This study investigates the rheological behavior of ethylene propylene diene monomer (EPDM)/styrene butadiene rubber (SBR) nanocomposites reinforced with varying loadings of multi-walled carbon nanotubes (MWCNTs), ranging from 0 to 4 phr (parts per hundred rubber). The focus of the research is on understanding the effects of MWCNT concentration on the viscoelastic properties of the EPDM/SBR matrix under dynamic conditions. Rheological tests were conducted using a frequency sweep analysis over a range of 0.5 Hz to 35 Hz to examine the material's response in both the linear viscoelastic region and beyond. The results reveal significant changes in the storage modulus (G') and loss modulus (G'') with increasing MWCNT content, indicating a marked reinforcement effect, particularly at higher frequencies. As the MWCNT loading increases, the nanocomposites exhibit enhanced stiffness and elastic behavior, reflecting improved filler-matrix interactions. These findings suggest that the introduction of MWCNTs into EPDM/SBR blends improves their rheological performance, making them suitable for advanced applications requiring enhanced mechanical stability and flow properties.

Keywords: Polymer Nanocomposite, SBR/EPDM, Rheological behavior, Rubber Blend, CNT

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Investigating joint failure mechanisms in continuous ultrasonic welding of GF/PA6 thermoplastic composites

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Abstract

Continuous ultrasonic welding is a new method for joining thermoplastic composites. In this process, ultrasonic vibrations are transmitted into the composite materials, generating sufficient heat through surface and intermolecular friction to melt the composite matrix. Simultaneously, pressure is applied, and two composite plates with a specific overlap are joined together. In this research, continuous welds with varying shear strength were obtained by adjusting the main process parameters, namely power, speed, and pressure. In each experiment, the failure mechanisms of the welds were investigated using microscopic images. The results show that in high-speed welding at a speed of 30 mm/s, due to the shallow penetration and low uniformity of the resulting weld, the composite polymer matrix plays the primary role in the joint. Therefore, the dominant failure modes are matrix cracking and the presence of numerous voids. At a low welding speed of 10 mm/s, sufficient heat supply at the interface of the plates results in a weld with high penetration, uniformity, and strength. Therefore, the dominant mechanisms of connection failure include fiber breakage, debonding, and local peeling of the layer in contact with the interface.

Keywords: Continuous ultrasonic welding, thermoplastic composite, Joint failure mechanisms, Joining

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A-10-1929-2

Investigation of the effect of using an energy director on the quality of static ultrasonic welding of CF/PA6 thermoplastic composite

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Abstract

Ultrasonic welding is one of the fastest methods for joining thermoplastic composites, resulting in high-strength connections. In this method, ultrasonic vibrations are transmitted to the composite material, generating viscoelastic heat within it, which provides the necessary energy to melt the polymer. By simultaneously applying pressure to the overlap of the welded samples, a high-strength joint is formed in a fraction of a second. In this research, various static ultrasonic welding tests, with and without an energy director, were conducted, considering three parameters: generator power percentage, welding time, and welding pressure. By analyzing welding energy consumption and the fracture surface, the effect of the energy director on the quality of static ultrasonic welding was determined. The results showed that welding shear strength is directly related to energy consumption. Low energy results in weak welds, while excessive energy causes polymer decomposition and thermal degradation of the composite. Using a 0.3 mm thick flat energy director made of PA6 concentrates the viscoelastic heat at the interface, reducing energy consumption, preventing thermal degradation, and increasing the joint shear strength.

Keywords: Static ultrasonic welding, Thermoplastic composites, CF/PA6, Joining

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A-10-1930-1

Tensile Properties of Vacuum Infusion and Hand Lay-Up Processed Glass Reinforced Composites

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Abstract

Reducing material consumption is one of the most important parameters for reducing the finished cost of a component. In this study, it has been tried to decrease the required resin in composite lamination as well as optimizing the mechanical properties, by changing the manufacturing process from hand lay-up to infusion. It will be the consequence of higher glass content and lower wastes of infused composites. The experimental analysis of samples made of epoxy resin and CSM glass fiber showed by changing the method from hand lay-up to infusion, glass content increased from 32.5 to 49 wt% which directly affects the mechanical properties. Tensile test results indicat the growth in Young modulus and ultimiate strength from 9 GPa to 13 GPa, and from 120 MPa to 220 MPa, respectively. This occurs along with a more than 50 wt% decrease in resin consumption. Afetr investigating the effect of the manufacturing process on the mechanical properties of fiberglass composite, a numerical analysis of the wind turbine nacelle cover has been conducted. This analysis leads to specifying the influence of changing the manufacturing process on strength criteria.

Keywords: Wind Turbine, Vacuum Infusion, Hand Lay-Up, Manufacturing Process, Composites

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Numerical Analysis of Fall Protection System Load in 2.5 MW MAPNA Wind Turbine Nacelle Cover

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Abstract

The nacelle cover is a critical composite component of wind turbines, protecting the internal components while also withstanding external loads, particularly from wind and fall protection systems. International standards require that the fall protection system support at least 22 kN of static load in every direction. To ensure the structural integrity of the nacelle cover, appropriate strength criteria must be incorporated during the design phase. Two methods for implementing fall protection systems in the MAPNA 2.5 MW wind turbine nacelle cover—using eyebolts and unirail—were analyzed in this study. Using numerical analysis based on experimental tests, the composite strength of both methods was compared. The analysis was conducted using the Ansys ACP module (Pre & Post), and the composite structure consisted of glass fiber, plywood, foam, and epoxy resin. The mechanical properties of single-layer fiberglass composites, plywood, and foam were determined through experimental tests. This study was part of the optimization project for the wind turbine structure at MAPNA PARS.

Keywords: Wind Turbine, Composite Structure, Fall Protection System, fiber-glass composite, Simulation

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Advanced plant-derived wound dressing with enhanced healing properties

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Abstract

This study presents the development of a double-layer wound dressing designed to closely mimic the natural structure of the skin, enhancing the healing process. The dressing comprises a protective cellulose (Cel) microfiber top layer and a healing-support nanofibrous bottom layer, incorporating pectin (Pec), soy protein isolate (SPI), pomegranate peel extract (P). Scanning electron microscopy confirmed the successful formation of the bilayer structure. The dressing exhibited significant weight loss (60.05%) over seven days in a phosphate-buffered solution, while mechanical properties such as tensile strength, elastic modulus, and elongation at break ranged from 3.14 to 3.57 MPa, 32.26 to 36.58 MPa, and 59.04 to 63.19%, respectively. The release profiles of SPI and phenolic demonstrated antibacterial activity, and the dressing was non-cytotoxic to human keratinocyte cells. Furthermore, the Cel/Pec-SPI-P enhanced cell adhesion, migration, and angiogenesis. In vivo studies revealed accelerated epidermal formation, blood vessel generation, collagen deposition, and a faster overall wound healing rate. This innovative bilayer dressing represents a promising advancement in wound treatment strategies for clinical applications.

Keywords: Cellulose, Pectin, Pomegranate peel extract, Micro/nanofiber dressing, Soy protein isolate

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Development of a honey-based bilayer wound dressing: a novel strategy for effective wound recovery

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Abstract

To address the limitations of traditional single-layer wound dressings, bilayer dressings have emerged as a viable alternative for effective and sustained wound management. This study presents a novel bilayer wound dressing aimed at enhancing wound healing. The dressing combines a polyacrylic acid (PAAc)-honey (Hny) sponge layer with an electrospun nanofiber layer composed of Keratin (Kr), Hny, and vascular endothelial growth factor (VEGF). Comprehensive evaluations assessed the physiochemical properties, VEGF release profiles, and biological responses, including cytocompatibility and cell migration. The results demonstrated favorable mechanical properties and significant water absorption. Moreover, the PAAc-Hny/Hny-Kr-VEGF exhibited sustained VEGF release over seven days, promoting enhanced angiogenesis and improved cellular response. In vivo experiments in rat models, revealed significantly improved healing rates, reduced inflammation, and increased collagen deposition in wounds treated with the PAAc-Hny/Hny-Kr-VEGF dressing. Histological analysis confirmed complete wound closure and regeneration of skin appendages. This bilayer dressing shows significant promise for effective wound management in clinical applications.

Keywords: Honey, Bilayer wound dressing, Polyacrylic acid, Sponge, Electrospun, Nanofiber

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Designing and Manufacturing a Composite Grain Spout

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Abstract

This study focuses on designing and manufacturing a glass-epoxy composite grain spout for industrial use in transporting granular materials via gravity. Unlike conventional steel spouts, a glass-epoxy composite alternative offers several advantages, including a lower density that results in a lighter structure, making it easier to transport and install. Additionally, the composite's moisture resistance makes it ideal for use in humid environments. The design process began with the collection of data on the dimensions and load capacities of existing spouts, followed by a force analysis. This was followed by the design of layers, materials, connections, and a stress analysis. A comparison between the composite spout and its steel counterpart was also conducted. Due to the impact and cyclic loading typically encountered by spouts, fatigue analysis was performed using a modeling approach. Stress analysis was conducted on steel spouts under cyclic and impact loads, and safety factors were calculated. A coefficient (denoted as G) was derived by dividing safety factors for impact and cyclic loading. Composite layers were then designed based on a constant impact load, and the strength ratio (SR) was multiplied by G to determine the fatigue SR. The results showed that the glass-epoxy composite spout offers the advantages of easier handling and transportation while maintaining comparable performance to the steel spout under both static and dynamic loads.

Keywords: Grain spout design, Lightweight structure, Cyclic and impact loading

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Novel Experimental Approach to Enhancing the Tensile Properties of GFRP Laminates through Steel Wire Reinforcement

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Abstract

The limitations of traditional composite laminates in bearing complex and diverse loads have led researchers to explore innovative reinforcement methods. One such approach is the reinforcement of composite laminates using metallic wires. Due to their low cost and excellent mechanical properties, stainless steel wires are among the most suitable materials for reinforcing composite laminates. In this study, the effect of steel wire reinforcement on the tensile properties of Glass Fiber Reinforced Polymer (GFRP) laminates is investigated. Specimens with 1, 2, 3, and 4 longitudinal wires embedded in glass fiber laminates and fabricated using the vacuum bagging technique and subjected to tensile loading. The results demonstrated that wire reinforcement significantly enhances the tensile behavior of the laminates. Specifically, specimens with four wires exhibited a 32-fold increase in absorbed energy, a 5.3-fold increase in tensile modulus, and a 24-fold increase in specific energy absorption (SEA) compared to non-reinforced samples. Additionally, the use of wires substantially increased the ultimate displacement of the specimens. The findings of this study offer a novel solution, assisting researchers in optimizing the design and fabrication of wire-reinforced composites for various applications, enabling the production of lighter, stronger, and more durable components.

Keywords: Wire-reinforced composites, Tensile lading, Reinforcement methods, GFRP, Mechanical Properties

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Comparative Experimental Study of Open Hole GFRP and Aluminum Plates under Tensile Loading

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Abstract

Composite laminates and aluminum alloys are widely used in industries like aerospace and automotive due to their excellent properties, especially their high strength-to-weight ratios. Plates used in these industries often feature cutouts of various geometries to reduce weight or provide pathways for electrical wires and fluids. When these cutouts are circular, they are referred to as "holes," and the plates are known as "open-hole plates." The presence of holes significantly influences the mechanical properties and structural performance of the material, particularly under tensile loading. This paper presents an experimental study investigating the tensile performance of glass fiber-reinforced polymer (GFRP) composite and aluminum plates, both of which feature a centrally located circular hole. For this study, three specimens of each material, with identical dimensions, were manufactured and subjected to tensile testing. The experimental results highlight considerable differences in the tensile responses of the GFRP composite and aluminum plates. In particular, the aluminum plates exhibited higher tensile module but showed greater sensitivity to stress concentration around the hole. On the other hand, the GFRP composite demonstrated better stress distribution, which resulted in less pronounced failure near the open hole and significant energy absorption. These findings underscore the significant influence of the open hole on the mechanical behavior of both materials and provide insight into their potential applications in industries where weight reduction and structural integrity are critical.

Keywords: Aluminum, GFRP, Open-hole, Tensile loading, Mechanical Properties

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Effect of carbon and boron addition on physical and mechanical properties of aluminum metal matrix composite, a simulation study

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Abstract

Today, the development of metal base composites plays an effective role in the manufacture of various parts, and in the meantime, special attention has been paid to aluminum metal base composites. In the present study, the effect of boron carbide and the presence of boron and carbon elements in the physical and mechanical properties of aluminum have been considered. This study was a simulation study and only simulator software was used in it. Al-5B-5C, Al-5B-10C and Al-5B-15C compounds were defined in software and mechanical properties were investigated. The results show that with the increase in the weight percentage of carbon in the chemical composition, the presence of the Al_4C_3 phase is strengthened and this causes the strength of the material to increase from 296 MPa at 5 %wt carbon to 905 MPa at 15 %wt carbon. Also, the presence of AlB_2 phase has been one of the main factors in increasing the strength of this material. It should be noted that T6 heat treatment was used in the simulation calculations. Notably, the density was also calculated in the simulation calculations and the results showed that the density increased by 3.07% with the increase in weight percentage of carbon.

Keywords: Aluminium Carbide, AlB_2, Metal base composites, Software Simulation

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A novel Taguchi-based tabular neural network (TabNet) algorithm for simultaneous anticipation of elastic properties of anisotropic short fiber reinforced composites

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Abstract

This study explores the use of a novel Tabular Neural Network (TabNet) algorithm to simultaneously predict all 21 components of the elastic stiffness tensor of anisotropic short fiber reinforced composites (SFRCs). The dataset used for training, validation, and testing the TabNet model consisted of 24,540 data points generated using a micromechanics-based model. The dataset was split into 80% for training, 15% for validation, and 5% for testing. To optimize the hyperparameters of the TabNet algorithm efficiently, the Taguchi design of experiments was applied. The Taguchi method suggested an optimal structure for the TabNet algorithm, including 24 decision blocks, 16 attention blocks, and 5 decision steps, with the "Adam" optimizer, a gamma of 2, a learning rate of 0.001, and a lambda-sparse of 0.0001, resulting in the highest predictive accuracy. Using the proposed configuration, predictive accuracies of 94.656%, 93.956%, and 93.67% were achieved for the training, validation, and test sets, respectively. The experimental data points were predicted with less than 10% difference from the model, confirming the reliability of the Taguchi-based TabNet algorithm for predicting the elastic properties of anisotropic SFRCs.

Keywords: Tabular neural network (TabNet) algorithm, Taguchi design of experiment, Elastic properties, Short fiber reinforced composites

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Addition of Graphene Content on Silicone-Epoxy Nanocomposite: Hydrophobicity, Adhesion, and Hardness

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Abstract

Hydrophobic polymer nanocomposite coatings have many important applications in thermal management, including enhancing desalination yield and improving condenser efficiency. In this study, hydrophobic nanocomposite coatings based on silicone epoxy containing 0.2, 0.5, and 1 wt.% graphene nanoplates, 0.5 wt.% fumed silica, and 5 wt.% hydrophobic additive were fabricated. The properties of hydrophobicity, surface roughness, adhesion/cohesion, and hardness of the coatings were assessed using a contact angle test, atomic force microscopy (AFM), pull-off tests, and Shore D hardness measurements, respectively. It was found that the nanocomposite modified with 5 wt.% hydrophobic additive, 0.5 wt.% fumed silica, and 1 wt.% graphene nanoplate (SE/5B/0.5R200/1G) exhibits the highest contact angle (35%), surface roughness (Rq) (17 times), hardness (11%), and adhesion compared to pure resin. In contrast, the nanocomposite modified with 5 wt.% hydrophobic additive, 0.5 wt.% fumed silica, and 0.5 wt.% graphene nanoplate (SE/5B/0.5R200/0.5G) demonstrates the lowest improvement compared to silicone epoxy, with contact angle, surface roughness, hardness, and adhesion enhanced by approximately 27%, 1.37 times, and only 2.13%, respectively.

Keywords: Polymer Nanocomposite, Graphene, Fumed Silica, Wettability, Shore D, Pull-off

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Optimization and Simulation of Energy Absorption in Composite Propeller Under High Speed Impact

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Abstract

This research investigates the impact resistance of composite propellers subjected to high-speed impacts. Carbon, Kevlar, and glass fibers were used for the propeller's outer shell, while polyurethane foam served as the core material. The study aimed to assess the energy absorption performance of these materials during impact and optimize the propeller's resistance under various conditions. Six different fiber lay-up combinations were analyzed, with the propeller design being derived from scanning the original sample to allow for more accurate simulation using the finite element method (FEM). In the simulation, the residual velocity of the propeller after impact with a rod under controlled conditions was measured, and the data were analyzed to compare energy absorption in 18 different scenarios. The results indicated that propellers with Kevlar fibers as the outer shell and a ±45-degree lay-up exhibited the best energy absorption performance. In this configuration, the propeller's speed after impact was reduced by approximately 8%, highlighting Kevlar's efficiency in enhancing impact resistance. These findings could contribute to the development of more resilient composite propellers for industries such as aerospace, offering insights into optimizing propeller structures for improved performance under impact and loading conditions.

Keywords: Composite propeller, Energy absorption, Impact, Polyurethane core, Mechanical Properties

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A-10-1940-2

Analysis of Energy Absorption in Composite Sandwich Panels with Different Core Structures Under Impact Loading

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Abstract

This paper investigates the behavior of composite sandwich panels with cellular cores, including hexagonal, square, triangular, and circular structures, against projectile impact. The main objective of this study is to compare the energy absorption of these panels by measuring the residual velocity of the projectile after impact with each sandwich panel. This analysis is conducted to evaluate the mechanical performance of different cores in improving impact resistance and to provide an optimal design for such structures. Simulations of the projectile impact on the panels were performed using Abaqus software and the finite element method (FEM). In these simulations, different cores with varying geometric and mechanical properties were modeled to examine the effect of different cellular structures on energy absorption and the reduction of projectile speed after impact. The results demonstrate that various cellular cores exhibit different performance in energy absorption during impact. However, each core has its own advantages and disadvantages, which, depending on the application and design requirements, can be utilized in various industries. This study shows that selecting the most suitable core structure for composite sandwich panels can significantly improve their impact resistance and performance, and contribute to the optimal design of lightweight and durable structures in different industries.

Keywords: Composite Sandwich Panel, Core Material, Energy absorption, Impact, Mechanical Properties

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Experimental Study on Foam Density Influence in 3D-Printed Foam-Filled Sandwich Beams Under Flexural Loading

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Abstract

The demand for lightweight structures has led to the exploration of foam filling as an effective method for enhancing flexural strength without significantly increasing weight. In this study, we developed a novel 3D composite beam with a re-entrant anti-trichiral honeycomb core, fabricated using PLA-based 3D printing. To investigate the effect of foam filling on flexural properties, the beams were filled with two types of polyurethane foam with densities of 100 and 130 kg/m³, and their flexural performance was evaluated through three-point bending tests. The results indicated that foam density plays a critical role in determining flexural performance, including flexural modulus (Ef), flexural strength (σ_f), energy absorption (EA), and specific energy absorption (SEA). The low-density foam resulted in an 11.9% increase in EA, 5.22% in SEA, 3.35% in Ef, and 28.94% in σ_f compared to the hollow beam. Conversely, the high-density foam showed no change in EA, a 3.9% decrease in SEA, but marked improvements in Ef 9.23% and σ_f 74.08% compared to the hollow sample. These findings highlight the significant impact of foam filling on the flexural modulus and load-bearing capacity of the composite beams, offering valuable insights for the design of lightweight, high-strength structures.

Keywords: 3D printing, Sandwich beam, Foam filled, Honeycomb, Three point bending

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Study on The Prevention of Laminated UPVC Profiles from Deformation by Simultaneous Decrease in Heat Buildup (HBU) and Enhancement of Their Heat Deflection Temperature (HDT): A Review Paper

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Abstract

The black surface of a laminated UPVC profile is susceptible to absorbing the unwanted infrared sun rays, hence, the overall temperature is significantly increased. This phenomenon was known as heat buildup (HBU), leading to the temperature passing through the Heat deflection temperature (HDT), and as a result, dimensional deformation occurred at these profiles. The use of various coolant pigments such as TiO2, annealed ZnO at higher temperatures, etc. increased the spectral reflection (R(Θ)) inside the UPVC profile and cools down temperature. Therefore, the interior temperature is reduced below the HDT of UPVC. On the other hand, the use of reinforcement fiber (e.g., Carbon fiber, glass fiber, etc.) affects the HDT and Tg temperature in the UPVC profile, consequently, the dimensional stability increase. To the best of our knowledge, this is the first study conducted on the UPVC composites that deals with the HBU phenomenon and provides suitable solutions to improve the deformation shortage that occurred in the black laminated UPVC profiles, installed out in the Sun.

Keywords: Heat buildup, Applicable UPVC composites, carbon fiber, coolant pigment, spatial reflectant, Mechanical Properties

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A novel polymeric nanocomposite based on MXene toward EMI shielding material: a Review paper

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Abstract

The development of polymer-based nanocomposites has revolutionized electromagnetic interference (EMI) shielding technology. This nanocomposites is integrating conductive fillers with a non-conductive polymeric matrix. Various conductive fillers can be used as wave absorber, among them, MXene nanofiller due to its Accordion structure and superior properties such as high electrical and low thermal conductivity have a potential to improve EMI shielding performance with lightweight, high flexibility and thermal management. In this study, we summarize various attempting toward fabrication, characterization and classification of MXene based polymeric nanocomposites. Also, to compare MXene based polymeric nanocomposites with other nanocomposites, we look at the research conducted on other conductive fillers.

Keywords: Polymer Nanocomposites, Conductivity, EMI Shiehding, MXene, Lightweight and high Flexible composites

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A-10-1942-3

An Ablative EPDM based nanocomposites: A Review Paper

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Abstract

The ablative nanocomposites fulfills a fundamental task in aerospace industry. As an applicable instance, this nanocomposites could be used as a thermal insulating materials for Solid Rocket Motors (SRMs) to protect their structures from severe conditions. This nanocomposites undergoes endothermic sacrificial ablation, wherein the outer surface of the material degrades to form a carbonized char layer, which isolates the underlying material from an intense thermal-heat flux environment. Our research focused on the different polymeric ablative heat protection nanocomposites that include a combination of various nano material, fiber, Flame retardant and a proper elastomeric matrix, which providing exceptional thermal and mechanical properties. This will permit us to investigate the safeguarding mechanism, investigation techniques, as well as diverse nanocomposites' performance.

Keywords: Ablative polymer nanocomposites, Nanofillers, skeleton like fiber, Thermal stability, Heat sink

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MXene based polymeric nanocomposites as promising dielectric material: A Review Paper

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Abstract

Numerous researchers have extensively investigated the two-dimensional (2D) MXene nanofiller a with the general formula of Mn+1XnTx. The nanometer-scale dimensions and large aspect ratio make MXenes an excellent material for nanocomposite engineering. On the other hand, the polymer nanocomposites with high dielectric permittivity and low dielectric loss have also attracted much attention for external applications such as energy storage capacitors. It has been reported that the incorporation of MXene nanofiller with a higher aspect ratio into a proper polymer matrix increases the dielectric and mechanical properties of nanocomposites simultaneously. In the present study, we summarize and categorize various attempts to enhance the dielectric properties of MXene-based nanocomposite. In this field, we will explore the main improvement mechanisms, such as the percolation mechanism and the Maxwell-Wagner-Sillars (MWS) polarization for heterogeneous systems.

Keywords: Dielectric, loss of dielectric, Mxene, nanocomposites, conductivity, super-capacitor

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Investigating the impact of different boundary conditions on the dynamic behavior of composite panels

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Abstract

This study investigates the impact of various boundary conditions on the dynamic behavior and vibration response of composite panels. The performance of composite structures is significantly influenced by their mechanical properties. However, their dynamic response can be affected by the type of boundary conditions applied. Through experimental investigations, this research explores how these boundary conditions impact the natural frequencies, mode shapes, and overall vibrational characteristics of composite panels. The findings show that boundary conditions play a crucial role in the dynamic performance and vibration response of composite panels

Keywords: Composite panel, dynamic behavior, boundary conditions, natural frequencies

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A case study for mechanical behavior of lattice reinforced cementitious composites under uniaxial compression

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Abstract

Concrete is widely used in construction due to its exceptional compressive strength, but it faces significant challenges related to tensile loading, crack propagation, and brittleness. Conventional reinforcements, such as rebars and stirrups, help mitigate these issues but often fall short when dealing with novel, slender structural members and extreme loading conditions, such as blasts and explosions. Moreover, increasing the reinforcement ratio is not practical for large-scale applications. Since 2020, the use of 3D geometries for reinforcement, utilizing meta-materials within cement-based composites, has emerged as a promising solution. The rapid development of additive manufacturing has enabled the creation of complex geometries, allowing for more efficient material use compared to traditional reinforcement methods. While most existing studies focus on experimental work, comprehensive numerical simulations are lacking. This research addresses this gap by presenting a finite element analysis-based numerical simulation of reinforced cementitious composites using lattice structures. The study further investigates the concrete-lattice interface, contributing to the advancement of 3D reinforcement techniques in structural applications.

Keywords: Lattice reinforced Cementacious Composites, Meta materials, Numerical analysis, Damage, Mechanical behaviour

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Numerical Simulation of Cone-Jet Formation for processing polymeric particles using Electrohydrodynamic Atomization technique

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Abstract

Controlled particle manufacturing is vital in the nanocomposite industry for ensuring uniformity, consistency, and customization of materials. Electrohydrodynamic atomization (EHDA) has emerged as an innovative technique for depositing micro- and nanoparticulate materials onto surfaces in a precise and controlled manner. Due to its simplicity and flexibility, EHDA has been widely adopted to generate particles with tunable compositions, structures, sizes, morphologies, and shapes. Numerical simulation plays a crucial role in enhancing the precision, efficiency, and predictive capability of EHDA, enabling better control over nanoparticle fabrication. This study presents a single-nozzle EHDA system designed as an instructive case to simultaneously solve the coupled continuity, momentum, and electric potential equations. The simulation calculates the velocity and pressure fields, as well as the shape of the liquid cone, as a function of factors such as liquid flow rate, needle-to-counter electrode distance, applied voltage, and the physical properties of polymer fluid solutions (e.g., viscosity, density, electrical conductivity, electrical permittivity). The model assumes the fluid issuing from the nozzle is a viscous liquid, with air as the surrounding ambient fluid and an electric field generated by the potential difference between the nozzle and a downstream horizontal electrode.

Keywords: Electrohydrodynamic atomization, Numerical Simulation, cone-jet

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Fabrication of Nanocomposites Based on PANI and P3HT by Crystallization Method

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Abstract

Nanocomposites of Polyaniline (PANI) and Poly(3-hexylthiophene) (P3HT) were fabricated in various solvents with different quality respect to P3HT. Chloroform, amyl acetate, and *p*-xylene were used to form dilute solutions of mixed polymers. Various molecular weight of PANI and P3HT were used. Effect of various solvent quality and molecular weight of polymers on formed nanostructures were investigated. Crystallization induced nanocomposites were constructed by acting PANI as seeds. The nanostructures were characterized by atomic force microscopy (AFM), transmission electron microscopy equipped with selected area electron diffraction (SAED) (TEM). Three types of nanocomposites were constructed. The prepared nanocomposites can be applicable in electronic equipment used conducting polymers such as solar cells.

Keywords: PANI, P3HT, Crystallization, Nanocomposites

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Application of Carbon-based Nanocomposites for Stability Enhancement of Polymer Solar Cells

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Abstract

Surface modified Carbon nanotubes including CNT-g-poly(3-dodecylthiophene) (CNT-g-PDT) and CNT-g-polyaniline (CNT-g-PANI), reduced graphene oxide (rGo), rGO-g-poly(3-dodecylthiophene) (rGO-g-PDT), rGO-polythiophene (rGOPT), phenyl-C61-butyric acid methyl ester (PC71BM), and poly[benzodithiophene-bis(decyltetradecyl-thien) naphthothiadiazole] (PTDT) chains were utilized for fabrication of various nanocomposites. Obtained nanostructures including CNT-g-PDT/PTDT, CNT-g-PANI/PTDT, rGO/PTDT, rGO-g-PDT/PTDT, and rGOPT/PTDT/PC71BM were used in active layer construction of polymer solar cells (PSCs). After one-month exposure of devices to air, observed changes of PSCs performance characteristics, comprising power conversion efficiency (PCE), short circuit current density (Jsc), open circuit voltage (Voc), and fill factor (FF), revealed that the highest stability were belonged to CNT-g-PANI/PTDT and rGO/PTDT nanostructures.

Keywords: Nanocomposite, Polymer Solar cells, Stability

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Investigation of the effect of shape memory alloys on Pressure capacity of polymer composite Pipes

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Abstract

Composite pipes under pressure are an example of the cases where the composite materials industry has stepped. Composite materials consist of two or more components in two phases of reinforcement and matrix, which the reinforcement is Embedded in the matrix phase. The reinforcing phase can be unidirectional or woven fibers, or even particles with different geometrical shapes can play a role in composite materials from the reinforcing phase. In this research, composite material T300/5208 is considered as a material to create a composite pipe with special conditions. The composite pipe made of unidirectional carbon-epoxy is made by wound filament method. In the current research, the composite pipe with arrangement [55/-55] by different layups has been investigated. NiTiNol Shape memory alloy wires under pre-strain will be placed inside several layers as an actuator to create a compressive load against tensile residual stresses created by Curing. Finally, the increase in the pressure capacity of the composite pipe will be measured in this research.

Keywords: composite pipes, Laminated composites, residual stress by curing, temperature, Shape memory alloy, Smart composite pipe

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Experimental Comparison of Damage in Fiber-Metal Laminates with Different Layer Arrangements Subject to Static Loading

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Abstract

Fiber-Metal Laminates (FMLs) are structures composed of several thin metal sheets and composite layers bonded together. Despite their widespread applications in various industries, these structures are prone to failure. This study conducts experimental tests to investigate the initiation, growth of damage, and failure in FML. FMLs with different layer arrangements were subjected to static uniaxial loading, and the resulting damage was monitored. The results indicated that altering the layer arrangement—particularly the positioning of metal and composite layers—results in different damage modes in FMLs. Additionally, the failure strain was compared among FMLs with various layer arrangements and the aluminum layer used in FMLs. The findings showed that the presence of composites in the intermediate layers of FMLs increases the failure strain compared to the aluminum layer alone. This improvement can be attributed to the significant elongation observed in the aluminum layer due to the presence of the composite layers. However, if the composite layers are located in the outer layers of the FML, this increase in failure strain is not observed, as the FML specimens tend to fail due to the failure of the composite layers before the metal layers can fail.

Keywords: Fiber-Metal Laminate (FML), Experiment, Damage, Failure Strain, Composite

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Design and stress analysis of the protective rod of a rail-car bogie bolster made of hybrid metal and carbon/epoxy composites under low-velocity impact

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Abstract

Today, with the increase in population and the volume of rail travel and commercial exchanges, the need to develop this industry has become more apparent. On the other hand, society's concern about the production of pollutants and global warming has limited the development of this industry. One of the approaches to deal with this limitation is to lighten the railway cars to reduce fuel consumption and pollutant production. In this study, firstly, the concepts of material resistance and composite material mechanics have been used to design the composite structure of this part according to the impact loading applied to it. Then, to use the finite element method to analyze the stresses and critical areas of the designed piece, Abaqus software and its Explicit solver have been used. A similar analysis was performed on the original steel sample to compare its behavior and performance with that of the designed composite sample. At the end of this study, a composite bolster protective bar sample was designed using a combination of steel and epoxy/carbon composite (CFRP). This design reduces the weight and increases the reliability factor. In addition to these results, the critical regions of the part and the type of damage the designed sample is prone to have been determined.

Keywords: Composites materials, Carbon/Epoxy, Bolster protection bar, Finite element method, Low-velocity impact.

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Detection of Transverse Cracking Damage in GFRP by Acoustic Emission and Digital Image Correlation Techniques

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Abstract

Transverse cracking in 90° plies of glass-fiber laminated composites was studied to detect by using acoustic emission and digital image correlation techniques. Acoustic emission data is used to identify and localize transverse cracking by analyzing acoustic emission signal features. The digital image correlation method is used to verify the acoustic emission data obtained at the moment of transverse cracking formation in 90-degree layers. This method makes it possible to obtain acoustic emission data related to transverse cracking damage at a specific location with higher reliability. The manuscript and obtained data as the function of loading force related to cross-ply laminated composite with layup $[0/90_7/0]$ is presented. This paper concludes that the acoustic emission method is unreliable. The digital image correlation technique increases the reliability of this method. The method presented in this paper may be used as a powerful analysis tool that can detect the investigated phenomena. Acoustic emission and digital image correlation techniques detect transverse cracking in GFRP, showing higher reliability.

Keywords: Transverse Cracking, Acoustic Emission, Digital Image Correlation, GFRP.

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A-10-1951-3

Anisotropy of thin metal foils used in flexible electronics

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Abstract

In applications ranging from microelectronics to advanced coatings and flexible electronics, 3D characterization of thin metal foils becomes challenging. Due to their minimal thickness, thin foils present significant difficulties in accurate 3D material characterization, particularly in capturing their anisotropic mechanical behavior. The complex interaction between grain structure, surface effects, and thickness necessitates sophisticated modeling techniques. To simplify this problem, we propose using the transversely isotropic assumption, which reduces computational complexity while retaining the essential features of the foil's behavior. This assumption recognizes the material's symmetry about an axis perpendicular to the foil's plane, allowing for more manageable simulations without compromising accuracy. For this matter, tensile tests were executed in different material orientations to achieve a transversely isotropic material model for thin metal Al and Cu foils. Strains were measured using digital image correlation, and the results show a significant difference in Young's modulus, yield stress, and ultimate stress values. The findings contribute to more efficient and accurate characterization methods, facilitating the design of advanced materials.

Keywords: Flexible electronics, Foils, Characterization, Transversely isotropic assumption, Finite element analysis.

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Strain-based failure criteria utilizing the modified maximum strain

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Abstract

One of the existing problems is increasing the accuracy of failure criteria under multidirectional loading. The results obtained from different tests have shown that the maximum strain values in samples under multidirectional loading differ from those under unidirectional loading. One of the ways to increase the accuracy of failure criteria is to use the generalized maximum strain in determining the maximum strain of the material under multidirectional loading, whose values depend on the loading type. This research aims to introduce the generalized maximum strain, provide a method to calculate it, and finally, use the obtained method for the failure criterion. The maximum strain energy values in the same direction were used to obtain the maximum strain values. In this way, the amount of strain energy depending on different loading directions and the new value of the maximum strain is calculated. In previous studies, the maximum strain values were not a function of the loading type and had constant values. In this research, the generalized maximum strain value is calculated depending on the type of loading. Among the results obtained in this research is the introduction of the generalized maximum strain phenomenon and its use in the failure criterion. The results show that the maximum stress values predicted by the failure criterion presented in the present study, compared with the results obtained from the experimental tests, have higher accuracy than those obtained by the Hashin failure criterion.

Keywords: failure criterion, modified maximum strain, composite, modified Hashin criteria.

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Effect of fabrication method on electromagnetic properties of nanocomposites based on MWCNTs for RCS reduction

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Abstract

Nowadays, hiding from the sight of radars and detectors, i.e., stealth, is particularly important. The current research aims to investigate the effect of the fabrication method on the electromagnetic properties and radar absorption of nanocomposites to reduce the RCS in the X-band. Electromagnetic absorbers are one of the most important materials for stealth coatings. This research will consider presenting a method to increase the dispersion of nanoparticles in the polymer matrix to increase the ability to absorb waves. Radar-absorber materials (RAMs) absorb the energy of electromagnetic fields passing through them and convert it into heat. RAMs must be able to dissipate electrical and magnetic parts of the waves. In the current research, radar absorbent composite coatings were made by adding multi-walled carbon nanotubes (due to suitable mechanical, electrical and thermal properties) to epoxy resin (due to impedance matching with air) using three different fabrication methods, and their electromagnetic properties (Complex permittivity) were characterized. Also, the performance of radar absorption of the above composites was reported.

Keywords: Nanocomposite, Reduction of radar cross-section, Radar absorbing material, X-band, Multi-walled carbon nanotubes.

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Numerical study of low-velocity impact on GLARE laminates based on elasticity concepts

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Abstract

Fiber metal laminates (FMLs) are vulnerable to low-velocity impacts that can degrade their mechanical properties and performance. The current study aimed to model the low-velocity impacts at different energy levels on GLARE laminates through numerical simulation based on elasticity concepts. It assessed the damage patterns caused by the delamination and matrix cracking in each composite layer and the area of metal plasticity. GLARE laminates, with the $[Al/0/90/0/90]_s$ layup, were modeled. The Johnson-Cook criterion was employed in the numerical simulation to characterize Aluminum's stress-strain relationship in both elastic and plastic regions. Furthermore, the three-dimensional modified Hashin criteria were utilized to model the failure initiation in composite layers subjected to impact conditions. The progressive damage was simulated through an elasticity-based approach by degrading the stiffness matrix. The modified Hashin criteria and progressive damage were coded into the user-material subroutine VUMAT within the ABAQUS/Explicit finite element package. The results show that if a crack does not form in the metal, an increase in impact energy leads to a larger area of damage in composite layers. The results also showed that the area of damage caused by the delamination was more significant than that caused by the matrix cracking under a constant impact energy. This study proposed a method for assessing and classifying the damage pattern induced in GLARE laminates by low-velocity impacts, employing numerical solutions based on elasticity concepts.

Keywords: Fiber-metal laminates (FMLs), Progressive damage, Low-velocity impact, Numerical simulation.

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A-10-1951-7

Evaluating Shape Memory Properties of Recycled PET and HDPE vs PET with Carbon Fibers

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Abstract

Shape memory polymers (SMPs) are smart materials that can return to their original shape from a deformed state when exposed to external stimuli, such as temperature changes, light, or electric/magnetic fields. This phenomenon is known as the shape memory effect (SME). Due to their dynamic adaptability to environmental changes, SMPs find applications in diverse fields, including medical devices, soft robotics, and aerospace. This study investigates the SME of recycled polyethylene terephthalate (PET) and high-density polyethylene (HDPE) as novel sustainable materials. It compares them with the SME of PET combined with carbon fiber (CF). The SME was evaluated through bending tests, where samples were deformed at room temperature and heated to assess their ability to return to their original shape. The findings reveal that recycled PET and HDPE exhibit SME characteristics comparable to PET combined with CF, highlighting the potential of using recycled materials in applications requiring shape memory functionality. Recycled PET and HDPE offer viable alternatives as sustainable materials, demonstrating effective shape memory properties near those of PET+CF filaments.

Keywords: Shape memory polymers (SMPs), Shape memory effect (SME), Recycled PET, Bending tests, Smart materials.

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Statistical analysis of fatigue life of laminated composites using artificial intelligence

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Abstract

Fatigue life prediction of laminated composites is a crucial aspect of materials engineering, particularly for applications that demand durability and reliability under cyclic loading. This study introduces a novel approach for analyzing fatigue life using statistical methods and artificial intelligence. A Kohonen map was employed to classify the dataset into four distinct groups, facilitating more effective data preprocessing tailored to each group. The preprocessed data was then analyzed using machine learning algorithms, including linear and polynomial regression, Tree base Regressions including Decision tree and Random forest algorithm, and a hybrid artificial neural network model (ANN) combined with long short-term memory (LSTM). Each model's performance was assessed using key metrics such as mean absolute error (MAE) and R-squared (R^2). The results demonstrate significant differences in the model's predictive capabilities, emphasizing the importance of preprocessing and group-specific analysis to enhance the reliability of predictions. Among the applied models, the random forest algorithm and hybrid RNN model exhibited superior performance due to their ability to capture complex nonlinear relationships and interactions within the data.

Keywords: Laminated composites, Fatigue life, Kohnen map, Machine learning, Neural Networks.

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The effect of grid-box material on energy absorption of shear thickening fluid-filled hyperelastic structure: A numerical study

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Abstract

Shear thickening fluids (STFs), consisting of nanoparticles suspended in a carrier fluid, play a critical role in energy absorption systems, particularly for body protection applications. The matrix, acting as a fluid container, provides structural flexibility, enhancing usability. This paper investigates the impact behavior of a hyperelastic nested structure filled with STF under three impact energies: 14 J, 28 J, and 56 J. Numerical simulations using the Finite Element Method (FEM) reveal that fluid-solid interaction (FSI) is the dominant energy absorption mechanism. The material type of the grid box significantly influences FSI activation, which is highly dependent on the impact velocity. Three types of materials—polyurethane foam (low modulus) and elastomers (mid and high modulus)—were analyzed for the grid box. The study concludes that as impact velocity increases, the effectiveness of foam in activating FSI diminishes, whereas at lower velocities, foam performs better in energy absorption. For STF-filled structures, at an impact energy of 14 J, the peak load decreases by 16.45% and 72.96% for elastomer-based and foam-based grid boxes, respectively. At an impact energy of 56 J, the elastomer-based grid box maintains its peak load reduction, while the foam-based grid box loses efficiency.

Keywords: Shear thickening fluids (STFs), Hyperelastic materials, Energy absorption, Fluid-solid interaction (FSI).

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A numerical investigation of Newtonian and non-Newtonian fluid-filled nested hyperelastic structures under low-velocity impact loading

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Abstract

In body protection applications under impact loadings, the aim is to dissipate the striker's energy through energy conversion mechanisms; therefore, utilizing applicable materials is one of the primary steps. A useful approach to absorbing the kinetic energy is employing fluids that offer the potential for viscous dissipation. This paper studied a class of smart materials known as shear thickening fluids (STFs) with a variable shear strain rate-dependent viscosity. Since the instability and fluidity of STFs probably influence their proper usage, an appropriate medium is required to keep and seal them. A hyperelastic material with high flexibility and low density is utilized as a nested medium for three fluid types: high viscous, low viscous, and STF. Subsequently, a low-velocity impact test was simulated using FEM, which is based on the coupled Eulerian-Lagrangian approach. Compared to the unfilled structure, numerical results show that the peak value of contact force between the striker and the sample in structures (filled with low-viscosity Newtonian fluid, high-viscosity Newtonian fluid, and non-Newtonian shear thickening fluid) reduced by 38%, 64%, and 74%, respectively, indicating a considerable increase in impact energy absorption and STF superiority over other two Newtonian fluids.

Keywords: Shear thickening fluids (STFs), Low-velocity impact, Coupled Eulerian-Lagrangian (CEL), Fluid-solid interaction (FSI).

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Design and fabrication of a flexible battery fatigue tester to investigate the effect of geometrical parameters on electrochemical performance

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Abstract

The development of the flexible electronics industry in recent years and the need for flexible energy storage devices have brought attention and research to the field of flexible batteries. This research investigates the effect of the radius of curvature and bending angle as the main geometric test parameters that affect the battery's electrochemical performance. For this purpose, a unique fatigue apparatus has been designed and manufactured to control the radius of curvature and bending angle and collect real-time resistance data using a built-in ohmmeter. Experimental tests can be executed to thoroughly investigate the effect of these parameters on the internal resistance of battery electrodes by studying the damage (i.e., cracks and delamination) initiation and propagation in flexible battery electrodes. Test results show that by reducing the radius of curvature and increasing the bending angle, the internal resistance of the electrode is increased significantly.

Keywords: Flexible battery, Fatigue, Apparatus design, Electrochemical performance, Crack, Delamination.

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An analytical investigation on lithium-ion battery electrode electrical conductivity using micromechanics

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Abstract

The electrodes in lithium-ion batteries (LIBs) consist of active materials and binders that are electrically insulating. To enhance the electrical, thermal, mechanical, and processing properties, conductive additives, which combine fillers of various dimensions, are used to form interconnected conductive networks. While the impact of electronic conductivity on battery performance is widely acknowledged, it has typically been measured through experiments and simulations. Few studies have employed theoretical models to predict the conductivity of LIB electrodes. This paper evaluates various micromechanical models for electrical conductivity, focusing on those based on percolation theory. While simpler models are easier to use, they fail to predict the sharp increases in conductivity. In contrast, percolation-based models provide more accurate predictions. Specifically, the Bruggeman, General Effective Media, McCullough, and Scarsbrick models were applied to the electrical conductivity of LIB electrodes. Among them, the McCullough model showed the best agreement with experimental data. The findings of this study can assist in estimating the optimal composition of electrode components for specific applications, helping to avoid unnecessary experimental trials when altering component formulations.

Keywords: Lithium-ion batteries, Micromechanics, Percolation Theory, Electrical Conductivity.

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Comparative analysis of re-entrant honeycomb and star-shaped auxetic meta-structures: energy absorption and Poisson's ratio performance

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Abstract

Auxetic meta-structures, characterized by their negative Poisson's ratio, offer unique mechanical properties that enhance energy absorption and structural resilience. This study compares two distinct auxetic configurations: the re-entrant honeycomb and the star-shaped auxetic meta-structures. The investigation focuses on two critical parameters (specific energy absorption (SEA) and Poisson's ratio) to evaluate their suitability for applications requiring superior impact mitigation and deformability. Finite element analysis (FEA) was employed to determine these parameters under quasi-static loading conditions. Results indicate that while both structures exhibit auxetic behavior, the re-entrant honeycomb demonstrates higher SEA due to its efficient load distribution and densification mechanisms. Conversely, the star auxetic structure achieves a more pronounced negative Poisson's ratio, providing enhanced lateral expansion under compression. These findings highlight the trade-offs between energy absorption efficiency and auxetic performance, offering insights for designing materials tailored to specific engineering applications, such as protective gear, packaging, and biomedical devices.

Keywords: Re-entrant honeycomb, Star auxetic structure, Auxetic meta-structure, Special energy absorption.

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A-10-1951-14

Stress Analysis of Coated Thin Foils in Flexible Batteries under Static Bending Load: A Finite Element Approach

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Abstract

Thin foils are used in diverse industries, including aerospace, electronics, and other sensitive sectors. The electronics industry's rapid advancements and the growing need for portable devices have created a vital opportunity for innovative battery technology. The crucial role of thin foils in flexible battery design has led to significant research interest. This study examines stress distribution in thin foils and their coatings during static bending, focusing on how these materials respond to significant deformation under load at the cathode and anode. The simulation of a full battery pack under static bending loads was conducted using finite element techniques, enabling a comprehensive examination of stress distribution within the layers of bendable batteries. The study reveals that the onset of damage in the battery layers is highly influential in determining the mechanical efficacy of the battery system.

Keywords: Thin foils, Flexible batteries, Stress distribution, Static bending loads, Finite element methods.

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Influence of Printing Parameters on 4D-Printed Samples

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Abstract

4D-printed materials are smart, with shape memory fabricated using 3D printers. Due to their shape-changing capabilities over time, time is considered the fourth dimension. Recently, this technology has gained significant attention due to the growing application of 3D printing across various fields. In the 3D printing process, many parameters, such as printing speed and printing temperature, influence the quality of the prints. Printing temperature affects sample-to-bed adhesion, leading to warping, distortion, color changes from inefficient extrusion, and filament oozing (stringing). This study examines the effect of printing temperature on the permanent shape of 4D-printed samples.

Keywords: 4D-Printing, Shape Memory Polymer, Printing Temperature, Additive Manufacturing, Thermal Effects.

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Improving lightning strike protection by through-thickness direction fibers in 3D CFRP composites using woven carbon fibers and nanoparticles

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Abstract

Lightning strike protection (LSP) in composite structures is crucial in the aerospace industry due to the low electrical conductivity of this material. Efforts to minimize the damage caused by lightning strikes have led to a focus on increasing the electrical conductivity in the through-thickness direction of carbon fiber-reinforced polymers (CFRPs). This characteristic can significantly reduce the severity of damage caused by lightning strikes. 3D composite manufacturing aims to achieve electrical conductivity in the through-thickness direction with woven carbon fibers and convert the insulating carbon/epoxy matrix into an electrical conductor to minimize lightning strike damage. Additionally, the buckling behavior of the 3D composite structure is investigated. To achieve this, carbon fibers woven in the through-thickness direction, 8-fibers, copper nanoparticles and carbon nanotubes (CNTs) were used to increase the electrical conductivity of the matrix and turn it into an electrical conductor. The research found that improving electrical conductivity through the thickness of CFRP layers via the alignment of woven carbon fibers with 8-fibers in CFRP layers can more effectively eliminate artificial lightning current.

Keywords: carbon fiber reinforced polymers (CFRPs), Lightning Strike Protection (LSP), Electrical Conductivity, Carbon nanotubes (CNTs).

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Mechanical characterization of thin-walled Al-honeycomb core sandwich structures reinforced thin-ply carbon-glass fiber facings

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Abstract

This research explores the design and analysis of sustainable thin-walled sandwich panels composed of an aluminum honeycomb core (H) and unidirectional thin-ply carbon (C) and glass fiber fabric (G) face sheets. The study aims to investigate the impact of hybridization and stacking sequence on the static and dynamic mechanical properties of these panels, while maintaining a constant thickness. Hybrid face sheets with three different lay-up configurations—[G2C2G2H]s, [GCG2CGH]s, and [CG4CH]s—were produced and compared to non-hybrid configurations like [G4H]s and [C2H]s as baseline samples. A comprehensive examination of the panels was carried out through 3-point flexural tests, Charpy impact tests, visual inspections, and SEM analysis. The results revealed that hybrid configurations, particularly the [G2C2G2H]s stacking sequence, significantly enhanced the mechanical properties compared to the baseline [G4H]s configuration. Specifically, the hybrid panel exhibited a 100% increase in flexural strength, a 109.1% increase in core shear strength, a 59.87% increase in facing bending strength, and a 70% increase in static energy absorption. Furthermore, the dynamic energy absorption of the [GCG2CGH]s configuration showed a remarkable increase of 123.53%, highlighting the potential benefits of optimizing stacking sequences and hybridization in lightweight sandwich panel design for high-performance applications. These findings suggest that hybridization and stacking sequence optimization can significantly improve the mechanical properties, energy absorption, and overall performance of sandwich panels. The results provide valuable insights into the design of lightweight, high-strength materials for engineering applications where weight and thickness limitations are critical, paving the way for more efficient and durable solutions in various industries.

Keywords: Thin-walled sandwich panel, Al-honeycomb core, Thin-ply carbon fiber, Mechanical properties.

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A-10-1953-1

Quasi static indentation of fully polypropylene sandwich panel

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Abstract

This research investigates the quasi-static penetration behavior of thermoplastic sandwich panels made using ultrasonic welding and polypropylene pins. The panels consist of polypropylene skins and cores, and the use of polypropylene is motivated by its excellent mechanical properties as well as its high recyclability, making it an environmentally friendly material choice. In the ultrasonic welding process, the surface and core layers of the panels are bonded, and polypropylene pins are used to create mechanical connections that enhance the structural integrity of the sandwich panels. Two series of sandwich panels were tested in quasi-static penetration experiments, with different pin spacings: one series with 8 cm pin spacing and another with 5.2 cm spacing. The results of the study show that reducing the pin spacing significantly improves the panels' resistance to penetration. Specifically, the panels with smaller pin spacing (5.2 cm) demonstrated better load distribution and higher resistance to applied forces, leading to increased strength and mechanical performance. This improvement in mechanical properties is accompanied by the environmental benefit of using polypropylene, a recyclable material, which enhances the sustainability of the panels.

Keywords: Thermoplastic sandwich panels, Ultrasonic welding, Polypropylene, Quasi-static penetration, Mechanical properties.

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A-10-1955-1

The Impact of Projectile Velocity on the Ballistic Performance of Layered Composites Consisting of Aluminum, Glass Epoxy Composite and Alumina-Reinforced Elastomer

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Abstract

This study investigates the impact of projectile velocity on laminated composites consisting of aluminum, elastomer reinforced with alumina, and glass epoxy composite layers subjected to high-velocity impacts. High-speed impact tests were conducted using a gas gun and the resulting damage and energy absorption were analyzed. Six categories of elastomer with different percentages of alumina from 0% to 25% were used. Adding alumina increases the hardness of the elastomeric layer, impacting energy absorption efficiency and overall damage patterns. Additionally, specific percentages of alumina led to a greater reduction in final velocity and, consequently, greater energy absorption. Results show that by increasing the velocity from 180 to 190 mm/s, the effect of alumina reinforcement reduced. The mechanisms of damage in various samples at speeds of 180 and 190 m/s were examined, revealing that adding alumina has a more significant effect on reducing output velocity and enhancing energy absorption at lower speeds. Furthermore, based on the tests conducted, an increase of just 10 m/s in input speed in some samples resulted in an approximately 30% increase in output speed.

Keywords: High-velocity impact, Composite materials, Energy absorption, Alumina reinforcement.

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A-10-1957-1

Localized impulsive response of aluminum three-layerd sandwich cylinders with auxetic core

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Abstract

Auxetic materials and structures are increasingly developed in advanced industriessuch as aerospace and aviation. Due to their negative Poissons's ratio, they show interesting static and dynamic behaviors. In this paper, an auxetic structure is used in the core of a thin sandwich cylindrical shell. The effect of geometric parameters of the unit cell of the cellular auxetic core structure is modeled according to the existing relation for the equivalent mechanical properties. Based on the classical shell theory, transient dynamic response of the shell under localized impulse load is investigated using mode superposition method. Verification of the result is done by making comparison with ABAQUS simulationresult and good agreement is observed. Then, parametric study is achieved by studing the influence of the geometric parameters of the unit cell on the transient deformation of the shell. Results show that the corner angle and dimensional aspect ratio of the unit cell govern the maximumdeflection of the shell under a specified loading.

Keywords: Auxetic Core, Unit Cell Geometry, Imlulsive Load, Local Deformation.

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A-10-1957-2

Parametric stability of fiber metal laminate cylindrical shells under harmonic axial loads

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Abstract

In aerospace, due to the fluctuations of excitation sources such as the engine propulsion, there is a possibility of dynamic instability, which is a destructive phenomenon. In this paper, the dynamic stability of fiber-metal-laminate(FLM) cylindrical shells unser a combinational loading of static and harmonic forces in axial direction is investigated using the Love theory for thin-walled shells. The development of a normal mode for motion equations leads to a system of Mathieu-Hill equations. The Bolotin's method is used to determine the istability regions to solve the Mathieu-Hill equations. The effect of the metal-volume-fraction (MVF) parameter and FML configuration on the size and shapeof the unstable areas is discussed. Verifications of the results is done by comparison with those existed in the literature. The results show that MVF and FML Configuration (Al/GFRP 2/1, 3/2, 4/3 and 5/4) are the two important parameters that drastically influence the dynamic stability behavior of the cylindrical shell.

Keywords: Fiber-Metal-Laminate (FML), Cylindrical Shell, Dynamic Stability, Love theory, Mathieu-Hill equations.

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A-10-1958-1

On the comparison between penetrating glue and composite patch in fatigue crack growth retardation in 5456 Al alloy

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Abstract

Cracking is a common cause of failure in industrial components, particularly in structures made from aluminum alloys. This study focuses on the gradual expansion of cracks in these components after they are subjected to loads, ultimately leading to failure. The research compares two primary techniques aimed at increasing material resistance to fracture: composite patching and the use of penetrating glues. The study's methodological rigor is evident in its design, which seeks to identify the most effective method for preventing crack propagation. To achieve this, three CTS specimens made from 5083 aluminum alloy were loaded using a fatigue testing machine to create cracks. A glass woven-epoxy composite patch was applied to the first specimen, while a penetrating glue called selenium was used to fill the crack in the second specimen. All specimens were then subjected to increasing loads until failure, allowing for an evaluation of each method's effectiveness in resisting crack propagation. The results indicated that the composite patch provided superior resistance, increasing the failure load by up to 70%. In contrast, the penetrating glue did not have a significant impact on the failure process.

Keywords: Composte Patch, Penetrating Glue, Aluminum Alloy, fatigue crack growth, Crack Retardation

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A-10-1959-1

Comparison of Different Fiber Distribution Models in Vibration of Functionally Graded Nanocomposite Cylindrical Shells

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Abstract

This research investigates the effects of different functionally graded distribution models on the natural frequencies of a polymer nanocomposite cylindrical shell reinforced with carbon nanotubes. For this purpose, the first and second vibrational frequencies of the functionally graded cylindrical shell under clamped-clamped boundary conditions have been analyzed. In this regard, after property homogenization through the Mori-Tanaka micromechanical model, the problem was analyzed using two-dimensional numerical analysis in axisymmetric problems through the finite element method. Then, to validate the numerical results, the model presented in this research was compared with other references, showing very good agreement between the results of this research and other references, indicating the efficiency of the modeling performed in this research in calculating functionally graded materials. This research showed that the FG-V distribution model has the highest first and second natural frequencies, and the FG-Λ model has the lowest natural frequencies, indicating that the FG-V model was more suitable for reinforcing cylindrical shells than other models.

Keywords: Free vibration, Finite element method, Cylindrical shells, Functionally graded nanocomposites, Carbon nanotubes.

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A-10-1959-2

Vibration Analysis of Nanocomposite Cylindrical Shells Reinforced with Randomly Distributed Wavy Carbon Nanotubes

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Abstract

This article investigates the effects of random orientation of wavy carbon nanotube (CNT) reinforcements on the natural frequencies of a functionally graded nanocomposite cylindrical shell. The results are then compared with the cases of unidirectional distribution along the axial and circumferential directions of the nanocomposite cylinder. The influence of various aspect ratios, including changes in length, radius, and thickness of the nanocomposite cylindrical shell, on its vibrations is also examined. For this purpose, the mechanical properties of the nanocomposite are first homogenized using the Mori-Tanaka micromechanical model. Then, the vibrations of the nanocomposite cylindrical shells reinforced with randomly distributed CNTs are analyzed using finite element method. Finally, this study demonstrates that nanocomposites reinforced with wavy CNTs and having completely random orientation exhibit higher frequencies compared to composites with oriented fiber distribution. Furthermore, increasing the length-to-diameter ratio and decreasing the thickness of the nanocomposite cylindrical shells may lead to a decrease in natural frequencies.

Keywords: Free vibrations, Functionally graded nanocomposites, Random distribution, Wavy carbon nanotubes, Finite element method.

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A-10-1960-1

In-situ growth of binder-free copper-zinc oxide Nanocomposite to enhance supercapacitor electrode performance

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Abstract

Researchers are seeking to develop new energy storage devices, including supercapacitors with outstanding performance, to enhance efficiency and speed in energy storage. Maximizing the performance of supercapacitors requires the selection of materials with suitable capacity and the design of stable and cost-effective electrodes. In this article, we employed a hydrothermal method for the in-situ growth of nanostructures using copper and zinc metals on a nickel foam substrate. The absence of a binder resulted in increased conductivity and significantly improved performance and high capacitance of the supercapacitor. The electrode was evaluated electrochemically using cyclic voltammetry and galvanostatic charge-discharge techniques. The copper-zinc oxide electrode exhibited a specific capacitance of 270 F g^{-1} at a current density of 0.5 A g^{-1}.

Keywords: Supercapacitors, in situ-growth nanostructure, Hydrothermal Method, Copper-Zinc Oxide.

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A-10-1963-1

A nature-inspired pattern for improvement in-plane compression of honeycomb structures

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Abstract

Honeycomb structures are widely used in various aspects of the industry, such as aerospace, marine, automotive, and medicine. Improving the mechanical properties of these structures has received significant attention in recent years. The main aim of the current research is to promote the performance of honeycomb structures by changing the honeycomb cell topology. In this study, a Fibonacci-based pattern was employed to enhance the mechanical performance of conventional honeycomb structures under in-plane compression. The conventinal and Fibonacci-pattern honeycomb samples were manufactured through the fused filament fabrication (FFF) method. Polylactic acid (PLA) filament was used to fabricate the specimens. The 3D-printed samples were tested under in-plane compression loading conditions. It was observed that in the presence of Fibonacci-based pattern, the weight of honeycomb structure is not enhanced significantly. The experimental results manifested that by changing the topology of conventional honeycomb structures, their strength and modulus were increased remarkably.

Keywords: Honeycomb, PLA, Nature-inspired structure, 3D printing, In-plane compression properties.

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A-10-1965-1

A chiral-based topology for improvement the mechanical properties of auxetic structures

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Abstract

Auxetic structures due to their unique properties have studied by a lot of researchers in last decades. These structure have zero or negative Poission's ratio under loading. Different topologies have been proposed by researchers to obtain their better performance. Chiral-based topologies are important category of the auxetic structures. In chiral-based topologies, various geometrical patterns such as square, hexagonal, and triangular are connected using simple links. In the current research, it was tried to develop in a novel chiral-based topology for improving their properties. Polylactic acid (PLA) filament was provided to manufacture the specimens using 3D printing FDM technology. The 3D printed chiral-based structures made of PLA polymer were tested under in-plane compression loading states. It was displayed that the novel chiral-based topology, the weight of structure is not increased remarkably. The emperical results demonstrated that by changing the topology of conventional chiral-based structures, their mechanical properties were improved.

Keywords: Auxetic, PLA, 3D printing, In-plane compression properties.

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A-10-1970-1

Application of biodegradable polymeric composites in cartilage tissue regeneration using the electrospinning approach

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Abstract

Cartilage tissue, despite its critical role in joint function and structural support of the skeletal system, presents significant challenges in treatment due to its limited self-repair capacity and complex architecture. Conventional approaches, such as autologous and allogeneic transplantation, face inherent limitations, which leads to increased attention on tissue engineering using biodegradable composites as a desirable alternative. In this context, the electrospinning technique has emerged as an efficient and cost-effective method for producing nanofibrous composite scaffolds that mimic the structure of the natural extracellular matrix (ECM) of cartilage. These composite scaffolds, combining natural and synthetic polymers with reinforcing materials or additives, provide a conducive environment for the growth and proliferation of chondrocytes or mesenchymal stem cells, facilitating cartilage tissue regeneration. The use of various composite formulations, combined with process parameter optimization and enhanced cell-scaffold interactions, holds potential for the development of scaffolds with superior mechanical, biological, and structural properties, tailored for cartilage repair applications.

Keywords: Electrospinning, Polymeric Composites, Cartilage Tissue, Biodegradable Scaffold

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A-10-1970-2

Development of metal-based composites with anti-inflammatory properties for joint regeneration

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Abstract

Osteoarthritis (OA) is a degenerative joint disorder characterized by progressive cartilage degradation, subchondral bone changes, and chronic inflammation. Conventional treatments primarily target symptom relief but often fail to address the underlying inflammatory pathways effectively. On the other hand, recent advancements in composite materials, particularly those incorporating anti-inflammatory metals such as gold, silver, zinc, and selenium, have shown promising therapeutic potential. These composites offer dual benefits by modulating oxidative stress and inflammatory signaling pathways while promoting cartilage regeneration. This paper focuses on the development of multifunctional composites for intra-articular applications, utilizing metal nanoparticles embedded within biocompatible polymer matrices. These materials are designed to deliver sustained anti-inflammatory effects directly to the inflamed joint environment, minimizing systemic side effects. Furthermore, advanced fabrication techniques such as nanostructuring and targeted delivery mechanisms further enhance the therapeutic efficacy of these composites. The findings highlight the potential of composite-based therapeutics in transforming osteoarthritis management, offering a targeted and long-lasting solution for this pervasive disease.

Keywords: Anti-inflammatory Composites, Metallic Nanoparticles, Cartilage, Biocompatible Materials

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A-10-1972-1

Creep behavior of KER 828 epoxy resin reinforced by MWCNT: experimental approach

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Abstract

The application of adhesives, with the advent of nanoparticles, has introduced new features in modern design. The addition of nanoparticles to adhesives can significantly improve the performance and durability of adhesive joints. Current study experimentally investigates the creep behavior of KER 828 epoxy resin that is reinforced with multi-walled carbon nanotubes (MWCNTs) at varying weight percentages of 0.25%, 0.5%, 0.75%, and 1%. Uniaxial creep tests were conducted on bulk specimens under two different loads, 7.5 and 9 MPa. The effect of adding MWCNTs to the pure epoxy adhesive on the creep behavior of this type of epoxy is evaluated. The results demonstrate that epoxy reinforced with 0.5% by weight of carbon nanotubes is the optimal mixture. Under constant loading, this formulation exhibit superior creep resistance compared to the pure epoxy and adhesive.

Keywords: Multi-walled carbon nanotubes (MWCNTs), Creep behavior, KER 828 epoxy resin, Experimental investigation

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A-10-1972-2

Experimental Investigation of the Effect of Adding MWCNT on Crack Growth in Mode III Fracture of Adhesive Joints

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Abstract

Epoxy adhesives and resins are widely used in various engineering fields and applications due to their reliable mechanical properties, such as high strength and elastic modulus, low creep, and excellent performance at elevated temperatures. However, one of their main drawbacks is their poor resistance to crack growth. Therefore, any effort to enhance the fracture resistance of these joints, including the addition of nanoparticles to epoxy resins, is of great significance. In this study, the effect of adding MWCNT to KER 828 epoxy adhesive at different weight percentages (0.25%, 0.5%, and 1% wt.) on crack growth in Mode III fracture of adhesive joints with polymeric substrates was evaluated. The results showed that adding 0.5% wt. MWCNT to the epoxy could increase joint strength by approximately 30% and improve fracture toughness.

Keywords: Multi-walled carbon nanotubes (MWCNTs), Crack growth, Mode III fracture, KER 828 epoxy resin, Polycarbonate substrates

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A-10-1975-1

Investigating the Fe-Cu-Ni composite formation using elemental powders

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Abstract

In this research, composites were prepared with different molar ratios of Fe, Cu and Ni. The effect of stoichiometric ratios on the microstructure and density of the products was investigated. It was found that with the increase of copper ratio, the amount of available holes increases and the density of the obtained part decreases.

Keywords: Fe-Cu-Ni Composite, Elemental powder, Density, Prosity

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A-10-1975-2

Thermodynamic Investigation of Possible Composite Compound Formation from SiO_2-Al_2O_3 Reaction

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Abstract

In this research, Al-Si-O ternary system was studied at first. It was found that Al_2SiO_2 can be produced with a specific ratio of Al_2O_3 and SiO_2. Subsequently, the stability of the phases that can form in Al_2O_3-SiO_2 system was calculated and predicted via HSC software using the Gibbs free energy of formation. The results showed that Al_2SiO_5 is the most stable phase in comparison to SiO_2 and Al_2O_3. Therefore, it is possible to form Al_2SiO_5 using SiO_2 and Al_2O_3 powder mixture.

Keywords: Al_2O_3, SiO_2, Al_2SiO_5, Reaction, Composite

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A-10-1975-3

Investigation of TiO_2-Al_2O_3 Composite, Applications, Thermodynamics, and Producible Compounds

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Abstract

In this research, the applications of Al_2O_3-TiO_2 composite will be stated, then the thermodynamics of the binary system of these two oxides will be studied. Finally the compounds that can be produced from their reaction will be stated. The results of this research show that titania and alumina have a wide variety of applications in the industry due to their special and unique properties, and by compositing them, the valuable properties of both oxides can be used simultaneously.

Keywords: TiO_2, Al_2O_3, Composite, Application, Thermodynamic, Compound

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A-10-1983-1

An Experimental Investigation of the Creep Behavior of Single-Lap Adhesive Joints with PMMA Sheets

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Abstract

The design and selection of joints in various structural components are considered key topics in mechanical engineering. The addition of nanoparticles to adhesives can significantly impact the performance and durability of adhesive joints. Given the extensive use of polymer material joints in the industry, the primary objective of this research is to investigate the creep behavior of single-lap adhesive joints made of PMMA polymer sheets in the presence of CNT nanoparticles in Araldite 2015 adhesive. The results indicated that the creep behavior of single-lap adhesive joints reinforced with 0.5 wt.% CNT under 0.075 and 0.9 MPa loads demonstrated superior strength compared to pure epoxy adhesive.

Keywords: Single-lab adhesive joints, Creep behavior, Araldite 2015 resin epoxy, Carbon-Nano-Tubes (CNTs), PMMA sheets

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A-10-1984-1

Numerical Investigation of Tensile Properties of GFRP Composites Reinforced with Stainless Steel Wires

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Abstract

One of the critical parameters in the design and construction of various types of vessels is the selection of appropriate materials for their fabrication. Due to their lightweight and corrosion-resistant properties, GFRP composites are widely used in the marine industry. Reinforcing these composites with stainless steel wires can be an effective solution to enhance their performance under severe working conditions and various dynamic loads. In current study, nonlinear finite element analyses were conducted using quasi-dynamic loading through the ABAQUS software. In the finite element simulations, stainless steel wires were modeled as cylindrical elements with a diameter of 0.3 mm, and the GFRP sheets were represented as single-layer plates with a thickness of 0.2 mm. The results demonstrated that GFRP composites reinforced with stainless steel wires exhibit significantly higher tensile strength compared to unreinforced GFRP composites.

Keywords: Glass fiber reinforced polymer (GFRP), Stainless steel wires, Finite element method, Tensile strength, Numerical investigation.

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Predicting Fatigue Behavior of Glass-Epoxy Composites with Initial Damage

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Abstract

Fatigue is a key factor in the failure of polymer matrix composites, affecting their service life and performance. This study investigates the effect of initial damage on the fatigue behavior and lifespan of glass-epoxy laminates using infrared thermography to monitor thermal changes. The results showed that delamination reduced fatigue life by 76.6%. Damaged specimens experienced higher temperature increases due to greater stress concentration and faster crack propagation. Finally, a predictive model using entropy generation and thermal data effectively estimated fatigue life, aiding in optimizing composite design and safety.

Keywords: Laminated Composites, Initial Damage, Thermal Analysis, Fatigue Life Prediction.

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