

Materials

Papers Presented at the AIAA SciTech Forum and Exposition
2025

Orlando, Florida, USA
6-10 January 2025

ISBN: 979-8-3313-1804-8

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

The contents of this work are copyrighted and additional reproduction in whole or in part are expressly prohibited without the prior written permission of the Publisher or copyright holder. The resale of the entire proceeding as received from CURRAN is permitted.

For reprint permission, please contact AIAA's Business Manager, Technical Papers. Contact by phone at 703-264-7500; fax at 703-264-7551 or by mail at 34922 Uwptkug'Xcmg{ 'F tkxg."Uwkug"422, Reston, VA 20191, USA.

TABLE OF CONTENTS

HIGH PERFORMANCE MATERIALS FOR EXTREME ENVIRONMENTS

Development and Characterization of Quartz/Polysiloxane Low-Density Flexible Ablators Using Varying Architectures	1
<i>Steven D. Kim, Remy M. Feru, Ben Rech, Joseph H. Koo</i>	
C-C Composite Ablation and Oxidation in Hypersonic Airflow	24
<i>Ryan Bencivengo, Alin Stoica, Sergey B. Leonov, Richard Gulotty</i>	
Strain Rate Dependent Peridynamics Model of High-Speed Spherical Hail Impact.....	40
<i>Batuhan Alicioglu, Ugur Can, Ibrahim Guven</i>	

NANOSTRUCTURED MATERIALS II

Comparison of Interfacial Delamination of Nanoparticle Modified Reinforcements in Functional Composites	56
<i>Alexander Skoppe, Yuxuan Wu, Foram Madiyar, Sirish Namilae</i>	
Structural Health Monitoring in Epoxy/CNT Composites Exposed to High Doses of UV Radiation.....	64
<i>Joseph E. Cunningham, Brett Segal, Viswajit Talluru, Gary D. Seidel</i>	
Weibull Analysis of Multiscale Properties of Nanoparticle Bundles in Nanomembrane	70
<i>Masoud Yekani Fard, Tyler Norkus, Maximillian Westby</i>	

AI/ML IN STRUCTURES AND MATERIALS II

Application of Deep Learning for Defect Detection by X-Ray Computed Tomography in Large Aerospace Structures	82
<i>Abdullah Metiner, Yuri Nikishkov, Mustafa T. Kocyigit, Andrew Makeev</i>	
Comparative Analysis of Synthetic Microstructure Reconstruction for Metallic Aerospace Alloys with Generative Networks	97
<i>Zekeriya Ender Eger, Waris Khan, Kuang Kuang, Veera Sundaraghavan, Pinar Acar</i>	
Fusing Imbalanced Data Via Physical Condition-Aware Surrogate Modeling.....	110
<i>Yulun Wu, Yumeng Li</i>	

TESTING AND CHARACTERIZATION OF MATERIALS

Development, Manufacturing, Characterization, and Modeling of a Novel Alumina/Polysiloxane/Boron Carbide Ablative Composite	121
<i>Colin M. Yee</i>	
Flexural Analysis of a Fluid-Filled, Sandwich Core Composite with a Biaxial Clamped Plate Test	136
<i>Gabriel Maestas, Ashok K. Ghosh</i>	
QUAD and DOUBLE-DOUBLE Laminates Under Cylindrical Bending: A Virtual Characterization Study.....	149
<i>Antonio F. Avila, Lidianne Mapa</i>	

Photogrammetry Methods for Transient Surface Recession Measurement of Materials During Aerothermal Testing	161
<i>Remy M. Feru, Colin M. Yee, Ben Rech, Joseph H. Koo</i>	

AI/ML IN STRUCTURES AND MATERIALS I

Optimizing Aerospace Engineering: A Machine Learning Strategy for Accelerated Structural Substantiation	172
<i>Yuval Freed, Maoz Koren, Boris Dorfman</i>	
Probabilistic Fatigue Life Prediction of AM-Built Alloy Using Physics-Guided Neural Network	182
<i>Rakesh Balamurugan, Jie Chen, Changyu Meng, Yongming Liu</i>	
Deep-Learning-Based Optimization of Non-Periodic Porous and Composite Materials for Aerospace Structures	193
<i>Saltuk Yildiz, Zekeriya Ender Eger, Pinar Acar</i>	
Defect Detection During Composite Processing Using Machine Learning Methods.....	206
<i>Pragathi Agraharam Chan, Deepak Kumar, Yongxin Liu, Sirish Namilae</i>	

NANOSTRUCTURED MATERIALS I

Deconvolution of Atomic Force Microscopy Data from the Effects of Destructive Indentation in Heterogeneous Polymer Composite Systems	213
<i>Maximillian Westby, Brian Raji, Joshua D. Wilbur, Masoud Yekani Fard</i>	
Low-Velocity Impact Response of IM7/5320-1 Unidirectional Laminates Reinforced with Vertical Aligned Carbon Nanotubes	223
<i>Emmanuel Vielma, Daniela Garcia, Vipul Ranatunga, Alejandra G. Castellanos</i>	
Tailoring Solvothermal Synthesis for Ti-MIL-125 Nanoparticles.....	241
<i>Selis Onel, Elif Gökçen Dilci</i>	
Enhancing Composite Material Lifespan: The NAWAStitch Advantage in Mechanical Strength, Fatigue and Impact Resistance Properties	248
<i>Kevin Retz</i>	
Fabrication of High Volume Fraction Aligned Carbon Nanotube/Poly(Methyl Methacrylate) Nanocomposite Laminates	258
<i>Yuying Lin, Carina Xiaochen Li, Erick Gonzalez, Jingyao Dai, Luiz Acauan, Brian L. Wardle</i>	

MULTISCALE MODELING

Crystal Viscoplastic Modeling of Full-Scale Single Crystal and Directionally Solidified Nickel-Base Superalloy Turbine Blade	265
<i>Navindra Wijeyeratne, Ali P. Gordon, Firat Irmak</i>	
Development of a Material Response Model for Carbon/Polysiloxane Ablative	286
<i>Kaelyn Wagner, Samantha Bernstein, Colin M. Yee, Joseph H. Koo</i>	
Microscale Constitutive Model Sensitivity on Multiscale Modeling of Fiber Reinforced Composites	299
<i>Jamal Husseini, Scott Stapleton, Eric Carey, Evan J. Pineda</i>	

Simulation of Fracture at Epoxy/ Silica Interface with Uncertainty Quantification.....	314
<i>Sankha Subhra Aditya, Mohammad Din Al Amin, Sameer B. Mulani, Samit Roy</i>	

FATIGUE AND FRACTURE

Finite Element Analysis of Ductile Failure Under Severe Shear.....	326
<i>R. Vigneshwaran, Amine Benzerga</i>	
A Multiscale Modeling Approach for Progressive Damage Analysis of Notched Ceramic Matrix Composites	338
<i>James Roach, Dianyun Zhang</i>	
Rootfinding and Optimization Techniques for Solving Nonlinear Systems of Equations Arising from Cohesive Zone Models	350
<i>Alberto Cattaneo, Varun Shankar, Michael Ballard</i>	
Modified Mode-I Traction Separation Law for Z-Pinned Interface	363
<i>Paul Davidson</i>	
Observations About Load-Displacement Plots Beyond the Maximum Load from Short Beam Strength Testing: The Case of CNT-Reinforced CFRPs.....	371
<i>Ricardo Braga Nogueira Branco, Namiko Yamamoto, Jackson A. Schwarz, Charles E. Bakis</i>	
Investigating the Viability of Material Extrusion Additive Manufacturing of Inconel 718 for Fatigue Driven Applications.....	377
<i>Matthew B. Mathesius, Erica Kozak, Onome Scott-Emuakpor, Sanna F. Siddiqui</i>	

STRUCTURES AND MATERIALS IN EXTREME ENVIRONMENTS

Micrometeoroid Impact Detection on Lunar Structures: A Peridynamics Approach.....	391
<i>Bala P. Shanmugam, Gary D. Seidel</i>	
Interface Detection for Fluid-Structure Interaction Modeling with Material Failure and Fragmentation.....	403
<i>Ugur Can, Monal Patel, Manuel Viqueira-Moreira, Christoph Brehm, Ibrahim Guven</i>	
Size-Dependent Thermomechanical Contact Analysis Via Boundary Element Formulation	416
<i>Ali Reza Hadjesfandiari, Li Lin, Saptarshi Bandyopadhyay, Gary F. Dargush</i>	
Launchable Lunar Anchors.....	431
<i>Kalind Carpenter, Saptarshi Bandyopadhyay, Hannah Stuart, Ashish Goel, Scott Moreland, Christine Gebara, Elizabeth Jens, Benjamin Hockman</i>	

MATERIALS FOR ADDITIVE MANUFACTURING

Additively Manufactured Spinodal Metamaterials for Aerospace Systems: A Data-Driven Design Framework.....	439
<i>Saltuk Yildiz, Zekeriya Ender Eger, Pinar Acar</i>	
Optimization of Post-Processing Heat Treatment for an High-Performance Aerospace Grade Aluminum Alloy Manufactured by Laser Powder Bed Fusion (LPBF)	453
<i>Marco Bona, Antonio M. Grande</i>	

Designing Anisotropic Porosity in Binder Jetted Green Parts	460
<i>Reshma Kubsad, Sirish Namilae</i>	
Peridynamics Investigation of the Compressive Behavior of Additively Manufactured Porous Titanium Structures	467
<i>Riza Kaan Gonuleri, Michael W. Czabaj, David J. Cohen, Barbara D. Boyan, Zvi Schwartz, Ibrahim Guven</i>	
Characterization of Interlayer Healing in PETG Parts Made with Fused Filament Fabrication.....	480
<i>Anna Keim, Cyra Hanson, Cameron McCoy, Monique McClain</i>	
Rare-Event Uncertainty Quantification of Additively Manufactured Composites with High-Throughput Tests	490
<i>Shafi Shahriar, Ryan Weng, Robert Hudson, Logan Gotwalt, Wen Luo</i>	

INTEGRATED COMPUTATIONAL MATERIAL ENGINEERING (ICME)

Inverse Design of Snap-Through Multiscale Lattice Structures.....	499
<i>Charlie Aveline, Dilaksan Thillaithovan, Robert Hewson, Matthew J. Santer</i>	
Application of CUF for the Structural Optimization of Wings.....	513
<i>Donato Cardone, Rauno Cavallaro, Andrea Cini, Marco Petrolo, Enrico Zappino</i>	
Design of Functionally Graded Inconel 718 Alloy Structures by Developing Material Property Closures.....	533
<i>Md Maruf Billah, Pinar Acar</i>	
Shape Optimization of Porous Electrode Batteries.....	550
<i>Murtaza Bookwala, Alexandre T. Guibert, Filippo Agnelli, Alicia A. Kim</i>	
Microstructural Uncertainty Propagation Over Meso and Macro-Scale Mechanical Properties of Aerospace Metallic Alloys	564
<i>Waris Khan, Md Maruf Billah, Pinar Acar</i>	

MULTIFUNCTIONAL MATERIALS FOR AEROSPACE I

Experimental Investigation of Sensing in Polymer Bonded Energetic Materials with MWCNTs Exposed to Elevated Temperature.	577
<i>Viswajit Talluru, Shivanash Shah, Gary D. Seidel</i>	
Charging Behaviors of a Piezoelectric Energy Harvester.....	586
<i>Tian-Bing Xu, Bingqi Zhao</i>	
Investigating the Relationship of Molecular Attributes and Intrinsic Self-Healing Efficiency in PDMS Based Polymers with Application Towards Coatings in UAVs	601
<i>Jenny B. Vu, Foram Madiyar, Forrest Dohner, Logan Shaffer</i>	

AI/ML IN STRUCTURES AND MATERIALS III

Physics-Informed Machine Learning Model for Ceramic Matrix Composite Creep.....	609
<i>Mohamed Hamza, Luke Borkowski, Aditi Chattopadhyay</i>	

Efficient Estimation of Hierarchical Honeycomb Mechanical Properties by a Knowledge-Extraction-Based Surrogate Model	624
--	-----

Fakhreddin Emami, Md. Amanullah Kabir Tonmoy, Chadwick D. Severt, Andrew J. Gross, Yi Wang

A Physics-Informed Neural Network Based Modelling of Vibration of a Beam with Breathing Crack	636
---	-----

Sumanth Yegurla, Bhavana Bollarapu, Mira Mitra

A Convolutional Neural Network for Enhancement of Multi-Scale Localization in Fiber-Reinforced Polymer Matrix Composite Representative Unit Cells.....	641
--	-----

Cristian Sanchez, Evan J. Pineda, Brandon L. Hearley, Joshua Stuckner, Trenton M. Ricks, Peter A. Gustafson

PROCESS MODELING OF AEROSPACE MATERIALS

Composite Cure Process Modeling and Simulation – a Mean-Field Based Multiscale Method	665
---	-----

Deepak Kumar Patel, Huidi Ji, Ross McLendon, Juan Hurtado

Repeatable Methodology for Analysis and Decision Making Regarding Strategic Aerospace Material Supply Chains	674
--	-----

Lin Al Atik, Maxwell Hoem, Titien Berberian, Ghizlane Jari, Neil R. Weston, Dimitri Mavris

Computational Study on Binder Jet Additive Manufacturing of Ceramic Materials	696
---	-----

Osama Aljarrah, Jun Li

AI/ML IN STRUCTURES AND MATERIALS IV

A Computationally Efficient Abstract Model for Capturing the Nonlinear Response of Bolted Joints.....	705
---	-----

Aditya B. Bansod, P. M. Anilkumar, Sven Scheffler, Raimund Rolfes

Failure Prediction of the Three-Dimensional Woven Composite Wing Box by Deep Shapley Additive Explanation.....	715
--	-----

Yeonhi Kim, Jungsun Park

Discovery of High-Entropy Ultra-High Temperature Ceramics Through Neural Networks	723
---	-----

Matthew Arviso, Enrique A. Bermudez, Alejandro F. Ornelas, Alejandra G. Castellanos

MICROSTRUCTURE CHARACTERIZATION AND MODELING

Flow-Induced Strain of Parachute Textiles with Multiscale Digital Image Correlation.....	736
--	-----

Cutler Phillippe, David Ehrhardt, Francesco Panerai, Laura Villafaña Roca

Deep Learning with Uncertainty Quantification for X-Ray CT Segmentation of Microdamage in Advanced Composites	750
---	-----

Reed Kopp, Rohan Patel, Xinchen Ni, Brian L. Wardle

Effect of Embedment Depth of Hard Inclusions on Force-Displacement Curves Through AFM and FEA	767
---	-----

Jett J. Church, Brian Raji, Joshua D. Wilbur, Masoud Yekani Fard

Coupled Microstructural Analysis and Simulated Mechanical Testing of Ablative Materials with Empirical Validation.....	781
--	-----

Samantha Bernstein, Remy Feru, Akshar Mashruwala, Steven D. Kim, Wei Li, Joseph H. Koo

Calculating Effective Mechanical and Thermal Properties of Rayon FiberForm.....	799
<i>Khaleda Akter Maya, Donglai Liu, Hailong Chen</i>	
Manufacturing of Durable Riblet Coating for Green Aviation	808
<i>Abdelkader Benhalima, Damien Maillard, Naiheng Song, Lucy Li, Evgueni Bordatchev</i>	

Author Index