

Materials

Papers Presented at the AIAA SciTech Forum and Exposition
2021

Online
11-15 & 19-21 January 2021

ISBN: 978-1-7138-2625-5

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 12700 Sunrise Valley Drive, Suite 200, Reston, VA 20191, USA.

TABLE OF CONTENTS

TESTING AND CHARACTERIZATION I

INSPECTION OF FIBER WAVINESS IN CARBON FIBER LAMINATES BY TALBOT-LAU X-RAY GRATING INTERFEROMETRY	1
<i>Jonathan Glinz, Michael Thor, Santhosh Ayalur-Karunakaran, Johann Kastner, Sascha Senck</i>	
EFFECTS OF LONG-TERM EXPOSURE TO HEAT AND HUMIDITY ON SUB-MICRON SCALE PROPERTIES IN COMPOSITE MATERIALS.....	9
<i>Masoud Yekani Fard, Brian Raji</i>	
EFFECT OF ELECTRON FLUX ON THE DEGRADATION OF ORGANIC POLYMERS IN A SIMULATED GEO ENVIRONMENT.....	16
<i>Daniel P. Engelhart, Vanessa J. Murray, Elena A. Plis, Karin Fulford, Dale C. Ferguson, Ryan Hoffmann</i>	

HIGH STRAIN COMPOSITES MATERIALS STRUCTURES, MATERIAL CHARACTERIZATION, AND MODELING I

EFFECTS OF FIBER NON-LINEARITY AND MATRIX TYPE ON THE REALIZATION OF FOLDABLE STRUCTURES.....	23
<i>Arthur Schlothauer, Dominik Cueni, Georgios A. Pappas, Paolo Ermanni</i>	
NUMERICAL MODELING OF STRESS CONCENTRATION AROUND FAILED FIBERS IN UNIDIRECTIONAL COMPOSITES	37
<i>Francisco Lopez Jimenez</i>	
UNFURLABLE SPACE STRUCTURE OPTIMIZATION.....	47
<i>Munira Sibai, Daisaku Inoyama, Tom G. Stoumbos, Rakesh K. Kapania</i>	

TESTING AND CHARACTERIZATION II

HIGH-RATE IN-PLANE SHEAR TESTING OF CFRP USING THE SPLIT HOPKINSON TENSION BAR.....	65
<i>Noah Ledford, Mathieu Imbert, Michael May</i>	
EFFECTS OF CARBON NANOTUBE FILLER ON MECHANICAL AND ELECTRICAL PROPERTIES OF FUSED FILAMENT FABRICATED POLYETHERKETONEKETONE	73
<i>Greg Cobb, Travis E. Shelton, Carl Hartsfield, Ryan Kemnitz</i>	
MECHANICAL CHARACTERIZATION AND BRITTLE FAILURE OF STONY METEORITE (ABA PANU) USING DIGITAL IMAGE CORRELATION.....	84
<i>Md Fazle Rabbi, Siddhant Datta, Aditi Chattopadhyay, Laurence A. Garvie, Erik Asphaug, Desiree Cotto-Figueroa</i>	

HIGH STRAIN COMPOSITES MATERIALS STRUCTURES, MATERIAL CHARACTERIZATION, AND MODELING II

EXPERIMENTAL CHARACTERIZATION OF THE DIMENSIONAL STABILITY OF DEPLOYABLE COMPOSITE BOOMS DURING STOWAGE	94
<i>Joshua E. Salazar, Juan M. Fernandez</i>	
SOME CONSIDERATIONS INVOLVING TESTING GUIDELINES FOR LARGE CURVATURE BENDING OF HIGH STRAIN COMPOSITES USING THE COLUMN BENDING TEST	116
<i>Ajay H. Sharma, Riley Perez, Nicholas W. Bearns, Tj Rose, Francisco Lopez Jimenez</i>	
THERMOVISCOELASTIC MODELING OF THIN-PLY HIGH STRAIN COMPOSITES BY MEANS OF MULTISCALE BEAM MODELS	129
<i>Orzuri Rique Garaizar, Su Tian, Juan M. Fernandez, Andrew Bergan, Wenbin Yu</i>	
NONLINEAR HOMOGENIZATION OF FINITELY DEFORMED VISCOELASTIC-VISCOPLASTIC COMPOSITES USING MECHANICS OF STRUCTURE GENOME	156
<i>Liang Zhang, Wenbin Yu, Juan M. Fernandez, Andrew Bergan</i>	
MULTISCALE SIMULATION OF DEPLOYABLE COMPOSITE STRUCTURES	192
<i>Yufei Long, Orzuri Rique Garaizar, Juan M. Fernandez, Andrew Bergan, Wenbin Yu</i>	

NANOSTRUCTURED MATERIALS I

POLYSILOXANE/AEROGEL NANOCOMPOSITES: MORPHOLOGY, THERMAL, AND FLAME-RESISTANT PROPERTIES	213
<i>Hao Wu, Steven D. Kim, Joseph H. Koo</i>	
FLEXIBLE NANO-REINFORCED POLYMERIC PROXIMITY SENSORS	220
<i>Reza Mohemani, Mangilal Agarwal, Hamid Dalir</i>	
MULTISCALE MODELING OF DAMAGE RESPONSE IN COMPOSITES REINFORCED WITH CNT FIBERS	229
<i>Neslihan Genckal, Stefan J. Povolny, Gary D. Seidel, Shengfeng Cheng</i>	

APPLICATION OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING TO PROBLEMS IN STRUCTURES AND MATERIALS

EFFICIENT CLUSTERING OF THE DYNAMIC RESPONSE OF A STRUCTURE SUBJECT TO IMPULSE LOADING	242
<i>Donovan K. Birky, Ivan Guardiola, Andrew Young</i>	
MACHINE-LEARNING BASED DESIGN OF NEAR-SPHERICAL SHELLS UNDER EXTERNAL PRESSURE	252
<i>Mitansh Doshi, Xin Ning</i>	
SURROGATED FINITE ELEMENT MODELS USING MACHINE LEARNING	265
<i>Maria Chierichetti, Fatemeh Davoudi, Daniel Huang, Poojitha Vurturbadarinath, Matthew Linzmeyer</i>	
A CONVOLUTIONAL NEURAL NETWORK FOR MULTISCALE MODELING OF COMPOSITE MATERIALS.....	271
<i>Alexander Sorini, Evan J. Pineda, Joshua Stuckner, Peter A. Gustafson</i>	

NANOSTRUCTURED MATERIALS II

FRACTURE BEHAVIOR IN POLYMER NANOCOMPOSITES: A MOLECULAR DYNAMICS STUDY	279
<i>Samit Roy, Tanvir Sohail</i>	
CARBON NANOTUBE/EPOXY SUBMICRON FILAMENTS FOR COMPOSITE REINFORCEMENT APPLICATIONS	298
<i>Nojan Aliahmad, Vidya Wable, Pias Kumar Biswas, Iran Hernandez, Hamid Dalir, Mangilal Agarwal</i>	
EFFECT OF MATRIX VISCOELASTICITY ON PIEZORESISTIVITY OF CARBON NANOTUBE POLYMER COMPOSITES	302
<i>Wolfgang J. Klimm, Kawai Kwok</i>	
QUANTITATIVE STRUCTURE-PROPERTY RELATIONSHIP STUDY OF 1D-ALIGNED SOFT MAGNETIC NANOCOMPOSITES FOR FAST ACTUATION	316
<i>Yagmur Atescan, Ricardo Braga Nogueira Branco, Kohei Oyama, Anna Madra, Namiko Yamamoto</i>	

ENABLING NEXT-GENERATION MATERIALS

IN-SITU HEALING OF MODE-I FATIGUE CRACK IN FIBER REINFORCED COMPOSITES	326
<i>Nilesh J. Vishe, Sameer B. Mulani, Samit Roy</i>	
INTEGRATED FLUID AND MATERIALS MODELING OF ENVIRONMENTAL BARRIER COATINGS	335
<i>David Newsome, Rae Waxman, Andreas F. Hoffie, Ashok Raman, Debasis Sengupta, Stewart Silling</i>	
MACRO-SCALE TESTING AND MICROMECHANICS MODELING OF FRACTURE BEHAVIORS FOR BORON CARBIDE COMPOSITES WITH HIERARCHICAL MICROSTRUCTURES	343
<i>Jingyao Dai, Evan J. Pineda, Brett A. Bednarczyk, Jogender Singh, Namiko Yamamoto</i>	
NANOSTRUCTURED V ₂ O ₅ -SWCNTS BASED LITHIUM ION BATTERY FOR MULTIFUNCTIONAL ENERGY STORAGE COMPOSITES: MATERIALS SYNTHESIS AND FABRICATION	356
<i>Pias Kumar Biswas, Nojan Aliahmad, Hamid Dalir, Mangilal Agarwal</i>	

MATERIALS AND DESIGNS FOR ADDITIVE MANUFACTURING

3D-PRINTED FLEXIBLE STRUCTURES WITH EMBEDDED DEFORMATION/DISPLACEMENT SENSING FOR THE CREATIVE INDUSTRIES	364
<i>Reza Moheimani, Mangilal Agarwal, Hamid Dalir</i>	
ABLATION PERFORMANCE OF 3D PRINTED CONTINUOUS CARBON FIBER-REINFORCED PEEK	375
<i>Hao Wu, Steven D. Kim, Colin M. Yee, William P. Fahy, Zack August, Zhe Liu, Joseph H. Koo</i>	

QUANTIFICATION OF SURFACE-NEAR POROSITY IN ADDITIVELY MANUFACTURED ALUMINUM BRACKETS USING X-RAY MICROCOMPUTED TOMOGRAPHY	388
<i>Sascha Senck, Michael Hapfl, Michael Scheerer, Jonathan Glinz, Thomas Reiter, Johann Kastner</i>	

COMPARISON OF HIGH STRAIN RATE MECHANICAL PROPERTIES OF ADDITIVELY AND TRADITIONALLY MANUFACTURED INCONEL 718 SAMPLES	395
<i>Russell A. Rowe, Bailee Gilbreath, Anthony Palazotto, Keivan A. Davami</i>	

INTERNAL GEOMETRY EFFECTS ON INHERENT DAMPING PERFORMANCE OF ADDITIVELY MANUFACTURED COMPONENTS.....	403
<i>Onome E. Scott-Emuakpor, Austin Schoening, Andrew Goldin, Joseph Beck, Brian Runyon, Tommy George</i>	

MULTIFUNCTIONAL MATERIALS

SUB-MICRON SCALE PROPERTIES OF INTERPHASE OF CARBON NANOTUBE AGGLOMERATES AND CARBON FIBER MONOFILAMENTS IN COMPOSITE MATERIALS	414
<i>Masoud Yekani Fard</i>	

HYPERVELOCITY IMPACT RESPONSE OF POLYETHYLENE PLATES	422
<i>Jacob Rogers, Paul T. Mead, Khari Harrison, Kalyan Raj Kota, James D. Leaverton, Gavin Lukasik, Waruna D. Kulatilaka, Justin W. Wilkerson, Thomas E. Lacy</i>	

INVESTIGATION OF ACTUATION-SIZE EFFECTS IN PH-RESPONSIVE POLYMER ARTIFICIAL MUSCLES	432
<i>Sevketcan Sarikaya, Frank Gardea, Jeffrey Auletta, Jamshid Kavosi, Alex Langrock, David Mackie, Mohammad Naraghi</i>	

MULTISCALE AND FATIGUE MODELING I

BUCKLING OF AXIALLY LOADED NANOBEAMS MODELED WITH THE GENERAL NONLOCAL THEORY	439
<i>Samantha M. Ceballes, Abdessattar Abdelkefi</i>	

PREDICTION OF VISCOELASTIC BEHAVIOR OF PARTICULATE COMPOSITES BY A TIME-DOMAIN HOMOGENIZATION APPROACH	448
<i>Hangil You, Hyoungjun Lim, Hoil Choi, Gunjin Yun</i>	

GEOMETRIC REQUIREMENTS FOR MODELING POLYCRYSTALLINE REPRESENTATIVE VOLUME ELEMENT USING THE GENERALIZED METHOD OF CELLS.....	461
<i>Evan J. Pineda, Luis F. Silva, Peter A. Gustafson</i>	

MODELING POLYMER-MATRIX COMPOSITES WITH FIBER WAVINESS DEFECTS UNDER CYCLIC LOADING.....	471
<i>Paulina Diaz Montiel, Satchi Venkataraman, Hyonny Kim</i>	

MULTISCALE AND FATIGUE MODELING II

STOCHASTIC MICROSTRUCTURAL ANALYSIS OF CERAMIC MATRIX COMPOSITES USING A HIGH-FIDELITY MULTISCALE FRAMEWORK.....	493
<i>Khaled H. Khafagy, Karthik Rajan R. Venkatesan, Kranthi Balusu, Siddhant Datta, Aditi Chattopadhyay</i>	
BENCHMARKING AND PERFORMANCE OF THE NASA MULTISCALE ANALYSIS TOOL.....	501
<i>Evan J. Pineda, Trenton M. Ricks, Brett A. Bednarczyk, Steven M. Arnold</i>	
A NEW FRAMEWORK FOR FATIGUE LIFE PREDICTION UNDER RANDOM LOADING CONDITIONS.....	509
<i>Jie Chen, Yongming Liu</i>	

MATERIALS FOR HYPERSONIC APPLICATIONS AND EXTREME ENVIRONMENTS I

CONCEPTUAL DESIGN: ISRU MOON REGOLITH CONCRETE AND CONSTRUCTION MODULES.....	516
<i>Keith J. Stober, Ana Emilia Hernandez Lara</i>	
DESIGN OF ADDITIVELY-MANUFACTURED LATTICE STRUCTURE FOR THERMAL PROTECTION SYSTEM: THERMAL CHARACTERIZATION AND ABLATION PERFORMANCE	526
<i>Yu-Chuen Chang, Colin M. Yee, William P. Fahy, Abdullah Kafi, Stuart Bateman, Hao Wu, Joseph H. Koo</i>	
DEVELOPMENT OF STOCHASTIC MODEL FOR FIBROUS ABLATORS	541
<i>Sean McDaniel, Mujan Seif, Rui Fu, Matthew Beck, Alexandre Martin</i>	
RECENT DEVELOPMENTS OF ABLATIVE THERMAL PROTECTION SYSTEMS FOR ATMOSPHERIC ENTRY.....	550
<i>William P. Fahy, Andrew Chang, Hao Wu, Joseph H. Koo</i>	

MATERIALS FOR HYPERSONIC APPLICATIONS AND EXTREME ENVIRONMENTS II

STOCHASTIC MODELING OF ELASTIC BEHAVIOR OF FIBROUS ABLATORS.....	571
<i>Mujan Seif, Sean McDaniel, Matthew Beck, Alexandre Martin</i>	
MULTI-SCALE PHYSICS-BASED MODELING OF PARTICLE-IMPACT EROSION OF CMCS.....	580
<i>David Newsome, Rae Waxman, Stephen Giles, Debasis Sengupta, Ashok Raman, Stewart Silling</i>	

REALIZING ICME, INCLUDING UQ AND EXPERIMENTAL VALIDATION I

SHAPE MOMENT INVARIANTS AS A NEW METHODOLOGY FOR UNCERTAINTY QUANTIFICATION IN MICROSTRUCTURES.....	587
<i>Arulmurugan Senthilnathan, Pinar Acar</i>	

ELEMENTS OF ICME FOR MATERIALS AND STRUCTURES

ACHIEVING MESH-SIZE OBJECTIVITY IN FATIGUE DAMAGE ANALYSIS IN LAMINATED COMPOSITES.....	600
<i>Zimu Su, Caglar Oskay</i>	

MODELING THE COMPRESSION-AFTER-IMPACT BEHAVIOR OF A Z-PINNED COMPOSITE LAMINATE.....	610
<i>Alex Faupel, Caglar Oskay</i>	

ICME: MATERIALS AND STRUCTURES SOLUTIONS FOR LOW-COST HIGH-RATE PRODUCTION I

IN-SITU INSPECTION OF REFLOWABLE-INTERFACE COMPOSITE JOINTS DURING CURE IN AN AUTOCLAVE	623
<i>Tyler B. Hudson, Austin J. Smith, Roberto J. Cano, Jin Ho Kang, Yi Lin, Frank L. Palmieri</i>	

QUANTIFICATION OF THERMOSET COMPOSITE MICROSTRUCTURES FOR PROCESS MODELING.....	631
<i>Sagar Shah, Evgenia Plaka, Mathew Schey, Jie Hu, Fuqiang Liu, Tibor Beke, Scott E. Stapleton, Marianna Maiaru</i>	

PROCESS-STRUCTURE-PROPERTY CHARACTERIZATION OF PHENOLIC MATRIX NANOCOMPOSITES REINFORCED WITH DENSE ALIGNED CARBON NANOTUBE ARRAYS.....	640
<i>Ashley L. Kaiser, Jennifer C. Nwenyi, Brian L. Wardle</i>	

IN-SITU MONITORING OF THE MANUFACTURING PROCESS AND RESIDUAL STRESS EVOLUTION IN THIN-PLY COMPOSITES.....	653
<i>Sandeep Chava, Sirish Namilae</i>	

ICME: MATERIALS AND STRUCTURES SOLUTIONS FOR LOW-COST HIGH-RATE PRODUCTION II

POROSITY MODEL PARAMETER EFFECTS ON METAL ADDITIVE MANUFACTURING SIMULATIONS	660
<i>Luis F. Silva, Evan J. Pineda, Peter A. Gustafson</i>	

GEOMETRIC SENSITIVITY OF RESIDUAL FIELDS IN METAL ADDITIVE MANUFACTURING.....	672
<i>Luis F. Silva, Evan J. Pineda, Peter A. Gustafson</i>	

A NOVEL APPROACH TO CHARACTERIZATION OF COMPOSITE POLYMER MATRIX MATERIALS FOR INTEGRATED COMPUTATIONAL MATERIALS ENGINEERING APPROACHES	684
<i>Michael N. Olaya, Gregory M. Odegard, Marianna Maiaru</i>	

THE EDGE-EFFECT IN THERMOPLASTIC INDUCTION WELDING	694
<i>Darun Barazanchy, Jaspreet Pandher, Michael J. Van Tooren</i>	

REALIZING ICME, INCLUDING UQ AND EXPERIMENTAL VALIDATION II

UNCERTAINTY QUANTIFICATION FOR FATIGUE NUCLEATION IN TITANIUM ALLOY MICROSTRUCTURES	708
<i>Xiaoyu Zhang, Caglar Oskay</i>	
BAYESIAN CALIBRATION OF EXPENSIVE COMPUTER EXPERIMENTS	720
<i>Yoonji Kim, Oksana A. Chkrebtii, Denielle E. Ricciardi, Stephen R. Niezgoda</i>	
UNCERTAINTY QUANTIFICATION OF MESOSCALE MELT-POOL MODEL FOR POWDER BED FUSION ADDITIVE MANUFACTURING OF METALS	728
<i>Sayan Ghosh, Andrey I. Meshkov, Vipul Gupta, Piyush Pandita, Yiming Zhang, Liping Wang</i>	

APPLICATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR STRUCTURES AND MATERIALS I

UNCERTAINTY MANAGEMENT AND REDUCTION OF MACHINE LEARNING POTENTIAL	743
<i>Akash Singh, Yumeng Li</i>	
TRACTABLE MULTISCALE MODELING WITH AN EMBEDDED MICROSCALE SURROGATE	752
<i>Joshua Stuckner, Sawyer Graeber, Brooke Weborg, Trenton M. Ricks, Steven M. Arnold</i>	

APPLICATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FOR STRUCTURES AND MATERIALS II

LEARNING DAMAGE CONSTITUTIVE LAW OF COMPOSITES VIA LAMINATION THEORY ENHANCED ABAQUS-PDNN MECHANICS SYSTEM	760
<i>Fei Tao, Xin Liu, Haodong Du, Wenbin Yu</i>	
MACHINE LEARNING-ASSISTED MODELING OF COMPOSITE MATERIALS AND STRUCTURES: A REVIEW	775
<i>Xin Liu, Su Tian, Fei Tao, Haodong Du, Wenbin Yu</i>	
AUTOMATED SEGMENTATION OF IN SITU X-RAY MICROTOMOGRAPHY OF PROGRESSIVE DAMAGE IN ADVANCED COMPOSITES VIA DEEP LEARNING	796
<i>Reed Kopp, Joshua Joseph, Brian L. Wardle</i>	

Author Index