

Table of Contents

Preface

xvii

Structural Design and Analysis Methods

A Comparison of Analytic, Finite Element and Experimental Results for Unstiffened and Hat-Stiffened Rectangular Orthotropic Plates under In-Plane and Out-of-Plane Loads	3
<i>J. C. Roberts, The Johns Hopkins University, Applied Physics Laboratory, Laurel, MD 20723</i>	
<i>G. Bao and W. Jiang, The Johns Hopkins University, Department of Mechanical Engineering, Baltimore, MD 20723</i>	
Analysis of Initial Response of Composite Laminates under Low-Velocity Impact Using LSDYNA3D	12
<i>D. Liu and X. Dang, Department of Materials Science and Mechanics, Michigan State University, East Lansing, MI 48824</i>	
<i>D. X. Lu, Safety and CAE Technology Department, Ford Motor Company, Dearborn, MI 48121</i>	
Three Dimensional Spline Variational and Finite Element Theory: A Comparison for a Laminate with a Circular Hole	20
<i>D. Pullman and J. R. Schaff, Wright Laboratory Materials Directorate, 2941 P Street Bldg. 654 Ste 1, Wight-Patterson AFB, OH 45433</i>	
Design and Testing of Composite Radial Flanges	30
<i>G. E. Griesheim, K. Kersey, D. Murphy and A. Foose, Pratt & Whitney, 400 Main Street, E. Hartford, CT 06108</i>	
<i>C. Cimini, Stanford University, Pa/o A/to, CA 94305</i>	
Performance Evaluation of Conceptual Designs for High Temperature Composite Turbine Blades	40
<i>C. C. Chamis, NASA Lewis Research Center, 21000 Brookpark Road, MS 5-1 1, Cleveland, OH 44135</i>	
<i>G. H. Abumeri, NYMA, Inc., 2001 Aerospace Parkway, Brook Park, OH 44142</i>	
Design Optimization of a Laminated Composite Femoral Component for Hip Joint Arthroplasty	50
<i>W. Fu and S. B. Biggers, Jr., Department of Mechanical Engineering, Clemson University, Clemson, SC 29634</i>	
<i>R. A. Latour, Jr., Department of Bioengineering and Materials Science and Engineering, Clemson University, Clemson, SC 29634</i>	
Response of Segmented-Stiffness Composite Cylinders to Axial End Shortening.	60
<i>J. C. Riddick and M. W. Hyer, Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0219</i>	
An Investigation of the Response of Composite Cylinders of Elliptical Cross Section to Axial Compression.	70
<i>C. A. Meyers, Delphi Packard Electric, 1177 W. Long Lake, Troy, MI 48098</i>	
<i>M. W. Hyer, Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0219</i>	

Buckling and Postbuckling Behavior of Curved Composite Panels Due to Thermal and Mechanical Loading.80
N. L. Breivik and M. W. Hyer, <i>Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0219</i>	
The Effect of Lamination Sequence on Secondary Buckling of Compression Loaded Composite Plates90
N. Tiwari and M. W. Hyer, <i>Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0219</i>	
The Room-Temperature Shape of General Unsymmetric Laminates	100
M.-L. Dano and M. W. Hyer, <i>Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0219</i>	
Development of Repair Methodology for the MH-53E Composite Sponson 111
A. Dobyms, <i>Sikorsky Aircraft, Stratford, CT 06497</i>	
E. Rosenzweig, <i>Naval Air Warfare Center, Warminster, PA</i>	
C. Francis, <i>Naval Aviation Depot, Cherry Pt, NC</i>	
Circumferential and Radial Behavior of Anisotropic Shell of Variable Cross-Section	121
K. P.K. Potty and J. R. Vinson, <i>Department of Mechanical and Aerospace Engineering, University of Delaware, Newark, DE 19716</i>	
A Simplified Method for Predicting Interlaminar Stresses in Layered Materials	130
J. F. Newill, <i>U.S. Army Research Laboratory, AMSRL-WT-PD, Aberdeen Proving Ground, MD 21005</i>	
J. R. Vinson, <i>Department of Mechanical Engineering, University of Delaware, Newark, DE 19716</i>	
Optimized Lamination of Hybrid Thick-Walled Cylindrical Shell under External Pressure by Using GA.	140
O-IlByon (Goichi Ben) and Y. Nishi, <i>Department of Mechanical Engineering, College of Industrial Technology, Nihon University I-2-1, Izumicho, Narashino-shi, Chiba 275, Japan</i>	
S. Sato, <i>Graduate school, Nihon University</i>	
A Quasi-3-Dimensional Strength Analysis Method for Laminated Composite Materials	150
T. Nishiwaki, <i>ASICS Corporation, Takatsukadai, Nishi-ku, Kobe 651-22, Japan</i>	
A. Yokoyama, <i>Mie University, Kamihamacho, Tsu, Mie 514, Japan</i>	
Compressive Behavior	
A Study of the Effects of Fiber Waviness on the Buckling Characteristics of Laminated Plates.	161
R. A. Raouf, <i>Mechanical Engineering Department, United States Naval Academy, Annapolis, MD 21402</i>	
Post Buckling Analysis of Multiple Delaminated Composite Plate.	168
H. Huang, <i>333660, GA Tech Station, Atlanta, GA 30332-1510</i>	
G. A. Kardomateas, <i>School of Aerospace Engineering, Georgia Institute of Technology, Atlanta, GA 30332- 1050</i>	
Dynamic Compressive Properties of Laminated Composites at High Rates of Loading.	178
J. T. Tzeng and A. S. Abrahamian, <i>U.S. Army Research Laboratory, Weapons Technology Directorate, AMSRL-WT-PD, Aberdeen Proving Ground, MD 21005-5066</i>	
Composites for Infrastructures	
A Survey of Integral Fit Joint Technologies for Composites.	191
D. E. Lee and H. T. Hahn, <i>Integrated Manufacturing Engineering Program for Advanced Transportation Systems, UCLA School of Engineering and Applied Science, Box 951597, Los Angeles, CA 90095-1597</i>	

High Strain Rate Characterization of Unidirectional Fiber and Woven Glass Composites	201
S. V. Thiruppukuzhi and C. T. Sun, <i>School of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907</i>	
Effect of Silane Coupling Agents on the Durability of Polymer Concrete	211
A. J. Chawalwala, R.L. McCullough and G. R. Palmese, <i>Center for Composite Materials and Materials Science Program, University of Delaware, Newark, DE 19716</i>	
Adhesive Selection Methodology for Rehabilitation of Steel Bridges with Composite Materials	222
G. Rajagopalan, K. M. Immordino and J. W. Gillespie, Jr., <i>Center for Composite Materials and Materials Science Program, University of Delaware, Newark, DE 19716</i>	
Rehabilitation of Steel Bridge Girders: Large Scale Testing	231
J. W. Gillespie, Jr., D. I. Mertz, W. M. Edberg and J. R. Demitz, <i>Department of Civil and Environmental Engineering, University of Delaware, Newark, DE 19716</i>	
K. Kasai and I. Hodgson, <i>Department of Civil Engineering, Lehigh University, Bethlehem, PA 18015</i>	
Experimental Support for the Cell-Model Description of Hyper-Concentrated Suspensions	241
J. S. Burns, S. B. Kirschner and J. Powell, <i>Department of Mechanical Engineering, 5500 Campanile Dr., San Diego, CA 92182- 1323</i>	
Titanium Matrix Composites	
Frequency Effects on Fatigue Behavior of a Unidirectional Metal Matrix Composite at Elevated Temperature.	253
R. N. Pittman and S. Mall, <i>Department of Aeronautics and Astronautics, Air Force Institute of Technology, Wright-Patterson Air Force Base, OH 45433</i>	
B. I. Sanders, <i>Air Force Office of Scientific Research, Washington, D.C.</i>	
The Nonlinear Behavior of Unidirectional SCS-6/Ti-6Al-4V Composite	262
M. Xie and S. R. Soni, <i>AdTech Systems Research, Inc., 1342 N. Fairfield Road, Beavercreek, OH 45432</i>	
D. Hanley and A. Anto, <i>AlliedSignal Engines, P.O. Box 52181, Phoenix, AZ 85072-2181</i>	
Life Prediction in Continuous Fiber Metal Matrix Composites Subjected to Environmental Degradation	272
J. W. Foulk, K. L. E. Helms and D. H. Allen, <i>Center for Mechanics of Composites, Texas A&M University, College Station, TX 77843-3141</i>	
The Slice Compression Test: A Preliminary Numerical Analysis	282
K. Alzebdeh, X. Dang, A. Al-Ostaz and I. Jasiuk, <i>Department of Materials Science and Mechanics, Michigan State University, East Lansing, MI 48824</i>	
Effects of Titanium Plies on the Strength of a Hybrid Titanium Composite Laminate	291
D. R. Veazie and A. M. Badir, <i>Department of Engineering, Clark Atlanta University, Atlanta, GA 30314</i>	
R. O. Grover, Jr., <i>Center for High Performance Polymers and Composites, Clark Atlanta University, Atlanta, GA 30314</i>	
Progressive Damage Analysis of Metal Matrix Composite Components	300
S. Subramanian, I. Kizhakkethara and S. R. Soni, <i>AdTech Systems Research, 1342 N. Fairfield Road, Beavercreek, OH 45432</i>	
D. Allen, <i>Aero Power and Propulsion Directorate, Wright Laboratory, WPAFB, OH 45433</i>	
Assessment of a Local Fiber Stress Parameter for Thermomechanical Fatigue Life Prediction of Titanium Matrix Composites	310
J. R. Calcaterra and W. S. Johnson, <i>Georgia Institute of Technology, Atlanta, GA 30332</i>	

Tensile Properties of Clad TMCs320
U. Ramamurty and F.W. Zok, <i>Materials Department, University of California, Santa Barbara, CA 93106</i>	
F. A. Leckie, <i>Mechanical and Environmental Engineering Department, University of California, Santa Barbara, CA 93 106</i>	
Evaluation of Inter-facial Fracture Toughness of MMCs Using a Computational Approach330
S. Mukherjee, C. R. Ananth and N. Chandra, <i>Department of Mechanical Engineering, FAMU-FSU College of Engineering, Florida A&M University/Florida State University, 2525 Pottsdamer Road, Tallahassee, FL 32310</i>	
Effect of Matrix and Interfacial Behavior on Load Sharing in Metal Matrix Composites340
S. R. Voleti, C. R. Ananth and N. Chandra, <i>Department of Mechanical Engineering, FAMU-FSU College of Engineering, Florida A&M University/Florida State University, 2525 Pottsdamer Road, Tallahassee, FL 32310</i>	
B. S. Majumdar, <i>Universal Energy Systems, Dayton, OH</i>	
Detailed Interpretation of Off-Axis and Iosipescu Test Data on Metal Matrix Composites349
S. Chandu and J. Ahmad, <i>Research Applications, Inc., 7026 Corporate Way, Suite 211, Centerville, OH 45459</i>	
G. M. Newaz, <i>Department of Mechanical Engineering, 5050 Anthony Wayne Drive, 2 100 Engineering Building, Detroit, MI 48202</i>	
Effects of Temperature and Frequency on the TMF Mechanisms in Cross-Ply Titanium Matrix Composites359
R. W. Neu and D. T. Scott, <i>Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0405</i>	
Ceramic Matrix Composites	
Approach to Inherently Stable Interfaces for Ceramic Matrix Composites371
T. M. Besmann, E. R. Kupp and D. P. Stinton, <i>Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831-6063</i>	
S. Shanmugham, <i>Department of Materials Science and Engineering, University of Tennessee, Knoxville, TN 37996</i>	
Optimization of Composite Processing Using CVI381
D. Y. Chiang and T. L. Starr, <i>School of Materials Science and Engineering (0245), Georgia Institute of Technology, Atlanta, GA 30332</i>	
Micromechanics Based Analysis of Fatigue in Ceramic Matrix Composites390
J. Solti, <i>HQ USAFA/DFEM, 2354 Fairchild Dr., USAF Academy, CO 80840</i>	
S. Mall and D. Robertson, <i>AFIT/ENY, 2950 P Street, Bldg. 640, WPAFB, OH 45433</i>	
Tensile-Flexural Test of Ceramic Matrix Composite T-Joints398
M. Xie and S. R. Soni, <i>AdTech Systems Research, Inc., 1342 N. Fairfield Road, Beavercreek, OH 45432</i>	
J. E. Grady, <i>NASA Lewis Research Center, Cleveland, OH 44135</i>	
Oxidation and Fracture in a SiC/Si₃N₄ Composite at Elevated Temperature407
F. Yang, A. Saxena and T. L. Starr, <i>School of Materials Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245</i>	
L. Riester and M. Ferber, <i>High Temperature Materials Laboratory, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6062</i>	

Damage Mechanics and Damage Tolerance

Characterizing Fatigue Delamination Onset under Mode III Loading for Laminated Composites	419
J. Li, <i>MS 188E, NASA Langley Research Center, Hampton, VA 23681</i>	
T. K. O'Brien, <i>U.S. Army Research Laboratory, Vehicle Structures Directorate, NASA Langley Research Center, Hampton, VA 23681</i>	
Prediction of Microcracking Distributions in Composite Laminates Using a Monte-Carlo Simulation Method	428
Y. Michii and H. L. McManus, <i>Massachusetts Institute of Technology, Cambridge, MA 02139</i>	
Devices for Transmitting High Shear Loads in Composite Structures	437
C. f? R. Hoppel, <i>U.S. Army Research Laboratory, AMSRL-WT-PD, Aberdeen Proving Ground, MD 21005</i>	
T. A. Bogetti, <i>U.S. Army Research Laboratory, University of Delaware, Center for Composite Materials, Newark, DE 19716</i>	
J. W. Gillespie, Jr., <i>University of Delaware, Center for Composite Materials, Newark, DE 19716</i>	
Delamination Crack Tip Behaviour at Failure in Composite Laminates under Mode I Loading	447
I. Paris and A. Poursartip, <i>Composites Group, Department of Metals and Materials Engineering, The University of British Columbia, Vancouver, B.C., Canada V6T1Z4</i>	
Damage Progression and Failure of Glass Fabric Composites Subjected to Tension/Tension and Tension/Shear Combined Stresses	457
A. Ishikawa and T. Fujii, <i>Department of Mechanical Engineering, DOSHISHA University, Kyoto 61 0-03, Japan</i>	
T. Tanaka, <i>Kobe Steel Co. Ltd., Takasago 676, Japan</i>	
Dynamic Delamination Crack Propagation in Unidirectional Fiber Composite	467
C. Guo and C. T. Sun, <i>School of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907</i>	
Effects of Long-Term Thermal Cycling on Microcracking Behavior in Composite Materials	476
T. L. Brown and M. W. Hyer, <i>Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0219</i>	
High Strain Rate Effects on AS4/PEKK Graphite Fiber Thermoplastic Matrix Composites	486
B. M. Powers, <i>Department of Mechanical Engineering, University of Delaware, Newark, DE 19716</i>	
J. R. Vinson, <i>Department of Mechanical and Aerospace Engineering, University of Delaware, Newark, DE 19776</i>	
M. Wardle and B. Scott, <i>E.I. DuPont de Nemours Co., Inc., Wilmington, DE</i>	
Interlaminar Fracture of GFRP Angle-Ply Laminates.	495
L. Xu and L. A. Carlsson, <i>Department of Mechanical Engineering, Florida Atlantic University, Boca Raton, FL 33431</i>	
P. Davies, <i>Marine Materials Laboratory, IFREMER, Brest Center, 29286 Plouzane, France</i>	
An Evaluation of Hybrid Titanium Composite Laminates for Room Temperature Fatigue	505
E. Li and W. S. Johnson, <i>Materials Science and Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0245</i>	
On the Use of Dent Depth as an Impact Damage Metric for Thin Composite Structures	515
B. L. Wardle and P. A. Lagace, <i>Technology Laboratory for Advanced Composites, Massachusetts Institute of Technology, 77 Mass. Ave., Cambridge, MA 02139</i>	

Advances in Polymers and Fibers

Thermo-Chemical Characterization of S2 Glass/Vinyl Ester Composites	529
M. A. Stone and J. W. Gillespie, Jr., Center for Composite Materials, <i>University of Delaware, Newark, DE 19716</i>	
B. F. Fink and T. A. Bogetti, <i>Army Research Laboratory, Materials Directorate, University of Delaware, Newark, DE 19716</i>	
Characterization and Fracture Toughness of Diffuse Adhesive Interphases	539
G. Rajagopalan, K. M. Immordino and J. W. Gillespie, Jr., <i>Center for Composite Materials and Materials Science Program, University of Delaware, Newark, DE 19716</i>	
S. H. McKnight, <i>Army Research Laboratory, Materials Directorate, Aberdeen Proving Ground, MD 21005-5069</i>	
Axial Compression Behavior of Polymeric Fibers-A Status Report	548
S. Kumar and V. R. Mehta, <i>School of Textile and Fiber Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0295</i>	
Nanolayer Reinforcement in Polymer-Clay Nanocomposites	558
T. J. Pinnavaia and T. Lan, Center for Fundamental Materials Research and <i>Department of Chemistry, Michigan State University, East Lansing, MI 48824</i>	
Interphase Formation and Properties in Vinyl Ester/S2-Glass Fiber Composites	566
G. R. Palmese, D. Gan and G. Chhabra, <i>Center for Composite Materials, University of Delaware, Newark, DE 19716</i>	
Effect of Resin Formulation and Reaction Temperature on the Curing Kinetics of Vinyl Ester Resins.	576
R. I? Brill, R. L. McCullough and G. R. Palmese, <i>Center for Composite Materials and Department of Chemical Engineering, University of Delaware, Newark, DE 19716</i>	
Critical Evaluation of Fibers for High Performance Flexible Composites	584
S.-M. Chang, V. Sharma and f? Desai, <i>School of Textile and Fiber Engineering, Polymer Education and Research Center, Georgia Institute of Technology, Atlanta, GA 30332-0295</i>	
A. S. Abhiraman, <i>School of Chemical Engineering, Polymer Education and Research Center, Georgia Institute of Technology, Atlanta, GA 30332-0295</i>	
Evolution of Structure and Properties in the Formation of PAN-Based Carbon Fibers	594
S. Damodaran, H. Jiang, P. Desai and A. S. Abhiraman, <i>Georgia Institute of Technology, Atlanta, GA 30332</i>	
Long Term Durability of PMCs	
A Computational Procedure for Durability Prediction of Polymers and Their Composites	603
S. Roy and S. Denduluri, <i>University of Missouri-Rolla, 1870 Miner Circle, Rolla, MO 65409-0050</i>	
Long-Term Durability of Carbon- and Glass-Epoxy Composite Materials in Wet Environments	613
T. K. Tsotsis and S. M. Lee, <i>Hexcel Composites, Anaheim, CA</i>	
Interlaminar Shear Strength and Fracture Behavior in Aged Composite Laminates	625
J. Tad and C. T. Sun, <i>School of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907-1 282</i>	
C. Arendt and M. Brunner, <i>McDonnell Douglas Aerospace-West, Bldg. 71 MC 71-34, 7510 Hughes Way, Long Beach, CA 90810-1870</i>	

Relating Elastic Modulus to Indentation Response Using Atomic Force Microscopy	635
M. R. VanLandingham, G. I. Palmese, R. F. Eduljee, J. W. Gillespie, Jr. and R. L. McCullough, University of Delaware, 207 Center for Composite Materials, Newark, DE 19716	
S. H. McKnight, Army Research Laboratory-Materials Directorate, c/o Center for Composite Materials, Newark, DE 19716	
Mechanistic Representations of the Long-Term Durability of Polymer Composite Materials	645
K. Reifsnider, J. Lesko, S. Case and A. Caliskan, Virginia Polytechnic Institute and State University, Materials Response Group, Blacksburg, VA 24061-0219	
The Effect of Microstructural Heterogeneities of Interfacial Debonding in Polymeric Matrix Composite Materials	655
C. A. Wood and W. L. Bradley, Texas A&M University, Department of Mechanical Engineering, College Station, TX 77843-3123	
Effects of Thermal Aging on the Mechanical Behavior of K3B Matrix Material	666
S. Sacks and S. Johnson, Department of Materials Science and Engineering, 778 Atlantic Drive, Georgia Institute of Technology, Atlanta, GA 30332	
Degradation Behavior of SRTM Composite Parts in Hot Water	675
H. Hamada, Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606, Japan	
N. Ikegawa, Matsushita Electric Works, Ltd., Kadoma, Kadoma-shi, Osaka 571, Japan	
T. Morii, Shonan Institute of Technology, Tsujido-nishikaigan, Fujisawa, Kanagawa 251, Japan	
Influence of Ultrasonic Vibration Frequency on Acceleration of Hydrothermal Aging of FRP	685
T. Morii and N. Ikuta, Shonan Institute of Technology, Tsujido-nishikaigan, Fujisawa, Kanagawa 251, Japan	
H. Hamada, Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606, Japan	
Applications	
Experimental Investigation of Damage Growth in a Random Fiber Composite Beam	697
Y. Zhang, D. L. Sikarskie and I. Miskioglu, Department of Mechanical Engineering and Engineering Mechanics, Michigan Technological University, Houghton, MI 49931	
D. Post, Department of Engineering Science and Mechanics, College of Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061	
The Design, Analysis, and Fabrication of a Composite Intermedullary Implant	707
A. Corvelli, P. Biermann and J. Roberts, Johns Hopkins University Applied Physics Laboratory, Johns Hopkins Rd., Laurel, MD 20723	
The New Production Technology for Discontinuously Reinforced Al-SiC Composites-Future Prospects for Commercial Development	717
V. M. Kevorkijan, Alpha and Omega in Composites, Borova vas 4, 2000 Maribor, Slovenia (EU)	
Manufacturing Processes for Polymeric Composites	
Filament Wound Elastomeric Matrix Composites for Flywheel Energy Storage Systems	729
C. W. Gabrys and C. E. Bakis, Department of Engineering Science and Mechanics, 227 Hammond Bldg., The Pennsylvania State University, University Park, PA 16802	
Direct Observations of Transverse Flow in Fibre Reinforced Composite Materials during Processing	738
P. Hubert and A. Poursartip, Composites Group, Department of Metals and Materials Engineering, The University of British Columbia, Vancouver, B.C., V6T 1Z4, Canada	
W. L. Bradley, Center for Mechanics of Composites and Department of Mechanical Engineering, Texas A&M University, College Station, TX 77843	

Prepregging and Composite Manufacture with Toughened Cyanate Ester Resin Systems	748
A. V. Rau and A. C. Loos, <i>Department of Engineering Science and Mechanics, National Science Foundation Science and Technology Center for High Performance Polymeric Adhesives and Composites, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061</i>	
S. A. Srinivasan and J. E. McGrath, <i>Department of Chemistry, National Science Foundation Science and Technology Center for High Performance Polymeric Adhesives and Composites, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061</i>	
A Neural Network Approach to Robotic Thermoplastic Tow Placement Process Control	758
D. Heider, R. C. Don and J. W. Gillespie, Jr., <i>Center for Composite Materials, University of Delaware, Newark, DE 19716</i>	
Measurement of Mold Filling Times in Vibration-Assisted Liquid Composite Molding	768
R. F. Gibson, E. O. Ayorinde, S. Yang and B. Baig, <i>Department of Mechanical Engineering, Advanced Composites Research Laboratory, Wayne State University, Detroit, MI 48202</i>	
Residual Stress and Warpage Development during the Automated Fiber Placement Process	777
J. J. Tierney, R. F. Eduljee and J. W. Gillespie, Jr., <i>Materials Science Program and Center for Composite Materials, University of Delaware, Newark, DE 19716</i>	
Assessing Thermal Residual Stress in Integral Hybrid Composite Armor	787
X. Huang and J. W. Gillespie, Jr., <i>Center for Composite Materials, University of Delaware, Newark, DE 19716</i>	
T. Bogetti, <i>U.S. Army Research Laboratory, Center for Composite Materials, University of Delaware, Newark, DE 19716</i>	
Adhesion between Thermoplastic Polymer Particles and Carbon and Glass Fibers	797
J. S. Colton, <i>Composites Manufacturing Research Program, School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0405</i>	
G. Braithwaite, B. J. Briscoe and P. F. Luckham, <i>Particle Technology Group, Department of Chemical Engineering, Imperial College of Science, Technology and Medicine, London, UK SW7 2BY</i>	
Fiber Coiling during Bladder Molding of Thermoplastic Composites	802
J. S. Colton and M. S. Beeson, <i>Composites Manufacturing Research Program, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0405</i>	
Through Transmission Ultrasonics for Process Monitoring of Thermoplastic Fusion Bonding	812
K. D. Tackitt and J. W. Gillespie, Jr., <i>University of Delaware Center for Composite Materials and Materials Science Department, Academy St., Newark, DE 19716</i>	
3-Dimensional Composite Photolithography	822
A. A. Ogale, T. Renault and C. Greer, <i>Department of Chemical Engineering, Clemson University, Clemson, SC 29634-0909</i>	
A Study on Permeability of Unidirectional Fiber Beds	829
M.-K. Um, <i>Korea Institute of Machinery and Materials, Composites Materials Group, Changwon 641-010, South Korea</i>	
W. I. Lee, <i>Department of Mechanical Engineering, Seoul National University, Seoul 151-742, South Korea</i>	

Micromechanics

St. Venant Effect in the Iosipescu Shear Specimen	845
J. M. Whitney, <i>Department of Civil and Environmental Engineering and Engineering Mechanics, University of Dayton, 300 College Park, Dayton, OH 45469-0243</i>	
Finite Element Based Degradation Model for Composites with Transverse Matrix Cracks. 853
K. Srirengan and J. D. Whitcomb, <i>Aerospace Engineering Department, Texas A&M University, TX 77843</i>	
A Micromechanics Model of Stiffness Matrix for Composite Rod Reinforced Laminates	863
J. S. Wang and W. S. Chan, <i>Center for Composite Materials, Department of Mechanical and Aerospace Engineering, University of Texas at Arlington, Arlington, TX 76019</i>	
Using Spatial Descriptors to Identify Damage Initiation in Nicalon™/MAS-5 875
V.N. Bulsara, R. Talreja and J. Qu, <i>The George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0405</i>	
A Micromechanics Model for Fatigue Life Prediction of Metal Matrix Composites. 885
S. Subramanian, <i>AdTech Systems Research, 1342 N. Fairfield Road, Beavercreek, OH 45432</i>	
Test Methods for Estimation of Interfacial Normal Strength in Unidirectional Fiber Reinforced Composites. 896
G. P. Tandon, <i>AdTech Systems Research Inc., 1342 N. Fairfield Rd., Dayton, OH 45432</i> R. Y. Kim, <i>University of Dayton Research Institute, 300 College Park, Dayton, OH 45469</i>	
A Micromechanics Approach for Predicting the Strength of Fiber Composites 906
H. Zhu and B. V. Sankar, <i>Department of Aerospace Engineering, Mechanics and Engineering Science, University of Florida, P. O. Box 116250, Gainesville, FL 32611</i> R. V. Marrey, <i>Advance USA, O/d Lyme, CT 06377</i>	
A Quasi-Isotropic Composite Laminate with Reduced Interlaminar Stresses. 916
A. Rotem, <i>Faculty of Mechanical Engineering, Technion-Israel Institute of Technology, Technion City, Haifa 32000, Israel</i>	
Calculation of Effective Moduli of Filament Wound Tubes 926
G. Anlas, <i>Mechanical Engineering Department, Boğaziçi University, Istanbul, Turkey</i> E. S. Ardiç and A. Gediz, <i>Baris Elektrik Endüstrisi A.Ş., P.O. Box 709, 06044 Uslu, Ankara, Turkey</i>	

Functionally Graded Composites

Residual Thermal Stresses in Gradient Coatings 937
A. W. Obst, <i>Deutsche Forschungsanstalt für Luft- und Raumfahrt e. V., Institut für Strukturmechanik, Lilienthalplatz 7, D-381 08 Braunschweig, Germany</i> M. W. Hyer, <i>Department of Engineering Science and Mechanics, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061</i>	
Characterization of Multifunctional Composite Armor 947
F. Ko and J. Z. Yu, <i>Fibrous Materials Research Center, Drexel University, Philadelphia, PA 19104</i> J. W. Song, <i>U.S. Army Soldier Systems Command, Natick Research, Development and Engineering Center, Natick, MA 01760</i>	
Large Deflections of Heated Functionally Graded Simply Supported Rectangular Plates with Varying Rigidity in Thickness Direction. 957
F. Mizuguchi, <i>Japan Maritime Safety Academy, 5-1, Wakaba-cho, Kure-shi, Hiroshima-ken 737, Japan</i> H. Ohnabe, <i>Ishikawajima-Harima Heavy Industries, 3-5-1, Mukodai-cho, Tanashi-shi, Tokyo 188, Japan</i>	

Textile Composites

Application of Textiles to Aircraft Primary Structures	969
A. C. Jackson, <i>Lockheed Martin Aeronautical Systems</i>	
Penetration Failure Mechanisms of Woven Textile Composites	979
T.F. Walsh and B. L. Lee, <i>The Pennsylvania State University, Department of Engineering Science and Mechanics, University Park, PA 16802</i>	
J. W. Song, <i>U.S. Army Soldier Systems Command, Natick Research, Development and Engineering Center, Science and Technology Directorate, Natick, MA 01760</i>	
A Selective Averaging Method for Micromechanics of Textile Composites	989
B. V. Sankar, <i>Department of Aerospace Engineering, Mechanics and Engineering Science, P. O. Box 116250, University of Florida, Gainesville, FL 32611-6250</i>	
R. Marrey, <i>Advance USA, Old Lyme, CT 06371</i>	
Effects of Yarn Crimping on Compressive Strength Design Allowables of Braided Composites	999
A. C. West and D. O. Adams, <i>Department of Aerospace Engineering and Engineering Mechanics, Iowa State University, 2019 Black Engineering Building, Ames, IA 50011</i>	
Sensitivity of Mechanical Properties to Braider Misalignment in Triaxial Braid Composites	1007
J. Chen, T. M. McBride and S. B. Sanchez, <i>Department of Aerospace and Mechanical Engineering, Boston University, Boston, MA 02215</i>	
The Process Model of Three-Dimensional Rectangular Braiding for Textile Preforms	1016
J.-H. Byun, <i>Composite Materials Laboratory, Korea Institute of Machinery and Metals, 66 Sangnam-Dong, Changwon, South Korea</i>	
Mechanical Properties for Self-Reinforced Braided Composite Tube	1026
H. Hamada, A. Nakai and M. Masui, <i>Faculty of Textile Science, Kyoto Institute of Technology, Matsugasaki Sakyo-ku, Kyoto 606, Japan</i>	

Joints

Environmental Effects on the Opening Mode Fracture Behavior of Bonded Boron-Epoxy/Aluminum Joints	1039
L. M. Butkus, <i>School of Mechanical Engineering, Box #1001, 801 Ferst Drive, Georgia Institute of Technology, Atlanta, GA 30332-0405</i>	
W. S. Johnson, <i>School of Materials Science and Engineering, 778 Atlantic Drive, Georgia Institute of Technology, Atlanta, GA 30332-0245</i>	
Stress Analysis and Experimental Testing of a Structural Composite Laminate with a Hole	1049
J. I? Schaff, D. H. Mollenhauer and D. H. Rose, <i>Wright-Laboratory Materials Directorate, 2941 P. Street, Bldg. 654 Ste 1, Wright-Patterson AFB, OH 45433-7750</i>	
Transverse Load Effects on Repaired Composites	1059
D. R. Dykstra, <i>Outboard Marine Corporation, W238 N1700 Rockwood Drive, Waukesha, WI 53188</i>	
J. B. Ligon and I. Miskioglu, <i>ME-EM Department, Michigan Technological University, Houghton, MI 49931</i>	
Durability of Thermoplastic Adhesive Bonding to Metals: Ti to PEKEKK	1069
K. Ramani and C. Ingram, <i>Purdue University, 1288 Mechanical Engineering Bldg., W. Lafayette, IN 47907</i>	
Effects of Thermal Aging on the Bolt Bearing Behavior of Highly Loaded Composite Joints	1076
R. J. Wright and W. S. Johnson, <i>Department of Materials Science and Engineering, 778 Atlantic Drive, Georgia Institute of Technology, Atlanta, GA 30332</i>	

**Three Dimensional Asymptotic and B-Spline Based Numerical Analysis
of Composite Laminates with Fastener Holes1086**
E. V. Iarve, *University of Dayton Research Institute, 300 College Park,
Dayton, OH 45469-0168*

Author Index 1097