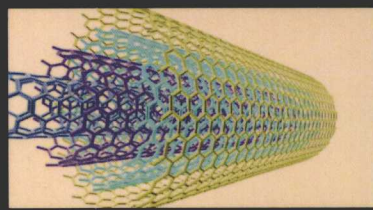
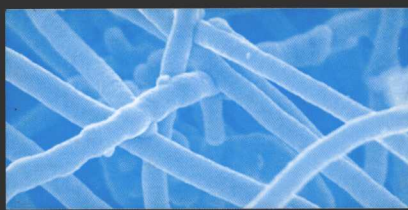
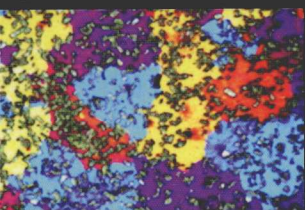


Founding Editor, Stuart M. Lee



 WILEY
ENCYCLOPEDIA
— OF —
COMPOSITES

SECOND EDITION

LUIGI NICOLAIS
ASSUNTA BORZACCHIELLO

VOLUME 4

WILEY ENCYCLOPEDIA OF COMPOSITES SECOND EDITION

VOLUME 4

EDITED BY

Luigi Nicolais

Assunta Borzacchiello

FOUNDING EDITOR

Stuart M. Lee



WILEY

A John Wiley & Sons, Inc., Publication

Copyright © 2012 by John Wiley & Sons, Inc. All rights reserved

Published by John Wiley & Sons, Inc., Hoboken, New Jersey
Published simultaneously in Canada

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at <http://www.wiley.com/go/permission>.

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

Library of Congress Cataloging-in-Publication Data is available.

ISBN: 978-0-470-12828-2 (Set)

ISBN: 978-0-470-27568-9 (Vol. 4)

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

**WILEY ENCYCLOPEDIA OF
COMPOSITES
SECOND EDITION
VOLUME 4**

WILEY ENCYCLOPEDIA OF COMPOSITES

SECOND EDITION

Editors

Luigi Nicolais

University of Naples "Federico II" &
Institute of Composite and Biomedical Materials, National Research Council of Italy,
Piazzale Tecchio 80, 80125, Naples, Italy

Assunta Borzacchiello

Institute of Composite and Biomedical Materials, National Research Council of Italy,
Piazzale Tecchio 80, 80125, Naples, Italy

Associate Editors

Alan Baker

Advanced Composite Structures Australia and Defence Science and Technology Organisation,
Australia

Michael Bannister

Cooperative Research Centre for Advanced Composite Structure 506 Lorimer Street,
Fishermans Bend, Victoria, 3207, Australia

Anthony Bunsell

Centre des Matériaux, Mines Paris, ParisTech BP87 91003 Evry Cedex, France

Tsu-Wei Chou

Pierre S. du Pont Chair of Engineering, Department of Mechanical Engineering,
University of Delaware, Newark, Delaware, 19716

Paul Hogg

School of Materials University of Manchester Paper Science Building Sackville Street Manchester,
M13 9PL, United Kingdom

Yiu-Wing Mai

Centre for Advanced Materials Technology (CAMT) School of Aerospace, Mechanical and
Mechatronic Engineering J07 The University of Sydney, Sydney, NSW 2006 Australia

James Seferis

Polymeric Composites Laboratory GloCal Network Corporation,
Seattle, Washington 98121

Alain Vautrin*

Centre Sciences des Matériaux et des Structures,
École Nationale Supérieure des Mines de Saint-Étienne,
42023 Saint-Étienne, France

*Deceased.

CONTRIBUTORS

Mohammad Tahaye Abadi, Aerospace Research Institute, Tehran, Iran, *Micromechanical Modeling of Heterogeneous Materials at Finite Strain*

André Bastos Abibe, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany, *Joining: Mechanical Fastening of Polymers, Composites, and Polymer-Metal Hybrid Structures*

Domenico Accardo, University of Naples Federico II, Naples, Italy, *Lightning Protection; Systems Avionics Applications*

Mehrdad Adl, Zhejiang University, Hangzhou, China, *Polyvinyl Chloride Composites*

Suresh G. Advani, University of Delaware, Newark, DE, *Molding: Short-Fiber Composites, Flow Processing*

Farid Akhtar, Stockholm University, Stockholm, Sweden; University of Engineering and Technology, Lahore, Pakistan, *Stainless Steel Polymer Composites*

M. K. Akkapeddi, Allied-Signal Inc., *Polypivalolactone-Carbon Fiber Composites*

Mikko J. Alava, Aalto University, Aalto, Finland, *Statistical Fracture Theories*

Sergio de Traglia Amancio-Filho, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany, *Joining: Mechanical Fastening of Polymers, Composites, and Polymer-Metal Hybrid Structures*

Veronica Ambrogio, University of Naples, Naples, Italy, *Fillers, Microspheres, and Microcapsules*

Luigi Ambrosio, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Soft Tissue Repair and Regeneration: Composite Materials toward the Design of Advanced Prostheses and Scaffolds*

Preejith Ambuken, Tennessee Technological University, Cookeville, TN, *Polymeric Composites: Heat Transfer*

Eugenio Amendola, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *In Situ Composites*

Amie NorFreeda Amir, Universiti Sains Malaysia, Nibong Tebal, Penang, Malaysia, *Hybrid Mats*

Solaiappan Ananthakumar, National Institute for Interdisciplinary Science & Technology, CSIR, Trivandrum, India, *Composite Electroceramics*

Vincenza Antonucci, Institute of Composite and Biomedical Materials IMCB - CNR, Portici, Italy, *Processing: Autoclave*

Ahmad Arefazar, Amirkabir University of Technology, Tehran, Iran, *Coupling Agents: Basics and Classifications*

Aziz Armağan Arici, Kocaeli University, Izmit, Turkey, *Fiber Reinforcement: Continuous Fibers*

Luigi Ascione, University of Salerno, Fisciano (SA), Italy, *Mechanical Behavior of Composites for Construction*

Maria Assunta Autiello, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Standards and Specifications; Novel Biomimetic Design for Composite Material*

Egemen Avcu, Kocaeli University, Izmit, Turkey, *Fiber Reinforcement: Continuous Fibers*

Abdul Awal, University of Toronto, Toronto, Ontario, Canada, *Natural Composites: Fiber Modification*

Cagri Ayranci, University of Alberta, Edmonton, Alberta, Canada, *Processing and Performance of Braided Composites*

Alan Baker, Advanced Composite Structures Australia and Defence Science and Technology Organisation, Australia, *Bonded Composite Patch Repair of Metallic Aircraft Structures; Bonded Repair of Composite Aircraft Structures*

Alberto Balsamo, University of Naples Federico II, Naples, Italy, *Composites for Structural Strengthening; Externally Bonded Masonry Structures*

Alexis Baltazar-y-Jimenez, University of Toronto, Toronto, Ontario, Canada, *Natural Composites: Fiber Modification*

Cemal Basaran, University at Buffalo, The State University of New York, Buffalo, NY, *Damage Coupled Viscoplastic Modeling of Particulate Composites with Imperfect Interphase*

Claude Bathias, LEME, University Paris 10, Paris, France, *Fatigue and Fracture of Rubbers*

Federica Bellucci, PROPLAST, Alessandria, Italy, *Flammability of Polymer Composites*

Enrico Bernardo, University of Padova, Padova, Italy, *Glass Matrix Composite*

Massimiliano Bestetti, Politecnico di Milano, Milano, Italy, *Metal Matrix Composites: Corrosion*

A. Beukers, Delft University of Technology, Delft, The Netherlands, *Filament Winding: Design, Materials, Structures, and Manufacturing Processes*

Marco Biagioni, AVIO s.p.a., Torino, Italy, *Composite Materials in Launch Vehicles*

Alexander Bismarck, Imperial College London, London, UK, *Carbon Fiber: Properties, Testing, and Analysis; Carbon Fiber: Surface Properties*

- Andrzej K. Bledzki**, University of Kassel, Kassel, Germany; West Pomeranian University of Technology, Szczecin, Poland, *Processing of Biofiber-Reinforced Composites; Wood Plastic Composite: Present and Future*
- Bertrand Bloch**, Division des Matériaux, ONERA, Chatillon, Vert Le Petit, France, *Polystyrylpyridine Resins and Composites*
- Philippe Boisse**, Université de Lyon, Lyon, France, *Composite Fiber Reinforcement Forming*
- Assunta Borzacchiello**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Novel Biomimetic Design for Composite Material*
- John Botsis**, Institute of Mechanical Engineering, Lausanne, Switzerland, *Fiber Bragg Grating Applied to In Situ Characterization of Composites*
- Abderrahim Boudenne**, CERTES, Université Paris-Est Créteil Val de Marne, Créteil Cédex, France, *Thermophysical and Thermal Expansion Properties*
- Jack Boyd**, Cytec Engineered Materials Inc., Anaheim, CA, *Partially Fluorinated Polyimide Resins and Composites*
- Michael Bruyneel**, SAMTECH Headquarters, Analysis and Optimization Groups, Angleur, Belgium, *Structural Composite Design: Concepts and Considerations*
- Anthony R. Bunsell**, Mines ParisTech, Evry Cedex, France, *Fiber Reinforcement*
- Pavel Bystricky**, Mat-IQ, L.L.C., Lexington, MA, *Smart Structures*
- Zhiyong Cai**, USDA Forest Service, Madison, WI, *Wood-Based Composite Board; Wood Composite Laminates*
- Paul Calvert**, University of Arizona, Tucson, AZ, *Optical Properties of Polymer Composites*
- Giovanni Camino**, Turin Polytechnic-Alessandria Site, Alessandria, Italy, *Flammability of Polymer Composites*
- Yves Candau**, CERTES, Université Paris-Est Créteil Val de Marne, Créteil Cédex, France, *Thermophysical and Thermal Expansion Properties*
- Paolo Canonico**, Saati SpA, Via Milano 14, Appiano Gentile (Como), Italy, *Woven Composite Structures*
- Jason P. Carey**, University of Alberta, Edmonton, Alberta, Canada, *Processing and Performance of Braided Composites*
- Cosimo Carfagna**, University of Naples, Naples, Italy; National Council of Research of Italy, Pozzuoli, Italy; CNR Institute of Composite and Biomedical Material IMCB, Naples, Italy, *Fillers, Microspheres, and Microcapsules; In Situ Composites*
- Gianfranco Carotenuto**, National Research Council, Napoli, Italy; Istituto per i Materiali Compositi e Biomedici, CNR, Napoli, Italy, *Graphene-Polymer Composites; Polymer-Embedded Metal and Metal Sulfide Clusters*
- Nicolas Carrère**, ONERA, Châtillon, France, *Metal Matrix Composites: Continuous Silicon-Carbide Fibers/Titanium-Alloy Matrix*
- Antonio Cassinese**, University of Naples Federico II, Naples, Italy, *Conductive Composites*
- Alain Castellan**, Université de Bordeaux, Pessac, France, *Phenolic Resins and Composites*
- María M. Castillo-Ortega**, Universidad de Sonora, Hermosillo, Sonora, México, *Ordered Polymer Fibers*
- Francesca Ceroni**, University of Sannio, Benevento, Italy, *Externally Bonded Masonry Structures; Externally Bonded Reinforced Concrete Structures*
- Chi-Ming Chan**, Hong Kong University of Science and Technology, Kowloon, Hong Kong, *Surface Analysis*
- Namas Chandra**, University of Nebraska-Lincoln, Lincoln, NE, *Thermal and Mechanical Properties of Copper-Carbon Composites in Electronic Packaging*
- Stephen Z. D. Chang**, University of Akron, Akron, OH, *Polyimide Fibers, Aromatic*
- Amit Chatterjee**, University of Delaware, DE; DRDO, NMRL, Ambernath, India; Intellectual Venture, Wilmington, DE, *Thermoset Resins*
- Shive K. Chaturvedi**, Ohio State University, Columbus, OH, *Damping Characterization of Polymer Matrix Composite Materials*
- Krishan K. Chawla**, University of Alabama at Birmingham, Birmingham, AL, *Automotive Composites*
- Nikhilesh Chawla**, Arizona State University, Tempe, AZ, *Automotive Composites*
- Kingsley Kin Chee Ho**, Cytec Engineered Materials, Wrexham, UK; Imperial College London, London, UK, *Carbon Fiber: Properties, Testing, and Analysis; Carbon Fiber: Surface Properties*
- Fujia Chen**, University of Oxford, Oxford, UK, *Impact Damage*
- S. H. Chen**, South China University of Technology, Guangzhou, China, *Laminated Glass*
- Deborah D. L. Chung**, University at Buffalo, State University of New York, Buffalo, NY, *Sensors in Composites*
- Gianluca Cicala**, University of Catania, Catania, Italy, *Material Selection: Polymeric Composites Matrix*
- Onur Çoban**, Kocaeli University, Izmit, Turkey, *Fiber Reinforcement: Continuous Fibers*
- Sandro Cobror**, Chemtex Italia spa, Tortona, AL, Italy, *Bio-Based Chemistry for Polymeric Matrices*
- Xavier Colin**, ARTS ET METIERS ParisTech, Paris, France, *Aging of Organic Matrix Composite Materials*
- Francis Collombet**, Université de Toulouse, Toulouse Cedex 4, France, *Carbon/Polymeric Composites Autoclave Cure Monitoring with Optical Fiber Bragg Grating (FBG) Sensors*
- Carlos Conceição António**, University of Porto, Porto, Portugal, *Design with Composites: Material Uncertainty in Designing Composites Component*
- John W. Connell**, NASA Langley Research Center, Langley Blvd Hampton, VA, *Polyquinoxaline Matrix Resins and Composites*
- Edoardo Cosenza**, University of Naples Federico II, Naples, Italy, *Composites for Structural Strengthening; Externally Bonded Reinforced Concrete Structures; FRP Structural Profiles and Shapes*
- Alan Crosky**, University of New South Wales (UNSW), Sydney, Australia, *Fiber Placements*
- Ugo D'Amora**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Soft Tissue Repair and Regeneration: Composite Materials toward the Design of Advanced Prostheses and Scaffolds*
- Peter Davies**, Institut Français de Recherche sur l'Exploitation de la Mer (IFREMER), Plouzané, France, *Marine Composites*

- Raju S. Davé**, HSR Rapperswil, Washington, DC, *Processing: Autoclave Modeling*
- João Paulo Davim**, University of Aveiro, Aveiro, Portugal, *Cutting and Machining of Polymer Composites*
- Antonio De Luca**, University of Miami, Coral Gables, FL, *FRP-Reinforced Concrete Structures*
- Roberto De Santis**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Soft Tissue Repair and Regeneration: Composite Materials toward the Design of Advanced Prostheses and Scaffolds*
- Gregory De Temmerman**, FOM Institute for Plasma Physics, Association EURATOM-FOM, Nieuwegein, The Netherlands, *Composite Materials for Plasma-Facing Applications in Nuclear Fusion*
- Chadwick Delano**, Aerotherm Corporation, Mountain View, CA, *Polybenzimidazole Matrix Resins and Composites*
- Hom Nath Dhakal**, University of Portsmouth, UK, *Polymer Matrix Composites: Moisture Effects and Dimensional Stability*
- Brij Kumar Dhindaw**, Indian Institute of Technology Ropar, Rupnagar, India, *Metal Matrix Composites: Aluminum*
- Claudio Di Fratta**, ETH Zurich, Zurich, Switzerland, *Molding: Liquid Composite Molding (LCM)*
- Marco Di Ludovico**, University of Naples Federico II, Naples, Italy, *Composites for Structural Strengthening: Externally Bonded Reinforced Concrete Structures; FRP Prestressed Concrete Structures*
- Ernesto Di Maio**, University of Naples Federico II & Institute of Composite and Biomedical Materials, Naples, Italy, *Biodegradable Composites*
- Luciano Di Maio**, University of Salerno, Fisciano (SA), Italy, *Polymeric Extrusion*
- Cezar Diaconu**, SAMTECH Japan, Nagoya, Aichi, Japan, *Structural Composite Design: Concepts and Considerations*
- Anthony T. DiBenedetto**, University of Connecticut, Storrs, CT, *Creep; Creep Rupture*
- Marija Dimitrijević**, University of Belgrade, Belgrade, Serbia, *Nondestructive Evaluation Methods for Composites: Ultrasonic Measurements and Image Analysis Application on Testing in Extreme Conditions*
- Mengxian Ding**, Chinese Academy of Sciences, Changchun, Jilin province, China, *Polyimides: Condensation*
- Marina Dojcinovic**, University of Belgrade, Belgrade, Serbia, *Nondestructive Evaluation Methods for Composites: Ultrasonic Measurements and Image Analysis Application on Testing in Extreme Conditions*
- Shanyan Dong**, LEME, University Paris 10, Paris, France, *Fatigue and Fracture of Rubbers*
- Yu Dong**, Curtin University, Perth, Australia, *Fillers*
- Vasileios M. Drakonakis**, GloCal/F.R.E.E.D.O.M., Seattle, WA, *Prepreg Manufacturing*
- Patricia Dreyfuss**, Michigan Molecular Institute, Midland, Michigan, *Amino Resins*
- Peter Dreyfuss**, Michigan Molecular Institute, MI, *Polybutadiene Rubbers and Resins*
- Pierre J. J. Dumont**, CNRS, Grenoble Institute of Technology, Grenoble, France, *Sheet Molding Compounds*
- Frank Ehrig**, University of Applied Science Rapperswil (HSR), Rapperswil, St. Gallen, Switzerland, *Molding: Polymer Injection*
- Paolo Ermanni**, ETH Zurich, Zurich, Switzerland, *Molding: Liquid Composite Molding (LCM); Out-of-Autoclave Prepreg Processing; Processing: Autoclave Modeling*
- Mariano Escobar**, University of Buenos Aires, Las Heras, Buenos Aires, Argentina, *Pultrusion*
- Joseph C. Farmer**, Lawrence Livermore National Laboratory, Livermore, CA; United States Naval Postgraduate School, Monterey, CA, *High Performance Corrosion-Resistant Materials*
- Omar Faruk**, University of Toronto, Toronto, Ontario, Canada; University of Kassel, Kassel, Germany, *Processing of Biofiber-Reinforced Composites; Wood Plastic Composite: Present and Future*
- Luciano Feo**, University of Salerno, Fisciano (SA), Italy, *Mechanical Behavior of Composites for Construction*
- Monica Ferraris**, Politecnico di Torino, Torino, Italy, *Adhesion Aspects in Composites*
- Frank Feyerabend**, Institute of Materials Research, Geesthacht, Germany, *Metal Matrix Composites: Magnesium*
- Merton C. Flemings**, Massachusetts Institute of Technology, Cambridge, MA, *Metal Matrix Composites: Infiltration*
- Massimiliano Fraldi**, University of Napoli Federico II, Napoli, Italy, *Problems and Fundamental Models for Inverse Methods in Composite Materials*
- Leandro A.L. Franco**, Instituto de Aeronáutica e Espaço, Comando da Aeronáutica, Brazil, *Fractography of Composite Materials*
- Mariaenrica Frigione**, University of Salento, Via Arnesano, Lecce, Italy, *Curing Agent*
- Elisabete Frollini**, University of São Paulo, São Carlos, Brazil, *Phenolic Resins and Composites*
- Shao-Yun Fu**, Chinese Academy of Sciences, Beijing, China, *Testing: Methods for Strength Characterization of Woven Fabric Composites at Cryogenic Temperatures*
- Benedetto Gambino**, Alenia Aermacchi SpA, Naples, Italy, *Project Management Considerations: Design Architectures for Civil and Military Aircraft*
- Paolo Gardonio**, Università di Udine, Udine, Italy, *Composite Smart Panels for Active Control of Sound Radiation*
- Elisabetta Gariboldi**, Politecnico di Milano, Milano, Italy, *Metal Matrix Composites: Discontinuously Reinforced, Microstructure and Mechanical Property Correlations*
- Riccardo Gennaro**, University of Salento, Monteroni, Lecce, Italy, *Thermoforming of Thermoplastics Matrix Composites; Thermoplastic Composite Manufacturing Cost Analysis*
- Giancarlo Genta**, Politecnico di Torino, Torino, Italy, *Tires, Automobile*
- Randall M. German**, San Diego State University, San Diego, CA, *Particulate Composites by Powder Injection Molding*
- James W. Giancaspro**, University of Miami, Coral Gables, FL, *Fracture: Toughness*
- Cinzia Giannini**, Istituto di Cristallografia, CNR, Bari, Italy, *Polymer-Embedded Metal and Metal Sulfide Clusters*
- Katia Gigliotti**, Alenia Aermacchi SpA, Torino, Italy, *Static Electricity and Aircraft*
- Michele Giordano**, Institute of Composite and Biomedical Materials IMCB - CNR, Portici, Italy, *Processing: Autoclave*

- Antonio Gloria**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Soft Tissue Repair and Regeneration: Composite Materials toward the Design of Advanced Prostheses and Scaffolds*
- W. B. Goldsworthy**, W. Brandt Goldsworthy & Associates Inc., *Pulforming*
- Carroll Grant**, Composites Consultant, Sandy, UT, *Fiber Placements*
- Antonio Greco**, University of Salento, Monteroni, Lecce, Italy, *Thermoforming of Thermoplastics Matrix Composites; Thermoplastic Composite Manufacturing Cost Analysis*
- Eitan Grossman**, Soreq NRC, Yavne, Israel, *Space Environment Effects on Polymer Matrix Composites*
- Stephen Grove**, University of Plymouth, Plymouth, UK, *Manufacture of Polymer Composites*
- Rui M. Guedes**, Engenharia da Universidade do Porto, Porto, Portugal, *Fracture: Interlaminar; Matrix-Controlled Failure Modes of Polymeric Composites*
- Eray M. Gunel**, University at Buffalo, The State University of New York, Buffalo, NY, *Damage Coupled Viscoplastic Modeling of Particulate Composites with Imperfect Interphase*
- Igor A. Guz**, University of Aberdeen, Aberdeen, Scotland, UK, *Compressive Response of Composite Stiffened Panels with Open Holes*
- John C. Halpin**, JCH Consultants Inc., Centerville, OH, *Requirements for Certification of Composite Airframes: Historical Evolution*
- Masanori Hara**, Rutgers University, Piscataway, NJ, *Mechanical Properties of Molecular Composites*
- Frank W. Harris**, University of Akron, Akron, OH, *Polyimide Fibers, Aromatic*
- Jean-Marc Heintz**, CNRS Université de Bordeaux, Pessac, France, *Thermal and Mechanical Properties of Copper-Carbon Composites in Electronic Packaging*
- Markus Henne**, HSR Rapperswil, Rapperswil, Switzerland, *Processing: Autoclave Modeling*
- F. C. Henson**, Dow Chemical Company, Midland, MI, *Vinyl Ester Matrix Resins and Composites*
- Carl T. Herakovich**, University of Virginia, Charlottesville, VA, *Composite Materials: Lamination Theory; Testing: Mechanical Characterization*
- Paul M. Hergenrother**, NASA Langley Research Center, Langley Blvd Hampton, VA, *Polyquinoxaline Matrix Resins and Composites*
- Pedro J. Herrera-Franco**, Universidad Marista de Mérida, Mérida, México, *Ordered Polymer Fibers*
- Norbert Himmel**, Institut für Verbundwerkstoffe GmbH, Kaiserslautern, Germany, *Stitched Preforms, NCF*
- Hong Hocheng**, National Tsing Hua University, Hsinchu, Taiwan, *Micromechanisms of Delamination in Composite Materials Induced by Drilling*
- John M. Hodgkinson**, Imperial College London, London, UK, *Carbon Fiber: Properties, Testing, and Analysis; Impact Damage*
- Jung Hong**, Sungkyunkwan University, Suwon, South Korea, *Nanofillers*
- Norbert Hort**, Institute of Materials Research, Geesthacht, Germany, *Metal Matrix Composites: Magnesium*
- Tim Huber**, University of Canterbury, Christchurch, New Zealand, *All-Cellulose Composites*
- Tae-seon Hwang**, Sungkyunkwan University, Suwon, South Korea, *Nanofillers*
- Salvatore Iannace**, University of Naples Federico II & Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Biodegradable Composites; Bio-Based Chemistry for Polymeric Matrices; Foamed Cores*
- Michele Iannone**, Alenia Aermacchi, Naples, Italy, *Composite Materials for Aeronautic Application*
- N. Igata**, University of Tokyo, Tokyo, Japan, *Microscopy: High Resolution Electron (HREM)*
- Loredana Incarnato**, University of Salerno, Fisciano (SA), Italy, *Polymeric Extrusion*
- Avraam I. Isayev**, The University of Akron, Akron, OH, *Liquid Crystalline Composite; Molding: Compression*
- Josef Jancar**, Brno University of Technology, Brno, Czech Republic, *Composite Micromechanics*
- Heli Jantunen**, University of Oulu, Oulu, Finland, *Composite Electroceramics*
- Dhirendra Kumar Jha**, Indian Institute of Technology Bombay, Powai, Mumbai, India, *Laminates: Static Strength*
- Fan-Long Jin**, Jilin Institute of Chemical Technology, Jilin City, People's Republic of China, *Epoxy Resins: Fluorine Systems*
- Frank R. Jones**, University of Sheffield, Sheffield, UK, *Interfacial Analysis in Fiber Composite Materials; Interphase in Fiber-Reinforced Composites*
- Jari Juuti**, University of Oulu, Oulu, Finland, *Composite Electroceramics*
- Musa R. Kamal**, McGill University, Montreal, Quebec, Canada, *Polymer-Clay Nanocomposites*
- Tarun Kant**, Indian Institute of Technology Bombay, Powai, Mumbai, India, *Laminates: Static Strength*
- József Karger-Kocsis**, Budapest University of Technology and Economics, Budapest, Hungary, *Structure and Fracture Mechanics of Injection-Molded Composites*
- Maria Kashtalyan**, University of Aberdeen, Aberdeen, Scotland, *Damage Mechanisms in Cross-Ply Fiber-Reinforced Composite Laminates*
- Sari Katz**, Soreq NRC, Yavne, Israel, *Space Environment Effects on Polymer Matrix Composites*
- Masamichi Kawai**, University of Tsukuba, Tsukuba, Japan, *Fatigue of Composites—Life Prediction Methods*
- Michael W. Keller**, The University of Tulsa, Tulsa, OK, *Self-Healing Composites*
- Donald Kelly**, University of New South Wales (UNSW), Sydney, Australia, *Fiber Placements*
- David J. Kemmish**, ICI Materials, *Poly(Aryl Ether Ketone) Matrix Resins and Composites*
- Samuel Kenig**, Shenkar College, Ramat Gan, Israel, *Discontinuous Fiber Thermoplastic Composites: Void Formation during Melt Processing; Short-Fiber Thermoplastics Composites: Fiber Fracture During Melt Processing*
- José Maria Kenny**, Università di Perugia, Perugia, Italy; Institute of Polymer Science and Technology, CSIC, Madrid, Spain, *Composites Based on Nanocomposite Matrices*
- Petri Kere**, Tampere University of Technology, Tampere, Finland, *Design with Composites*

- Michael R. Kessler**, Iowa State University, Ames, IA, *Cyanate Ester Resins*
- Boris I. Kharisov**, Universidad Autónoma de Nuevo León, Monterrey, México, *Radiation-Assisted Synthesis of Composites, Materials, Compounds, and Nanostructures*
- Oxana V. Kharissova**, Universidad Autónoma de Nuevo León, Monterrey, México, *Radiation-Assisted Synthesis of Composites, Materials, Compounds, and Nanostructures*
- Dong Ouk Kim**, Sungkyunkwan University, Suwon, South Korea; Samsung Advanced Institute of Technology (SAIT), Gyeonggi-do, South Korea, *Nanofillers*
- Ian A. Kinloch**, University of Manchester, Manchester, UK, *Graphene Composites*
- Otmar Kolednik**, Austrian Academy of Sciences, Leoben, Austria, *Fracture Mechanics*
- Vassilis Kostopoulos**, University of Patras, Greece, *Epoxy Resins*
- Sotiris Koussios**, Delft University of Technology, Delft, The Netherlands, *Filament Winding: Design, Materials, Structures, and Manufacturing Processes*
- Ryszard Kozłowski**, Institute for Engineering of Polymers Materials and Dyes, Piastow, Warsaw, Poland; ESCORENA Focal Point, Institute of Natural Fibres and Medicinal Plants, Poznan, Poland, *Natural Fibers*
- Agnieszka Kregielczak**, Medical University, Poznan, Poland, *Natural Fibers*
- Harry S. Ku**, University of Southern Queensland (USQ), Toowoomba, Australia, *Processing of Materials Using Electromagnetic Fields*
- G. T. Kwiatkowski**, Amoco Performance Products, Inc., Alpharetta, GA, *Polysulfone Thermoplastic Composites*
- Antonio Langella**, DIMP - University of Naples Federico II, Naples, Italy, *Processing: Autoclave*
- Manoj Lanka**, Centre for Nanoscience & Nanotechnology (A joint initiative of IGCAR, Kalpakkam & Sathyabama University), Chennai, India, *Ceramic Matrix Composites: Carbon Fiber Reinforced*
- Ireneusz Lapczyk**, DS Simulia Inc., Providence, RI, *Continuum Damage Mechanics*
- Domenico Larobina**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Osmotic Effects*
- Marino Lavorgna**, National Research Council, Napoli, Italy, *Nanostructured Polymer Composites by Sol-Gel Method*
- David C. Leach**, ICI Materials, *Poly(Aryl Ether Ketone) Matrix Resins and Composites*
- Leonardo Lecce**, University of Naples Federico II, Naples, Italy, *Laminates Progressive Failure Analysis: Recent Approaches Based on Finite Element Analysis Techniques*
- Jun-Ho Lee**, Sungkyunkwan University, Suwon, South Korea, *Nanofillers*
- Koon-Yang Lee**, Imperial College London, London, UK, *Carbon Fiber: Properties, Testing, and Analysis*
- Pyoung-Chan Lee**, Korea Automotive Technology Unstitute (KATECH), Chungnam, South Korea, *Nanofillers*
- Woo Il Lee**, Seoul National University, Seoul, Korea, *Manufacturing: Economic Consideration*
- Yong-Keun Lee**, Institute for Clinical Performance of Biomaterials (ICPB), Seoul, Republic of Korea, *Colorants for Composites*
- Manrico de Leo**, Alenia Aermacchi S.p.A., Naples, Italy, *Quality Assurance and Quality Control*
- Alan Y. L. Leong**, PETRONAS Research, Kawasan Institusi Bangi, Kajang, Selangor DE, Malaysia, *Processing Polymer Matrix Composites*
- K. H. Leong**, PETRONAS Research, Kawasan Institusi Bangi, Kajang, Selangor DE, Malaysia, *Processing Polymer Matrix Composites*
- Martin Leuchs**, MT Aerospace AG, Augsburg, Germany, *Ceramic Matrix Composites: CVI (Chemical Vapor Infiltration)*
- Jinsong Li**, Beijing University of Aeronautics and Astronautics, Beijing, China, *Carbon/Carbon Composites*
- Kecheng Li**, Xi'an Jiaotong University, Xi'an, Shaanxi, China, *Multifunctional Low Loss Ceramic-Polymer Composites for Microwave Applications*
- Gian Piero Lignola**, University of Naples Federico II, Naples, Italy, *Composites for Structural Strengthening; Externally Bonded Masonry Structures; Externally Bonded Reinforced Concrete Structures; FRP Prestressed Concrete Structures*
- Dahsin Liu**, Michigan State University, East Lansing, Michigan, *Composite Impact; Composite Joining*
- Hongsheng Liu**, South China University of Technology, Guangzhou, China, *Polymer-Polymer Composites*
- Xiaobo Liu**, University of Electronic Science and Technology of China, Chengdu, PR, China, *Polyarylene Sulfide Matrix Resins and Composites*
- Antonietta Lo Conte**, Politecnico di Milano, Milano, Italy, *Metal Matrix Composites: Design Methodology*
- Carmelo Lo Faro**, Cytec Engineered Materials Inc., Tempe, AZ, *Material Selection: Polymeric Composites Matrix*
- Bryan Louis**, ETH Zurich, Zurich, Switzerland, *Processing: Autoclave Modeling; Out-of-Autoclave Prepreg Processing*
- Jose Antonio Loya**, Universidad Carlos III de Madrid, Leganés, Madrid, Spain, *Processing and Mechanical Properties of the Workpiece in Machining of Long-Fiber-Reinforced Composites*
- Ruiying Luo**, Beijing University of Aeronautics and Astronautics, Beijing, China, *Carbon/Carbon Composites*
- Shen-Yi Luo**, University of Nevada, Reno, NV, *Flexible Composites*
- Bérençère J. C. Luthringer**, Institute of Materials Research, Geesthacht, Germany, *Metal Matrix Composites: Magnesium*
- Alfonso Maffezzoli**, University of Salento, Monteroni, Lecce, Italy, *Curing Agent; Thermoforming of Thermoplastics Matrix Composites; Thermoplastic Composite Manufacturing Cost Analysis*
- Jelena Majstorović**, University of Belgrade, Belgrade, Serbia, *Nondestructive Evaluation Methods for Composites: Ultrasonic Measurements and Image Analysis Application on Testing in Extreme Conditions*
- Gaetano Manfredi**, University of Naples Federico II, Naples, Italy, *Composites for Structural Strengthening; Externally Bonded Masonry Structures; Externally Bonded Reinforced Concrete Structures; FRP Prestressed Concrete Structures*
- Jean-Gabriel Maquart**, SNPE Centre de Recherches du Bouchet, Vert Le Petit, France, *Polystyrylpyridine Resins and Composites*

- F. Mares**, Allied-Signal Inc., *Polypivalolactone-Carbon Fiber Composites*
- Eric Martin**, LCTS, Université de Bordeaux, Pessac, France, *Metal Matrix Composites: Continuous Silicon-Carbide Fibers/Titanium-Alloy Matrix*
- Sanja Martinović**, Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, Serbia, *Nondestructive Evaluation Methods for Composites: Ultrasonic Measurements and Image Analysis Application on Testing in Extreme Conditions*
- Francesco Marulo**, Università di Napoli "Federico II", Naples, Italy, *Spacecraft Structures: Development*
- Leno Mascia**, Loughborough University, Loughborough, United Kingdom, *Nanostructured Polymer Composites by Sol-Gel Method*
- Branko Matović**, University of Belgrade, Belgrade, Serbia, *Nondestructive Evaluation Methods for Composites: Ultrasonic Measurements and Image Analysis Application on Testing in Extreme Conditions*
- M. Matzner**, Amoco Performance Products, Inc., Alpharetta, GA, *Polysulfone Thermoplastic Composites*
- Luca Mazzola**, University "Roma Tre", Rome, Italy, *Composite Materials in Launch Vehicles*
- Massimo Mazzola**, AVIO s.p.a., Torino, Italy, *Composite Materials in Launch Vehicles*
- R. A. McCarthy**, Harborside Research Group, *Styrenic Composites*
- Ubaldo Ortiz Méndez**, Universidad Autónoma de Nuevo León, Monterrey, México, *Radiation-Assisted Synthesis of Composites, Materials, Compounds, and Nanostructures*
- Giuseppe Mensitieri**, University of Naples Federico II, Naples, Italy, *Environmental Resistance of High Performance Polymeric Matrices and Composites*
- Véronique Michaud**, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, *Fibrous Preforms and Preforming*
- M. J. Michno Jr.**, Amoco Performance Products, Inc., Alpharetta, GA, *Polysulfone Thermoplastic Composites*
- Maria Henar Miguélez**, Universidad Carlos III de Madrid, Leganés, Madrid, Spain, *Processing and Mechanical Properties of the Workpiece in Machining of Long-Fiber-Reinforced Composites*
- Nilanjana Mitra**, Indian Institute of Technology, Kharagpur, India, *Structures: Marine Sandwich*
- Peter Mitschang**, Institut für Verbundwerkstoffe GmbH, Verarbeitungstechnik, Kaiserslautern, Germany, *Manufacturing of Thermoplastic Fiber-Reinforced Polymer Composites*
- Kashmiri L. Mittal**, Hopewell Junction, NY, *Fiber Surface Treatment: Relevance to Interfacial Characteristics*
- Yasushi Miyano**, Kanazawa Institute of Technology, Hakusan Ishikawa, Japan, *Viscoelastic Behavior*
- János Móczó**, Budapest University of Technology and Economics, Budapest, Hungary; Hungarian Academy of Sciences, Budapest, Hungary, *Polymer/Wood Composites*
- Marco Molina**, CGS SpA, Milano, Italy, *Protective Coatings for Space Applications*
- Ernesto Monaco**, University of Naples Federico II, Naples, Italy, *Laminates Progressive Failure Analysis: Recent Approaches Based on Finite Element Analysis Techniques*
- Mauro Montabone**, Thales Alenia Space, Turin, Italy, *Spacecraft Structure*
- Marco Monti**, Università di Perugia, Perugia, Italy, *Composites Based on Nanocomposite Matrices*
- John J. Morena**, American Composite Education, Inc., *Mold Fabrications*
- Marcelo F. S. F. de Moura**, Engenharia da Universidade do Porto, Porto, Portugal, *Fracture: Interlaminar; Matrix-Controlled Failure Modes of Polymeric Composites*
- Raffaele Mucciolo**, Alenia Aermacchi S.p.A., Foggia, Italy, *Quality Assurance and Quality Control*
- Matthieu Mulle**, Université de Toulouse, Toulouse Cedex 4, France, *Carbon/Polymeric Composites Autoclave Cure Monitoring with Optical Fiber Bragg Grating (FBG) Sensors*
- Zaleha Mustafa**, University of Glasgow, Glasgow, UK, *Composites for Hard Tissue Repair*
- Malgorzata Muzyczek**, Institute of Natural Fibres and Medicinal Plants, Poznan, Poland, *Natural Fibres*
- Masayuki Nakada**, Kanazawa Institute of Technology, Ishikawa, Japan, *Accelerated Testing Methodology for Life Prediction of Polymer Composites*
- Wataru Nakao**, Yokohama National University, Yokohama, Japan, *Ceramic Matrix Composites: SiC Whisker-Reinforced*
- Jae-Do Nam**, Sungkyunkwan University, Suwon, South Korea, *Nanofillers*
- Antonio Nanni**, University of Miami, Coral Gables, FL; University of Naples, Naples, Italy, *FRP-Reinforced Concrete Structures*
- Moshe Narkis**, Technion-IIT, Haifa, Israel, *Discontinuous Fiber Thermoplastic Composites: Void Formation during Melt Processing; Hybrid Electrically Conducting Nano Composites Comprising Carbon Nanotubes/Intrinsically Conducting Polymer Systems; Short-Fiber Thermoplastics Composites: Fiber Fracture During Melt Processing*
- Maurizio Natali**, Università di Perugia, Perugia, Italy, *Composites Based on Nanocomposite Matrices; Composite Materials: Ablative*
- Melba Navarro**, Institute for Bioengineering of Catalonia (IBEC), Barcelona, Spain, *Composite Scaffolds for Bone Tissue Regeneration*
- Anil N. Netravali**, Cornell University, Ithaca, NY, *Fiber Surface Treatment: Relevance to Interfacial Characteristics*
- Nuno M. Neves**, University of Minho, Guimarães, Portugal, *Structural Natural Composites*
- Golam Newaz**, Wayne State University, Detroit, MI, *Damage Tolerance Analysis for Advanced Composites*
- Salvatore De Nicola**, Cytec Engineered Materials, Abenbury way, Wrexham, UK, *Chemical Analysis and Characterization of Polymer Composite Materials*
- Luigi Nicolais**, University of Naples Federico II & Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Graphene-Polymer Composites; Novel Biomimetic Design for Composite Material; Polymer-Embedded Metal and Metal Sulfide Clusters*
- Shihua Nie**, University at Buffalo, The State University of New York, Buffalo, NY, *Damage Coupled Viscoplastic Modeling of Particulate Composites with Imperfect Interphase*
- Maria Rossella Nobile**, University of Salerno, Fisciano, Italy; Institute of Composite and Biomedical Materials, National

- Research Council, Naples, Italy, *Carbon Nanotube Polymer Composites; In Situ Composites*
- Phani K. V. V. Nukala**, Oak Ridge National Laboratory, Oak Ridge, TN, *Statistical Fracture Theories*
- Jun Suk Oh**, Sungkyunkwan University, Suwon, South Korea, *Nanofillers*
- Philippe Olivier**, Université de Toulouse, Toulouse Cedex 4, France, *Carbon/Polymeric Composites Autoclave Cure Monitoring with Optical Fiber Bragg Grating (FBG) Sensors*
- Sergio Oller**, Technical University of Catalonia (UPC), Barcelona, Spain, *Advanced Models for Finite Element Analysis of Composite Materials*
- Eugenio Oñate**, Technical University of Catalonia (UPC), Barcelona, Spain, *Advanced Models for Finite Element Analysis of Composite Materials*
- Laurent Orgéas**, CNRS, Grenoble Institute of Technology, Grenoble, France, *Sheet Molding Compounds*
- Alberto Ortona**, iCIMS-SUPSI, Manno, Switzerland, *Ceramic Matrix Composites: Reaction Bonded*
- Mohamed Osmani**, Loughborough University, Loughborough, UK, *Investigation into Sustainable Composites: Glass Reinforced Plastic Waste Filled Concrete*
- Abdul Rahim Othman**, Universiti Sains Malaysia, Nibong Tebal, Penang, Malaysia, *Hybrid Mats; Honeycomb*
- Michael Overd**, AgustaWestland, Cascina Costa di Samarate, Italy, *Helicopter Composite Materials Applications: Airframe*
- Mustafa Özgür Bora**, Kocaeli University, Izmit, Turkey, *Fiber Reinforcement: Continuous Fibers*
- Igor Palley**, National Starch and Chemical Co., New Jersey, *Characterization*
- Raymond J. Palmer**, Boeing Company (Retired), *Composite Processes in Aeronautics; History of Composites in Aeronautics*
- Mark R. Pankow**, The University of Michigan, Ann Arbor, MI, *3D Textile Composites: Mechanical Properties*
- Marianna Pannico**, National Council of Research of Italy, Pozzuoli, Italy, *Fillers, Microspheres, and Microcapsules*
- Antonio Paonessa**, Alenia Aermacchi a Finmeccanica company, Italy, *Vibration and Damping of Composite Structures*
- Asokan Pappu**, Advanced Materials and Processes Research Institute, Bhopal, India, *Investigation into Sustainable Composites: Glass Reinforced Plastic Waste Filled Concrete*
- Christophe Paris**, Université de Toulouse, Toulouse Cedex 4, France, *Carbon/Polymeric Composites Autoclave Cure Monitoring with Optical Fiber Bragg Grating (FBG) Sensors*
- Chung Hae Park**, University of Le Havre, Le Havre, France, *Manufacturing: Economic Consideration*
- Soo-Jin Park**, Inha University, Nam-gu, Incheon, South Korea, *Epoxy Resins: Fluorine Systems*
- C. W. Paul**, Allied-Signal Inc., *Polypivalolactone-Carbon Fiber Composites*
- Charles W. Paul**, National Starch and Chemical Co., New Jersey, *Characterization*
- Lech Pawłowski**, University of Limoges, Limoges, France, *Thermal Spray Coatings*
- Marisa Pecce**, University of Sannio, Benevento, Italy, *FRP Structural Profiles and Shapes*
- Michael Pecht**, University of Maryland, College Park, MD, *Printed Circuit Board Laminates*
- Alessandro Pegoretti**, University of Trento, Trento, Italy, *Environmental Resistance: Stability of Structural Composites under Aggressive Conditions*
- Roberto Petrucci**, Università di Perugia, Perugia, Italy, *Composites Based on Nanocomposite Matrices*
- Stephen J. Pickering**, The University of Nottingham, Nottingham, UK, *Recycling Thermoset Composite Materials*
- Michael R. Piggott**, University of Toronto, Toronto, Ontario, Canada, *Angle Ply Laminates; Compression Properties of Fibers and Polymer Composites; Mechanical Aging; Reinforcements: Fibers, Whiskers, and Platelets; Shear Properties of Polymers and Composites*
- Volker Piottter**, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany, *Powder Injection Molding*
- Elena Pisanova**, FMC Corporation, Tonawanda, NY, *Polycarbonate Composites; Recycling of Carbon Fiber Composites*
- Josep A. Planell**, Institute for Bioengineering of Catalonia (IBEC), Barcelona, Spain, *Composite Scaffolds for Bone Tissue Regeneration*
- Damian Pliszka**, National University of Singapore, Singapore, *Processing: Electric Fields for Fiber Orientation; Electrospinning*
- Prasad Potluri**, University of Manchester, Manchester, UK, *Braiding*
- James Pratte**, Cytec Engineered Materials Inc., Havre de Grace, MD, *Polyetheretherketone (PEEK) Composites: An Update on Processing-Morphology-Property Relationships; Polyetherimide Matrix Resins and Composites; Partially Fluorinated Polyimide Resins and Composites*
- Barbara Previtali**, Politecnico di Milano, Milano, Italy, *Metal Matrix Composites: Casting Processes*
- Andrea Prota**, University of Naples Federico II, Naples, Italy, *Composites for Structural Strengthening; Externally Bonded Masonry Structures; Externally Bonded Reinforced Concrete Structures; FRP Prestressed Concrete Structures*
- Debora Puglia**, Università di Perugia, Perugia, Italy, *Composites Based on Nanocomposite Matrices*
- Béla Pukánszky**, Budapest University of Technology and Economics, Budapest, Hungary; Hungarian Academy of Sciences, Budapest, Hungary, *Polymer/Wood Composites*
- Hui Qian**, Imperial College London, London, UK, *Carbon Fiber: Surface Properties*
- Xiangqun Qian**, Zhejiang University, Hangzhou, China, *Polyvinyl Chloride Composites*
- Seeram Ramakrishna**, National University of Singapore, Singapore; Institute of Materials Research and Engineering, Singapore, Singapore; King Saud University, Riyadh, Saudi Arabia, *Processing: Electric Fields for Fiber Orientation; Electrospinning*
- J. N. Reddy**, Texas A&M University, College Station, Texas, *Laminates: Developments in the Multiscale Analysis of Multifunctional Nanocomposite Materials*
- Károly Renner**, Budapest University of Technology and Economics, Budapest, Hungary; Hungarian Academy of Sciences, Budapest, Hungary, *Polymer/Wood Composites*

- Fabrizio Ricci**, University of Naples Federico II, Naples, Italy, *Laminates Progressive Failure Analysis: Recent Approaches Based on Finite Element Analysis Techniques*
- Vladimir R. Romanovskii**, Russian Research Center Kurchatov Institute, Moscow, Russia, *Superconducting Composites*
- Roger Max Rowell**, University of Wisconsin Madison, WI; EcoBuild, Stockholm, Sweden, *Modified Natural-Fiber-Based Composites*
- Luisa Russo**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Novel Biomimetic Design for Composite Material*
- Teresa Russo**, Institute of Composite and Biomedical Materials, National Research Council, Naples, Italy, *Soft Tissue Repair and Regeneration: Composite Materials toward the Design of Advanced Prostheses and Scaffolds*
- Abdul B. Sadat**, California State Polytechnic University, Pomona, CA, *Machining of Composites*
- Mohini Sain**, University of Toronto, Toronto, Ontario, Canada, *Natural Composites: Fiber Modification*
- Gabriele Salvago**, Politecnico di Milano, Milano, Italy, *Metal Matrix Composites: Corrosion*
- Subhranshu S. Samal**, Centre for Nanoscience & Nanotechnology (A joint initiative of IGCAR, Kalpakkam & Sathyabama University), Chennai, India, *Ceramic Matrix Composites: Carbon Fiber Reinforced*
- Luigi Sanguigno**, Institute of Italian Technology, Naples, Italy, *Osmotic Effects*
- T. S. N. Sankara Narayanan**, National Metallurgical Laboratory, Chennai, India, *Electro- and Electroless Deposited Composite Coatings: Preparation, Characteristics, and Applications*
- Carlos Santiuste**, Universidad Carlos III de Madrid, Leganés, Madrid, Spain, *Processing and Mechanical Properties of the Workpiece in Machining of Long-Fiber-Reinforced Composites*
- Jorge Fernandez Dos Santos**, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany, *Joining: Mechanical Fastening of Polymers, Composites, and Polymer-Metal Hybrid Structures*
- Vito Sapienza**, Alenia Aermacchi S.p.A., Torino, Italy, *Quality Assurance and Quality Control*
- Francesco Scapinello**, Rotor Systems Design and Development, AgustaWestland, Cascina Costa di Samarate, Italy, *Helicopter Composite Materials Applications: Rotors*
- Giuseppe Scherillo**, University of Naples Federico II, Naples, Italy, *Environmental Resistance of High Performance Polymeric Matrices and Composites*
- Hazel R. C. Screen**, Queen Mary University of London, London, UK, *Structure and Biomechanics of Biological Composites*
- Mailadil Thomas Sebastian**, National Institute for Interdisciplinary Science & Technology, CSIR, Trivandrum, India, *Composite Electroceramics*
- James C. Seferis**, GloCal University and GloCal Systems Management, Athens, Greece; GloCal/F.R.E.E.D.O.M., Seattle, WA, *Nanofillers; Prepreg Manufacturing*
- Michal Šejnoha**, Czech Technical University in Prague, Praha, Czech Republic, *Weaving*
- M. Selvaraj**, CSIR-Central Electrochemical Research Institute, Karaikudi, India, *Interpenetrating Polymer Networks, High Performance*
- S. K. Seshadri**, Indian Institute of Technology Madras, Chennai, India, *Electro- and Electroless Deposited Composite Coatings: Preparation, Characteristics, and Applications*
- Abdel-Fattah Seyam**, North Carolina State University, Raleigh, NC, *Needlepunched Composite Structures*
- Vincenzo M. Sglavo**, University of Trento, Trento, Italy, *Ceramic Laminates*
- Siti-Ros Shamsuddin**, Imperial College London, London, UK, *Carbon Fiber: Properties, Testing, and Analysis*
- Lik-Kwan Shark**, University of Central Lancashire, Preston PR1 2HE, England, *Nondestructive Testing and Evaluation of Composite Aerospace Structures*
- Jamal Y. Sheikh-Ahmad**, The Petroleum Institute, Abu Dhabi, UAE, *Cutting and Machining of Polymer Composites*
- Kuichuan Sheng**, Zhejiang University, Hangzhou, China, *Polyvinyl Chloride Composites*
- Yasuhide Shindo**, Tohoku University, Sendai, Japan, *Testing: Methods for Strength Characterization of Woven Fabric Composites at Cryogenic Temperatures*
- Shirin Shokoohi**, Amirkabir University of Technology, Tehran, Iran, *Coupling Agents: Basics and Classifications*
- Michael Shusser**, Technion, Israel Institute of Technology, Haifa, Israel, *Composite Rocket Propellants*
- Arnon Siegmann**, Technion-IIT, Haifa, Israel, *Discontinuous Fiber Thermoplastic Composites: Void Formation during Melt Processing; Short-Fiber Thermoplastics Composites: Fiber Fracture During Melt Processing*
- Dritan Siliqi**, Istituto di Cristallografia, CNR, Bari, Italy, *Polymer-Embedded Metal and Metal Sulfide Clusters*
- Jean-François Silvain**, CNRS Université de Bordeaux, Pessac, France, *Thermal and Mechanical Properties of Copper-Carbon Composites in Electronic Packaging*
- Graham D. Sims**, National Physical Laboratory, Teddington, UK, *Standards for Composite Materials: National, European, and International*
- Harpreet Singh**, Indian Institute of Technology Ropar, Rupnagar, India, *Metal Matrix Composites: Aluminum*
- Tamer Sinmazcelik**, Kocaeli University, Izmit, Turkey, *Fiber Reinforcement: Continuous Fibers*
- John P. Smith**, BAE Systems, Bridge Road, Barrow in Furness, England, *Nondestructive Testing and Evaluation of Composite Aerospace Structures*
- Xavier Soldani**, Universidad Carlos III de Madrid, Leganés, Madrid, Spain, *Processing and Mechanical Properties of the Workpiece in Machining of Long-Fiber-Reinforced Composites*
- Bhanu Sood**, University of Maryland, College Park, MD, *Printed Circuit Board Laminates*
- Luigi Sorrentino**, National Research Council, Naples, Italy, *Foamed Cores*
- Constantinos Soutis**, University of Sheffield, Sheffield, England, UK, *Compressive Response of Composite Stiffened Panels with Open Holes; Damage Mechanisms in Cross-Ply Fiber-Reinforced Composite Laminates*
- Mark P. Staiger**, University of Canterbury, Christchurch, New Zealand, *All-Cellulose Composites*
- Andrey L. Stepanov**, Kazan Federal University, Kazan, Russia; Kazan Physical-Technical Institute, Kazan, Russia; Laser Zentrum Hannover, Hannover, Germany, *Nanofillers: Synthesis of Metal Nanoparticles in Viscous Polymer*

- Holly A. Stretz**, Tennessee Technological University, Cookeville, TN, *Polymeric Composites: Heat Transfer*
- Chenhan Su**, Beijing University of Aeronautics and Astronautics, Beijing, China, *Carbon/Carbon Composites*
- Ganesanpotti Subodh**, Universität Stuttgart, Stuttgart, Germany, *Composite Electroceramics*
- Ran Y. Suckeveriene**, Technion-IIT, Haifa, Israel, *Hybrid Electrically Conducting Nano Composites Comprising Carbon Nanotubes/Intrinsically Conducting Polymer Systems*
- John Summerscales**, University of Plymouth, Plymouth, UK, *Resin Infusion Under Flexible Tooling (RIFT)*
- K. Swaminathan**, Indian Institute of Technology Bombay, Powai, Mumbai, India, *Laminates: Static Strength*
- K. Elizabeth Tanner**, University of Glasgow, Glasgow, UK, *Composites for Hard Tissue Repair; Structure and Biomechanics of Biological Composites*
- Ibrahim N. Tansel**, Florida International University, Miami, Florida, *Manufacturing Automation, Polymer Composites*
- Martin R. Tant**, Eastman Chemical Company, Kingsport, TN, *Polymeric Composites: Heat Transfer*
- Maria Cristina Tanzi**, Politecnico di Milano, Milano, Italy, *Polyurethane Precursors*
- Merja Teirikangas**, University of Oulu, Oulu, Finland, *Composite Electroceramics*
- Andrea Terenzi**, Università di Perugia, Perugia, Italy, *Composites Based on Nanocomposite Matrices*
- Robert Y. Ting**, Naval Research Laboratory, Orlando, FL, *Phthalocyanine Matrix Resins and Composites*
- Radhouan Tlili**, CERTES, Université Paris-Est Créteil Val de Marne, Créteil Cédex, France, *Thermophysical and Thermal Expansion Properties*
- Blanka Tomková**, Technical University of Liberec, Liberec, Czech Republic, *Weaving*
- Luigi Torre**, University of Perugia, Terni, Italy, *Composite Materials: Ablative*
- François Trochu**, École Polytechnique de Montréal, Montréal, Canada, *Molding: Liquid Composite Molding (LCM)*
- Chung Chen Tsao**, Ta Hua Institute of Technology, Hsinchu, Taiwan, *Micromechanisms of Delamination in Composite Materials Induced by Drilling*
- V. Unnikrishnan**, Texas A&M University, College Station, Texas, *Laminates: Developments in the Multiscale Analysis of Multifunctional Nanocomposite Materials*
- Jorge Uribe-Calderon**, McGill University, Montreal, Quebec, Canada, *Polymer-Clay Nanocomposites*
- Aslihan Usumez**, Bezmialem Vakif University, Istanbul, Turkey, *Bonding and Restorative Composite Materials in Dentistry*
- Serdar Usumez**, Bezmialem Vakif University, Istanbul, Turkey, *Bonding and Restorative Composite Materials in Dentistry*
- Aysegul Uygün Gök**, Suleyman Demirel University, Isparta, Turkey, *Furan Composites*
- Luca Valentini**, Università di Perugia, Perugia, Italy, *Composites Based on Nanocomposite Matrices*
- Massimo Valentino**, CNR-SPIN Piazzale Tecchio 80, Naples, Italy, *Electrical and Electronic Composites*
- Anastasios P. Vassilopoulos**, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, *Fatigue Stiffness*
- Antonios Vavouliotis**, University of Patras, Greece, *Epoxy Resins*
- Anita Vaxman**, Carmel Olefins Ltd, Haifa, Israel; Technion-IIT, Haifa, Israel, *Discontinuous Fiber Thermoplastic Composites: Void Formation during Melt Processing; Short-Fiber Thermoplastics Composites: Fiber Fracture During Melt Processing*
- Analia Vázquez**, University of Buenos Aires, Las Heras, Buenos Aires, Argentina, *Pultrusion*
- Amelie Veillere**, CNRS Université de Bordeaux, Pessac, France, *Thermal and Mechanical Properties of Copper-Carbon Composites in Electronic Packaging*
- Chris N. Velisaris**, GloCal/F.R.E.E.D.O.M., Seattle, WA, *Prepreg Manufacturing*
- Jacques Verdu**, ARTS ET METIERS ParisTech, Paris, France, *Aging of Organic Matrix Composite Materials*
- Tatjana Volkov-Husović**, University of Belgrade, Belgrade, Serbia, *Nondestructive Evaluation Methods for Composites: Ultrasonic Measurements and Image Analysis Application on Testing in Extreme Conditions*
- Claudio Voto**, Alenia Aermacchi, SpA, Italy, *Standards and Specifications*
- Anthony M. Waas**, The University of Michigan, Ann Arbor, MI, *3D Textile Composites: Mechanical Properties*
- Hong Wang**, Xi'an Jiaotong University, Xi'an, Shaanxi, China, *Multifunctional Low Loss Ceramic-Polymer Composites for Microwave Applications*
- Hui Wang**, Zhejiang University, Hangzhou, China, *Polyvinyl Chloride Composites*
- Jessada Wannasin**, Prince of Songkla University, Hat Yai, Songkhla, Thailand, *Metal Matrix Composites: Infiltration*
- Lu-Tao Weng**, Hong Kong University of Science and Technology, Kowloon, Hong Kong, *Surface Analysis*
- Robert C. Wetherhold**, University at Buffalo, SUNY, Buffalo, NY, *Shells: Buckling Loads of Laminated Cylinders; Short-Fiber-Reinforced Polymeric Composites: Structure-Properties Relations*
- D. M. White**, General Electric Research and Development Center, *Poly(Phenylene Ether) Matrix Resins*
- Mary N. White**, Dow Chemical Company, Midland, MI, *Vinyl Ester Matrix Resins and Composites*
- Philip J. Withers**, Manchester University, Manchester, UK, *Stress Residual*
- Feng Xiang**, Xi'an Jiaotong University, Xi'an, Shaanxi, China, *Multifunctional Low Loss Ceramic-Polymer Composites for Microwave Applications*
- Fengwei Xie**, The University of Queensland, Brisbane, Australia, *Biodegradable Starch-Based Nano-Composites*
- Yan Xu**, Jilin University, Changchun, China, *Modified Natural-Fiber-Based Composites*
- Gang Yang**, Sichuan University, Chengdu, China, *Phthalonitrile Matrix Resins and Composites*
- Qingda Yang**, University of Miami, Coral Gables, FL, *Fracture: Toughness*
- Haibo Yang**, Xi'an Jiaotong University, Xi'an, Shaanxi, China, *Multifunctional Low Loss Ceramic-Polymer Composites for Microwave Applications*
- Aylin Yenilmez-Gurkok**, Istanbul Technical University, Gumussuyu, Istanbul, Turkey, *Manufacturing Automation, Polymer Composites*

Robert J. Young, University of Manchester, Manchester, UK, *Diacetylene Composites and Fiber; Graphene Composites*

Ali Yousefpour, National Research Council Canada, Montréal, Québec, Canada, *Joining: Thermoplastic Composites Fusion Bonding/Welding*

Long Yu, South China University of Technology, Guangzhou, China; CSIRO Materials Science and Engineering, Melbourne, Australia, *Polymer-Polymer Composites*

M. Y. Zang, South China University of Technology, Guangzhou, China, *Laminated Glass*

Stefano Zapperi, CNR-IENI, Milano, Italy; ISI Foundation, Torino, Italy, *Statistical Fracture Theories*

Evgeni Zelikman, Technion-IIT, Haifa, Israel, *Hybrid Electrically Conducting Nano Composites Comprising Carbon Nanotubes/Intrinsically Conducting Polymer Systems*

Jan Zeman, Czech Technical University in Prague, Praha, Czech Republic, *Weaving*

Ke Zeng, Sichuan University, Chengdu, China, *Phthalonitrile Matrix Resins and Composites*

Jiangsong Zhang, Beijing University of Aeronautics and Astronautics, Beijing, China, *Carbon/Carbon Composites*

Jincao Zhang, Beijing University of Aeronautics and Astronautics, Beijing, China, *Carbon/Carbon Composites*

Yunfeng Zhang, Beijing University of Aeronautics and Astronautics, Beijing, China, *Carbon/Carbon Composites*

Zhongyi Zhang, University of Portsmouth, UK, *Polymer Matrix Composites: Moisture Effects and Dimensional Stability*

Jiachun Zhong, University of Electronic Science and Technology of China, Chengdu, PR, China, *Polyarylene Sulfide Matrix Resins and Composites*

Yuanxin Zhou, Tuskegee University's Center for Advanced Materials (T-CAM), Tuskegee, AL, *Fatigue Strength Distribution of Carbon Fiber*

Yaroslav Zhuk, Timoshenko Institute of Mechanics, Kiev, Ukraine, *Compressive Response of Composite Stiffened Panels with Open Holes*

Lanfranco Zucconi, CGS SpA, Milano, Italy, *Protective Coatings for Space Applications*

CONTENTS

Contributors, ix

VOLUME 1

Accelerated Testing Methodology for Life Prediction of Polymer Composites, 1

Adhesion Aspects in Composites, 11

Advanced Models for Finite Element Analysis of Composite Materials, 22

Aging of Organic Matrix Composite Materials, 35

All-Cellulose Composites, 50

Amino Resins, 64

Angle Ply Laminates, 69

Automotive Composites, 72

Bio-Based Chemistry for Polymeric Matrices, 79

Biodegradable Composites, 84

Biodegradable Starch-Based Nano-Composites, 102

Bonded Composite Patch Repair of Metallic Aircraft Structures, 114

Bonded Repair of Composite Aircraft Structures, 121

Bonding and Restorative Composite Materials in Dentistry, 128

Braiding, 138

Carbon/Carbon Composites, 153

Carbon Fiber: Properties, Testing, and Analysis, 165

Carbon Fiber: Surface Properties, 182

Carbon Nanotube Polymer Composites, 193

Composites Based on Nanocomposite Matrices, 213

Carbon/Polymeric Composites Autoclave Cure Monitoring with Optical Fiber Bragg Grating (FBG) Sensors, 230

Ceramic Laminates, 241

Ceramic Matrix Composites: Carbon Fiber Reinforced, 251

Ceramic Matrix Composites: CVI (Chemical Vapor Infiltration), 259

Ceramic Matrix Composites: Reaction Bonded, 271

Ceramic Matrix Composites: SiC

Whisker-Reinforced, 274

Characterization, 280

Chemical Analysis and Characterization of Polymer Composite Materials, 298

Colorants for Composites, 356

Composite Electroceramics, 361

Composite Fiber Reinforcement Forming, 377

Composites for Structural Strengthening, 393

Composites for Hard Tissue Repair, 418

Composite Materials in Launch Vehicles, 431

Composite Impact, 439

Composite Joining, 448

Composite Materials: Lamination Theory, 454

Composite Materials: Ablative, 459

Composite Materials for Aeronautic Application, 472

Composite Materials for Plasma-Facing Applications in Nuclear Fusion, 485

Composite Micromechanics, 493

Composite Processes in Aeronautics, 504

Composite Rocket Propellants, 527

Composite Scaffolds for Bone Tissue Regeneration, 544

Composite Smart Panels for Active Control of Sound Radiation, 558

Compression Properties of Fibers and Polymer Composites, 580

Compressive Response of Composite Stiffened Panels with Open Holes, 585

Conductive Composites, 595

Continuum Damage Mechanics, 605

Coupling Agents: Basics and Classifications, 611

Creep, 619

Creep Rupture, 631

Curing Agent, 643

Cutting and Machining of Polymer Composites, 648

Cyanate Ester Resins, 658

VOLUME 2

Damage Coupled Viscoplastic Modeling of Particulate Composites with Imperfect Interphase, 673

Damage Mechanisms in Cross-Ply Fiber-Reinforced Composite Laminates, 688

Damage Tolerance Analysis for Advanced Composites, 703

Damping Characterization of Polymer Matrix Composite Materials, 711
 Design with Composites, 725
 Design with Composites: Material Uncertainty in Designing Composites Component, 737
 Diacetylene Composites and Fiber, 749
 Discontinuous Fiber Thermoplastic Composites: Void Formation during Melt Processing, 756

Electrical and Electronic Composites, 767
 Electro- and Electroless Deposited Composite Coatings: Preparation, Characteristics, and Applications, 775
 Environmental Resistance: Stability of Structural Composites under Aggressive Conditions, 791
 Environmental Resistance of High Performance Polymeric Matrices and Composites, 804
 Epoxy Resins, 829
 Epoxy Resins: Fluorine Systems, 842
 Externally Bonded Masonry Structures, 848
 Externally Bonded Reinforced Concrete Structures, 859

Fatigue and Fracture of Rubbers, 877
 Fatigue of Composites—Life Prediction Methods, 883
 Fatigue Stiffness, 915
 Fatigue Strength Distribution of Carbon Fiber, 924
 Fiber Bragg Grating Applied to *In Situ* Characterization of Composites, 930
 Fiber Placements, 945
 Fiber Reinforcement, 950
 Fiber Reinforcement: Continuous Fibers, 966
 Fiber Surface Treatment: Relevance to Interfacial Characteristics, 980
 Fibrous Preforms and Preforming, 999
 Filament Winding: Design, Materials, Structures and Manufacturing Processes, 1011
 Fillers, 1027
 Fillers, Microspheres, and Microcapsules, 1044
 Flammability of Polymer Composites, 1053
 Flexible Composites, 1069
 Foamed Cores, 1081
 Fractography of Composite Materials, 1099
 Fracture: Interlaminar, 1115
 Fracture Mechanics, 1126
 Fracture: Toughness, 1141
 FRP Prestressed Concrete Structures, 1153
 FRP-Reinforced Concrete Structures, 1160
 FRP Structural Profiles and Shapes, 1174
 Furan Composites, 1191

Glass Matrix Composite, 1197
 Graphene Composites, 1218
 Graphene-Polymer Composites, 1232

Helicopter Composite Materials Applications: Airframe, 1237
 Helicopter Composite Materials Applications: Rotors, 1244
 High Performance Corrosion-Resistant Materials, 1248

History of Composites in Aeronautics, 1280
 Hybrid Electrically Conducting Nano-Composites Comprising Carbon Nanotubes/Intrinsically Conducting Polymer Systems, 1319
 Hybrid Mats, 1334
 Honeycomb, 1338

VOLUME 3

Impact Damage, 1353
In Situ Composites, 1367
 Interfacial Analysis in Fiber Composite Materials, 1377
 Interpenetrating Polymer Networks, High Performance, 1383
 Interphase in Fiber-Reinforced Composites, 1396
 Investigation into Sustainable Composites: Glass Reinforced Plastic Waste Filled Concrete, 1402
 Joining: Thermoplastic Composites Fusion Bonding/Welding, 1413
 Joining: Mechanical Fastening of Polymers, Composites and Polymer-Metal Hybrid Structures, 1418

Laminates: Developments in the Multiscale Analysis of Multifunctional Nanocomposite Materials, 1431
 Laminated Glass, 1438
 Laminates Progressive Failure Analysis: Recent Approaches Based on Finite Element Analysis Techniques, 1445
 Laminates: Static Strength, 1451
 Lightning Protection, 1464
 Liquid Crystalline Composite, 1468

Machining of Composites, 1497
 Manufacture of Polymer Composites, 1506
 Manufacturing Automation, Polymer Composites, 1526
 Manufacturing: Economic Consideration, 1535
 Manufacturing of Thermoplastic Fiber-Reinforced Polymer Composites, 1548
 Marine Composites, 1562
 Material Selection: Polymeric Composites Matrix, 1572
 Matrix-Controlled Failure Modes of Polymeric Composites, 1610
 Mechanical Aging, 1620
 Mechanical Behavior of Composites for Construction, 1625
 Mechanical Properties of Molecular Composites, 1649
 Metal Matrix Composites: Aluminum, 1659
 Metal Matrix Composites: Casting Processes, 1676
 Metal Matrix Composites: Continuous Silicon-Carbide Fibers/Titanium-Alloy Matrix, 1695
 Metal Matrix Composites: Corrosion, 1707
 Metal Matrix Composites: Design Methodology, 1719
 Metal Matrix Composites: Discontinuously Reinforced, Microstructure and Mechanical Property Correlations, 1731
 Metal Matrix Composites: Infiltration, 1747
 Metal Matrix Composites: Magnesium, 1756