

Characterization of Minerals, Metals, and Materials 2017

Edited by

Shadia Ikhmayies

Bowen Li

John S. Carpenter

Jian Li

Jiann-Yang Hwang

Sergio Neves Monteiro

Donato Firrao

Mingming Zhang

Zhiwei Peng

Juan P. Escobedo-Diaz

Chenguang Bai

Yunus Eren Kalay

Ramasis Goswami

Jeongguk Kim

TMS

 **Springer**

The Minerals, Metals & Materials Series

Shadia Ikhmayies · Bowen Li
John S. Carpenter · Jian Li
Jiann-Yang Hwang · Sergio Neves Monteiro
Donato Firrao · Mingming Zhang
Zhiwei Peng · Juan P. Escobedo-Diaz
Chenguang Bai · Yunus Eren Kalay
Ramasis Goswami · Jeongguk Kim
Editors

Characterization of Minerals, Metals, and Materials 2017

TMS

 Springer

Editors

Shadia Ikhmayies
Al Isra University
Amman
Jordan

Mingming Zhang
ArcelorMittal Global R&D
East Chicago, IN
USA

Bowen Li
Michigan Technological University
Houghton, MI
USA

Zhiwei Peng
Central South University
Changsha
China

John S. Carpenter
Los Alamos National Laboratory
Los Alamos, NM
USA

Juan P. Escobedo-Diaz
University of New South Wales
Canberra
Australia

Jian Li
CanmetMATERIALS
Hamilton, ON
Canada

Chenguang Bai
Chongqing University
Chongqing
China

Jiann-Yang Hwang
Michigan Technological University
Houghton, MI
USA

Yunus Eren Kalay
Middle East Technical University
Ankara
Turkey

Sergio Neves Monteiro
Military Institute of Engineering, IME
Rio de Janeiro
Brazil

Ramasis Goswami
Naval Research Laboratory
Washington, DC
USA

Donato Firrao
Politecnico di Torino
Turin
Italy

Jeongguk Kim
Korea Railroad Research Institute
Ujiwang
South Korea

ISSN 2367-1181

ISSN 2367-1696 (electronic)

The Minerals, Metals & Materials Series

ISBN 978-3-319-51381-2

ISBN 978-3-319-51382-9 (eBook)

DOI 10.1007/978-3-319-51382-9

TMS owns copyright; Springer has full publishing rights

Library of Congress Control Number: 2016960729

© The Minerals, Metals & Materials Society 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer International Publishing AG

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The characterization of materials is an important step to be taken before utilizing the materials for any purpose. It starts from the production of the material, and continues after each processing and/or engineering stage to explore its influence on the structure and properties of the material. Depending on the purpose, one can subject the material to mechanical, thermal, chemical, optical, electrical, and other characterizations to make sure that the material under consideration can function without failure for the life of the final product. Therefore, advances in the materials science are strongly correlated with advances in the characterization technologies. The Characterization of Minerals, Metals, and Materials symposium sponsored by the Materials Characterization Committee of TMS focuses on material characterization from the bulk down to the nano-scale. All characterization techniques and their applications are covered in this symposium. Developments in these techniques and their application in the quantification of the microstructure of materials are essential facets of this symposium. Specific characterization focus areas include catalyst structure, waste and failure characterization, besides structure-property relationships in metals, minerals and materials.

The characterization symposium is a cornerstone symposium in the TMS annual meeting, which attracts materials scientists, metallurgists, mechanical engineers, microscopists, metallographers, from academia and industry from all over the globe. In the TMS 2017 Annual Meeting & Exhibition held in San Diego, California, USA, the characterization symposium received 229 submissions, of which are 137 oral presentations, and 67 will be presented as posters. Of the presented papers, 93 are published in this book after being peer reviewed. The topics of these papers cover a wide range of materials science, metallurgy, physics, chemistry, and engineering of materials. Minerals, ferrous and nonferrous metals, semiconductors, clays, ceramics, alloys, composites, electronic, magnetic, environmental, soft, and advanced materials are widely covered. In addition, research papers about extraction, processing, welding, solidification, corrosion and method development represent a large portion of the presented papers.

This book features original articles and the state-of-the-art reviews on theoretical and practical aspects of the characterization, extraction, processing, structure, and

behavior of minerals, metals, and materials. It is a good reference for academic and industry audiences from advanced undergraduates to seasoned professionals who wish to learn about all types of characterization methods in general, and specifically about real-world applications in the minerals, metals and materials. This book will also be relevant for scientists and engineers engaged in research, development, and production. This book will provide the industry audience with up-to-date information on many types of materials and their characterization with an underlying theme of explaining the behavior of materials using novel approaches.

The reader of this book will learn about all types of characterization methods, their development, and their applications. The reader will enjoy the diversity of topics in this book. He/she will find in this book up-to-date information about bulk materials, thin films, joints and interfaces, powders, slags, micro and nanostructures. The beautiful thing is that this book pays attention to the relationship between production, extraction, processing, recycling, and loading of materials and alloys in practical use. The knowledge gained from this book can be used to prompt innovations in characterization methods and techniques, and to produce new materials with the specific desired properties.

The editors of this book express their sincere thanks and appreciations to the TMS for giving this symposium the opportunity to publish a stand-alone volume. The editors also thank the Materials Characterization Committee for sponsoring this symposium. They also thank the publisher, Springer, for the production of this book, and the authors, who are the core of this scientific work. Finally the editors express their appreciation for the past chairs and members of the Materials Characterization Committee, who built this great symposium and who attracted talented and creative people to the committee, and attracted scientists and research groups from around the world to this symposium.

Shadia Ikhmayies
Bowen Li
John S. Carpenter
Jian Li
Jiann-Yang Hwang
Sergio Neves Monteiro
Donato Firrao
Mingming Zhang
Zhiwei Peng
Juan P. Escobedo-Diaz
Chenguang Bai
Yunus Eren Kalay
Ramasis Goswami
Jeongguk Kim

Contents

Part I Soft Materials

Charpy Toughness Behavior of Figue Fabric Reinforced Polyester Matrix Composites	3
Artur C. Pereira, Sergio N. Monteiro, Foluke S. Assis and Henry A. Colorado	
Comparative Analysis of Curaua Fiber Density Using the Geometric Characterization and Pycnometry Technique	11
Natália de O.R. Maciel, Carolina G.D. Ribeiro, Jordana Ferreira, Janaina da S. Vieira, Cláudio R. Marciano, Carlos Maurício Vieira, Frederico M. Margem and Sergio N. Monteiro	
Izod Impact Test in Polyester Matrix Composites Reinforced with Blanket of the Malva and Jute Fibers	21
Ygor Macabu de Moraes, Carolina Gomes Dias Ribeiro, Frederico Muylaert Margem, Sergio Neves Monteiro, Jean Igor Margem and João Batista Vasconcelos	
Tensile Behavior of Epoxy Matrix Composites Reinforced with Eucalyptus Fibers	27
Caroline G. de Oliveira, Anna C.C. Neves, Gilson V. Fernandes, Marcos V.F. Fonseca, Frederico M. Margem and Sergio N. Monteiro	
The Dimensional Characterization of Jute Fabric Strips for Reinforcement in Composite Polymeric	33
Sergio N. Monteiro, Frederico M. Margem, Glenio F. Daniel, Vinícius O. Barbosa, André R. Gomes and Victor B. de Souza	
Izod Toughness Behavior of Continuous Palf Fibers Reinforced Polyester Matrix Composites	41
Gabriel O. Glória, Giulio R. Altoé, Maycon A. Gomes, Carlos Maurício F. Vieira, Maria Carolina A. Teles, Frederico M. Margem and Sergio N. Monteiro	

Mechanical, Thermal, Morphology and Barrier Properties of Flexible Film Based on Polyethylene-Ethylene Vinyl Alcohol Blend Reinforced with Graphene Oxide	49
Julyana G. Santana, Angel Ortiz, Rene R. Oliveira, Vijay K. Rangari, Olgun Güven and Esperidiana A.B. Moura	
Radiation Effects on Crosslinking of Butyl Rubber Compounds	59
Sandra R. Scagliusi, Elizabeth C.L. Cardoso and Ademar B. Lugão	
Part II Clays and Ceramics	
Effect of Skin-Core Hierarchical Structure on Dielectric Constant of Injection Molded and Cast Film Extruded Liquid Crystalline Polymer	69
Mark H. Shooter, Michael A. Zimmerman and Anil Saigal	
Aging Behaviour in $\text{Ni}_{0.5}\text{Co}_x\text{Mn}_{2.5-x}\text{O}_4$ ($x = 0.5, 0.8$ and 1.1) Thermistors	85
Gökhan Hardal and Berat Yüksel Price	
Adsorption of Lead from Aqueous Solutions to Bentonite and Composite	91
Shujing Zhu and Ying Qin	
Part III Electronic, Magnetic, Environmental, and Advanced Materials	
Characterization of Low-Zinc Electric Arc Furnace Dust	103
Zhiwei Peng, Xiaolong Lin, Jiaying Yan, Jiann-Yang Hwang, Yuanbo Zhang, Guanghui Li and Tao Jiang	
Gamma-Radiation Effect on Biodegradability of Synthetic PLA Structural Foams PP/HMSPP Based	111
Elizabeth Carvalho L. Cardoso, Sandra R. Scagliusi and Ademar B. Lugão	
Study of Flexible Films Prepared from PLA/PBAT Blend and PLA E-Beam Irradiated as Compatibilizing Agent	121
Elizabeth Carvalho L. Cardoso, René R. Oliveira, Glauson Aparecido F. Machado and Esperidiana A.B. Moura	
Synthesis of ZnO Micro Prisms on Glass Substrates by the Spray Pyrolysis Method	131
Shadia Ikhmayies	
Electrical and Microstructural Investigation of $\text{Ni}_{0.5}\text{Co}_{0.5}\text{Cu}_{0.3}\text{Zn}_{0.3}\text{Mn}_{1.4}\text{O}_4$ Temperature Sensors	139
Gökhan Hardal and Berat Yüksel Price	

Part IV Nano Materials

Enhanced Physical Properties of Thin Film Nanocomposites 147
 T. Thuy Minh Nguyen, Sathish K. Lageshetty and Paul Bernazzani

A Study on the Size and Type of Inclusions in Si-Mn Combined Deoxidated Low Carbon Steel Strip 161
 Ting Wang, Wenqiang Bao, Shaobo Zheng, Qijie Zhai and Huigai Li

Effect of Argon Gas Purging of Spark Plasma Sintered ZrB₂+SiC Nano-Powder Composites 171
 Naidu Seetala, Owen Reedy, Lawrence Matson, HeeDong Lee and Thomas Key

Part V Alloys

Investigating the Anisotropic Behaviour of Lean Duplex Stainless Steel 2101 181
 A.A.H. Ameri, J.P. Escobedo-Diaz, M. Ashraf and Md. Z. Quadir

Microstructural Investigation and Impact Testing of Additive Manufactured Ti-6AL-4V 191
 D.C. Austin, M.A. Bevan, D. East, A.D. Brown, A.A.H. Ameri, P.J. Hazell, A. Chen, S.L.I. Chan, M.Z. Quadir and J.P. Escobedo

Part VI Powders and Foams

Synthesis of TiN Nano-Composite Powder by High-Energy Ball Milling of TiH₂ Under Nitrogen Atmosphere 203
 Xiaolong Wu, Xuewei Lv, Xuyang Liu, Chunxin Li and Yu Zhang

Application of AFM in Morphology Determination of Powder Material 209
 Jian Wu, Ping Long and Yaochun Yao

Effects of Thermal Processing on Closed-Cell Aluminium Foams 217
 A.D. Brown, W.D. Hutchison, M.A. Islam, M.A. Kader, J.P. Escobedo and P.J. Hazell

Experimental Investigation of Mechanical Behaviour of Closed-Cell Aluminium Foams Under Drop Weight Impact 225
 M.A. Islam, M.A. Kader, A.D. Brown, P.J. Hazell, J.P. Escobedo and M. Saadatfar

Deformation Mechanisms of Closed Cell-Aluminium Foams During Drop Weight Impact 233
 M.A. Kader, M.A. Islam, A.D. Brown, P.J. Hazell, M. Saadatfar and J.P. Escobedo

Part VII Minerals

Industrial Use of Brazilian Bentonite Modified by Mild Acid Attack	243
C.G. Bastos Andrade, D.M. Fermino, M.G. Fernandes and F.R. Valenzuela-Diaz	
Mullitization Characteristics and Sinterability of Kyanite in Ceramic Preparation	251
Huaguang Wang, Bowen Li, Mingsheng He and Jiann-Yang Hwang	
Ore Dressing and Technological Characterization of Palygorskite from Piauí/Brazil for Application as Adsorbent of Heavy Metals	261
Karla M.A. Simões, Bruna L. Novo, Adriana A.S. Felix, Julio C. Afonso, Luiz C. Bertolino and Fernanda A.N.G. Silva	
Technological Characterization of Waste from Gold Mining Dam	269
Vanessa P.R. Silva, Fabiano A.C.M. Passos, Lillian M.B. Domingos, Roberto B. Faria, Zuleica C. Castilhos and Fernanda A.N.G. Silva	
Synthesis and Characterization of Sodalite and Cancrinite from Kaolin	279
Fabiano A.C.M. Passos, Danielle C. Castro, Karoline K. Ferreira, Karla M.A. Simões, Luiz C. Bertolino, Carla N. Barbato, Francisco M.S. Garrido, Adriana A.S. Felix and Fernanda A.N.G. Silva	
Part VIII Ferrous Metals	
Effect of Alumina and Magnesia on Microstructure and Mineralogy of Iron Ore Sinter	291
Mingming Zhang and Marcelo W. Andrade	
Isothermal Reduction Kinetics of CaO-2Fe₂O₃ by Thermogravimetric Analysis	301
Chengyi Ding, Xuewei Lv, Senwei Xuan, Kai Tang, Yun Chen and Jie Qiu	
Phase Transformation of MnO₂ and Fe₂O₃ Briquettes Roasted Under CO–CO₂ Atmospheres	311
Bingbing Liu, Yuanbo Zhang, Zijian Su, Guanghui Li and Tao Jiang	
Contact Angle of Iron Ore Particles with Water: Measurements and Influencing Factors	321
Kai Tang, Senwei Xuan, Wei Lv, Xuewei Lv and Chenguang Bai	
Important Factors to Consider in FIB Milling of Crystalline Materials	329
Jian Li and Pei Liu	

Part IX Material Processing and Corrosion

Corrosion Behavior of Super-Ferritic Stainless Steels in NaCl Media 339
 Natalia S. Zadorozne, Jorge D. Vier, Raúl B. Rebak and Alicia E. Ares

Effect of Bromide Ions on the Pitting Corrosion of Hafnium in Anhydrous *t*-Butanol and Acetonitrile 349
 Wang Changhong, Yang Shenghai, Chen Yongming, Yang Xiyun, Wu Yanzeng, He Jing and Tang Chaobo

Compression Behaviour of Semi-closed Die Forged AZ80 Extrusion 361
 A. Gryguc, S.K. Shaha, S.B. Behraves, H. Jahed, M. Wells and B. Williams

Nondestructive Characterization of Microstructures of Heat-Treated Steels by Magnetic Barkhausen Noise Technique 371
 C. Hakan Gür

Part X Method Development

Development of a New Recycling Process of PGM from Metal-Supported Catalyst Using Complex Oxide 379
 Takashi Nagai, Hiroki Kumakura, Masahito Abe, Kotaro Seki and Daiki Noguchi

Part XI Composites

High Thermal Conducting Composites Using Percolation Theory 385
 Kenji Monden

Sorption Characteristics of Low Density Polyethylene/Kola Nut Composite 393
 G.C. Onuegbu, M.U. Obidiegwu and G.O. Onyedika

Residual Stress Analysis Within Steel Encapsulated Metal Matrix Composites Via Neutron Diffraction 405
 Sean Fudger, Dimitry Sediako, Prashant Karandikar and Chaoying Ni

Tensile Behavior of Epoxy Matrix Composites Reinforced with Pure Ramie Fabric 415
 Caroline G. de Oliveira, Janine F. de Deus, Ygor M. de Moraes, Marcos V.F. Fonseca, Djalma Souza, Frederico M. Margem, Luiz G.X. Borges and Sergio Monteiro

Hemp Fiber Density Using the Pycnometry Technique	423
Lázaro A. Rohen, Anna C.C. Neves, Dhyemila de P. Mantovani, F.V. Carlos Maurício, Janaina da Silva Vieira, Lucas de A. Pontes, Frederico M. Margem and Sergio Monteiro	
Preparation and Characterization of Clay Exfoliation and Vegetal Fibre on Properties of Recycled Low Density Polyethylene	429
Amauche Cyprian Achusim-Udenko, Coida D.S. Renata, Francisco R. Valenzuela-Diaz, Gerald Okwuchi Onyedika, Moura E.B. Esperidiana, Martin Chidozie Ogwuegbu and Graca Valenzuela-Diaz	
Part XII Ferrous Metals	
Estimation of Dislocation Density in Metals from Hardness Measurements	441
A.A.H. Ameri, N.N. Elewa, M. Ashraf, J.P. Escobedo-Diaz and P.J. Hazell	
Part XIII Welding and Solidification	
Interfacial Strength Characterization in a High-Modulus Low-Density Steel-Based Fe-TiB₂ Composite	453
Y.Z. Li and M.X. Huang	
Part XIV Materials Extraction	
Leaching of Copper–Cobalt Tailings from Democratic Republic of Congo	463
Y.R.S. Hara, S. Chama, D.M. Musowoya, G. Kaluba, J. Machona, P. Chishimba, Tina Chanda Phiri and S. Parirenyatwa	
Optimum Operating Conditions and Characterisation of Lignin Extracted from Palm Fruit Bunch	471
E.I. Akpan, S.O. Adeosun and M.A. Usman	
Selection on the Process of Enriching Gold by Smelting from Refractory Gold Ores	481
Weifeng Liu, Xunbo Deng, Shuai Rao, Tianzu Yang, Lin Chen and Duchao Zhang	
Selection on the Process for Removing and Recovering Antimony from Antimonial Refractory Gold Ores	489
Weifeng Liu, Xinxin Fu, Shuai Rao, Tianzu Yang, Duchao Zhang and Lin Chen	

Upgrading of Copper and Cobalt from the Democratic Republic of Congo Tailings	499
Y.R.S. Hara, S. Chama, D.M. Musowoya, G. Kaluba, J. Machona, P.W. Chishimba, K. Nyirenda and S. Parirenyatwa	
Characterization of Spent Printed Circuit Boards from Computers	507
Zhiwei Peng, Jiaxing Yan, Hongjin Zhang, Xiaolong Lin, Jiann-Yang Hwang, Yuanbo Zhang, Guanghui Li and Tao Jiang	
Study of the Effect of the Initial Nucleation Mechanism of Lead Anode Oxidation Film on Internal Stress in Chromic Acid Electrolyte	515
Yunkai Wang and Jianzhong Li	
Part XV Poster Session	
Addition of Cellulose Nanofibers in Reactive Powder Concrete	529
F.G.D. Machado, L.G. Pedroti, J.V.B. Lemes, G.E.S. Lima, L.A.F. Fioresi, W.E.H. Fernandes, R.C.S.S. Alvarenga and J. Alexandre	
Advanced Ion Column Solution for Low Ion Damage Characterization and Ultra-Fine Process	537
Sang Hoon Lee, Mostafa Maazouz, Liang Zhang, Mauricio Gordillo, Micah Ledoux and Jeff Blackwood	
Application of Membrane Separation Technology in Wastewater Treatment of Iron and Steel Enterprise	545
Lei Zhang, Shining Chen, Lina Wang, Pu Liu, Benquan Fu and Jiannyang Hwang	
Brillouin Scattering Study on Elastic Properties of Bulk hcp ZnO Single Crystal	553
Ping-Ping Fan and Yong-Quan Wu	
Characteristics of Stamp Charging Coke and Top Charging Coke	561
Gao Bing, Xiao Hong and Zhang Wenqiang	
Characterization and Leaching Proposal of Ag(I) from a Zn Concentrate in an $S_2O_3^{2-}$-O_2 Medium	567
Teja R. Aislinn Michelle, Juárez T. Julio Cesar, Hernández C. Leticia, Reyes P. Martín, Flores G. Mizraim Uriel, Reyes D. Iván Alejandro and Mendez R. Eliecer	
Mechanical Properties and Behavior of Additive Manufactured Stainless Steel 316L	577
M.A. Bevan, A.A.H. Ameri, D. East, D.C. Austin, A.D. Brown, P.J. Hazell and J.P. Escobedo-Diaz	

Characterization of Mercury Jarosite	585
Sayra Ordoñez, Francisco Patiño, Mizraim Uriel Flores, Iván Alejandro Reyes, Elia Guadalupe Palacios, Víctor Hugo Flores, Martín Reyes, Ister Mireles and Hernán Islas	
Characterization of Steel Production Dust and Their Use in Structural Ceramics	593
A.T. Machado, J.R. Matos, F.M.S. Carvalho, A.A.S. Araujo and M.G. Silva-Valenzuela	
Charpy Toughness Behavior of Jute Fabric Reinforced Polyester Matrix Composites	601
Foluke S. de Assis, Artur C. Pereira, Fábio O. Braga and Sergio Monteiro	
Chemical and Mineralogical Characterization of a Mixed Sulphide Ore at Zimapan, Hidalgo, Mexico	607
Laura Angeles, Martin Reyes, Miguel Perez, Elia Palacios, Francisco Patiño, Ivan Reyes and Mizraim Flores	
Contribution to the β Relaxation Study of the HDPE, LDPE and LLDPE	617
Washington Luiz Oliani, Duclerc Fernandes Parra, Luis Filipe Carvalho Pedroso Lima, Harumi Otaguro, Hélio Fernando Rodrigues Ferreto and Ademar Benevolo Lugao	
Determination of Ten Impurity Elements in Tin Concentrate and Smelting Products by ICP-AES	627
Yunke Wang, Ping Long, Jian Wu, Wenli Zhang, Peipei Liu, Xinlin Ren and Bin Yang	
Effects of Wet Grinding on the Structure and Granularity of Biological Origin Aragonite and Its Polymorphic Transformation into Calcite	637
Yunhui Tang and Mingsheng He	
Evaluation of Ballistic Armor Behavior with Epoxy Composite Reinforced with Malva Fibers	647
Lucio Fabio Cassiano Nascimento, Luane Isquerdo Ferreira Holanda, Luis Henrique Leme Louro, Sérgio Neves Monteiro, Alaelson Vieira Gomes and Édio Pereira Lima Júnior	
Evaluation of the Pozzolanic Activity of Residue From the Paper Industry	657
A.R.G. Azevedo, J. Alexandre, L.J.T. Petrucci, E.B. Zanelato and T.F. Oliveira	

Evaluation of the Properties of the Adhesive Mortar in the Fresh State with Addition of Glass Waste 663
 D.P. Santos, A.R.G. Azevedo, J. Alexandre, S.N. Monteiro, G.C. Xavier, B.C. Mendes and L.G. Pedroti

Experimental Evaluation of the Influence of Mortar’s Mechanical Properties on the Behavior of Clay Masonry 671
 Rita de C.S.S. Alvarenga, Gustavo H. Nalon, Lucas A.F. Fiorese, Monica C. Pinto, Leonardo G. Pedroti and José C.L. Ribeiro

Influence of Operation Conditions on Normal Stress and Flow Pattern of Burden Materials in Blast Furnace Based on Discrete Element Method 681
 Wenxuan Xu, Shusen Cheng and Guolei Zhao

Polymer Blend Based on Recycled Polyethylene and Ethylene Vinyl Acetate Copolymers Reinforced with Natural Fibers from Agricultural Wastes 689
 Renata D.S. Coiado, Gisele D. Lazo, Rene R. Oliveira, Rita C.L.B. Rodrigues and Esperidiana A.B. Moura

Preliminary Study of the Effect of Stirring Rate, Temperature and Oxygen Pressure on the Leach Rate of Copper Powder, Generated by Grinding of Printed Circuit Boards of Computer 699
 M.A. Mesinas Romero, I. Rivera Landero, M.I. Reyes Valderrama, E. Salinas Rodríguez, J. Hernández Ávila, E. Cerecedo Sáenz and E.G. Palacios Beas

Preparation and Characterization of Polyethylene Nanocomposites with Clay and Silver Nanoparticles 709
 Washington Luiz Oliani, Danilo Marin Fermino, Luiz Gustavo Hiroki Komatsu, Ademar Benevolo Lugao, Vijaya Kumar Rangari, Nilton Lincopan and Duclerc Fernandes Parra

Production of Concrete Interlocking Blocks with Partial Replacement of Sand in Bulk by Waste Glass Machined 719
 Niander A. Cerqueira, Victor B. Souza, Igor W.D.C. Pereira, Rondinelli C. Ribeiro, Afonso G. Azevedo, Mairyanne S. Souza and Victor T. Bartolazzi

Reactive Powder Concrete Production with the Addition of Granite Processing Waste 729
 J.V.B. Lemes, G.E.S. Lima, F.G.D. Machado, L.G. Pedroti, L.A.F. Fiorese, W.E.H. Fernandes, R.C.S.S. Alvarenga and S. Monteiro

Research on the Reason of the Different Type of Chloride Forming in the Process of Blast Furnace Ironmaking	737
Chuan Hui Li, Jian Liang Zhang, Cui Wang, Bing Ji Yan, Ya Peng Zhang and Hong Wei Guo	
Stress and Deformation Analysis of Hot Blast Stove Piping System	747
Kun Yan and Shusen Cheng	
Stress and Deformation Analysis of Top Combustion Hot Blast Stove Shell	757
Kun Yan and Shusen Cheng	
Study of Calcined Mixtures from Industrial Residues for Production of Agglomerates	767
L.I.C. Fernandez, L.G. Pedroti, E.B. Ferreira Filho, R.C.S.S. Alvarenga, L.G. Justino and W.E.H. Fernandes	
Study of Synergistic Effect of Light Stabilizer Additive, Conventional and Nanoparticles, Applied to Polyethylene Films Submitted to Ultraviolet Radiation	777
Patricia Negrini Siqueira Poveda and Leonardo G.A. Silva	
Study of the Effect of Surface Liquid Flow During Column Flotation of Mining Tailing of the Dos Carlos Dam	787
Javier Flores Badillo, Juan Hernández Ávila, Isauro Rivera Landero, María Isabel Reyes Valderrama, Eduardo Cerecedo Sáenz, Martín Reyes Pérez, Eleazar Salinas Rodríguez and Mauricio Guerrero Rodríguez	
Study on Bending Test on Concrete Structural Use Crumb Rubber as Substitute in Fine Aggregate	799
Niander A. Cerqueira, Victor B. Souza, Bruno Padilha, Pâmela Berçot, Afonso G. Azevedo and Victor T. Bartolazzi	
Synthesis and Structural Characterization of BaTiO₃ Doped with Gd³⁺	809
J.P. Hernández-Lara, M. Pérez-Labra, F.R. Barrientos-Hernández, J.A. Romero-Serrano, A. Hernández-Ramírez, A. Arenas-Flores and Pandiyan Thangarasu	
Texture Analysis and Anisotropic Properties of a Rolled CuZn36 Brass Alloy	815
A. Vazdirvanidis, G. Pantazopoulos, A. Toulfatzis and A. Rikos	
The Influence of Titanium Content on the Sinter Ore Phase Structure and the Crack	823
Dongdong Zhou, Shusen Cheng and Yongqiang Bai	

The Use of Network Simplex Method for Planning the Incorporation of Recycled Paper Mill Sludge in Manufacturing of Ceramic Bodies 833
Andreiva Lauren Vital do Carmo, Nirlane Cristiane Silva,
Anna Paula Sartori, Ana Augusta Passos Rezende,
Leonardo Gonçalves Pedroti, Wellington Emilio Hilarino Fernandes
and Benício Costa Ribeiro

Use of Alkaline Solid Wastes from Kraft Pulp and Paper Mills, Dregs and Grits in Cement Production 843
C.M.M.E. Torres, L.G. Pedroti, C.M. Silva, W.E.H. Fernandes,
N.G. Viana, R.O.G. Martins, G.E.S. Lima, L.M. Sathler,
I.K.R. Andrade and M.A. Caetano

Wood-to-Concrete Joints Using Steel Connectors: Experimental Evaluation 853
Juliano Correa, Rita de C.S.S. Alvarenga, Beatryz C. Mendes
and Márcio Sampaio S. Moreira

Author Index 863

Subject Index 869

About the Editors



Shadia Ikhmayies had received the B.Sc. degree from the Physics Department in the University of Jordan in 1983, the M.Sc. degree in Molecular Physics from the same university in 1987 and the Ph.D. working on producing and characterizing CdS/CdTe thin film solar cells from the same university in 2002. She worked in the Applied Science University from 2004 to 2009 as Assistant Professor, and now she works in Al Isra University as Associate Professor. Her research is focused on producing and characterizing semiconductor thin films such as SnO₂: F, ZnO, CdS, CdTe, CuInS₂, thin film bilayers such as SnO₂:F/CdS:In, and thin film CdS/CdTe solar cells. She also works in characterizing quartz in Jordan for the extraction of silicon for solar cells and characterizing different materials by computation. She published 40 research papers in international scientific journals, three chapters in books, and 62 research papers in conference proceedings. She is the author of two books for Springer —*Silicon for Solar Cell Applications*, and *Performance Optimization of CdS/CdTe Solar Cells* —which are in development.

Shadia is a member of The Minerals, Metals & Materials Society (TMS) and a member of the steering committee of the World Renewable Energy Network (WREN/WREC). She is a member of the international organizing committee and the international scientific committee in the Third and Fourth European Conference on Renewable Energy Systems (ECRES2015 and ECRES2016). She was an

associate editor in the journal of *Physics Express* published by Simplex Academic Publishers. She is an associate editor for the journal *Peak Journal of Physical and Environmental Science Research (PJPER)* published by Peak Journals. She is a member of the editorial board of the *International Journal of Materials and Chemistry* for Scientific & Academic Publishing, the editor-in-chief of the book *Advances in II-VI Compounds Suitable for Solar Cell Applications* for the Research Signpost, the editor-in-chief of the book *Advances in Silicon Solar Cells* for Springer, and the eBook series *Material Science: Current and Future Developments* for Bentham Science Publishers, where the last two books are under construction. She was the technical advisor/subject editor for *JOM* as a representative of the Materials Characterization Committee for the year 2014. She is a guest editor for a special section in the *Journal of Electronic Materials: Third European Conference on Renewable Energy*. Shadia is a reviewer in 22 international journals and five international conferences, and she is the 2016–2017 Chair of the TMS Materials Characterization Committee.



Bowen Li is a research professor in the Department of Materials Science and Engineering and Institute of Materials Processing at Michigan Technological University. His research interests include materials characterization, metals extraction, ceramic processing, antimicrobial additives, applied mineralogy, and solid waste reuse. He has more than 100 publications and 14 patents. Bowen Li received a Ph.D. degree in Mineralogy and Petrology from China University of Geosciences Beijing in 1998, and a Ph.D. degree in Materials Science and Engineering from Michigan Technological University in 2008. He has been an active member in TMS, SME, and China Ceramic Society. At TMS, he has served as a member in Materials Characterization Committee, Powder Materials Committee, Biomaterials Committee, EPD Award Committee, and *JOM* Subject Advisor, as well as symposium co-organizer and session chair.



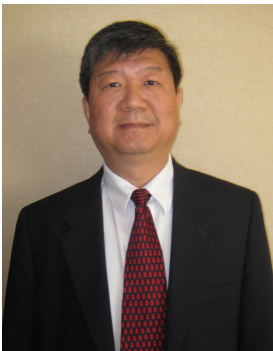
John S. Carpenter is a technical staff member in the Materials Science and Technology Division at the Los Alamos National Laboratory. Dr. Carpenter received his Ph.D. in Materials Science and Engineering from The Ohio State University in 2010 after performing his undergraduate studies at Virginia Tech.

His research interests include the characterization, processing, and mechanical testing of metallic nanocomposites fabricated via severe plastic deformation as well as additive manufacturing. Currently, his work focuses on understanding the relationship between plastic strain, texture, and the mechanical properties of bimetallic nanocomposites fabricated via accumulative roll bonding and joined using friction stir processing. This research involves the use of several characterization techniques including neutron scattering, X-ray synchrotron, PED, TEM, EBSD, and SEM. Mechanical testing for this work includes methods such as micropillar compression, microtension, and nanoindentation. He has more than 45 journal publications, one book chapter, and more than 20 invited technical talks to his credit.

With regard to TMS service, Dr. Carpenter currently serves as the past chair for the Materials Characterization Committee, a programming representative for the Extraction and Processing Division (EPD), and the chair for the Advanced Characterization, Testing & Simulation Committee. He is also a participating member of the Mechanical Behavior of Materials, Content Development and Dissemination, and the Nanomechanical Behavior committees. He serves as a Key Reader for *Metallurgical and Materials Transactions A* and has co-edited special sections in *JOM* related to neutron characterization, coherent X-ray diffraction imaging methods, and modeling in additive manufacturing. He is the 2012 recipient of the Young Leaders Professional Development Award for the EPD of TMS. Dr. Carpenter was also awarded an honorable mention for the 2012 Los Alamos National Laboratory Postdoctoral Distinguished Performance Award.



Jian Li is a senior research scientist at CanmetMATERIALS in Natural Resources Canada. He obtained his B.Sc. in Mechanical Engineering from Beijing Polytechnique University; M.Sc. in Metallurgical Engineering from Technical University of Nova Scotia (TUNS) and Ph.D. in Materials and Metallurgical Engineering from Queen's University, Kingston, Ontario. He has broad experience in materials processing and characterization including alloys deformation, recrystallization and micro-texture development. Dr. Li has extensive experience in focused ion beam (FIB) microscope techniques. He is also an expert in various aspects of SEM-EDS and EPMA techniques. Dr. Li holds a patent, authored three book chapters, and published more than 120 papers in scientific journals and conference proceedings.



Jiann-Yang Hwang is a professor in the Department of Materials Science and Engineering at Michigan Technological University. He is also the Chief Energy and Environment Advisor at the Wuhan Iron and Steel Group Company, a Fortune Global 500 company. He has been the Editor-in-Chief of the *Journal of Minerals and Materials Characterization and Engineering* since 2002. Dr. Hwang has founded several enterprises in areas including water desalination and treatment equipment, microwave steel production, chemicals, flyash processing, antimicrobial materials, and plating wastes treatment. Several universities have honored him as a Guest Professor, including the Central South University, University of Science and Technology Beijing, Chongqing University, Kunming University of Science and Technology, Hebei United University, etc.

Dr. Hwang received his B.S. degree from National Cheng Kung University in 1974, M.S. in 1980 and Ph.D. in 1982, both from Purdue University. He joined Michigan Technological University in 1984 and has served as Director of the Institute of Materials Processing from 1992 to 2011 and Chair of the Mining Engineering Department in 1995. He has been a TMS member since 1985. His research interests include the characterization and processing of

materials and their applications. He has been actively involved in the areas of separation technologies, pyrometallurgy, microwaves, hydrogen storages, ceramics, recycling, water treatment, environmental protection, biomaterials, and energy and fuels. He has more than 28 patents and has published more than 200 papers. He has chaired the Materials Characterization Committee and the Pyrometallurgy Committee in TMS (The Minerals, Metals & Materials Society) and has organized several symposiums. He is the recipient of TMS Technology Award and the Michigan Tech Bhata Rath Research Award.



Sergio Neves Monteiro graduated as metallurgical engineer (1966) at the Federal University of Rio de Janeiro (UFRJ), and received his M.Sc. (1967) and Ph.D. (1972) from the University of Florida. This was followed by a course (1975) in Energy at the Brazilian War College and postdoctorate (1976) at the University of Stuttgart. He joined (1968) the Metallurgy Department (1977) as full professor of the postgraduation program in engineering (COPPE) of the UFRJ, was elected head of department (1978), coordinator of COPPE (1982) and Under-Rector for Research (1983). Dr. Monteiro was invited as Under-Secretary of Science for the State of Rio de Janeiro (1985) and Under-Secretary of College Education for the Federal Government (1989). He retired in 1993 from the UFRJ and joined the State University of North Rio de Janeiro (UENF), from where he retired in 2012. He is now Professor at the Military Institute of Engineering (IME), Rio de Janeiro. He has published over 1200 articles in journals and conference proceedings and has been honored with several awards including the ASM Fellowship, top researcher (1A) of the Brazilian Council for Scientific and Technological Development (CNPq) and top scientist of State of Rio de Janeiro (FAPERJ). He served as president of the Superior Council of the State of Rio de Janeiro Research Foundation, FAPERJ, (2012) and currently is coordinator of the Engineering Area of this Foundation. Dr. Monteiro is the president of the Brazilian Association for Metallurgy, Materials and Mining—

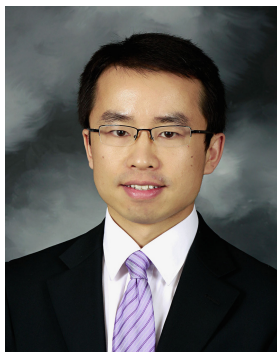
ABM (2017–2019), a consultant for the main Brazilian R&D agencies and member of the Editorial board of five international journals as well as Associate Editor of the *Journal of Materials Research and Technology*.



Donato Firrao earned his Laurea in chemical engineering at the Politecnico di Torino, Turin, Italy, in 1968 and his M.Sc. in Metallurgical Engineering at The Ohio State University (OSU) on a Fulbright Scholarship in 1970. He began teaching in 1968 as Assistant Professor of ferrous extractive metallurgy and Lecturer of chemistry at the Politecnico di Torino since 1971. In 1983 he became Associate Professor of technology of metallic materials, gaining full professorship in the subject three years later. He also stayed as visiting fellow from 1978 to 1979 at the OSU Materials Science and Engineering Department, where he was named Distinguished Alumnus in 2003. Firrao has authored more than 230 papers, primarily in the fields of physical and mechanical metallurgy and surface heat treatments. He is a member of Associazione Italiana di Metallurgia (AIM), ASTM International, ESIS, TMS, and the Turin Academy of Sciences, Fellow of ASM International (2011) and member of the Failure Analysis Society (FAS). A founding partner of the Italian Group on Fracture (IGF), he was its secretary since its establishment in 1982, and the president between 1988 and 1994. Firrao was co-chair of the ESIS Technical Committee I (Elasto-Plastic Fracture Mechanics) from 1987 to 1996 and was named ESIS Fellow in 2016. He was president of the Federation of European Materials Societies (FEMS) from 2000 to 2001. Since 1993, Firrao has been the president of the board of trustees of the Collegio Universitario di Torino (a private nonprofit university student housing foundation). Firrao served as the Dean of the First College of Engineering at the Politecnico di Torino from 2005 to 2012; he retired in November 2015. He is an expert in failure analysis, and has acted as technical advisor to the judge in national and international trials (such as the Ustica aircraft crash, the Mattei affair, and the Sgrena/Calipari cases).



Mingming Zhang is currently a senior research engineer at ArcelorMittal Global R&D in East Chicago, Indiana. His main responsibilities include raw material characterization and process efficiency improvement in the mineral processing and ironmaking areas. He also leads technical relationships and research consortia with university and independent laboratory members and manages pilot pot-grate sintering test facility at ArcelorMittal Global R&D East Chicago. Dr. Zhang has more than 15 years of research experience in the field of mineral processing, metallurgical and materials engineering. He obtained his Ph.D. degree in Metallurgical Engineering from The University of Alabama and his Master degree in Mineral Processing from General Research Institute for Non-ferrous Metals in China. Prior to joining ArcelorMittal, he worked with Nucor Steel Tuscaloosa, Alabama where he was a metallurgical engineer leading the development of models for simulating slab solidification and secondary cooling process. Dr. Zhang has conducted a number of research projects involving mineral beneficiation, thermodynamics and kinetics of metallurgical reactions, electrochemical processing of light metals, energy efficient and environmental cleaner technologies. He has published more than 30 peer-reviewed research papers and is the recipient of several U.S. patents. Dr. Zhang also serves as editor and key reviewer for a number of prestigious journals including *Metallurgical Transactions A and B*, *JOM*, *Journal of Phase Equilibria and Diffusion*, and *Mineral Processing and Extractive Metallurgy Review*. Dr. Zhang has made more than 20 research presentations at national and international conferences including more than 10 keynote presentations. He is the recipient of 2015 TMS Young Leader Professional Development Award. He has been invited by a number of international professional associations to serve as conference organizer and technical committee member. These associations include the Association for Iron & Steel Technology (AISTech) and The Minerals, Metals & Materials Society (TMS).



Zhiwei Peng is Associate Professor in the School of Minerals Processing and Bioengineering at Central South University and Adjunct Assistant Professor in the Department of Materials Science and Engineering at Michigan Technological University. He received his B.E. and M.S. degrees from Central South University in 2005 and 2008, respectively, and his Ph.D. degree in Materials Science and Engineering from Michigan Technological University in 2012. His research interests include heat transfer in microwave heating, dielectric characterization of materials, non-thermal microwave effects, extractive metallurgy, computational electromagnetics, microwave absorbing materials, and biomaterials.

He has published more than 70 papers, including 45 peer-reviewed articles in multiple journals such as *International Materials Reviews*, *Metallurgical and Materials Transactions A*, *JOM*, *Journal of Power Sources*, *Fuel Processing Technology*, *Energy & Fuels*, *IEEE Transactions on Magnetics*, *IEEE Transactions on Instrumentation and Measurement*, *Ceramics International*, and *Annals of Medicine*. He has served as a key reviewer for a number of journals and been on the editorial board of the *Journal of Minerals and Materials Characterization and Engineering* since 2012. He received a TMS Travel Grant Award for the 141st TMS Annual Meeting & Exhibition, the Doctoral Finishing Fellowship and Dean's Award for Outstanding Scholarship of Michigan Technological University in 2012 and the Bhakta Rath Research Award of Michigan Technological University in 2013.

Dr. Peng is an active member of The Minerals, Metals & Materials Society (TMS). He has co-organized five TMS symposia (Characterization of Minerals, Metals and Materials in 2013, 2014, 2015, 2016, and 2017) and co-chaired twelve TMS symposia sessions since 2012. He is a member of the Pyrometallurgy and Materials Characterization committees, the chair of the Continuing Education Sub-Committee of the Materials Characterization Committee, a *JOM* advisor for the Pyrometallurgy Committee, and a winner of the TMS EPD Young Leader Professional Development Award in 2014.



Juan P. Escobedo-Diaz is a senior lecturer in the School of Engineering and Information Technology (SEIT) at the University of New South Wales (UNSW) Canberra. He obtained his doctoral degree in Mechanical Engineering at Washington State University. Prior to taking up this academic appointment he held research positions at the Institute for Shock Physics and Los Alamos National Laboratory.

His main research interests center on the dynamic behavior of materials under extreme conditions, in particular high pressure and high strain rate. His focus has been on investigating the effects of microstructural features on the dynamic fracture behavior of metals and metallic alloys. He has published primarily in the fields of shock physics and materials science.

He has been a member of The Metals, Minerals & Materials Society (TMS) since 2011. During this time he has co-organized more than five symposia at the Annual Meetings including the symposium on Characterization of Minerals, Metals and Materials in 2014. He was awarded a 2014 SMD Young Leader Award.



Chenguang Bai is Professor in the Department of Metallurgical Engineering, School of Materials Science and Engineering at Chongqing University, China. He received his B.S. in 1982, M.S. in 1987, and Ph.D. in 2003 from Chongqing University. He also continued his studies in the Department of Metallurgy and Materials, University of Toronto as a visiting scholar between October 1995 to January 1997. Dr. Bai has been actively involved in the teaching and scientific research works in ferrous metallurgy, especially in the field of comprehensive utilization of vanadium-titanium magnetite resources. He has more than 20 patents, published more than 200 research articles, about 60 of which were in the international metallurgical periodicals. He also is Vice Chairman of the Chongqing Society for Metals, and was a member of the Advisory Committee of Experts, Department of Engineering and Materials Science, National Science Foundation of China (NSFC). He was the Vice President from 2009 to 2011, and the Vice Chairman of University Council of Chongqing University from 2011 to 2016.



Yunus Eren Kalay is Associate Professor in the Metallurgical and Materials Engineering Department and assistant to the president at Middle East Technical University (METU) Ankara, Turkey. Dr. Kalay received his Ph.D. degree with Research Excellence award from Iowa State University in 2009. His Ph.D. topic was related to the metallic glass formation in Al-based metallic alloy systems. Following his Ph.D., he pursued postdoctoral research in Ames National Laboratory, where he was given the opportunity to practice “Atom Probe Tomography”. In 2011, Dr. Kalay joined the Department of Metallurgical and Materials Engineering (METE) of METU as Assistant Professor and in 2014, he was promoted to Associate Professor. His research interests span microstructural evolution in metallic alloys, rapid solidification of metallic alloys, nanostructured and amorphous alloys, lead-free solders, electronic packaging, and advanced characterization techniques such as scanning and transmission electron microscopy, electron and X-ray spectroscopy, application of synchrotron X-ray scattering in materials research. Dr. Kalay was awarded the METU Prof. Dr. Mustafa Parlar Foundation Research Incentive Award, which is a very prestigious award that recognizes young scientists in Turkey with exceptional achievements and research productivity. He is also an active member of Materials Characterization Committee and Phase Transformations Committee of TMS, and served in organizing committees of three international congresses and one national congress including IMMC, MS&T and TMS. Dr. Kalay has also been involved in many synergistic activities such as being founder editor of Turkey’s first undergraduate research journal, *MATTER* (<http://matter.mete.metu.edu.tr/>), and organizing the Materials Science Camps for K-12 students.



Ramasis Goswami is a scientist with the Multifunctional Materials Branch of the Materials Science and Technology Division at Naval Research Laboratory, Washington, D.C., USA. He obtained his bachelor degree in Metallurgical Engineering from Bengal Engineering College, Shibpur, India. He then earned his Master's and Ph.D. degrees in Materials Engineering from Indian Institute of Science, Bangalore. Dr. Goswami is a recipient of the Alexander von Humboldt fellowship. His current areas of research include the study of dislocation structures ahead of the crack tip, the microstructure and property relationship in metals, alloys and in multilayered thin films, and the study of interfaces and defects in semiconducting thin films. He has published more than 90 peer-reviewed articles in scientific literature.



Jeongguk Kim received his Ph.D. in Materials Science and Engineering at the University of Tennessee, Knoxville, in 2002. The title of his Ph.D. thesis was "Nondestructive Evaluation (NDE) and Mechanical Behavior of Continuous Fiber Reinforced Ceramic Matrix Composites (CFCCs)." Currently, he is a director at the Future Transportation Systems Research Division, Korea Railroad Research Institute (KRRRI), Korea. He is also Professor in the Railway Systems Engineering Department, the KRRRI campus, at the University of Science and Technology, Korea.

Dr. Kim's research interests include testing and certification of railroad components and systems, failure and safety analyses of railroad materials and systems based on fracture mechanics and several different types of nondestructive evaluation (NDE) techniques including ultrasonic testing, acoustic emission, infrared thermography, magnetic particle testing, etc., and mechanical behavior of advanced railway materials.

His recent research efforts include development of future transportation systems such as rail-canal system based on multi-axle bogies, an innovative train-ferry system, and the smart container lift. He also enlarged his research on the development of effective maintenance technologies for high-speed train systems.

He has been a member of TMS since 1996, and he has been a regular contributor at TMS meetings as an author and session chair at the Characterization of Minerals, Metals and Materials session since 2005.

Part I
Soft Materials

Charpy Toughness Behavior of Fique Fabric Reinforced Polyester Matrix Composites

Artur C. Pereira, Sergio N. Monteiro, Foluke S. Assis
and Henry A. Colorado

Abstract The fique fiber is an important natural fiber, originally from Colombia where it is used for sacks and crafts while its plant is used to contain slopes. However, few studies were realized with the fiber obtained from the fique plant leaf, its mechanical properties are superior in many aspects in comparison to some other lignocellulosic fibers. This work investigated the toughness behavior of polyester matrix composites reinforced with up to 30% in volume of a fabric made of fique fiber by means of Charpy impact tests. It was found that the addition of fique fabric results in a marked increase in the absorbed energy by the composites. Macroscopic observation of the post-impact specimens and SEM fracture analysis showed that transversal rupture through the fique fabric interface with the polyester matrix is the main mechanism for the remarkable toughness of these composites.

Keywords Fique fabric · Polyester composites · Charpy impact test · Rupture mechanism

Introduction

The interest of this research is to develop composites with polyester resin matrix reinforced with continuous and aligned fique fibers, for applications in various industries, including construction and automotive industry. Conflicts related to the use of non-renewable forms of energy are increasing the interest to enter the market to replace natural materials; synthetic materials synthetics have a higher power consumption in its manufacture [1–4].

A.C. Pereira · S.N. Monteiro · F.S. Assis (✉)
Military Institute of Engineering, IME, Praça Gen. Tibúrcio, nº80 Urca,
Rio de Janeiro, RJ 22290-270, Brazil
e-mail: foluke.assis@hotmail.com

H.A. Colorado
Universidad de Antioquia, Calle 67 #53 - 108, Medellín, Antioquia, Colombia