



Proceedings of the 3rd Pan American Materials Congress

EDITED BY

Marc André Meyers
Hector Alfredo Calderon Benavides
Sonia P. Brühl
Henry A. Colorado
Elvi Dalgaard
Carlos Nelson Elias
Roberto B. Figueiredo
Omar Garcia-Rincon
Megumi Kawasaki
Terence G. Langdon
R.V. Mangalaraja
Mery Cecilia Gomez Marroquin
Adriana da Cunha Rocha
Julie M. Schoenung
Andre Costa e Silva
Mary Wells
Wen Yang



TMS

 Springer

The Minerals, Metals & Materials Series

Marc André Meyers · Hector Alfredo Calderon
Benavides · Sonia P. Brühl
Henry A. Colorado · Elvi Dalgaard
Carlos Nelson Elias · Roberto B. Figueiredo
Omar Garcia-Rincon · Megumi Kawasaki
Terence G. Langdon · R.V. Mangalaraja
Mery Cecilia Gomez Marroquin
Adriana da Cunha Rocha
Julie M. Schoenung · Andre Costa e Silva
Mary Wells · Wen Yang
Editors

Proceedings of the 3rd Pan American Materials Congress

TMS

 Springer

Editors

Marc André Meyers
University of California-San Diego
La Jolla, CA
USA

Terence G. Langdon
University of South California
Los Angeles, CA
USA

Hector Alfredo Calderon Benavides
ESFM-IPN
Mexico City
Mexico

R.V. Mangalaraja
University of Concepción
Concepción
Chile

Sonia P. Brühl
UTN-National University of Technology
Buenos Aires
Argentina

Mery Cecilia Gomez Marroquin
Universidad Nacional de Ingeniería
Lima
Peru

Henry A. Colorado
Universidad de Antioquia
Medellín
Colombia

Adriana da Cunha Rocha
Federal University of Rio de Janeiro
Rio de Janeiro
Brazil

Elvi Dalgaard
Pratt & Whitney Canada
Longueuil
Canada

Julie M. Schoenung
University of California, Irvine
Irvine, CA
USA

Carlos Nelson Elias
Military Institute of Engineering
Rio de Janeiro
Brazil

Andre Costa e Silva
Universidade Federal Fluminense
Rio de Janeiro
Brazil

Roberto B. Figueiredo
Universidade Federal de Minas Gerais
Belo Horizonte
Brazil

Mary Wells
University of Waterloo
Waterloo, ON
Canada

Omar Garcia-Rincon
Ternium Mexico SA de CV
San Nicolas de los Garza
Mexico

Wen Yang
ETH Zurich
Zürich
Switzerland

Megumi Kawasaki
Hanyang University
Seoul
Korea (Republic of)

ISSN 2367-1181
The Minerals, Metals & Materials Series
ISBN 978-3-319-52131-2
DOI 10.1007/978-3-319-52132-9

ISSN 2367-1696 (electronic)
ISBN 978-3-319-52132-9 (eBook)

TMS owns copyright; Springer has full publishing rights

Library of Congress Control Number: 2016962043

© 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. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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 Pan American Materials Congress (PAMC) is in its third iteration and was originally initiated from a partnership between the Associação Brasileira de Metalurgia, Materiais e Mineração (ABM) located in Brazil and The Minerals, Metals & Materials Society (TMS) located in the United States. This partnership produced two previously successful materials science and engineering conferences, titled “Pan American Materials Congress” occurring in 2010 and 2014 and held in conjunction with ABM’s large annual conference. These events were co-chaired by Prof. Sergio Neves Monteiro, ABM’s incoming President. The 3rd PAMC, hosted by TMS, includes nine participating professional societies, and is co-located with the TMS 2017 Annual Meeting & Exhibition. It is the first time that this international materials science and engineering conference is held in North America, with TMS in the role of host society. A program covering a variety of materials science topics has been created based on the input from leading scientists and engineers representing eight countries and nine international materials, metals, and minerals societies listed below:

1. Argentina: Asociación Argentina de Materiales (SAM)
2. Brazil: Associação Brasileira de Metalurgia, Materiais e Mineração (ABM)
3. Peru: Asociación Peruana de Metalurgia, Materiales Y Minerales (APMMM)
4. Colombia: Colombian Materials Society
5. Chile: Instituto de Ingenieros de Minas de Chile (IIMCh)
6. Canada: Metallurgy and Materials Society (MetSoc), Canadian Institute of Mining, Metallurgy, and Petroleum (CIM)
7. Chile: Sociedad Chilena de Metalurgia y Materiales (SOCHIM)
8. Mexico: Sociedad Mexicana de Materiales (SMM)
9. United States: The Minerals, Metals & Materials Society (TMS; Host Society)

The participation of additional materials societies throughout the Americas is being sought and is under discussion. The organizers of this congress seek to provide an international Pan American focused program to address the needs of the materials science and engineering communities as they relate to government, academic, and industrial institutions, while providing an intimate setting for professionals to interact with and form strategic partnerships with their peers. Student

participation is strongly encouraged and is a focus for the lead organizers of this event. Additionally, as far as we are aware, this is the only international materials science conference where the emphasis is exclusively on North and South America.

The 3rd PAMC technical programming encompasses a wide range of materials, metals, and minerals with applications specific to the international communities that are represented, including symposia on materials for transportation and infrastructure, materials for the oil and gas industry, and minerals extraction and processing. These proceedings contain the following sections, which correspond to the themes of the conference:

- Advanced Biomaterials
- Advanced Manufacturing
- Materials for Green Energy
- Materials for Infrastructure
- Materials for the Oil and Gas Industry
- Materials for Transportation and Lightweighing
- Minerals Extraction and Processing
- Nanocrystalline & Ultra-fine Grain Materials & Bulk Metallic Glasses
- Steels

From this program, it is expected that rich discussions and collaborative opportunities will result, heavily focused on the Americas. The congress is scheduled to run for three consecutive days, with sessions in both the morning and afternoon. Special attention has been paid to communications and complementary planning between the congress organizers and TMS staff, and TMS 2017 symposia organizers and volunteers, to ensure that the sessions are synergistic and not duplicative of the TMS 2017 Annual Meeting & Exhibition programming.

Marc André Meyers
Hector Alfredo Calderon Benavides
Sonia P. Brühl
Henry A. Colorado
Elvi Dalgaard
Carlos Nelson Elias
Roberto B. Figueiredo
Omar Garcia-Rincon
Megumi Kawasaki
Terence G. Langdon
R.V. Mangalaraja
Mery Cecilia Gomez Marroquin
Adriana da Cunha Rocha
Julie M. Schoenung
Andre Costa e Silva
Mary Wells
Wen Yang

Contents

Part I Advanced Biomaterials

- Analysis of Biomimetic Surgical Clip Using Finite Element Modeling for Geometry Improvement and Biomaterials Selection** 3
Thays Obando Brito, Bianca Bastos Dos Santos, Leonardo Sales Araújo, Luiz Henrique De Almeida and Marysilvia Ferreira Da Costa
- Chemical Composition Effect of Sol-Gel Derived Bioactive Glass Over Bioactivity Behavior** 11
L.A. Quintero and D.M. Escobar
- Effects of *Dialium guineense* Based Zinc Nanoparticle Material on the Inhibition of Microbes Inducing Microbiologically Influenced Corrosion** 21
Joshua Olusegun Okeniyi, Gbadebo Samuel John, Taiwo Felicia Owoeye, Elizabeth Toyin Okeniyi, Deborah Kehinde Akinlabu, Olugbenga Samson Taiwo, Olufisayo Adebola Awotoye, Ojo Joseph Ige and Yemisi Dorcas Obafemi
- Injectability Evaluation of Bone-Graft Substitutes Based on Carrageenan and Hydroxyapatite Nanorods** 33
J.I. González and C.P.O. Ossa
- Synthesis and Characterization of $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$ @mSiO₂ Core Shell Nanocarrier for Drug Delivery Applications** 47
Mohd Qasim, Khushnuma Asghar and Dibakar Das

Part II Advanced Manufacturing

- Carbon Based Coatings Deposited on Nitrided Stainless Steel: Study of Thermal Degradation** 57
Eugenia L. Dalibón, Naureen Ghafoor, Lina Rogström, Vladimir J. Trava-Airoldi, Magnus Odén and Sonia P. Brühl

Comparative Mechanical Analysis Between Epoxy Composite Reinforced with Random Short Curaua Fibers and Aligned Long Curaua Fibers	67
Natália O.R. de Maciel, Carolina G.D. Ribeiro, Jordana Ferreira, Janaina S. da Vieira, Carlos Maurício Vieira, Frederico M. Margem and Sergio N. Monteiro	
On Tool Wear in Rotary Tool Micro-Ultrasonic Machining	75
Sandeep Kumar, Akshay Dvivedi and Pradeep Kumar	
Numerical Modeling of High-Velocity Impact Welding	83
Ali Nassiri, Shunyi Zhang, Tim Abke, Anupam Vivek, Brad Kinsey and Glenn Daehn	
Selective Laser Sintering of Polyamide/Hydroxyapatite Scaffolds	95
Frederic Dabbas, Steferson Luiz Stares, José Maria Mascheroni, Dachamir Hotza and Gean Vitor Salmoria	
Part III Materials for Green Energy	
A Comparison Between Recycled Spent Zeolite and Calcite Limestone for Manganese Removal	107
Adarlene M. Silva, Rodrigo S. Figueiredo and Versiane A. Leao	
Effect of Mo⁶⁺ Substitution on Microstructure and Lithium Ionic Conductivity of Garnet-Type Li₇La₃Zr₂O₁₂ Solid Electrolytes by Field Assisted Sintering Technology	115
Fei Chen, Junyang Li, Yanhua Zhang, Dunjie Yang, Qiang Shen and Lianmeng Zhang	
Electromagnetic Levitation Refining of Silicon–Iron Alloys for Generation of Solar Grade Silicon	125
Katherine Le, Yindong Yang, Mansoor Barati and Alex McLean	
Green Extract of Mate Tea as Corrosion Inhibitor of Copper and Aluminum	135
Ana M. Derna, Claudia M. Méndez, Liliana M. Gassa and Alicia E. Ares	
Platinum Salt Synthesis as Precursor to Get Heterogeneous Catalyst for Biofuels Production	145
Adriana I. Martínez-Montalvo, Sherly C. Acosta-Beltrán, Jonathan F. Sierra-Cantor and Carlos A. Guerrero-Fajardo	
Technical and Environmental Assessment of an Alternative Binder for Low Traffic Roads with LCA Methodology	155
Alejandra Balaguera Quintero, Diana Gómez Cano, Gloria Carvajal Peláez and Yhan Paul Arias	

Part IV Materials for Infrastructure

Anticorrosion and Adsorption Mechanism of <i>Rhizophora mangle</i> L. Leaf-Extract on Steel-Reinforcement in 3.5% NaCl-Immersed Concrete.	167
Joshua Olusegun Okeniyi, Olugbenga Adeshola Omotosho, Cleophas Akintoye Loto and Abimbola Patricia Idowu Popoola	
<i>Cassia fistula</i> Leaf-Extract Effect on Corrosion-Inhibition of Stainless-Steel in 0.5 M HCl.	179
Olugbenga Adeshola Omotosho, Joshua Olusegun Okeniyi, Cleophas Akintoye Loto, Abimbola Patricia Idowu Popoola, Omokolade Babatunde Ajibola and Adebajji Samuel Ogiyi	
Effect of C₅H₁₁NO₂S on Reinforcing-Steel Corrosion in Concrete Immersed in Industrial/Microbial Simulating-Environment	191
Joshua Olusegun Okeniyi, Abiodun Oyekola Abioye, Zechariah Chiwonsoko Adikpewun, Adeola Abigail Otesanya, Michael Damilola Eleshin, Olanrewaju Oyewale Gabriel and Oluyori Adeoye	
Fiber Reinforced Concrete Manufactured with Electric Arc Furnace Slag	205
Vanesa Ortega-López, José A. Fuente-Alonso, Amaia Santamaría, Marta Skaf and Juan M. Manso	
Jigs, Hydrocyclones and Sensor-Based Sorting to Value Recycled Aggregate.	215
Régis Sebben Paranhos, Carlos Hoffmann Sampaio, Bogdan Grigore Cazacliu, Raul Oliveira Neto and Maria Alejandra Liendo	
Performance of Hydraulic Mixes Manufactured with Electric Arc Furnace Slag Aggregates.	227
Amaia Santamaría, Vanesa Ortega-López, Marta Skaf, Ignacio Marcos, José-Tomás San-José and Javier J. González	
Porous Asphalt Mixtures with 100% Siderurgic Aggregates	235
Marta Skaf, Vanesa Ortega-López, Ángel Aragón, José T. San-José and Javier J. González	

Part V Materials for Oil and Gas Industry

Blends of PVDF with Its Processing Waste: Study of the Mechanical Properties of the Blends Thermally Aged	247
L.C.M. Cirilo and M.F. Costa	

Dynamic Transformation and Retransformation During the Simulated Plate Rolling of an X70 Pipeline Steel	259
Samuel F. Rodrigues, Clodualdo Aranas Jr, Fulvio Siciliano and John J. Jonas	
Effect of Heat Input on the Microstructure and Toughness of Welded API Pipelines.	271
Fernando Guzmán, Moisés Hinojosa, Eduardo Frias and Elisa Schaeffer	
Evaluation of Non-destructive Techniques (Thermography, Ultrasound and Eddy Current) for Detection of Failures in Metallic Substrates with Composite Anticorrosive Coatings	281
Marcella Grosso, Priscila Duarte de Almeida, Clara Johanna Pacheco, Iane Soares, João Marcos Rebello, Sergio Damasceno Soares, Isabel Cristina Margarit-Mattos and Gabriela Ribeiro Pereira	
High Temperature In-Situ X-Ray Analysis of a Lean Duplex Stainless Steel	289
Adriana da Cunha Rocha, Andrea Pedroza da Rocha Santos and Gabriela Ribeiro Pereira	
Structural Integrity of Pipelines.	297
Aníbal C. Di Luch and Nicolás Oyarzábal	
Part VI Materials for Transportation and Lightweighting	
Advantages of Hot Compression in the Manufacture of Al-B₄C Composites.	307
Lucio Vázquez, Dulce Y. Medina, Ángel D. Villarreal, David A. López, Gilberto Rangel, Elizabeth Garfias and Manuel Vite	
An Improved Silicon Carbide Monofilament for the Reinforcement of Metal Matrix Composites.	317
Michael V. Rix, Mark Baker, Mark J. Whiting, Ray P. Durman and Robert A. Shatwell	
Analysis of Coir Fiber Porosity	325
Fernanda Santos da Luz and Sergio Neves Monteiro	
Ballistic Performance in Multilayer Armor with Epoxy Composite Reinforced with Malva Fibers	331
Lucio Fabio Cassiano Nascimento, Luis Henrique Leme Louro, Sérgio Neves Monteiro, Alaelson Vieira Gomes, Édio Pereira Lima Júnior and Rubens Lincoln Santana Blazutti Marçal	

Curaua Non-woven Fabric Composite for Ceramic Multilayered Armors: A Lightweight, Natural, and Low Cost Alternative for Kevlar™ 339
 Fábio de Oliveira Braga, Augusto Corrêa Cabral, Édio Pereira Lima Jr., Sergio Neves Monteiro and Foluke Salgado de Assis

Effect of Forging on Microstructure, Texture and Compression Behavior of Extruded AZ31B 347
 D. Toscano, S.K. Shaha, B. Behraves, H. Jahed, M. Wells, B. Williams and J. McKinley

Effect of Hypoeutectic Sc Additions to Al-4.5 wt% Cu Under Different Cooling Rates. 355
 A.-A. Bogno, J. Valloton, H. Henein, M. Gallerneault and D. Herlach

Izod Impact Tests in Polyester Matrix Composites Reinforced with Figue Fabric 365
 Artur C. Pereira, Sergio N. Monteiro, Foluke S. Assis and Henry A. Colorado

Izod Impact Tests in Polyester Matrix Composites Reinforced with Jute Fabric 373
 Foluke S. de Assis, Artur C. Pereira, Fábio O. Braga and Sergio N. Monteiro

Microstructure and Hardness of Subzero Quenched and Heat Treated Ti-6Al-4V Alloy. 379
 Abdelrahman Abbas, Andrew Seif, Iman El-Mahallawi and Waleed Khalifa

Nano-additive Reinforcement of Thermoplastic Microballoon Epoxy Syntactic Foams 393
 Kerrick R. Dando and David R. Salem

Nanocomposites Mechanical and Tribological Properties Using Graphene-Coated-SiC Nanoparticles (GCSiC_{NP}) for Light Weight Applications. 403
 A. El Ghazaly, M. Shokeir, S.N. El Moghazi, A. Fathy, M.M. Emar and H.G. Salem

Synthesis of Energetic Composites in Ti-Al-B-C System by Adiabatic Explosive Compaction. 417
 Mikheil Chikhradze and Fernand D.S. Marquis

Tensile and Impact Properties of Two Fiber Configurations for Curaua Reinforced Composites 429
 Fábio de Oliveira Braga, Noan Tonini Simonassi, Augusto Corrêa Cabral, Sérgio Neves Monteiro and Foluke Salgado de Assis

Thermo-mechanical Behavior of Nanostructure Polyacrylic Polymer Based on Al₂O₃ and Bentonite Nanoparticles	437
Rubén Castillo-Pérez, Mireya Lizbeth Hernández-Vargas, Oscar Hernández-Guerrero, Bernardo Fabián Campillo-Illanes and Osvaldo Flores-Cedillo	
Thermo-mechanical Properties of Waterborne Acrylate Hybrid Nanocomposites	447
Mireya Lizbeth Hernández-Vargas, Rubén Castillo-Perez, Oscar Hernández-Guerrero, Osvaldo Flores-Cedillo and Bernardo Fabián Campillo-Illanes	
Thermo-mechanical Properties of Copolymer/Clay Nanocomposites: A Comparative Study of Production Method by In-situ and Solution Mixture	457
Oscar Hernandez-Guerrero, Rubén Castillo-Pérez, Mireya Lizbeth Hernández-Vargas and Bernardo Fabián Campillo-Illanes	
Part VII Minerals Extraction and Processing	
Biotechnological Recycling of Precious Metals Sourced from Post-consumer Products	467
Norizoh Saitoh, Toshiyuki Nomura and Yasuhiro Konishi	
Biotechnologies for Wastewater Treatment in the Mineral Industry	477
Natalia R. Barbosa, Sueli M. Bertolino, Renata G.S. Cota and Versiane A. Leão	
Dissolution Thermodynamics of Smithsonite in Alkaline Iminodiacetate Aqueous Solution	487
Aichun Dou, Lei Yu, Mingru Su and Yunjian Liu	
Effect of Ethylenediamine on Smithsonite Flotation	499
Chao Lv, Shuming Wen, Shaojun Bai and Kun Yang	
Extraction of Gold from Sands and Slimes Tailings Dump from Mazowe Mine, Zimbabwe	507
Alain M. Bantshi and Peter Makuvise	
Gold Recovery from Waste Solutions of PCBs Gold Plating Process Using Hydro Cyclone Reactor for Demonstration Study	519
Mooki Bae, Sookyung Kim and Jae-chun Lee	
Improving Quality of Coke Made from Chinese Xinjiang Gas Coal with High Strength Modifier	529
Qiang Wu, Zizong Zhu, Guojing Shi, Feng Wang, Zilong Wang and Yangyang Xie	

Investigating the Dissolution Characteristics of Strontium Sulfide	539
İbrahim Göksel Hizli, Ayşegül Bilen, Raşit Sezer, Emre Yılmaz, Selim Ertürk and Cüneyt Arslan	
Kinetic Study on the Leaching of Vanadium-Bearing Converter Slag with Dilute Sulfuric Acid	547
Junyi Xiang, Qingyun Huang, Xuewei Lv and Chenguang Bai	
Leaching of Spent Ni–Mo Hydrodesulphurization (HDS) Catalyst in Oxalic Acid Solutions	557
Sedat İlhan	
Novel Adsorbent from Iron Ore Concentration Tailings for Toxic Cationic Dye Removal from Water	565
Yongmei Wang, Alejandro López-Valdivieso, Teng Zhang, Teza Mwamulima and Changsheng Peng	
Preliminary Analysis of the Application of Sensor Based Sorting on a Limestone Mine in the Region Caçapava do Sul, Brazil	579
Evandro Gomes dos Santos, Régis Sebben Paranhos, Carlos Otavio Petter, Aaron Young and Moacir Medeiros Veras	
Preparation of High Grade Industrial Copper Compound from a Nigerian Malachite Mineral by Hydrometallurgical Process	587
Alafara A. Baba, Ruth O. Sanni, Abdulrahman Abubakar, Rafiu B. Bale, Folahan A. Adekola and Abdul G.F. Alabi	
Process of Improving the Flotation Using Ultrasonic Bombardment	593
Erivelto L. Souza, Orimar B. Reis, Denise F. Pereira, Luiz C. Borges and Jeisa F.P. Rodrigues	
Production of Strontianite from Celestite Ore in Carbonate Media	607
İbrahim Göksel Hizli, Ayşegül Bilen, Raşit Sezer, Selim Ertürk and Cüneyt Arslan	
Reduction Kinetics and Characterization Study of Synthetic Magnetite Micro Fines	615
Saikat Kumar Kuila, Ritayan Chatterjee and Dinabandhu Ghosh	
Study on Leaching Valuable Elements from Bayan Obo Tailings.	633
Bo Zhang, Xiangxin Xue, Xiaowei Huang, He Yang and Jianxin Han	
Study on Thermal Decomposition and Oxidation Characteristics of Iron Ores.	643
Qingfeng Kang, Jianliang Zhang, Donghui Liu, Zhengjian Liu and Jie Yan	
The Direct Leaching of Micro-disseminated Gold Concentrate by Bromide Process and the Characterization of Leaching Products	653
Chao Li, Hongxu Li and Qiankun Jing	

Working Experience on the New WOX Washing and Leaching Plant at ZGH Boleslaw S.A., Poland	661
Angel Selke, Leszek Stencel, Mirosław Fatyga, Bogdan Pieczonka and Łukasz Zięba	
Part VIII Nanocrystalline and Ultra-fine Grain Materials and Bulk Metallic Glasses	
Continuous Dynamic Recovery in Pure Aluminium Deformed to High Strain by Accumulative Press Bonding	671
Sajjad Amir Khanlou, Mostafa Ketabchi, Nader Parvin and Fernando Carreño	
Effects of Natural Aging and Post-processed Heat Treatment on the Microstructure and Mechanical Properties of Friction Stir Processed Al-7B04	681
Y. Chen, H. Ding and J.Z. Li	
Evaluation of the Hardening and Softening Effects in Zn-21Al-2Cu with as Cast and Homogenized Microstructure Processed by Equal Channel Angular Pressing	689
J.L. Hernández-Rivera, E.E. Martínez-Flores, E. Ramírez Contreras, J. García Rocha, J.J. Cruz Rivera and G. Torres-Villaseñor	
Part IX Steels	
Effect of Titanium Sulfide Particles on Grain Size in Low Carbon Steel	701
Yuan Wu, Bowen Peng, Fangjie Li, Shaobo Zheng and Huigai Li	
Evolution of Austenite Dislocation Density During Hot Deformation Using a Physical Dynamic Recrystallization Model	709
Peng Zhou and Qingxian Ma	
A Rapid Heating Method for Press Hardening Processing	723
Anatolii Andreiev, Olexandr Grydin and Mirko Schaper	
New Generation Niobium Bearing Structural Steels for Future Infrastructure Demands	737
Steven G. Jansto	
Kinetic Study of the Austenite Decomposition During Continuous Cooling in a Welding Steel	749
Octavio Vázquez-Gómez, Edgar López-Martínez, Alexis Iván Gallegos-Pérez, Heber Santoyo-Avilés, Héctor Javier Vergara-Hernández and Bernardo Campillo	

Microstructural Evolution in Microalloyed Steels During Thermomechanical Rod Rolling	761
Lijia Zhao, Robert L. Cryderman and John G. Speer	
Modeling of Metal-Slag Mass and Momentum Exchanges in Gas-Stirred Ladles	771
Marco Ramírez-Argáez and Carlos González-Rivera	
Study on Adjustment and Optimization of LF Refining Slag of Spring Steel 55SiCrA	783
Chao Gu, Yan-ping Bao, Lu Lin, Min Wang, Li-hua Zhao and Zi-xuan Wu	
Tempering Response of Bainitic and Martensitic Microstructures	791
Igor Vieira and Emmanuel De Moor	
The Research on the Relationship Between Gas Movement Behaviors and Circulation Flow of the Molten Steel in RH	801
Jia-liang Xu, Yan-ping Bao, Li-hua Zhao, Min Wang, Lu Lin, Ya-di Li and Xing-le Fan	
Author Index	809
Subject Index	813

Performance of Hydraulic Mixes Manufactured with Electric Arc Furnace Slag Aggregates

Amaia Santamaría, Vanesa Ortega-López, Marta Skaf,
Ignacio Marcos, José-Tomás San-José and Javier J. González

Abstract Electric arc furnace slag (EAFS) has for many years simply been dumped in landfill sites; over the past few decades many researchers have investigated its reuse in cement mortar and concrete. By doing so, a waste product may be converted into a useful material with added value as a substitute for natural resources, the consumption of which is also minimized. Hydraulic mixes manufactured with EAFS normally have similar or even better hardened properties than mixes manufactured with natural aggregates. One disadvantage in the use of EAFS has been the poorer workability of the mixes, due to its higher density, porosity and water absorption levels. In this research, different EAFS mixes are manufactured and their properties in the fresh and the hardened state are closely analyzed; the results were very promising. The aim of this research is to demonstrate that EAFS concrete can achieve an acceptable workability at the correct dosages.

Keywords Electric arc furnace slag · Self-compacting mixes · Workability · Strength

A. Santamaría (✉) · J.-T. San-José · J.J. González
Department of Mining and Metallurgical Engineering,
UPV/EHU, Alameda Urquijo S/N, 48013 Bilbao, Spain
e-mail: amaia.santamaria@ehu.eus

V. Ortega-López
Department of Civil Engineering, University of Burgos,
Calle Villadiego S/N, 09001 Burgos, Spain

M. Skaf
Department of Construction, University of Burgos,
Calle Villadiego S/N, 09001 Burgos, Spain

I. Marcos
Department of Mechanical Engineering, UPV/EHU,
Calle Rafael Moreno “Pitxitxi” N°2, 48013 Bilbao, Spain

- The durability tests performed on the mortars were successful, showing that the aggregates had no non-stable volumetric compounds.
- All the tests performed on the self-compacting concrete are very encouraging. The next step will be to perform durability tests and if the results are positive, then the challenge of manufacturing reliable self-compacting concrete with EAFS aggregate will in all likelihood have been reached.

Acknowledgements The authors wish to express their gratitude to the Basque Regional Government (IT781-13 Research Group), to the Vice-Rectorate of Investigation of the University of the Basque Country (UPV/EHU) for grant PIF 2013, and to the Spanish Ministry (MINECO) for FEDER Funds through project BIA2014-55576-C2-2-R, which all contributed to financing this research work.

References

1. Manso, J. M., Gonzalez, J. J., & Polanco, J. A. (2004). Electric arc furnace slag in concrete. *Journal of Materials in Civil Engineering*, 16(6), 639–645.
2. San-José, J. T., Vegas, I., Arribas, I., & Marcos, I. (2014). The performance of steel-making slag concretes in the hardened state. *Materials and Design*, 60, 612–619.
3. Arribas, I., Vegas, I., San-José, J. T., & Manso, J. M. (2014). Durability studies on steelmaking slag concretes. *Materials and Design*, 63, 168–176.
4. Pellegrino, C., Cavagnis, P., Faleschini, F., & Brunelli, K. (2013). Properties of concretes with black/oxidizing electric arc furnace slag aggregate. *Cement & Concrete Composites*, 37, 232–240.
5. Okamura, H., & Ouchi, M. (1998). Self-compacting high performance concrete. *Progress in Structural Engineering and Materials*, 1(4), 378–383.
6. Okamura, H., & Ouchi, M. (2003). Self-compacting concrete. *Journal of advanced concrete technology*, 1(1), 5–15.
7. EFNARC. (2002). *Specification and guidelines for self-compacting concrete*. Farnham, Surrey GU9 7EN, UK, website: <http://www.efnarc.org/>. ISBN 953973344.