

EPD Congress 2010

Held during TMS 2010 Annual Meeting & Exhibition

**Seattle, Washington, USA
14-18 February 2010**

Editors:

**Edgar E. Vidal
Michael L. Free
Joseph Pomykala**

**Ann M. Hagni
Prince N. Anyalebechi
Christina E. M. Meskers**

ISBN: 978-1-61782-293-3

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2010) by the Minerals, Metals & Materials Society
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact John Wiley & Sons
at the address below.

John Wiley & Sons
111 River Street
Hoboken, NJ 07030-5774

Phone: (201) 748-6000
Fax: (201) 748-6088

info@wiley.com

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

TABLE OF CONTENTS

| | |
|----------------------------------|-----|
| EPD Council | xix |
| EPD Honors and Awards 2010 | xxi |

Characterization of Minerals, Metals and Materials

| | |
|------------------------|---|
| Organizers | 1 |
| Preface | 3 |
| About the Editor | 5 |

Characterization of Iron and Steel I

| | |
|--|----|
| Nondestructive Characterization of Microstructure and Properties of Steel Products | 9 |
| <i>J. Pandey, M. Raj, and N. Bandyopadhyay</i> | |
| 2D Imaging of Nano-Hardness and Phase Characterization in Steel by Noncontact Optical Photodeflection Microscopy | 17 |
| <i>N. Mingolo, O. Martinez, and U. Archiropoli</i> | |
| Classification and Rating of Inclusions in a High Carbon Steel | 25 |
| <i>M. Faraji, R. Thackray, I. Todd, and P. Tsakirooulos</i> | |
| As-cast Microstructures of Aluminum Containing Ductile Cast Irons | 37 |
| <i>A. Kiani-Rashid, A. Shayesteh-Zeraati, H. Naser-Zoshki, and M. Yousef-Sani</i> | |

Characterization of Iron and Steel II

| | |
|---|----|
| Methods to Characterize Very Thin Passive Film Formed in SCW Corrosion Tests | 51 |
| <i>J. Li, D. Guzonas, and W. Zheng</i> | |
| The Influence of Different Heat treatment Cycles on Controlled Surface Graphitization in CK45 Steel | 59 |
| <i>A. Kiani-Rashid, Y. Hamedi, and H. Shishegar</i> | |

Characterization of Alloys

| | |
|---|----|
| Detection of Creep Damage in a Nickel Base Super-Alloy by Nondestructive Means | 73 |
| <i>H. Carreon, and F. Caballero</i> | |
| Development of a High-temperature Micro-indentation Technique for Material Mechanical Property Evaluation up to 1200° C | 81 |
| <i>J. Tannenbaum, B. Conklin, B. Kang, and M. Alvin</i> | |

Influence of TCP Phase on Enduring Property of Single Crystal Nickel-Based Superalloys91
T. Sugui, Q. Benjiang, L. Tang, W. Minggang, and X. Jun

The Modeling and Processes Research of Titan Aluminides Structurization Received by SHS
Technology99
S. Borys, A. Zhrebtsov, and Y. Belokon'

Characterization of Grain Size, Morphology, Refractive Index, and Tomography

Using Transmittance Measurements to Investigate the Interdiffusion through the SnO₂/CdS
and CdS/CdTe interfaces in SnO₂/CdS/CdTe Solar Cells109
S. Ikhmayies, and R. Ahmad-Bitar

Effect of Refractive Index on the Determination of Layer Thickness of 4H-SiC Homo-Epitaxial
Films119
Z. Li, Y. Zhang, J. Sun, Y. Zhang, and X. Tang

Characterization of PMC's, Composites, Fibers, Polymers, and Organics

Weibull Analysis of Tensile Tested Piassava Fibers with Different Diameters127
D. Nascimento, L. Motta, and S. Monteiro

Thermal Analysis of Curaua Fiber Reinforced Polyester Matrix Composites135
A. Ferreira, R. Rodriguez, F. Lopes, and S. Monteiro

Characterization of the Flexural Properties of Polyester Matrix Composites Reinforced with
Continuous Jute Fibers.....143
S. Monteiro, L. Marques, and K. Satyanarayana

Charpy Toughness Behavior of Continuous Sisal Fiber Reinforced Polyester Matrix
Composites.....151
W. Inácio, F. Lopes, and S. Monteiro

Evaluation of the Interfacial Strength of Ramie Fibers in Polyester Matrix Composites159
F. Margem, F. Lopes, and S. Monteiro

Patterning Atop Shape Memory Polymers and Their Characterization.....167
Y. Zhao, M. Cai, W. Huang, and T. Tong

Characterization of a Natural Biofoam from the Buriti Palm Tree175
L. Costa, S. Monteiro, T. Portela, N. Santos, and C. Zavaglia

Characterization of Fibers from Different Parts of the Buriti Palm Tree183
T. Portela, L. Costa, F. Lopes, and S. Monteiro

Tensile Properties of Epoxy Composites Reinforced with Continuous Curaua Fibers191
F. Lopes, A. Ferreira, and S. Monteiro

Characterizing the Mechanical Properties of Wax-Coated Granular Composites.....199
J. Bridge, M. Peterson, and R. Beaumont

Mechanical Behavior of Polyester Matrix Composites Reinforced with Continuous Bamboo
Fibers.....211
L. Costa, S. Monteiro, and R. Loiola

Characterization of Cu, Zn, Mn, Fe, Au, and Carbon Phases

Characterization of Tin-rich Copper Anodes from Secondary Copper Refineries.....221
T. Chen, and J. Dutrizac

Synthesis and Characterization of Pure and Doped Nanocrystalline Zinc Oxide231
R. Rashmi, R. Bhatt, M. Kar, N. Singh, and M. Arora

Characterization of Micro-, Nano-, and Thin Films

Characterization of Nanocrystalline CdS:In Thin Films Prepared by the Spray-Pyrolysis
Technique.....241
S. Ikhmayies, and R. Ahmad-Bitar

Chemical Co-Deposited PbS – CuS Thin Film Characterization: Effect of Annealing249
M. Nnabuchi, C. Ekuma, and I. Owate

Nanosecond Electrical Discharges between Semiconducting Sulfide Mineral Particles in Water257
I. Bunin, and V. Chanturiya

Characterization of Refractories, Clays, Concrete, Interfaces, and Thermodynamics

Characterization of Refractories in Gasification Systems Using Post Mortem Analysis and
Thermodynamics.....265
K. Kwong, J. Bennett, R. Krabbe, and H. Thomas

The Reception of Ceramic Aluminum Silicate Refractories273
S. Borys, I. Krugljak, and A. Zhrebtsov

Utilization of Aluminum Slag for the Expansion of Lightweight Concrete.....279
X. Li, J. Hwang, H. Jeon, M. Andriese, and Z. Zhang

Characterization of Vitrified Tile Bodies with Kaolinitic Clay and Nepheline-Syenite287
C. Vieira, and S. Monteiro

Technological Characterization of Serpentinite Rock from Andorinha (Bahia/Brazil)293
A. Teixeira, J. Sampaio, F. Garrido, and M. Medeiros

| | |
|---|-----|
| Characterization of the Deep Interface Traps in Hf-based/Si Gate Stacks | 301 |
| <i>S. Tan, Y. Hsia, M. Wu, and H. Chen</i> | |

| | |
|--|-----|
| Arsenic Dopant Effect in Nickel Silicide Formation for NiSi/Hf-based/Si Gate Stacks..... | 309 |
| <i>S. Tan</i> | |

Poster Session

| | |
|--|-----|
| Embrittlement of Low Carbon Low Alloy Steel Occurring in the Austenite and γ -Ferrite Regions | 319 |
| <i>X. Gao, D. Chen, M. Long, L. Song, J. Zhang, Y. Bi, and X. Zhang</i> | |

| | |
|---|-----|
| Thermodynamic Research of the Dissolving of Chrysocolla ($\text{CuSiO}_3 \cdot \text{H}_2\text{O}$) in the Ammonia-Ammonium Chloride-Water System | 327 |
| <i>L. Wei, T. Motang, T. Zhaobo, H. Jing, Y. Jianguang, and Y. Shenghai</i> | |

| | |
|---|-----|
| Mechanical Behavior of Epoxy Composites Reinforced with Acetylation-Treated Coir Fibers | 335 |
| <i>H. Santafe, L. Costa, R. Rodriguez, F. Lopes, and S. Monteiro</i> | |

| | |
|---|-----|
| Onset of Void Coalescence Studied by X-Ray Computed Tomography..... | 343 |
| <i>A. Hosokawa, D. Wilkinson, and E. Maire</i> | |

| | |
|--|-----|
| The Effect of Y on the Refinement of Cast and Rapidly Solidified TiAl Alloys | 351 |
| <i>Z. Liu, I. Chai, and Y. Chen</i> | |

| | |
|--|-----|
| Surface Characterization of Single and Mixed Mineral Systems using Sedimentation Potential | 359 |
| <i>S. Uddin, M. Mirnezami, and J. Finch</i> | |

| | |
|---|-----|
| Ultrasonic Characterization of Copper USING Wavelet Analysis..... | 369 |
| <i>P. Shanmugasandaram, N. Narasimhan, K. Srinivasan, and P. Selvaraj</i> | |

| | |
|--|-----|
| Characterization of High Carbon Equivalent Cast Iron Using Thermal Analysis Curves | 379 |
| <i>W. Zhou, Y. Yan, D. Zheng, Q. Hua, and Q. Zhai</i> | |

| | |
|--------------------|-----|
| Author Index | 953 |
|--------------------|-----|

| | |
|---------------------|-----|
| Subject Index | 957 |
|---------------------|-----|

TABLE OF CONTENTS

| | |
|----------------------------------|-----|
| EPD Council | xix |
| EPD Honors and Awards 2010 | xxi |

Electrometallurgy - General Session

| | |
|---|-----|
| Organizer..... | 385 |
| Constant and Pulse Voltage Applications in CaWO ₄ Reduction..... | 387 |
| <i>O. Goksu, I. Karakaya, and M. Erdogan</i> | |
| ZrB ₂ Produced with Molten Salt Electrolysis..... | 395 |
| <i>S. Özkan, S. Timur, and M. Urgan</i> | |
| Author Index | 953 |
| Subject Index | 957 |

TABLE OF CONTENTS

| | |
|----------------------------------|-----|
| EPD Council | xix |
| EPD Honors and Awards 2010 | xxi |

Hydrometallurgy - General Session

| | |
|---|-----|
| Organizer..... | 403 |
| Characteristics of Cathodic Reduction of Oxygen on Gold Electrode | 405 |
| <i>Y. Yang, T. Jiang, Q. Li, and Y. Guo</i> | |
| Extraction of Copper from Sulfate Leach Solution Containing Minor Metallic Constituents in Mixer Settler Unit | 413 |
| <i>V. Kumar, M. Jha, M. Kumar, J. Jeong, and J. Lee</i> | |
| Pressure Leaching of Enargite-Pyrite Concentrates | 421 |
| <i>M. Ruiz, M. Vera, and R. Padilla</i> | |
| Author Index | 953 |
| Subject Index | 957 |

TABLE OF CONTENTS

| | |
|----------------------------------|-----|
| EPD Council | xix |
| EPD Honors and Awards 2010 | xxi |

Materials Processing Fundamentals

| | |
|-----------------------|-----|
| Organizer..... | 429 |
| Preface..... | 431 |
| About the Editor..... | 433 |

Deformation Processing and Heat Treatment

| | |
|--|-----|
| Mechanical Properties and Their Dependence on Microstructure in Hot-Rolled 3rd Generation Advanced High Strength Steels | 437 |
| <i>M. McGrath, D. VanAken, and V. Richards</i> | |
| Hot Working Behavior of 17-4 PH Stainless Steel..... | 447 |
| <i>H. Mirzadeh, and A. Najafzadeh</i> | |
| Influence of Direct Aged Treatment on Creep Behaviors of Hot Continuous Rolling GH4169 Superalloy | 455 |
| <i>S. Tian, Z. Li, Z. Zhao, L. Chen, and X. Liu</i> | |
| The Effect of Carburizing on the Fatigue Life of 4130 Steel | 463 |
| <i>R. Fragoudakis, and A. Saigal</i> | |
| Ag Exudation during Internal Oxidation in Various Contact Materials..... | 471 |
| <i>G. Schimmel, B. Kempf, and M. Rettenmayr</i> | |
| A Study on Heat Transfer Coefficient Distribution in High Pressure Hydrogen Quenching | 479 |
| <i>B. Xiao, G. Wang, and Y. Rong</i> | |

Solidification and Casting

| | |
|---|-----|
| Fe-Mn-Al-C Austenitic Steels Treated by Ca and Ce | 489 |
| <i>S. Lekakh, V. Richards, A. Schulte, and D. VanAken</i> | |
| Strong Magnetic Field Induced Phase Alignment during Solidification | 497 |
| <i>Z. Sun, M. Guo, J. Vleugels, O. VanderBiest, and B. Blanpain</i> | |

| | |
|---|-----|
| Experimental Analysis of Thermal, Tensile and Microhardness Properties in Directional Solidified ZA, Zn-Ag and ZINAG Alloys | 505 |
| <i>A. Ares, S. Gueijman, and C. Schvezov</i> | |
| Structure Evolution of Aluminum Foams during Foaming Process | 513 |
| <i>Z. Cao, J. Du, and G. Yao</i> | |
| Effects of Solidification Rate and Alloy Composition on the Cast Microstructure of Aluminum Alloy 5182 | 519 |
| <i>P. Anyalebechi</i> | |
| Secondary Cooling Technology for Casting of Hypo-Peritectic Steels..... | 535 |
| <i>J. Zhang, C. Dengfu, L. Mujun, W. Shuigen, and B. Yanyan</i> | |

Process Modeling and Measurements

| | |
|---|-----|
| Finite Element Modeling of the Twin-Roll Strip Casting Process: Application to an AZ31 Magnesium Alloy..... | 545 |
| <i>Y. He, and E. Essadiqi</i> | |
| Stress Analysis and Deformation Prediction of A Heavy Hydraulic Turbine Blade Casting in Heat Treatment Process | 553 |
| <i>J. Kang</i> | |
| Ultrasound Removing Oxygen Gas Bubbles on Anode and Reducing Cell Voltage during Pb Electrodeposition | 563 |
| <i>J. Xue, Y. Zheng, and J. Li</i> | |
| Multi-scale Solidification Model for Laser Engineered Net Shaping (LENS) Process..... | 571 |
| <i>H. Yin, and S. Felicelli</i> | |

Smelting, Refining, Aqueous and Liquid Processing

| | |
|--|-----|
| A Comparative Electrochemical Study of Arsenic Removal from Organic and Inorganic Sources using Various Sacrificial Electrodes | 583 |
| <i>J. Gomes, S. Rahman, S. Varma, K. Das, and D. Cocke</i> | |
| Characterization of Sodium and Bath Penetration in Industrial Graphitic and Graphitized Cathodes..... | 591 |
| <i>J. Xue, L. Wu, G. Jiang, Q. Niu, Q. Liu, H. Xin, J. Zhu, and H. Hua</i> | |
| A Laboratory Investigation of the Reduction of the Iron Carbonate Bearing Ore to Iron Nugget by Means of the ITmk3 Ironmaking Technology | 599 |
| <i>N. Panishev, R. Tahautdinov, and M. Buryakov</i> | |
| Fe-Ni Alloys Formation in Carbothermal Reduction Process using Laterite Nickel Ore | 603 |
| <i>J. Xue, L. Feng, and J. Zhu</i> | |

| | |
|---|-----|
| Preparation of MgO Whisker from Magnesite Tailings | 613 |
| <i>L. Yue-yuan, C. Hong-Xu, and C. Min</i> | |
| Remediation of Chicken Processing Wastewater using Electrochemically Produced Layered Double Hydroxides | 619 |
| <i>J. Gomes, D. Atambo, M. Rahate, K. Das, G. Irwin, H. Moreno, and D. Cocke</i> | |
| Carbon-thermal Reduction Process for making Al-Si Alloys from Al ₂ O ₃ -SiO ₂ Containing Industrial Wastes..... | 627 |
| <i>J. Xue, Y. Song, and J. Zhu</i> | |
| Author Index | 953 |
| Subject Index | 957 |

TABLE OF CONTENTS

| | |
|----------------------------------|-----|
| EPD Council | xix |
| EPD Honors and Awards 2010 | xxi |

Recycling General Sessions

| | |
|-----------------|-----|
| Organizer | 635 |
|-----------------|-----|

Recycling– General Session: Session I: Metals

| | |
|--|-----|
| Preliminary Research on Preparation Al-Si-Ti Alloy With Aluminum Ash as Electrolysis Materials | 639 |
| <i>L. Qingsheng, X. Jilai, and J. Qingxiu</i> | |
| Stabilization of Chromium-based Slags with MgO | 645 |
| <i>H. Cabrera-Real, A. Romero-Serrano, B. Zeifert, and M. Hallen-Lopez</i> | |
| Preparation of Potassium Ferrate by Hypochlorite Oxidation Method | 657 |
| <i>G. Jiang, L. Chai, Y. Wang, Y. Shu, and M. Yue</i> | |
| Isotherm and Kinetics Studies of the Biosorption of Cobalt from Aqueous Solutions by Waste Materials | 665 |
| <i>C. Yunnen, and F. Jingbiao</i> | |
| Novel Technology for Wastewater Treatment by Biologics in Hydrometallurgical Processes of Lead-zinc | 675 |
| <i>Q. Wang, L. Chai, Y. Wang, Q. Li, and Z. Yang</i> | |
| The Optimum Condition For Cr(VI) Bioremediation in Soils Contaminated by Chromate Ore Processing Residue | 683 |
| <i>C. Su, Y. Zhu, B. Wang, H. Li, and Y. Liao</i> | |
| Thermodynamic Equilibrium of Hydroxyl Complex Ions in Mn^{2+} -H ₂ O System | 691 |
| <i>F. Pei, Y. Wang, and L. Chai</i> | |

Recycling– General Session: Session II: Waste Utilization

| | |
|--|-----|
| Analysis of Light Hydrocarbon Gases in the Pyrolysis and Combustion Processes of Waste Tires | 703 |
| <i>J. Alves, C. Zhuo, Y. Levendis, and J. Tenorio</i> | |
| Utilization of Brazilian Waste Mica in Preparation of Pigments | 711 |
| <i>S. Santos, S. França, and T. Ogasawara</i> | |

| | |
|---|-----|
| Reuse of Fired Red Ceramic Brick Waste | 719 |
| <i>C. Vieira, and S. Monteiro</i> | |
| Preparation of Building Material Using Elemental Sulfur and Heavy-metal Containing Slag | 725 |
| <i>Y. Liang, L. Chai, X. Min, Z. Yang, S. Yang, and X. Cao</i> | |
| Author Index | 953 |
| Subject Index | 957 |

TABLE OF CONTENTS

| | |
|----------------------------------|-----|
| EPD Council | xix |
| EPD Honors and Awards 2010 | xxi |

Sustainable Materials Processing and Production

| | |
|--------------------------|-----|
| Organizers | 733 |
| Listing of Editors | 735 |

Motivating Sustainability I

| | |
|---|-----|
| Building a Sustainability Strategy into a Consumer Products Business..... <i>L. Sharp</i> | 739 |
| Building a Sustainability Strategy into a Consumer Products Business..... <i>L. Bruner, and P. White</i> | 751 |

Measuring Sustainability

| | |
|---|-----|
| Lighweight Materials for the Automotive: Environmental Impact Analysis of the Use of Composites..... <i>K. VanAcker, I. Verpoest, W. Dewulf, and J. Duflou</i> | 763 |
| The Challenge of Allocation in LCA: The Case of Open-Loop Recycling..... <i>E. Olivetti, A. Nicholson, J. Gregory, and R. Kirchain</i> | 767 |
| Screening Environmental Impact Assessment of Large-Scale Socio-Technical Metal Networks..... <i>C. Lam, S. Lim, O. Ogunseitan, and J. Schoenung</i> | 779 |
| Agent Based Modeling of Large-Scale Socio-Technical Metal Networks..... <i>I. Nikolic, A. Bollinger, and C. Davis</i> | 779 |
| Toxicity and Resource Depletion Potentials of Light-Emitting Diodes (LEDs) | 789 |
| Substance Flow Analysis of Cobalt in China | 791 |
| <i>S. Lim, D. Kang, O. Ogunseitan, and J. Schoenung</i> | |
| <i>X. Caimei, Z. Juya, G. Xueyi, and T. Qinghua</i> | |

Motivating Sustainability II

| | |
|--|-----|
| European Recycling Platform – Experiences from a New Venture | 801 |
| <i>H. Korfmacher</i> | |
| Lithium-Ion Batteries: Examining Material Demand and Recycling Issues | 809 |
| <i>L. Gaines, and P. Nelson</i> | |
| Critical and Strategic Failure of Rare Earth Resources | 817 |
| <i>J. Kennedy</i> | |
| Motivating Sustainable Material Use through Industry-Level Simulation Modeling of Platinum Stocks and Flows | 827 |
| <i>E. Alonso, R. Roth, F. Field, and R. Kirchain</i> | |
| A Collaborative Tool for Waste Management in the Industry | 835 |
| <i>M. Borges, H. Riella, and P. Janissek</i> | |

Sustainability in Education

| | |
|---|-----|
| Appropriate Technology and Sustainability | 845 |
| <i>R. LeSar</i> | |
| Depth through Breadth: Addressing the Grand Challenges of Teaching Sustainability | 853 |
| <i>S. Nikitina</i> | |
| Sustainability and Mineral Resource Utilisation: A Study Guide | 861 |
| <i>W. Rankin</i> | |
| Engagement is an Essential Skill in the 21st Century..... | 869 |
| <i>D. VanZyl</i> | |

Sustainable Technologies I

| | |
|--|-----|
| 'Slag Valorisation', as an Example of High Temperature Industrial Ecology | 877 |
| <i>D. Geysen, P. Jones, A. Sander, Y. Pontikes, Ö. Cizer, T. VanGerven, M. Craps, J. Eyckmans, and B. Blanpain</i> | |
| Sustainability Study in Selective Laser Sintering – An Energy Perspective | 885 |
| <i>R. Sreenivasan, and D. Bourell</i> | |
| Energy and Environmental Challenges in Aluminium Industry - A Review | 893 |
| <i>N. Krishnaswamy, B. Mishra, and R. Jagannathan</i> | |
| Towards Sustainable Material Usage: Investigating Limits to Secondary Aluminum Sinks..... | 907 |
| <i>G. Gaustad, E. Olivetti, and R. Kirchain</i> | |

| | |
|---|-----|
| Use of Eco Friendly Alternate Refining Flux in Aluminium Cast House - A Step Towards Sustainable Development..... | 915 |
| <i>N. Krishnaswamy, M. Kar, C. Mathur, and G. Dey</i> | |
| Sustainable Electrolysis for Electrowinning and Electrorefining of Metals..... | 927 |
| <i>G. Haarberg</i> | |
| 2010 Vittorio de Nora Award Winner: Designing Crushing and Grinding Circuits for Improved Energy Efficiency | 933 |
| <i>Z. Pokrajcic</i> | |

Sustainable Technologies II

| | |
|--|-----|
| Lightweight Structural Concrete Incorporating Volcanic Materials for Sustainable Construction..... | 937 |
| <i>K. Hossain</i> | |
| Leaching Studies for the Recovery of Metals from the Waste Printed Circuit Boards (PCBs) | 945 |
| <i>M. Jha, V. Kumar, B. Pandey, R. Kumar, and J. Lee</i> | |
| Author Index | 953 |
| Subject Index | 957 |