

# **International Thermal Spray Conference (ITSC 2018)**

**Orlando, Florida, USA  
7-10 May 2018**

## **Editors:**

**Fardad Azarmi  
Timothy Eden  
Hua Li  
Filofteia-Laura Toma**

**Kantesh Balani  
Tanvir Hussain  
Kentaro Shinoda**

ISBN: 978-1-5108-8040-5

**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© (2018) by ASM International  
All rights reserved.

Printed by Curran Associates, Inc. (2019)

For permission requests, please contact ASM International  
at the address below.

ASM International  
9639 Kinsman Road  
Materials Park, Ohio 44073-0002  
USA

Phone: +1 440.338.5151

[memberservicecenter@asminternational.org](mailto:memberservicecenter@asminternational.org)

**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](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# Contents

## Advanced Coatings for the Aerospace Industry

### **Abradable Coatings for Small Turboprop Engines: A Case Study of Nickel-Graphite Coating ..... 1**

J.Ziegelheim<sup>1</sup>, L. Lombardi<sup>1</sup>, Z. Pala<sup>1</sup>, Z.Cesanek<sup>2</sup>, S. Houdkova<sup>2</sup>, J. Schubert<sup>3</sup>, D.Jech, L. Celko<sup>3</sup>  
(1) GE Aviation Czech, Prague, Czech Republic  
(2) VZU Pilsen, Pilsen, Czech Republic  
(3) CEITEC, Brno, Czech Republic

### **Failure of Multi-Layer Suspension Plasma Sprayed Thermal Barrier Coatings in the Presence of Na<sub>2</sub>SO<sub>4</sub> and NaCl at 900° C ..... 8**

Krishna Praveen Jonnalagadda<sup>1</sup>, Stephanie Kramer<sup>1</sup>, Pimin Zhang<sup>1</sup>, Ru Lin Peng<sup>1</sup>,  
Satyapal Mahade<sup>2</sup>, Nicholas Curry<sup>3</sup>, Xin-Hai Li<sup>4</sup>  
(1) Department of Management and Engineering, Linköping University, Linköping, Sweden  
(2) Department of Engineering Science, University West, Sweden  
(3) Treibacher Industrie AG, Austria  
(4) Siemens Industrial Turbomachinery AB, Finspång, Sweden

### **HVOF Thermal Sprayed MCrAlY-Alumina Composite Coatings for High Temperature Applications ..... 16**

Mingwen Bai, Bo Song, Liam Reddy, Tanvir Hussain, Faculty of Engineering,  
University of Nottingham, Nottingham, UK

### **In-Flight Analysis and Microstructural Evaluation of CoNiCrAlY Coatings Deposited by HVPS ..... 24**

F.R. Caliari<sup>1</sup>, F.S. Miranda<sup>1</sup>, G.P. Filho<sup>1</sup>, A.Essiptchouk<sup>2</sup>, D.A.P. Reis<sup>3</sup>  
(1) Instituto Tecnológico de Aeronáutica, Centro de Ciência e Tecnologia de Plasmas e Materiais,  
São José dos Campos, São Paulo, Brasil  
(2) Universidade Estadual Paulista, Instituto de Ciência e Tecnologia, São José dos Campos, São  
Paulo, Brasil  
(3) Universidade Federal de São Paulo, Instituto de Ciência e Tecnologia, São José dos Campos,  
São Paulo, Brasil

### **Segmented Thermal Barrier Coatings for ID and OD Components Using the SimplexPro Plasma Torch ..... 28**

Dianying Chen, Riston Rocchio-Heller, Christopher Dambra Oerlikon Metco,  
Westbury, NY, USA

### **Thermal Cyclic Life of Functionally-Graded Gadolinium Zirconate/Yitria Stabilized Zirconia Thermal Barrier Coating ..... 35**

Azril Dahari Johari<sup>1</sup>, Abreeza Manap<sup>2</sup>, Salmi Mohd Yunus<sup>3</sup>  
(1) TNB Repair and Maintenance Sdn Bhd, Selangor, Malaysia  
(2) Universiti Tenaga Nasional, Selangor, Malaysia  
(3) Salmi Mohd Yunus TNB Research Sdn Bhd, Selangor, Malaysia

**Fabrication of Ceramic Coatings by Cold-Spray in Gagglomerated  $\text{Y}_2\text{O}_3$  Particles ..... 42**

Yang Yang, Rifei Han, Lingyan Kong, Tianying Xiong , Tiefan Li

Institute of Metal Research, Chinese Academy of Sciences, Shenyang, China

**Nanostructured CVD Tungsten Carbide Coating on Aircraft Actuators and Gearbox Shafts Reduces Oil Leakage and Improves Durability ..... 47**

Yuri Zhuk, Hardide plc, Oxford, UK

**Nondestructive Evaluation and Analyses of Thermal Spray Coatings: Latest Technology Progresses and Case Studies ..... 54**

Xinqing Ma and Peter Ruggiero

Surface Technologies Division, Curtiss-Wright Corporation, East Windsor, CT, USA

**Study of Mechanical Performance and Residual Stress in Kinetic Metallization™ WC-Co Coatings ..... 62**

Andrew S.M. Ang<sup>1</sup> and Christopher C. Berndt<sup>1</sup>, Vladimir Luzin<sup>2</sup>, Travis Crowe<sup>3</sup>, Howard Gabel<sup>3</sup>

(1) Faculty of Science, Engineering and Technology, Swinburne

University of Technology, Australia

(2) Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation, Australia

(3) Inovati, Santa Barbara, CA, USA

**Influence of Spray Process Parameters on Microstructure and Properties of AISi-hexagonal Boron Nitride Abradable Seal Coating ..... 69**

Tong Liu<sup>1,2</sup>, Yueguang Yu<sup>1,2</sup>, Jianming Liu<sup>1,2</sup>, Xuying Cheng<sup>1,2</sup>, Deming Zhang<sup>1,2</sup>, Suyuan Yang<sup>3</sup>

(1) BGRIMM Technology Group, Beijing, China

(2) Beijing Engineering Technology Research Center of Surface Strengthening and Repairing of Industry Parts, Beijing, China

(3) Beijing Institute of Technology

**Mechanical Properties and CMAS Corrosion Resistance of  $\text{La}_2\text{Ce}_2\text{O}_3/\text{YSZ}$  Composite Thermal Barrier Coatings ..... 75**

Y.X. Kang, Y. Bai, C.G. Bao, W. Fan, L. Zhang

State Key Laboratory for Mechanical Behavior of Materials, Xi'an Jiaotong University, Xi'an, China

**Effect of YSZ Thickness on the Thermal Cyclic Fatigue Performance of Gadolinium Zirconate/YSZ Double Layered TBCs ..... 79**

Satyapal Mahade<sup>1</sup>, Nicolae Markocsan<sup>1</sup>, Nicholas Curry<sup>2</sup>

(1) Per Nylén Department of Engineering Science, University West, Sweden

(2) Treibacher Industrie AG, Austria

**Effect of Spray Parameters on Porosity and Lifetime of Suspension Plasma Sprayed Thermal Barrier Coatings ..... 84**

Omkar Aranke<sup>1</sup>, Mohit Gupta<sup>1</sup>, Nicolae Markocsan<sup>1</sup>, Björn Kjellman<sup>2</sup>, Xin-Hai Li<sup>3</sup>

(1) University West, Trollhättan, Sweden

(2) GKN Aerospace Sweden, Trollhättan, Sweden

(3) Siemens Industrial Turbomachinery Finspong, Sweden

**Microstructural Characterization and Room Temperature Erosion Behaviour  
of As-deposited SPS, EB-PVD and APS YSZ-based TBCs ..... 92**

Rogerio S. Lima, Bruno M. H. Guerreiro and Maniya Aghasibeg  
National Research Council of Canada, Boucherville, QC, Canada

**Phase Stability, Fracture Toughness and Thermal Cycling Behavior of  
Supersonic Suspension Plasma Sprayed Scandia-Yttria Co-doped Zirconia  
Thermal Barrier Coatings ..... 100**

Wei Fan<sup>1</sup>, Yu Bai<sup>1</sup>, Yongxia Kang<sup>1</sup>, Lei Zhang<sup>1</sup>, Benqiang Li<sup>2</sup>  
(1) State Key Laboratory for Mechanical Behavior of Materials, Xi'an Jiaotong University,  
Xi'an, China  
(2) Department of Mechanical Engineering, University of Michigan, Dearborn, MI, USA

**Hybrid Suspension/Solution Precursor Plasma Spraying of a Complex Ban  
(Mg<sub>1/3</sub>Ta<sub>2/3</sub>)O<sub>3</sub> Perovskite: Effects of Processing Parameters and Precursor  
Chemistry on Phase Formation and Decomposition ..... 105**

Huidong Hou<sup>1,2</sup>, Jocelyn Veilleux<sup>1</sup>, François Gitzhofer<sup>1</sup>, Quansheng Wang<sup>2</sup>, Ying Liu<sup>2</sup>  
(1) University of Sherbrooke, Sherbrooke, Quebec, Canada  
(2) Beijing Institute of Technology, Beijing, China

**Suspension Sprayed YSZ Thermal Barrier Coatings: Road to Industrial  
Application ..... 113**

Maria Barbosa<sup>1</sup>, Filofteia-Laura Toma<sup>1</sup>, Denise Beitelshmidt Fraunhofer<sup>1</sup>, Omar Ligabue<sup>2</sup>,  
Simone Bursich<sup>2</sup>, Luca Tagliaferri<sup>2</sup>  
(1) Institute for Material and Beam Technology (IWS), Dresden, Germany  
(2) Turbocoating S.p.A., Rubbiano di Solignano, Italy

## Fundamentals/Research and Development

**Instrumented Strain-Gage Measurement for Coating Adhesion During  
Four-Point Bending ..... 120**

Derek Landwehr<sup>1</sup>, Jim Watts<sup>1</sup>, and Daryl Crammer<sup>1</sup>, Beth Aperavich<sup>2</sup>  
(1) Fisher Barton Technology Center, Watertown, WI, USA  
(2) Thermal Spray Technologies, Sun Prairie, WI, USA

**An Investigation into the Mechanism for Enhanced Mechanical Properties in Friction  
Stir Welded AA2024-T3 Joints Coated with Cold Spraying ..... 126**

Na Li<sup>1</sup>, Wenya Li<sup>1</sup>, Xiawei Yang<sup>1</sup>, Yaxin Xu<sup>1</sup>, Yan Feng<sup>1</sup>, Achilles Vairis<sup>1,2</sup>  
(1) State Key Laboratory of Solidification Processing, Shaanxi Key Laboratory of Friction Welding  
Technologies, Northwestern Polytechnical University Xi'an, China  
(2) Department of Mechanical Engineering, TEI of Crete, Heraklion, Crete, Greece

**Fabrication and Characterization of ICP Sprayed Boron Carbide Coating  
On Tungsten Monoblock ..... 134**

Qiuji Zhou<sup>1,2</sup>, Peng Zhao<sup>1</sup>, Qijia Guo<sup>1,2</sup>, Lin Li<sup>1</sup>, Junling Chen<sup>1</sup>, Yuedong Meng<sup>1</sup>  
(1) Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy  
of Sciences, Hefei, China  
(2) University of Science and Technology of China, Hefei, China

<b>Fatigue Crack Growth in Plasma Sprayed Refractory Materials .....</b>	<b>140</b>
Ondrej Kovarik <sup>1</sup> , Ales Materna <sup>1</sup> , Jan Siegl <sup>1</sup> , Jan Cizek <sup>2</sup> , Jakub Klecka <sup>1,2</sup>	
(1) Department of Materials, Faculty of Nuclear Science and Physical Engineering, Czech Technical University, Prague, Czech Republic	
(2) Institute of Plasma Physics, Czech Academy of Sciences, Prague, Czech Republic	
<b>Mechanisms on Vacuum Heat Treatment Promoting the Adhesion Strength of Thermal Sprayed Metallic Coatings .....</b>	<b>148</b>
Guo-Hui Meng, Bang-Yan Zhang, Hong Liu, Tong Xu, Guan-Jun Yang, Cheng-Xin Li, Chang-Jiu Li State Key Laboratory for Mechanical Behavior of Materials, School of Materials Science and Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, China	
<b>Particle In-Flight Behavior and Its Significance in Determining the Microstructure and Mechanical Properties of Zirconia Based Thermal Barrier Coatings .....</b>	<b>154</b>
L. Zhang, Y. Bai, Y. Wang, W. Fan, Y.X. Kanga State Key Laboratory for Mechanical Behavior of Materials, Xi'an Jiaotong University, Xi'an, China	
<b>Cold Spraying of Metallic Powders onto Polymeric Substrates: Influence of Gas Preheating Temperature on the Coating Deposition .....</b>	<b>159</b>
A.Sabard, A. Albassam, S. Chadha, T. Hussain Faculty of Engineering, University of Nottingham, Nottingham, UK	
<b>Cold Spraying of Mixed Sn-Al Powders onto Carbon Fibre Reinforced Polymers</b>	<b>166</b>
Andre Liberati <sup>1</sup> , Hanqing Che <sup>1</sup> , Stephen Yue <sup>1</sup> , Phuong Vo <sup>2</sup>	
(1) Mining and Materials Engineering, McGill University, Montreal, QC, Canada	
(2) National Research Council Canada, Boucherville, QC, Canada	
<b>Investigation of Cold Spray on Polymers by Single Particle Impact Experiments</b>	<b>173</b>
Hanqing Che <sup>1</sup> , Stephen Yue <sup>1</sup> , Phuong Vo <sup>2</sup>	
(1) Department of Mining and Materials Engineering, McGill University, Montreal, Canada	
(2) National Research Council Canada, Boucherville, Canada	
<b>Pin Fin Array Heat Sinks by Cold Spray Additive Manufacturing: Economics of Powder Recycling .....</b>	<b>179</b>
J.Perry <sup>1</sup> , P. Richer <sup>1</sup> , B. Jodoin <sup>1</sup> , E.Matte <sup>2</sup>	
(1) University of Ottawa Cold Spray Research Laboratory, Ottawa, Ontario, Canada	
(2) Ironside Engineering Inc., Ottawa, Ontario, Canada	
<b>Anisotropic Response of Cold Sprayed Copper Deposits .....</b>	<b>187</b>
Kang Yang, Wenya Li State Key Laboratory of Solidification Processing, School of Materials Science and Engineering, Northwestern Polytechnical University Xi'an, Shaanxi, China	
<b>Microstructure Characterization of Feedstock Ti-6Al-4V Powders and Their Evolution During Cold Spray Deposition and After Heat Treatment .....</b>	<b>194</b>
Venkata Satish Bhattiprolu, Grant A. Crawford Department of Materials and Metallurgical Engineering, South Dakota School of Mines and Technology, Rapid City, SD, USA	

**Cold Spray Additive Manufacturing of Al/Diamond Composites Using Core-Shell-Structured Diamond ..... 202**

Shuo Yin<sup>1</sup>, Rocco Lupoi<sup>1</sup>, Chaoyue Chen<sup>2</sup>

(1) Trinity College Dublin, The University of Dublin, Department of Mechanical and Manufacturing Engineering, Parsons Building, Dublin, Ireland

(2) Université Bourgogne Franche-Comté, Université de Technologie Belfort-Montbéliard, IRTES-LERMPS, Belfort, France

**Depositing Metallic Coatings on Polymer Substrates by Cold Spray Process ..... 210**

M.R. Rokni<sup>1</sup>, S.R. Nutt<sup>1</sup>, M.C. Gill<sup>1</sup>, C.A. Widener<sup>2</sup>, R.H. Hrabe<sup>2</sup>

(1) Composites Center, Department of Chemical Engineering and Materials Science, University of Southern California, Los Angeles, CA, USA

(2) VRC Metal Systems, Rapid City, SD, USA

**New Insights into the Formation Mechanism of Intertwining Interfaces in Cold Spray ..... 219**

Shuo Yin<sup>1</sup>, Rocco Lupoi<sup>1</sup>, Jan Cizek<sup>2</sup>

(1) Trinity College Dublin, The University of Dublin, Department of Mechanical and Manufacturing Engineering, Parsons Building, Dublin, Ireland

(2) Institute of Plasma Physics, Czech Academy of Sciences, Prague, Czech Republic

**Fundamental Investigation into the Effects of In-process Heat Treatment in Cold Spray ..... 227**

Barry Aldwell, Ben Hunter, Richard Jenkins, Rocco Lupoi Department of Mechanical and Manufacturing Engineering, Trinity College Dublin, Dublin, Ireland

**Grain Refinement of Pure Al Coating via In-Situ Shot-Peening-Assisted Cold Spray ..... 233**

Ying-Kang Wei, Xiao-Tao Luo, Chang-Jiu Li, State Key Laboratory for Mechanical Behavior of Materials, School of Materials Science and Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, China

**Investigation of Cold Spray Bonding Mechanism Focusing on the Thin Oxide Film Present in the Deposition Interface ..... 238**

Yuji Ichikawa, Ryotaro Tokoro, Kazuhiro Ogawa Tohoku University, Sendai, Japan

**Organic Composite Metallization using Low Pressure Cold Spraying ..... 242**

S. Costil<sup>1</sup>, E. Aubignat<sup>1</sup>, C. Langlade<sup>1</sup>, V. Gillet<sup>2</sup>, B. Courant<sup>2</sup>, P. Casari<sup>2</sup>, W. Knapp<sup>3</sup>

(1) ICB-LERMPS, Univ. Bourgogne Franche-Comté, UTBM, Belfort Cedex, France

(2) Institut de Recherche en Génie Civil et, Université de Nantes, Saint Nazaire, France

(3) Fraunhofer-Institut für Lasertechnik (ILT), Aachen, Germany

**Characterisation of Cold Sprayed Ni Alloy 718 Coatings ..... 248**

Mike Walker<sup>1</sup>, Paul Howes<sup>1</sup>, Phil McNutt<sup>2</sup>, Dave Harvey<sup>2</sup>, Hong Dong<sup>3</sup>,

Fernando Cacho-Nerin<sup>4</sup> and Paul Quinn<sup>4</sup>

(1) University of Leicester, Department of Physics, Leicester, UK

(2) TWI, Cambridge, UK

(3) University of Leicester, Department of Engineering, Leicester, UK

(4) Diamond Light Source, Oxford, UK

**Effects of Feedstock Mixing Composition on the Cold Sprayability of Bimodal Size 316L/Fe Powder Mixtures ..... 256**

Xin Chu<sup>1</sup>, Hanqing Che<sup>1</sup>, Stephen Yue<sup>1</sup>, Phuong Vo<sup>2</sup>

(1) Dept. of Mining and Materials Engineering, McGill University, Montreal, Quebec, Canada

(2) National Research Council Canada, Boucherville, Quebec, Canada

**Investigation of Particle/Substrate Bonding Between Copper Powder and Different Substrates in Cold Spray ..... 262**

Chaoyue Chen<sup>1</sup>, Yingchun Xie<sup>1</sup>, Xinliang Xie<sup>1</sup>, Sihao Deng<sup>1</sup>, Hanlin Liao<sup>1</sup>, Renzhong Huang<sup>2</sup>, Zhongming Ren<sup>3</sup>

(1) ICB UMR 6303, CNRS, Univ. Bourgogne Franche-Comté, UTBM, Belfort, France

(2) Guangdong Institute of New Materials, Guangzhou, China

(3) Shanghai University & State Key Laboratory of Advanced Special Steel, Yanchang Road, Shanghai, China

**Modeling the Continuous Heat Generation in the Cold Spray Coating Process .... 270**

Ozan C. Ozdemir<sup>1</sup>, Qiyong Chen<sup>1</sup>, Sinan Muftu<sup>1</sup>, Victor K. Champagne, Jr.<sup>2</sup>

(1) Northeastern University, Department of Mechanical and Industrial Engineering, Boston, MA, USA

(2) U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, USA

**Effects of Interface Bonding on the Residual Stresses in Cold Sprayed Al-6061: A Numerical Investigation ..... 278**

Enqiang Lin<sup>1</sup>, Qiyong Chen<sup>1</sup>, Ozan C. Ozdemir<sup>1</sup>, Sinan Müftü<sup>1</sup>, Victor K. Champagne<sup>2</sup>

(1) Department of Mechanical & Industrial Engineering Northeastern University, Boston MA, USA

(2) United States Army Research Laboratory Aberdeen Proving Ground, Maryland, USA

**Numerical Study using Nano-Particles by Varying the Expansion Ratio and Height of Cold Spray Nozzle to Predict Deposition Efficiency ..... 286**

Chirag Singhal<sup>1</sup> and Qasim Murtaza<sup>2</sup>

(1) Undergraduate Student, Department of Mechanical Engineering, ZH CET, AMU, Uttar Pradesh, India

(2) Professor, Department of Mechanical Engineering, Delhi Technological University, Delhi, India

**An Optical Emission Spectroscopy Study of Plasma-Precursor Interactions in Solution Precursor Plasma Spray ..... 294**

Jérôme Menneveux, Jocelyn Veilleux University of Sherbrooke, Canada

**Characterization of Plasma Sprayed Zirconium Coatings on Uranium Alloy Using Neutron Diffraction ..... 299**

Kendall J. Hollis, Dustin R. Cummins, Sven C. Vogel, Donald W. Brown, David E. Dombrowski Los Alamos National Laboratory, Los Alamos, NM, USA

**Thermal Stability of Thermophysical Properties of Multiphase Fe-Al Intermetallic/ Oxide Ceramics Coatings Deposited by Gas Detonation Spraying 307**

Andrzej J. Panas<sup>1</sup>, Cezary Senderowski<sup>2</sup>, Bartosz Fikus<sup>3</sup>, Waldemar Wołczyński<sup>4</sup>

(1) Air Force Institute of Technology, Warsaw, Poland

(2) University of Warmia and Mazury, Department of Materials Technology and Machinery, Olsztyn, Poland

(3) Military University of Technology, Faculty of Mechatronics and Aerospace, Warsaw, Poland

(4) Institute of Metallurgy and Materials Science, Krakow, Poland

**Influence of Grain Size on the Corrosion and Wear Behaviour of HVAF-Sprayed Fe-Based Coatings ..... 313**

K.Bobzin, M. Öte, M.A. Knoch, J. Sommer Surface Engineering Institute (IOT), RWTH Aachen University, Aachen, NRW, Germany

**Porous Stainless-Steel Coatings Produced by HVOF and Chemical Leaching ..... 321**

Nascimento, A. R. C.<sup>1</sup>, Devaraj, S.<sup>1</sup>, Moreau, C.<sup>1</sup>, Savoie, S<sup>2</sup>., Schulz, R.<sup>2</sup>

(1) Department of Mechanical, Industrial and Aerospace Engineering - Concordia University - Montréal, Québec, Canada

(2) Institut de Recherche d'Hydro Québec - Varennes, Québec, Canada

**Analysis and Optimization of the HVOF Process by Artificial Neural Networks Model ..... 330**

Liu Meimei, Yu Zexin, Chen Chaoyue, Liao Hanlin, Deng Sihao

Université de Bourgogne Franche-Comté, France

**Chemical Composition Changes of Composite Abradable Powders During the Deposition Process ..... 337**

Yueguang Yu, Jianming Liu, Xiaoliang Lu, Deming Zhang, Xuying Cheng, Beijing General Research Institute of Mining and Metallurgy Technology Group, Beijing, China

**Cost Effective Iron Based Alloys for Abrasive Wear ..... 343**

Barbara Maroli, Robert Frykholm, Sven Bengtsson Höganäs AB, Höganäs, Sweden

**Deposition of Lamellae Well Bonded Dense Ceramic Coatings by Plasma Spraying Through Materials Design ..... 349**

Chang-Jiu Li, Qi-Lan Zhang, Shu-Wei Yao, Guan-Jun Yang, Cheng-Xin Li, State Key Laboratory for Mechanical Behavior of Materials, School of Materials Science and Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi Province, China

**Investigation of High Temperature Compressor Abradable Coatings for Gas Turbine Applications ..... 355**

Winnie Tan<sup>1</sup>, Dimitrios Zois<sup>2</sup>, Scott Wilson<sup>3</sup>, Mitchell R. Dorfman<sup>4</sup>

(1) Siemens Energy Inc., Charlotte, NC, USA

(2) Siemens AG, Berlin, Germany

(3) Oerlikon Metco AG, Wohlen, Switzerland

(4) Oerlikon Metco (US) Inc., Westbury, NY, USA

**The Effect of Electromechanical Treatment on Structure and Properties of Plasma Sprayed Fe-30Cr-0.6C Coating ..... 361**

C.A. Bernard<sup>1,2,3</sup>, K. Ogawa<sup>2,3</sup>, J.-Y. Cavaillé<sup>3</sup>, O. Lame<sup>4</sup>, K. Ravi<sup>2,3,4</sup>, T. Deplancke<sup>4</sup>

(1) Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Sendai, Japan

(2) Fracture and Reliability Research Institute, Tohoku University, Sendai, Japan

(3) ELyTMax, UMI 3757, CNRS–Université de Lyon–Tohoku University International Joint Unit, Tohoku University, Sendai, Japan

(4) MATEIS, INSA LYON, Lyon, France

**On the Premise of Polymer Coating Modelling for Cold-Spray Process ..... 366**C.A. Bernard<sup>1,2,3</sup>, K. Ogawa<sup>2,3</sup>, J.-Y. Cavaillé<sup>3</sup>, O. Lame<sup>4</sup>, K. Ravi<sup>2,3,4</sup>, T. Deplancke<sup>4</sup>

(1) Frontier Research Institute for Interdisciplinary Sciences, Tohoku University, Sendai, Japan

(2) Fracture and Reliability Research Institute, Tohoku University, Sendai, Japan

(3) ELYTMAx, UMI 3757, CNRS–Université de Lyon–Tohoku University International

Joint Unit, Tohoku University, Sendai, Japan

(4) MATEIS, INSA LYON, Lyon, France

**High Strain Rate Sensitivity of Ultra-High Molecular Weight Polyethylene and Its Consequence on Cold-Spray Deposition Behavior ..... 371**Kesavan Ravi<sup>1</sup>, Kazuhiro Ogawa<sup>1</sup>, Tiana Deplancke<sup>2</sup>, Olivier Lame<sup>2</sup>, Jean-Yves Cavaillé<sup>3</sup>

(1) Fracture and Reliability Research Institute, Tohoku University, Sendai, Japan

(2) Material Engineering and Science lab, MATEIS, INSA Lyon, Lyon, France

(3) ELYTMAx, Tohoku University, Sendai, Japan

**TEM Studies of a Nano-Crystalline Cold Sprayed Ni-20Cr Coating ..... 375**M.Kumar<sup>1</sup>, H.Singh<sup>2</sup>, N.Singh<sup>3</sup>

(1) Department of Mechanical Engineering, Chandigarh University, Mohali, Punjab, India

(2) School of Mechanical, Materials &amp; Energy Engineering, Indian Institute of Technology Ropar, Rupnagar, Punjab, India

(3) Department of Chemistry, Indian Institute of Technology Ropar, Rupnagar, Punjab, India

**Thermally Sprayed Slippery and Icephobic Surfaces ..... 380**

H.Niemelä-Anttonen, H. Koivuluoto, M. Kyllmälähti, J. Laakso and P. Vuoristo Tampere University of Technology, Laboratory of Materials Science, Tampere, Finland

**Characterization of Powder-Precursor HVOF-Sprayed Al<sub>2</sub>O<sub>3</sub>-ZrO<sub>2</sub> Coatings ..... 385**Jarkko Kiviläkoski<sup>1</sup>, Jouni Puranen<sup>1,2</sup>, Heli Koivuluoto<sup>1</sup>, Petri Vuoristo<sup>1</sup>

(1) Laboratory of Materials Science, Tampere University of Technology, Tampere, Finland

(2) Elcogen Oy, Vantaa, Finland

**Effect of Molten Particle Temperature on the Bonding Formation During Plasma Spraying of Metal Alloy Coatings ..... 390**

Jun Wang, Jia-jia Tian, Chang-Jiu Li State Key Laboratory for Mechanical Behavior of Materials, School of Materials Science and Engineering, Xi'an Jiaotong University, China

**Investigations of A Pulsed DC Arc Spray Process ..... 397**Dirk Landgrebe<sup>1</sup>, Stefan Brumm<sup>1</sup>, Sven Kunze<sup>1</sup>, Jonas Kimme<sup>1</sup>, Sebastian Weis<sup>2</sup>,Jan Morgenschweis<sup>3</sup>

(1) Technische Universität Chemnitz, Institut für Werkzeugmaschinen und Produktionsprozesse, Germany

(2) Westsächsische Hochschule Zwickau, Institut für Produktionstechnik, Germany

(3) ELMA-Tech GmbH, Germany

**Variation of Vaporized Coating Material in Free Plasma Jet of Plasma Spray-Physical Vapor Deposition Process ..... 403**Mei-Jun Liu<sup>1</sup>, Meng Zhang<sup>1</sup>, Qiang Zhang<sup>1</sup>, Guan-Jun Yang<sup>1</sup>, Cheng-Xin Li<sup>1</sup>, Chang-Jiu Li<sup>1</sup>, Qiang Zhang<sup>2</sup>

(1) State Key Laboratory for Mechanical Behavior of Materials, School of Materials Science and Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, China

(2) AVIC Beijing Institute of Aeronautical Materials, Beijing, China

**Determination of the Temperature Distribution of a Substrate Exposed to a Moving Cold or Thermal Spray Heat Source ..... 410**

Amirhossein Mahdavi, André McDonald Department of Mechanical Engineering,  
University of Alberta, Edmonton, AB, Canada

**Evaluation on Dynamic Wetting in Flattening Behavior of Thermal Sprayed Particle ..... 417**

Masahiro Fukumoto and Natsuki Maeda, Toyohashi University of Technology  
Toyohashi, Aichi, Japan

**Numerical Study on Particle Trajectories Close to the Substrates in Thermal Spray Processes with High-Kinetic and Low-Pressure Conditions ..... 422**

Georg Mauer, Robert Vaßen Forschungszentrum Jülich, Institute of Energy and Climate Research IEK-1, Jülich, Germany

**Utilizing Big Data Informatics for Thermal Spray Materials Design ..... 430**

Justin Cheney, Ph.D. Oerlikon Metco, San Diego, CA USA

**Influence of Process Gas Composition on Laser Cladding Process Characteristics ..... 436**

A.Wank<sup>1</sup>, C. Schmengler<sup>1</sup>, A. Hitzek<sup>1</sup>, W.Kroemmer<sup>2</sup>, M. Runzka<sup>2</sup>, B. Merten<sup>2</sup>  
(1) GTV Verschleiss-Schutz GmbH, Luckenbach, Germany  
(2) Linde Gas Division, Linde AG, Unterschleissheim, Germany

**Internal Diameter Coating Processes for Bond Coat (HVOF) and Thermal Barrier Coating (APS) Systems ..... 443**

W. Tillmann<sup>1</sup>, C. Schaak<sup>1</sup>, L. Hagen<sup>1</sup>, G.Mauer<sup>2</sup>, G.Matthäus Thermico<sup>3</sup>  
(1) TU Dortmund University, Institute of Materials Engineering, Germany  
(2) Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research, IEK-1, Germany  
(3) GmbH & Co KG, Dortmund, Germany

**The Ballistic Test on Double-Layer Shaped Charge Liner Fabricated by Kinetic Spray ..... 451**

Seungtae Lee<sup>1</sup>, Jaeick Kim<sup>1</sup>, Changhee Lee<sup>1</sup>, Seong Lee<sup>2</sup>, Sijo Kim<sup>3</sup>  
(1) Kinetic Spraying Coating Laboratory, Division of Materials Science and Engineering,  
Hanyang University, Seoul, Republic of Korea  
(2) Agency for Defense Development, Daejeon, Republic of Korea  
(3) Department of Mechanical Design Engineering, Andong National University, Andong, Korea,  
Republic of Korea

**Deposition of Multiphase Coatings from Liquid Feedstock using Hybrid Water-Stabilized (WSP-H) Plasma Torch ..... 456**

Tomas Tesar, Radek Musalek, Jan Medricky, Jan Cizek, Frantisek Lukac, Tomas Chraska,  
Department of Materials Engineering, Institute of Plasma Physics CAS, v. v. i. Prague,  
Czech Republic

**Preparation of Functional, Compositionally Graded Metal Oxide Films via the Solution Precursor Plasma Spray Process ..... 463**

Zexin Yu<sup>1</sup>, Meimei Liu<sup>1</sup>, Michel Moliere<sup>1</sup>, Hanlin Liao<sup>1</sup>, Hatem Moussa<sup>2</sup>, Raphaël Schneider<sup>2</sup>, Weize Wang<sup>3</sup>

(1) Université de Bourgogne Franche-Comté, Belfort, France

(2) Université de Lorraine, Laboratoire Réactions et Génie des Procédés (LRGP), Nancy Cedex, France

(3) Key Lab of Safety Science of Pressurized System, Ministry of Education, School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai, China

**Electrical Properties of Dense Al<sub>2</sub>O<sub>3</sub> Coatings Prepared by SPS Process ..... 470**

Hiroyuki Ibe, Takaya Masuda, Kazuto Sato, Nobuaki Kato, FUJIMI Incorporated, Gifu, Japan

**Multivariate Analysis of the Influence of Process Parameters on Suspension Plasma-Sprayed Coatings ..... 475**

Yongli Zhao<sup>1</sup>, François Peyraud<sup>1</sup>, Marie-Pierre Planche<sup>1</sup>, Hanlin Liao<sup>1</sup>, Ghislain Montavon<sup>1</sup>, Jan Ilavsky<sup>2</sup>, Audrey Lasalle<sup>3</sup>, Alain Allimant<sup>3</sup>

(1) Université de Bourgogne Franche-Comté, UTBM, Belfort, France

(2) Advanced Photon Source, Argonne National Laboratory, Argonne, IL, USA

(3) Saint-Gobain CREE, Cavaillon, France

**Hydrophobicity of Suspension HVOF Sprayed Rare Earth Oxide Coatings ..... 483**

Mingwen Bai<sup>1</sup>, Hafsa Kazi<sup>1</sup>, Xiaoli Zhang<sup>2</sup>, Junpeng Liu<sup>1</sup>, Bo Song<sup>1</sup>, Tanvir Hussain<sup>1</sup>

(1) Faculty of Engineering, University of Nottingham, UK

(2) School of Engineering and Materials Science, Queen Mary University of London, UK

**Neutron Diffraction Residual Stress Measurements in Suspension HVOF Sprayed Al<sub>2</sub>O<sub>3</sub> and YSZ Coatings ..... 490**

T.Owoseni<sup>1</sup>, M. Bai<sup>1</sup>, T. Hussain<sup>1</sup>, N. H. Faisal<sup>2</sup>, T.L. Lee<sup>3</sup>, J. Kelleher<sup>3</sup>

(1) Faculty of Engineering, University of Nottingham, Nottingham, UK

(2) School of Engineering, Robert Gordon University, Aberdeen, Scotland, UK

(3) ISIS Neutron Source, Rutherford Appleton Laboratory, Harwell Oxford Didcot, UK

**Suspension High Velocity Oxy Fuel (SHVOF) Thermal Spraying of Cr<sub>2</sub>O<sub>3</sub> and Cr<sub>2</sub>O<sub>3</sub> with Graphene Platelets for Dry Sliding Wear Protection ..... 496**

J.Pulsford, M. Bai and T. Hussain Faculty of Engineering, University of Nottingham, Nottingham, UK

**High Temperature Corrosion Properties of Thermally Sprayed Ceramic Oxide Coatings ..... 501**

D.Fantozzi<sup>1</sup>, J. Kiilakoski<sup>1</sup>, H. Koivuluoto<sup>1</sup>, P. Vuoristo<sup>1</sup>, M.Uusitalo<sup>2</sup>, G.Bolelli<sup>3</sup>, V. Testa<sup>3</sup>, L. Lusvarghi<sup>3</sup>

(1) Tampere University of Technology, Tampere, Finland

(2) Valmet Technologies Ltd., Tampere, Finland

(3) University of Modena and Reggio-Emilia, Modena, Italy

**New Material Concepts for Thermally Sprayed Hydrodynamic Bearings ..... 508**

K.Bobzin<sup>1</sup>, M. Öte<sup>1</sup>, T. Königstein<sup>1</sup>, W. Wietheger<sup>1</sup>, T.Schröder<sup>2</sup>, G. Jacobs<sup>2</sup>, D. Bosse<sup>2</sup>

(1) Surface Engineering Institute (IOT), RWTH Aachen University, Aachen, Germany

(2) Chair for Wind Power Drives (CWD), RWTH Aachen University, Aachen, Germany

## **Posters**

### **Direct Spraying of Fine Ceramic Particles in Thermal Spray ..... 515**

Mohammed Shahien, Masato Suzuki, Kentaro Shinoda and Jun Akedo, Advanced Coating Technology Research Center, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan

### **Mechanisms of Structure Formation and Thermo-Physical Properties of Gas Detonation Sprayed Fe-Al Type Coatings ..... 521**

Cezary Senderowski<sup>1</sup>, Andrzej J. Panas<sup>2</sup>, Bartosz Fikus<sup>3</sup>, Waldemar Wołczyński<sup>4</sup>  
(1) University of Warmia and Mazury, Department of Materials Technology and Machinery, Olsztyn, Poland  
(2) Air Force Institute of Technology, Warsaw, Poland  
(3) Military University of Technology, Faculty of Mechatronics and Aerospace, Warsaw, Poland  
(4) Institute of Metallurgy and Materials Science, Krakow, Poland

### **Modeling Possibility and Assessment of Dynamic Properties and Thermal History of Powder Particles Under Gas Detonation Spraying Conditions Using Propane - Air Mixture ..... 528**

Bartosz Fikus<sup>1</sup>, Andrzej J. Panas<sup>1</sup>, Cezary Senderowski<sup>2</sup>, Waldemar Wołczyński<sup>3</sup>  
(1) Military University of Technology, Faculty of Mechatronics and Aerospace, Warsaw, Poland  
(2) University of Warmia and Mazury, Department of Materials Technology and Machinery, Olsztyn, Poland  
(3) Institute of Metallurgy and Materials Science, Krakow, Poland

### **Pulsed Current and Pulsed Powder Operation of the One-Cathode-One-Anode -Plasma-Generator (OCOAPG)-Part II ..... 535**

Stephan Zimmermann and Jochen Schein University of Federal Armed Forces Munich IPM (LPT), Neubiberg, Germany

### **Influence of Aluminum Oxide Grit Reuse on Surface Preparation and Bond Strength of Thermally Sprayed Coatings ..... 539**

Samantha Mayumi Zanella Odake<sup>1</sup>, Gustavo Bavaresco Sucharski<sup>1</sup>, Ramón Sigifredo Cortés Paredes<sup>1</sup>, Irene Bida de Araujo Siqueira Fernandes<sup>2</sup>, Rodolpho Fernando Vaz<sup>2</sup>  
(1) UFPR Federal University of Paraná, Curitiba, Brazil  
(2) Lactec Institute of Technology for Development, Curitiba, Paraná, Brazil

### **Hot Corrosion Behavior of Selected Thermally Sprayed Alloy Based Coatings .... 547**

Zdeněk Česánek<sup>1</sup>, Jan Schubert<sup>1</sup>, Šárka Houdková<sup>1</sup>, František Lukáč<sup>2</sup>  
(1) Research and testing Institute in Pilsen Ltd., Pilsen, Czech Republic  
(2) Institute of Plasma Physics, The Czech Academy of Sciences, Prague, Czech Republic

### **The Effects of Impurities on The Properties of YSZ Thermal Barrier Coatings ..... 553**

Ji Xiaojuan<sup>1,2</sup>, Yu Yueguang<sup>2</sup>, Zhang Deming<sup>2</sup>, Li Yujie<sup>2</sup>, Peng Haoran<sup>2</sup>, Hou Wei'ao<sup>2</sup>  
(1) Northeastern University, Shenyang China  
(2) BGRIMM Technology Group, Beijing, China

**The Structure and Oxidation Resistance Behavior of Ni-CrAlY Coatings Prepared by Plating Process ..... 557**

Lingfeng Huang<sup>1,2</sup>, Jianming Liu<sup>1,2</sup>, Xuying Cheng<sup>1,2</sup>, Deming Zhang<sup>1,2</sup>, Yueguang Yu<sup>1,2</sup>

(1) BGRIMM Technology Group, Beijing, China

(2) Beijing Engineering Technology Research Center of Surface Strengthening and Repairing of Industry Parts, Beijing, China

**High Temperature Erosion Mechanisms and Erosion Rate of Hard Coatings for Surface Recovery of Heavy-Fuel Engines ..... 561**

Javier Miranda, Lorena Bejarano, Alfredo Valarezo Mechanical Engineering Department, Universidad San Francisco de Quito, Quito, Ecuador

## **Thermal Spray Applications**

**Adhesion of Cold Sprayed Brass Coatings for Lead-Free Bearings ..... 568**

S.Theimer, M. Graunitz, F. Gärtner, T. Klassen, Department of Mechanical Engineering, Helmut Schmidt University, University of the Federal Armed Forces Hamburg, Hamburg, Germany

**Manufacture of Reflective Aluminium Surfaces Using Cold Spray ..... 574**

Richard Jenkins, Shuo Yin, Barry Aldwell, Rocco Lupoi Trinity College Dublin, The University of Dublin, Department of Mechanical and Manufacturing Engineering, Parsons Building, Dublin, Ireland

**Pretreatment and Coatability of Additive Manufactured Components Made by Means of Selective Laser Melting ..... 581**

W.Tillmann<sup>1</sup>, L. Hagen<sup>1</sup>, C. Schaak<sup>1</sup>, R. Zielke<sup>1</sup>, M.Schaper<sup>2</sup>, M. E. Aydinöz<sup>2</sup>

(1) TU Dortmund University, Institute of Materials Engineering, Dortmund, Germany

(2) Paderborn University, Chair of Materials Science, Paderborn, Germany

**Synthesis of Carbon Nanotube Reinforced Al Matrix Composites via Cold Spray Deposition ..... 589**

Xinliang Xie<sup>1</sup>, Chaoyue Chen<sup>1</sup>, Yingchun Xie<sup>1</sup>, Hanlin Liao<sup>1</sup>, Zhanqiu Tan<sup>2</sup>, Zhiqiang Li<sup>2</sup>, Gang Ji<sup>3</sup>

(1) Univ. Bourgogne Franche-Comté, UTBM, Belfort, France

(2) State Key Laboratory of Metal Matrix Composites, Shanghai Jiao Tong University, Shanghai, China

(3) Unité Matériaux et Transformations, CNRS UMR, Université Lille 1, France

**Potential New Application for VLPPS Process as an Additive Manufacturing Device ..... 597**

Geoffrey Darut<sup>1</sup>, Aymeric Niederhauser<sup>2</sup>, Bertrand Jacoud<sup>2</sup>, Martin Sigrist<sup>2</sup>, Elmar Mock<sup>2</sup>, Marie Pierre Planche<sup>1</sup>, Hanlin Liao<sup>1</sup>, Ghislain Montavon<sup>1</sup>

(1) UBFC, ICB-PMDM-LERMPS Belfort, France

(2) CREAHOLIC SA Switzerland

**Development of Protective Thermal Spray Coatings for Lightweight Al Brake Rotor Discs ..... 604**

Dominique Poirier, Jean-Gabriel Legoux, Eric Irissou, Danick Gallant, Jimmy Jiang, National Research Council of Canada, Boucherville/Saguenay/Vancouver, Canada

<b>Effects of Natural Gas Composition Variation On HVOF Coating .....</b>	<b>611</b>
Andrew D. Steinmetz Caterpillar Inc., Peoria, IL, USA	
<b>GROB Advances in Thermal Spray Technology Development for Cylinder Bore Applications in Mass Production .....</b>	<b>615</b>
Bernhard Gand, Andreas Wörfel, GROB Werke GmbH & Co. KG, Mindelheim, Bavaria, Germany	
<b>Restoring Body of Valuable Historic Vehicles: An Innovative Approach by the Use of Thermal Spray Techniques .....</b>	<b>622</b>
Andrea Chierichetti, Walter Cerri, Roberto Meloni, Flame Spray SpA, Roncello, Italy Luigino Barp Ferrari SpA, Maranello, Italy	
<b>Spinel Copper Ferrite and Zinc Ferrite Films Synthesized via Solution Precursor Plasma Spray Process for Functional Applications .....</b>	<b>627</b>
Zexin Yu <sup>1</sup> , Meimei Liu <sup>1</sup> , Michel Moliere <sup>1</sup> , Hanlin Liao <sup>1</sup> , Hatem Moussa <sup>2</sup> , Raphaël Schneider <sup>2</sup> , Weize Wang <sup>3</sup> (1) Université de Bourgogne Franche-Comté, Belfort, France (2) Université de Lorraine, Laboratoire Réactions et Génie des Procédés 54001 Nancy Cedex, France (3) Key Lab of Safety Science of Pressurized System, Ministry of Education, School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai, China	
<b>Development of a Thermal-Sprayed Coating System to Mitigate Ice Accumulation and Freezing Damage in Carbon Steel Pipes .....</b>	<b>635</b>
Milad Rezvani Rad, André McDonald University of Alberta, Edmonton, AB, Canada	
<b>High Velocity Oxygen Fuel Spraying of Nanostructured Hydroxyapatite on Magnesium Alloy Substrate for Biomedical Application .....</b>	<b>643</b>
Marzieh Mardali <sup>1</sup> , Hamidreza Salimjazi <sup>1</sup> , Fathallah Karimzadeh <sup>1</sup> , Tom Coyle <sup>2</sup> (1) Department of Materials Engineering, Isfahan University of Technology, Isfahan, Iran (2) Centre for Advanced Coating Technologies, University of Toronto, Toronto, Canada	
<b>Improvement of Corrosion Resistance of Gray Cast Iron Components by Surfacing with Gas Metal Arc Welding .....</b>	<b>647</b>
M.Oechsner <sup>1</sup> , G. Andersohn <sup>1</sup> , J. Ellermeier <sup>1</sup> , B. Heider <sup>1</sup> , U.Reisgen <sup>2</sup> , R. Sharma <sup>2</sup> , S. Wieland <sup>2</sup> , E. Gonzalez <sup>2</sup> (1) Center for Structural Materials, State Materials Testing Institute Darmstadt (MPA), Chair and Institute for Materials Technology (IfW), Germany (2) Welding and Joining Institute ISF, RWTH Aachen University, AACHEN, Germany	
<b>Manufacture of Low-Temperature SOFC by APS Coating Technology .....</b>	<b>655</b>
Kang Yuan <sup>1,2</sup> , Yueguang Yu <sup>1,2</sup> , Xiaojuan Ji <sup>1,2</sup> , Bin Zhu <sup>3</sup> (1) BGRIMM Technology Group, Beijing 100160, China (2) Beijing Engineering Technology Research Center of Surface Strengthening and Repairing of Industry Parts, Beijing, China (3) Loughborough University, Loughborough Leicestershire LE11 3TU, UK	
<b>Plasma Sprayed Raney Nickel Coatings for Hydrogen Production by Alkaline Water Electrolysis .....</b>	<b>660</b>
T.Liu, R. Reißner, G. Schiller and A. Ansar German Aerospace Center, Stuttgart, Germany	

**Study on the Fabrication and Performance of Very Low Pressure Plasma Sprayed Large-area Porous Metal Supported Solid Oxide Fuel Cell ..... 665**

Jiu-Tao Gao, Cheng-Xin Li , Yue-Peng Wang, Shan-Lin Zhang, Guan-Jun Yang, Chang-Jiu Li  
State Key Laboratory for Mechanical Behavior of Materials, School of Materials Science and Engineering, Xi'an Jiaotong University, China

**The Design of Readable Arc Spray Alloys For Boilers Using Big Data Techniques 670**

Justin Cheney, PhD , Oerlikon Metco, San Diego, CA USA

**An Economical Approach to Cold Gas Dynamic Spraying Using In-Line Nitrogen- Helium Blending ..... 675**

D. MacDonald<sup>1</sup>, S. Rahmati<sup>1</sup>, B. Jodoin<sup>1</sup>, W. Birtch<sup>2</sup>  
(1) University of Ottawa Cold Spray Laboratory, Ottawa, ON Canada  
(2) Metal Tech & Mgmt Inc., Menomonee Falls, WI USA

**Cost-Effective Plasma Spraying for Large-Scale Applications ..... 683**

Jan Medricky, Radek Musalek, Marek Janata, Tomas Chraska, Frantisek Lukac  
Department of Materials Engineering, Institute of Plasma Physics CAS, v. v. i., Prague, Czech Republic

**Development and Investigations of Special DC-Plasma Generator "Penta" ..... 690**

Stephan Zimmermann<sup>1</sup>, Michal Szulc<sup>1</sup> and Jochen Schein<sup>1</sup>, Karin Müller-Roden<sup>2</sup>, Christian Schmengler<sup>2</sup> and Andreas Wank<sup>2</sup>, Jochen Zierhut<sup>3</sup>  
(1) University of Federal Armed Forces Munich IPM (LPT), Germany  
(2) GTV Verschleiss-Schutz GmbH, Luckenbach, Germany  
(3) Zierhut Messtechnik GmbH, Munich, Germany

**The Role of Human Factors in the Future of Thermal Spray Processing ..... 697**

Graham Crannell<sup>1</sup>, Stephen Adams<sup>1</sup>, Jianyu Su<sup>1</sup>, Maxwell Patek<sup>1</sup>, Peter A. Beling<sup>1</sup>, Ann Bolcavage<sup>2</sup>, Roy McIntyre<sup>3</sup>  
(1) University of Virginia, Charlottesville, VA, USA  
(2) Rolls-Royce Corporation, Indianapolis, IN, USA  
(3) Rolls-Royce plc., Derby, UK

**Ultrafine Powder Feeding in Cold Spray and FAPS Applications ..... 705**

Sylvain Desaulniers, Eric Bessette, Jessica Breton. Polycontrols Technologies, Brossard, Quebec, Canada

**Comparison of TiO<sub>2</sub> Targets Manufactured by APS and Sintering Processes for PAPVD Coatings Suitable in Technological and Medical Applications ..... 709**

D. Jaramillo Raquejo<sup>1</sup>, C. C. Palacio<sup>1</sup>, H. Ageorges<sup>2</sup>  
(1) Grupo GEMA, Universidad EAFIT, Medellín, Colombia  
(2) UMR CNRS, University of Limoges, Limoges, France

**Bacillus sp.-triggered Biocorrosion of Arc Sprayed Aluminum Coatings in Artificial SeaWater ..... 716**

Leila Abdoli, Yi Liu, Xiaoyan He, Hua Li Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, China

**Corrosion and Algal Behaviors of HVOF Sprayed Fe-based Amorphous Coatings for Marine Applications ..... 721**

Haijun Zhang<sup>1,2</sup>, Yongfeng Gong<sup>2</sup>, Bota Zhang<sup>3</sup>, Xiuyong Chen<sup>2</sup>, Lijia Fang<sup>1,2</sup>, Peipeng Jin<sup>1</sup>, Hua Li<sup>2</sup>

(1) Qinghai Provincial Key Laboratory of New Light Alloys, Qinghai Provincial Engineering Research Center of High Performance Light Metal Alloys and Forming, Qinghai University, China

(2) Key Laboratory of Marine Materials and Related Technologies, Key Laboratory of Marine Materials and Protective Technologies of Zhejiang Province, Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, China

(3) Cixi Institute of Biomedical Engineering, Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, China

**Evaluation of Two Repair Methods for Duplex-Coatings ..... 727**

Kirsten Bobzin<sup>1</sup>, Mehmet Öte<sup>1</sup>, Martin Andreas Knoch<sup>1</sup>, Frank Prenger<sup>2</sup>, Raphael Jantze<sup>2</sup>

(1) Surface Engineering Institute, RWTH Aachen University, Germany

(2) Grillo-Werke AG, Germany Werner Krömer Linde AG, Germany

**Flame Sprayed Environmentally Friendly High Density Polyethylene (PE)- Capsaicin Composite Coatings for Marine Antifouling Applications ..... 732**

Yi Liu, Xiaoqi Shao, Jing Huang, Hua Li

Key Laboratory of Marine Materials and Related Technologies, Zhejiang Key Laboratory of Marine Materials and Protective Technologies, Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo China

**Influence of Spray Pattern on Residual Stresses and Coating Properties of Arc-Sprayed Aluminum Bronzes Sprayed with Different Gas Mixtures ..... 736**

M.Hauer<sup>1</sup>, R. Banaschik<sup>1</sup>, W.Krömmer<sup>2</sup>, K.-M. Henkel<sup>3</sup>

(1) Fraunhofer Research Institution for Large Structures in Production Engineering IGP, Rostock, Germany

(2) Linde AG - Linde Gases Division, Unterschleißheim, Germany

(3) University of Rostock, Rostock, Germany

**Microstructural Analysis of Aluminum Coatings Deposited by HVOF Process on Complex Surfaces ..... 744**

Karen Juliana Vanat<sup>1</sup>, Ramón Sigifredo Cortés Paredes<sup>1</sup>,

Anderson Geraldo Marenda Pukasiewicz<sup>2</sup>

(1) UFPR Federal University of Paraná, Curitiba, Paraná, Brazil

(2) UTFPR Federal University of Technology - Paraná, Ponta Grossa, Paraná, Brazil

**Evaluation of High Velocity Oxy-Fuel (HVOF) Deposition Process on Erosion and Abrasion Resistance of Tungsten Carbide Coatings ..... 752**

Murilo Sérgio Lamana<sup>1</sup>, Anderson Geraldo Marenda Pukasiewicz<sup>2</sup>

(1)(2) Federal University of Technology Paraná - UTFPR, Ponta Grossa, Brazil-Pr

**Investigation into the Suitability of HVOF Nickel Based Cermets in Marine Hydraulic Service Subject to Biofouling ..... 759**

Hugo Howse<sup>1</sup>, Andrew S.M. Ang<sup>2</sup>, Scott A Wade<sup>2</sup>, Christopher C. Berndt<sup>2</sup>, Matthew Leigh<sup>3</sup>, Richard Piola<sup>4</sup>

(1) United Surface Technologies Pty Ltd, Melbourne, Australia

(2) Swinburne University of Technology, Melbourne, Australia Defence Materials Technology

Centre (DMTC), Melbourne, Australia Centre for Thermal Spray Research, Stony Brook University, NY-USA

(3) MacTaggart Scott Australia Pty Ltd, South Australia, Australia

(4) Defence Science and Technology Group, Melbourne, Australia

**Macroline® - New Solutions to Improve Abrasive Wear Resistance ..... 766**Oliver Lanz<sup>1</sup> and Andrea Scrivani<sup>2</sup>

(1) H.C. Starck Surface Technology and Ceramic Powders GmbH, Laufenburg, Germany

(2) H.C. Starck Surface Technology and Ceramic Powders GmbH, Goslar, Germany

**Wear and Corrosion Behavior of Thermally Sprayed FeCrMnBC Coatings for Pump Parts ..... 774**Matthias Oechsner<sup>1</sup>, Marius Siebers<sup>1</sup>, Georg Andersohn<sup>1</sup>, Jörg Ellermeier<sup>1</sup>, Kirsten Bobzin<sup>2</sup>, Lidong Zhao<sup>2</sup>, Mehmet Öte<sup>2</sup>, Tim Königstein<sup>2</sup>

(1) Center for Engineering Materials, State Materials Testing Institute Darmstadt (MPA) Chair and Institute for Materials Technology (IfW), Germany

(2) Surface Engineering Institute, RWTH Aachen University, Kackertstraße Aachen, Germany

**Analysis of Mechanical and Tribocorrosion Properties of Thermally Sprayed Nb<sub>2</sub>O<sub>5</sub> Coatings ..... 781**Carlos R. C. Lima<sup>1</sup>, Maria J. X. Belém<sup>1</sup>, Flávio Camargo<sup>2</sup>

(1) Methodist University of Piracicaba, Santa Bárbara d'Oeste, São Paulo, Brazil

(2) Ogramac Surface Engineering, Santo Antônio de Posse, São Paulo, Brazil

**Characterizations and Properties of Titanium Nitride Composited Coatings Deposited by Very Low Pressure Reactive Plasma-Spraying ..... 787**

Xiujuan FAN, Geoffrey Darut, Marie Pierre Planche, Hanlin Liao, Ghislain Montavon

UBFC, ICB-PMDM-LERMPS UMR6303, Belfort, France

**Fabrication of Superhydrophobic Ceramic Coatings via a Novel Solution Precursor Vacuum Plasma Spray Process ..... 792**

Pengyun Xu, Thomas W. Coyle, Javad Mostaghimi, Larry Pershin Centre for Advanced Coating Technologies, University of Toronto, Toronto, Ontario, Canada

**Influence of Spraying Parameters on the Diamond Decomposition of HVOF-sprayed Nickel-Diamond Coatings ..... 799**

W.Tillmann, A. Brinkhoff TU Dortmund University, Institute of Materials Engeneering, Germany

**Characteristics of Stainless Steel Powder of SUS316 Treated by Plasma Spheroidization using DC-Arc Plasma Spray Gun ..... 806**

Hirotomo Itagaki, Kotaro Hanada, and Shingo Hirose National Institute of Advanced Industrial Science and Technology (AIST), Advanced Manufacturing Research Institute, Tsukuba, Ibaraki, Japan

**Development of Thermal Sprayed Thin Copper Coatings ..... 811**

Satish Tailor, Ankur Modi, S. C. Modi Metallizing Equipment Company Pvt. Ltd. E-101, MIA Phase-II, Basni, Jodhpur, India

**Investigations and New Physical Behaviour of Special DC-Plasma Generator Mettech "Axial III" ..... 818**Stephan Zimmermann<sup>1</sup>, Jochen Schein<sup>1</sup>, Georg Mauer<sup>2</sup>, Karl-Heinz Rauwald<sup>2</sup>

(1) University of Federal Armed Forces Munich IPM (LPT), Germany

(2) Forschungszentrum Juelich, Germany

**Thermal Ageing Fatigue Behavior of Some Functionally Graded TBCs:  
Oxidation Failure ..... 825**

Kang Yuan<sup>1,2</sup>, Yueguang Yu<sup>1,2</sup>, Xiaojuan Ji<sup>1,2</sup>, Ru Lin Peng<sup>3</sup>

(1) BGRIMM Technology Group, China

(2) Beijing Engineering Technology Research Center of Surface Strengthening and  
Repairing of Industry Parts, China

(3) Linkoping University, Sweden