

# **12th International Symposium on Multiscale, Multifunctional and Functionally Graded Materials**

## **(FGM 2012)**

**Journal of Physics: Conference Series Volume 419**

**Beijing, China  
22 October 2012**

**Editors:**

**Zhangjian Zhou**

**ISBN: 978-1-62748-295-0  
ISSN: 1742-6588**

**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© (2012) by the Institute of Physics  
All rights reserved.

Printed by Curran Associates, Inc. (2013)

For permission requests, please contact the Institute of Physics  
at the address below.

Institute of Physics  
Dirac House, Temple Back  
Bristol BS1 6BE UK

Phone: 44 1 17 929 7481  
Fax: 44 1 17 920 0979

[techtracking@iop.org](mailto:techtracking@iop.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: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## TABLE OF CONTENTS

<b>012001 Preparation and Microstructure of Laminated ZrB<sub>2</sub>-SiC Ceramics with Porous ZrB<sub>2</sub> Interlayers .....</b>	1
<i>H Yuan, J Li, Q Shen, L Zhang</i>	
<b>012002 Fabrication of Al/Diamond Particles Functionally Graded Materials by Centrifugal Sintered-Casting Method .....</b>	7
<i>Y Watanabe, M Shibuya, H Sato</i>	
<b>012003 Design, Manufacturing and Characterization of Functionally Graded Flextensional Piezoelectric Actuators .....</b>	11
<i>R C R Amigo, S L Vatanabe, E C N Silva</i>	
<b>012004 Functionally Graded Dual-Nanoparticulate-Reinforced Aluminum Matrix Composite Materials .....</b>	15
<i>H Kwon, G-G Lee, M Leparoux, A Kawasaki</i>	
<b>012005 Dynamics of Nonhomogeneous Carbon Steel Plates .....</b>	19
<i>J-H Kim, L Zhang, R Hebert, J T Wright, A Shukla</i>	
<b>012006 Cold Spray and Pressureless Sintering of Zirconium Phosphate Bonded Silicon Nitride Ceramics with Porous Gradient Structure .....</b>	27
<i>F Chen, F Li, Q Shen, L Zhang</i>	
<b>012007 Effective Thermoelastic Moduli of FGMs with Temperature-dependent Constituents and Initial Eigenstrains .....</b>	33
<i>D Boussaa</i>	
<b>012008 Precipitation Phases at Different Processes and Heat Treatments As Well As Their Effects on the Mechanical Properties of Super-austenitic Stainless Steel .....</b>	37
<i>H Sun, Z Zhou, M Wang, S Li, L Zhang, L Zou</i>	
<b>012009 The Fabrication and Characterization of Polymeric Microcellular Foams with Designed Gradient Density .....</b>	46
<i>Q Shen, Y Xiong, H Yuan, G Luo, X Liang, L Zhang</i>	
<b>012010 Fabrication of Al-W Functionally Graded Impact Material via Vacuum Hot-Pressing Sintering Method .....</b>	51
<i>P Chen, G Luo, Y Liu, Q Shen, L Zhang</i>	
<b>012011 Molecular Dynamic Simulation of Failure of Ettringite .....</b>	55
<i>W Sun, D Wang, L Wang</i>	
<b>012012 Preparation and Properties of ATO Films and Their Effects on the TiO<sub>2</sub>/ATO System .....</b>	61
<i>J A Galaviz-Pérez, F Chen, J R V García, Q Shen, L Zhang</i>	
<b>012013 High-temperature Oxidation Behavior of ZrO<sub>2</sub>-ZrSiO<sub>4</sub>/NiCr Composites and Its Applicability for Functionally Graded Materials .....</b>	65
<i>K Wu, A Rosin, H Park, M Willert-Porada</i>	
<b>012014 Microstructure Deformation and Fracture Mechanism of Highly Filled Polymer Composites under Large Tensile Deformation .....</b>	75
<i>Z J Tao, S D Ping, Z Mei, Z P Cheng</i>	
<b>012015 Fracture Analysis of a Viscoelastic Functionally Graded Materials Strip with a Central Crack .....</b>	82
<i>Z H Wang, L Zhang, L C Guo</i>	
<b>012016 The Influencing Mechanism of Modification Layer on the Performance of SiC<sub>3</sub>D/Al Multi-function Gradient Composite .....</b>	86
<i>B Li, Z Ma, Y Wang, F Wang</i>	
<b>012017 Preparation and Characterization of PMMA Graded Microporous Foams Via One-step Supercritical Carbon Dioxide Foaming .....</b>	92
<i>H Yuan, J Li, Y Xiong, G Luo, Q Shen, L Zhang</i>	
<b>012018 Fabrication of W/Cu FGM By Aqueous Tape Casting .....</b>	97
<i>S Liu, Q Shen, G Luo, M Li, L Zhang</i>	
<b>012019 Influence of Al<sub>2</sub>O<sub>3</sub>/YSZ Micro-laminated Coatings on High Temperature Oxidation and Spallation Resistance of MCrAlY Alloys .....</b>	102
<i>J Yao, Y He, D Wang</i>	
<b>012020 Numerical Simulation in Relation to Adiabatic Shearing Behaviors in Titanium Alloy .....</b>	110
<i>R Gao, Q Fan, F Wang</i>	
<b>012021 Microstructural Characterization of the Mg/Cu/Al Diffusion Bonded Joint .....</b>	117
<i>J Zhang, Q Shen, G Luo, Y Wang, M Li, L Zhang</i>	

<b>012022 Study for Double-layered AZO/ATO Transparent Conducting Thin Film .....</b>	121
<i>M Cao, Y Li, J Yang, Y Chen</i>	
<b>012023 Microstructure of Diffusion-Bonded Mg-Ag-Al Multilayer Composite Materials.....</b>	128
<i>Y Wang, G Luo, J Zhang, Q Shen, L Zhang</i>	
<b>012024 Modeling the Dynamic Damage Process of the SiC<sub>3</sub>D/Al Interpenetrating Phase Composites.....</b>	132
<i>G Li, Q Fan, Z Wu, X Zhang, Y Wang, F Wang</i>	
<b>012025 Mechanical Properties of Tantalum-tungsten Interlayer Between Tungsten Tile and Thimble to Prevent Helium Leak from He-cooled Divertor.....</b>	138
<i>P Zhang, W Shen, Y Zhou, Q Zhang</i>	
<b>012026 The Influence of ALN-Al Gradient Material Gradient Index on Ballistic Performance .....</b>	145
<i>Y Wang, Q Liu, Y Li, Q Shen</i>	
<b>012027 Layered Composite of TiC-TiB<sub>2</sub> to Ti-6Al-4V in Graded Composition by Combustion Synthesis in High-gravity Field.....</b>	150
<i>X Huang, Z Zhao, L Zhang</i>	
<b>012028 Microstructure and Properties of (Ti, Al) N Coatings on WC-Co Cemented Carbide .....</b>	158
<i>Y Li, Z Liu, J Yang, Y Chen</i>	
<b>012029 Fabrication and Mechanical Properties of a 14Cr-ODS Steel.....</b>	165
<i>H Hu, Z Zhou, L Liao, M Wang, S Li</i>	
<b>012030 Preparation and Oxidation of ZrB<sub>2</sub>/SiC/Zr<sub>2</sub>Al<sub>4</sub>C<sub>5</sub> Multi-phase Ceramics with Spark Plasma Sintering .....</b>	170
<i>Q Guo, J Li, Z Ma, Y Nie, Q Shen, L Zhang</i>	
<b>012031 Fabrication and Characterization of Multiscale Graded SMAT-MAO Composite Coating Formed on the Surface of 2024 Al Alloy .....</b>	175
<i>L Wen, Y Wang, Y Jin, D Sun</i>	
<b>012032 Fabrication of ATO/Graphene Multi-layered Transparent Conducting Thin Films.....</b>	183
<i>N Li, F Chen, Q Shen, C Wang, L Zhang</i>	
<b>012033 Study on the Preparation and Properties of Colored Iron Oxide Thin Films.....</b>	188
<i>X Zhao, C Li, Q Liu, Y Duan, J He, S Liu, H Wang, S Liang</i>	
<b>012034 Discrete Element Analysis of Sedimentary Body Density of Functionally Graded Materials Derived from Particle Co-Sedimentation.....</b>	197
<i>J Ye, G Luo, A Yang, Q Shen, L Zhang</i>	
<b>012035 Structure and Nanomechanical Properties of Al<sub>1-x</sub>Sc<sub>x</sub>N Thin Films .....</b>	205
<i>J Yang, Y Li, M Cao, Y Chen</i>	
<b>012036 Microstructure and Mechanical Properties of 16 Cr-ODS Ferritic Steel for Advanced Nuclear Energy System.....</b>	211
<i>S Li, Z Zhou, M Wang, H Hu, L Zou, G Zhang, L Zhang</i>	
<b>012037 Effect of Strain Rate on the Plastic Strain Gradient Beneath the Deformed Surface of Iron .....</b>	218
<i>X Zhang, K Matsuura, M Ohno</i>	
<b>012038 Thermal-mechanical Analysis on W/CuCrZr Plasma Facing Component with Functionally Graded Material Interlayer .....</b>	222
<i>D H Zhu, J L Chen, Z J Zhou, R Yan</i>	
<b>012039 Development of Thermal Spraying and Coating Techniques by Using Thixotropic Slurries Including Metals and Ceramics Particles .....</b>	229
<i>S Kirihara, Y Itakura, S Tasaki</i>	
<b>012040 Study on Cd Vacancy in CdZnTe Crystal by Positron Annihilation Technology .....</b>	233
<i>W Liu, J Min, X Liang, J Zhang, X Sun, L Wang, A Ran, B Ye</i>	
<b>012041 Thermal Residual Stresses in SiC Particle Reinforced Aluminium Composites: A Study by the Taylor-based Nonlocal Theory of Plasticity .....</b>	239
<i>D F Cao, X Liu, H Mei, Z T Lei, L S Liu</i>	
<b>012042 Effect of Particle Shapes on Effective Strain Gradient of SiC Particle Reinforced Aluminum Composites .....</b>	247
<i>X Liu, D F Cao, H Mei, Z T Lei, L S Liu</i>	
<b>012043 The Application of Ti/Al<sub>2</sub>O<sub>3</sub> Composite in W-Mo-Al System Wave Impedance Graded Flier-plate .....</b>	254
<i>Z Wang, S Feng, G P Shi, Q Shen, L M Zhang</i>	
<b>012044 Numerical Simulation of the Dynamic Performance of the Ceramic Material Affected by Different Strain Rate and Porosity.....</b>	259
<i>Z Wang, L S Liu, H Mei, X Lai, P C Zhai, D F Cao</i>	
<b>012045 Multiscale Numerical Simulation of the Shaped Charge Jet Generated from Tungsten-Copper Powder Liner .....</b>	268
<i>J Liu, H Cai, F Wang, Q Fan</i>	

<b>012046 A Study on Propagation Characteristic of One-dimensional Stress Wave in Functionally Graded Armor Composites.....</b>	276
<i>S Y Yang, X Liu, D F Cao, H Mei, Z T Lei, L S Liu</i>	
<b>012047 Synthesis and Characterization of Dopamine Graft Compound N-methacryloyl 3,4-dihydroxyl-phenylamine .....</b>	282
<i>X Xiong, S Qu, Y Liu</i>	
<b>012048 Functionally Graded Materials using Plasma Spray with Nano Structured Ceramic .....</b>	289
<i>E L Sioh, A I Y Tok</i>	
<b>012049 Analysis of Mechanical Properties of Nanocrystalline Al+<math>\alpha</math>-Al<sub>2</sub>O<sub>3</sub> Composites Using Molecular Dynamics Simulation .....</b>	298
<i>H Mei, L S Liu, X Lai, P C Zhai</i>	
<b>012050 Ceramic/Metal Composites with Positive Temperature Dependence of Thermal Conductivity.....</b>	306
<i>J Li, Q Yu, W Sun, R Zhang, D Ichigozaki, K Wang, J-F Li</i>	
<b>012051 Thermal Stress Analysis of W/Cu Functionally Graded Materials by Using Finite Element Method.....</b>	312
<i>Z Yang, M Liu, C Deng, X Zhang, C Deng</i>	
<b>012052 Processing and Structure of a Nitrogen Alloyed Oxide Dispersion Strengthened Austenitic Stainless Steel by Mechanical Alloying .....</b>	318
<i>Y Xu, Z Zhou</i>	
<b>012053 Dielectric Propertiies of the Compositionally Graded BaZr<sub>x</sub>Ti<sub>2-x</sub>O<sub>5</sub> Thin Films Prepared by Sol-gel Method .....</b>	324
<i>Y P Gong, D Y Guo, C B Wang, Q Shen, L M Zhang</i>	
<b>012054 Numerical Investigation on Anti-penetration Behavior of Ceramic/Metal Target Under Ballistic Impact .....</b>	328
<i>H Mei, Y C Wang, X Liu, D F Cao, L S Liu</i>	
<b>012055 Stress Wave Attenuation in SiC<sub>3</sub>P/Al Composite.....</b>	334
<i>C Yuan, Y Wang, G Li, X Zhang, J Gao</i>	
<b>012056 The Photocatalytic Activity of Nano-TiO<sub>2</sub> (anatase) Gradient Coating on Tourmaline Beads .....</b>	340
<i>F Huang, Y Fan, J Sun</i>	
<b>012057 Research on Self-propagating High Temperature Synthesis Prepared ZrC-ZrB<sub>2</sub> Composite Ceramic .....</b>	345
<i>Y Cheng, X Su, G Hou, Y Xing</i>	
<b>Author Index</b>	