24th Annual Conference on Composites, Advanced Ceramics, Materials, and Structures: B

Todd Jessen
Ersan Ustundag
Editors

January 23–28, 2000
Cocoa Beach, Florida

Published by
The American Ceramic Society
735 Ceramic Place
Westerville, OH 43081

© 2000 The American Ceramic Society
ISSN 0196-6219
24th Annual Conference on Composites, Advanced Ceramics, Materials, and Structures: B
CERAMIC ENGINEERING & SCIENCE PROCEEDINGS

W. Paul Holbrook, Executive Director
Mark Mecklenborg, Senior Director, Publications
Mary J. Cassells, Product Manager, Books
Sarah Godby, Developmental Editor, Books
Jennifer Brewer, Marketing Assistant, Books
Cleopatra G. Eddie, Circulation Supervisor
John Wilson, Publications Production Manager
Carl Turner, Production Coordinator, Graphics

Committee on Publications

John Blendell, chair
John Petrovic
Richard Riman
Leslie Struble

John Hellmann, ex officio
J. Richard Schorr, ex officio
W. Paul Holbrook, ex officio
Mark Mecklenborg, ex officio

Editorial and Subscription Offices:

2000 SUBSCRIPTION OPTIONS

<table>
<thead>
<tr>
<th>OPTION 1:</th>
<th>ACerS Member</th>
<th>List/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete, five-issue set</td>
<td>North America: $143</td>
<td>$195</td>
</tr>
<tr>
<td></td>
<td>International: $183</td>
<td>$235</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTION 2:</th>
<th>ACerS Member</th>
<th>List/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose any two issues</td>
<td>North America: $83</td>
<td>$103</td>
</tr>
<tr>
<td></td>
<td>International: $99</td>
<td>$119</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OPTION 3:</th>
<th>ACerS Member</th>
<th>List/Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose any three issues</td>
<td>North America: $110</td>
<td>$137</td>
</tr>
<tr>
<td></td>
<td>International: $137</td>
<td>$161</td>
</tr>
</tbody>
</table>

Libraries may call for package pricing. Single copies are $48 for members and $60 for nonmembers, plus postage and handling. Published five times a year. Printed in the United States of America. POSTMASTER: Please send address changes to Ceramic Engineering and Science Proceedings, PO Box 6136, Westerville, OH, 43086-6136. Periodical postage paid at Westerville, OH, and additional mailing offices. Allow six weeks for address changes.

CESPDK Vol. 21, No. 4, 2000

The American Ceramic Society assumes no responsibility for the statements and opinions advanced by the contributors to its publications or by the speakers at its programs.

Each issue of Ceramic Engineering and Science Proceedings, ISSN 0196-6219, includes a collection of technical articles in a general area of interest. These articles are of practical value for the ceramic industries and the general public. The issues are based on the proceedings of a conference. Both American Ceramic Society and non-Society conferences provide these technical articles. Each issue is organized by an editor who selects and edits material from the conference proceedings. The opinions expressed are entirely those of the presenters. There is no other review prior to publication.
Contents
24th Annual Conference on Composites, Advanced Ceramics, Materials, and Structures: B

Preface ...................................... .xv

ADVANCED SYNTHESIS and PROCESSING

Materials Synthesis
Synthesis of Single Phase (Ba,Sr)TiO₃ by a Reactive Process . . . .3
S. Bhaduri, W.A. Prisbrey, J.B. Jokisaari, and S.B. Bhaduri

Fabrication of Ceramic/Epoxy Crystals by Stereolithography . . . .13
S. Kirihara, Y. Miyamoto, and K. Kajiyama

Unidirectionally Porous Oxides Prepared Using Eutectic Reactions ..................19
Y. Suzuki, T. Yamada, S. Sakakibara, and T. Ohji

Plasma Jet Generation over the Liquid Surface and Its Application to Diamond Synthesis ................. .25
T. Suzuki and S. Wada

Synthesis and Characterization of Fine-Grained 3Y-TZP/Hexaferrite In Situ Composites ..................31
Y. Suzuki, M. Awano, N. Kondo, and T. Ohji

Environment Conscious Ceramics (Ecoceramics) ................. .39
M. Singh

Materials Processing
Suspension of SiC Powders in Allyhydridopolycarbosilane (AHPCS): Control of Rheology ..................45
F.I. Horwitz
Solid Freeform Fabrication of Advanced Ceramics ..............135
C. Gasdaska, V. Jamalabad, M. Ortiz, B. Mitlin, and D. Twait

Solid Freeform Fabrication of a Telescoping Actuator via Laminated Object Manufacturing .................143
B.A. Bender, R.J. Rayne, and C.C. Wu

Solid Freeform Fabrication of Intermetallics and Their Ceramic Composites by Reactive Rapid Prototyping ... 151
K. Matsuura, M. Kudoh, S. Kirihara, and Y. Miyamoto

Design Tools for Multi-Material Layered Manufacturing System ...........................................................159
N.A. Langrana, D. Qui, W. Han, M.A. Jafari, S.C. Danforth, and A. Safari

Wear Resistant Coatings

The Influence of Substrate Microstructure on the Crack Formation of CrN Coatings on Brass .............167
S. Krishnamurthy and I.E. Reimanis

Environmentally Benign Ceramic Composite Coatings with Advanced Tribological Properties ...........177
D.F. Scherer, R. Gadow, and A. Killinge

Reactive Coating of SiC on Diamond Particles ..............185
Y. Miyamoto, J. Lin, Y. Yamashita, T. Kashiwagi, O. Yamaguchi, H. Moriguchi, and A. Ikegaya

Determination of Strength of Double-Layer Brittle Coatings on Metallic Substrates by Four-Point Bend Test ...193
O. Unal and D.J. Sordelet

Interface Debond Coatings: Oxide

Monazite and Scheelite Deformation Mechanisms ..............203
R.S. Hay

Porous Rare-Earth Aluminate Fiber Coatings for Oxide-Oxide Composites .......................................219
M.K. Cinibulk, T.A. Parthasarathy, K.A. Keller, and T. Mah
Monazite Coatings on Nextel 720™, 610™, and Tyranno-SA Fiber Tows: Effect of Precursors on Fiber Strength ............. 229
E.E. Boakye, M.D. Petry, R.S. Hay, L.M. Douglas

Mg-Si-Al-O Coatings on Hi-Nicalon SiC Fiber by Alkoxide Method ................................................................. 237
N. Igawa, T. Taguchi, R. Yamada, and S. Jitsukawa

Effects of Mullite/YSZ Coatings on the Performance of SiC/SiC Composite Combustion Liners ...................... 243

Surface Characterization of Plasma Sprayed Hydroxyapatite Coatings ......................................................... 251
L. Sun, C.C. Berndt, A. Kucuk, R.S. Lima, and K.A. Khor

Interface Debond Coatings: Non-oxide

Effect of Multiple Coating Interfacial Structures on Bending Properties of FCVI SiC/SiC Composites .............. 259

BN and SiBN Fiber Coatings via CVD Using a Single-Source Liquid Precursor Based on Borazine .................. 267
F.I. Horwitz, D.R. Wheeler, P.V. Chayka, C. Xu, T.R. McCue, and Y.L. Chen

Silicon Carbide Fibers with Boron Nitride Coatings ........... 275
M.D. Sacks and J.J. Brennan

Optimization of New Precursor Systems for Continuous Fluid Carbon Fiber Coating .............................. 283
N. Doslik, R. Fischer, and R. Gadow

Fiber/Whisker Synthesis and Characterization

Fabrication and Mechanical Properties of Si-M-C-(0) Tyranno Fibers .......................................................... 291
MONOLITHIC STRUCTURAL MATERIALS

Oxide Based Ceramics

Mechanical Behavior

Environmental Effects on Crack Propagation of Alumina Ceramics ...........................................385
M.E. Ebrahimi, J. Chevalier, and G. Fantozzi

Strengths and Deformation of Single Crystal Oxides at Ambient and Elevated Temperatures for Refractive Solar Concentrator Applications ........................................397
S.R. Choi, D. Zhu, and R.A. Miller

Electrokinetic Aspect of Friction and Wear of Oxide Ceramics ................................................407
S. Novak and J. Vizintin

Processing and Structure

Conformation of Honey-Rod ....................................415
M. Rodriguez, E. Rocha, and R.T. Hernandez

Transparent MgAl$_2$O$_4$ Spinel-Revisited ..................423
M.C.L. Patterson, J.E. Caiazza, G. Glide, and D.W. Roy

Processing of Bone Ash Based Dental Implant Material with Zirconia Addition ..........................431
R. Artir; Y. Karakas, and C. Bindal

The Effects of Waste Loading on the Durability of Nuclear Waste Glasses ...................................439
G. Darby, D.E. Clark, and G. Wicks

Glass-Ceramics in the System
Ca$_5$[PO$_4$)$_3$F-CaAl$_2$Si$_2$O$_8$-CaMgSi$_2$O$_6$ ..........................447
D. Tulyaganov

Martensitic Transformation of Y$_2$Al$_2$O$_9$ .......................455
M. Shimada, H. Yamane, and B.A. Hunter
Microstructure Control of Alumina Ceramics .......................... 461
S. lio, H. Yamamoto, and T. Mitsuoka

On The Mechanism of MoSi₂ Pesting in the
Temperature Range 400–500°C .............................. 469

An Investigation of the Microstructure in the Pest
Oxide of a MoSi₂-Based Composite ......................... 477

Non-Oxide Based Ceramics

Mechanical Behavior

Gelcast AS800 Materials Characterization for
Rocket Engine Applications .............................. 485
S.R. Khoshbin

Intermediate Temperature Inert Strength
and Dynamic Fatigue of Candidate Silicon Nitrides
for Diesel Exhaust Valves .............................. 497
A.A. Wereszczak, T.P. Kirkland, H.T. Lin, and S.K. Lee

Superplastically Sinter-Forged Silicon Nitride ............... 509
N. Kondo, Y. Suzuki, and T. Ohji

Creep Resistant Silicon Nitride Ceramics—Approaches
of Microstructural Design .............................. 515
A. Rendtel and H. Hubner

Testing and Finite Element Analysis of Sintered
Silicon Nitride Specimens under Four-Point Bending .... 527

Effect of Heat-Treatment on Creep Behavior of a
Self-Reinforced Silicon Nitride ......................... 537
Q. Wei, J. Sankar, and J. Narayan
Material Design to Improve Wear Resistance of Silicon Nitride with CVD Coatings ........................................... 545
PK. Mehrotra

Environmental Effects on the Mechanical Properties of SiC-Based Hot Gas Cleaning Filters .......................... 553
PH. Pastila, A.P. Nikkila, and T.A. Mantyla

Corrosion of Ceramic Filters for Hot Cleaning in Thermal Power Plants ........................................................ 561
L. Montanaro, A. Negro, O. Frantz, P. Billard, and R. Rezakhanlou

Tribochemical Wear of Boron Carbide in Sliding Contacts ... 569
P. Larsson and N. Axen

Processing and Structure

Preceramic-Modified Reaction-Bonded Silicon Nitride (PM-RBSN): Processing and Properties with Focus on Long-Term High-Temperature Stability ........................................ 575
G. Wotting, A. Herzog, and L. Schonfelder

Shaping SRBSN Parts by a Closed-Mold Casting Method ... 583
G.M. Crosbie and G.T. Bretz

Joining of Non-Oxide Ceramics Using Conventional and Microwave Heating .............................................. 589
J.G. Lee and E.D. Case

Microwave Sintering at High Temperature .............................................. 599
H.E. Huey, Q.S. Wang, M.S. Morrow, and D.E. Schechter

Processing and Mechanical Properties of Silicon Nitride Formed by Robocasting Aqueous Slurries .............. 607
G. He, D.A. Hirschfeld, and J. Cesarano III

Influence of Boron and Carbon on the Oxidation of Sintered Silicon Carbide at 1500°C .............................. 615
C. Schumacher and K.G. Nickel
Thermal Barrier Coatings

Thermophysical and Thermomechanical Properties of Thermal Barrier Coatings Systems ............... 623
D. Zhu and R.A. Miller

Thermal Fatigue Testing of Layer-Graded Thick Thermal Barrier Coating Systems ......................... 635

Microstructure, Mechanical, and Thermal Properties of Undirectionally Aligned Silicon Nitride .......... 645

Deformation and Strength Behavior of Plasma-Sprayed ZrO₂-8wt% Y₂O₃ Thermal Barrier Coatings in Biaxial Flexure and Trans-Thickness Tension ......................... 653
S.R. Choi, D. Zhu, and R.A. Miller

Residual Stress Characterization of Thermal Barrier Coatings—Comparison of Thermally Sprayed, EB-PVD, and CVD Based Coatings ...................................................... 663
M. Buchmann, C. Friedrich, and R. Gadow

Rapid, Cost-Effective Silicon Carbide Optical Component Manufacturing Technique ........................... 671

Deformation Characteristics of Plasma Sprayed Thermal Barrier Coatings ........................................ 681

Improvement of High-Temperature Corrosion Resistance of Carbon by Ceramic Oxide Coats .............. 691
N. Bahlawane and T. Watanabe