

FOCUS ISSUE

Achieving Superior Ceramics and Coating **Properties through Innovative Processing**



MATERIALS RESEARCH SOCIETY® Advancing materials. Improving the quality of life.

CAMBRIDGE UNIVERSITY PRESS

Journal of MATERIALS RESEARCH

JOURNAL OF MATERIALS RESEARCH (JMR) is an interdisciplinary journal serving the materials research community through publication of original research articles and invited reviews encompassing the synthesis, processing, characterization, properties, and theoretical description of materials.

JMR publishes new research that demonstrates a significant impact or advance of scientific understanding of interest to the materials research community. Engineering studies and applications to commercial products are beyond the scope of *JMR* and should be submitted elsewhere. Manuscripts that report data without giving an analysis, interpretation, or discussion are only acceptable if the data are sufficiently important that publication is expected to lead to significant new studies or advancements in science or technology.

Manuscripts must be submitted to the *Journal of Materials Research* electronically via ScholarOne manuscripts, at the following website address: http://mc.manuscriptcentral.com/jmr. Electronic submission expedites the review process and also allows authors to track the status of their manuscripts at any time. Complete instructions are available on the ScholarOne site and authors will be prompted to provide all necessary information.

Manuscripts must be prepared in English, using a word processing program, formatted to fit 8½ ×11 in. paper, and saved as .doc, .pdf, .rtf, or .ps files. Separate graphics files (.eps and .tif) must be uploaded for each figure. Authors may also upload .xls or .ppt supplemental files as part of the manuscript submission process. All of these files will be converted to .pdf format. Detailed instructions are available on the submission web site. During submission, authors must enter all coauthor names and e-mail addresses. Manuscripts will not be considered for peer review until this information is provided. Authors must also enter manuscript keywords using the *JMR* keyword list (located on the submission web site). Authors who are not fluent in English must have their manuscript dited for correct English grammar and sentence structure before submission.

Authors are expected to follow the conventional writing, notation, and illustration style prescribed in *Scientific Style and Format: the CSE Manual for Authors, Editors and Publishers, 7th edition, 2006.* Authors should also study the form and style of printed material in this journal. SI units should be used. Authors should use an identical format for their names in all publications to facilitate use of citations and author indexes.

Manuscripts are accepted with the understanding that they represent original research, except for review articles, and that they have not been copyrighted, published, or submitted for publication elsewhere. Authors submitting manuscripts to *JMR* who have related material under consideration or in press elsewhere should send a copy of the related material to *JMR* at the time of submission. While their manuscripts are under consideration at *JMR*, authors must disclose any such related material. To expedite the review process, authors may provide names and contact information for up to four possible reviewers.

Articles are original research reports that include complete, detailed, self-contained descriptions of research efforts. All articles must contain an abstract and section headings.

Commentaries and Reviews: *Journal of Materials Research* occasionally publishes commentaries on topics of current interest or reviews of the literature in a given area. If an author proposes a review, the title, abstract, and a brief outline should be submitted to the Editorial Office via e-mail for prior consultation on the appropriateness of the topic.

Color policy: It is not necessary for authors to indicate that a figure should be displayed in color online. *JMR* will assume that any author who submits figures in color wants and agrees to their being produced in color online. Figures may be printed in color at the author's request for an additional charge. Color figures must be submitted before the paper is accepted for publication, and cannot be received later in the process. Authors cannot submit two versions of the same figure, one for color and one for black and white; only one version can be submitted. Authors need to carefully consider the following when submitting figures in color that will

be published in color online only: 1) The colors chosen must reproduce effectively and the colors should be distinguishable when printed in black and white; 2) The descriptions of figures in text and captions must be sufficiently clear for both online and print copy. When submitting figures to be in color online only, authors should include the phrase <<color online>> in the figure captions. This is the author's responsibility. Authors will see these color figures when viewing their author page proofs on screen. Authors should always print their page proofs in black and white to see how they will appear in print. Authors will NOT be allowed to submit color figures to replace black and white figures in the page proof stage. To maximize the probability that figures will be published in color online and also print as good quality black and white or grayscale graphics, authors are encouraged to follow these figure submission guidelines: 1) Submit a color graphic in Tagged Image File Format (.tif); 2) Submit color graphics with a resolution of at least 300 dpi (600 dpi if there is text or line art in the figure); 3) Submit color graphics in CMYK format; 4) Submit figures sized to fit the actual column or page width of the journal so that reduction or enlargement is not necessary; 5) Submit multipart figures in one single electronic file.

Copyright © 2017, Materials Research Society. All rights reserved. No part of this publication may be reproduced, in any form or by any means, electronic, photocopying, or otherwise, without permission in writing from Cambridge University Press. Policies, request forms and contacts are available at: http://www.cambridge.org/rights/permissions/permission. htm. Permission to copy (for users in the USA) is available from Copyright Clearance Center at: http://www.copyright.com, email: info@ copyright.com.

Journal of Materials Research Subscription Prices (2017) [includes on-line web access] USA and Online Poss. Non-US Only

	Poss.	Non-US	Only
MRS Regular and Student			
Members	\$273.00	\$334.00	\$105.00
Institutions	\$2053.00	\$2053.00	\$1852.00

Journal of Materials Research (ISSN: 0884-2914) is published twenty-four times a year by Cambridge University Press, One Liberty Plaza, 20th Floor, New York, NY 10006 for the Materials Research Society. Periodical Postage Paid in New York, NY and additional mailing offices. **POSTMASTER:** Send address changes to Journal of Materials Research, c/o Journals Dept., Cambridge University Press, One Liberty Plaza, 20th Floor, New York, NY 10006, USA.

Subscriptions, renewals, address changes, and single-copy orders should be addressed to Subscription Fulfillment, *Journal of Materials Research*, Cambridge University Press, One Liberty Plaza, 20th Floor, New York, NY 10006, USA (for USA, Canada, and Mexico); or Cambridge University Press, University Printing House, Shaftesbury Road, Cambridge, CB2 8BS, England (for UK and elsewhere). Allow at least six weeks advance notice. For address changes, please send both old and new addresses and, if possible, include a mailing label from a recent issue. Requests from subscribers for missing journal issues will be honored without charge only if received within six months of the issue's actual date of publication; otherwise, the issue may be purchased at the single-copy price.

Reprints of individual articles in *Journal of Materials Research* may be ordered. For information on reprints, please contact Cambridge University Press. Reprints of complete back issues older than the prior volume year may be ordered on an individual basis via the Cambridge Journals Online website. To determine availability, visit the appropriate page for the *JMR* back issue desired (cambridge.org/journal-of-materials-research).

Individual member subscriptions are for personal use only.

Journal of MATERIALS RESEARCH

Editor-in-Chief: Gary L. Messing, *Ceramic materials, The Pennsylvania State University, USA* Associate Editor, Susmita Bose, *Biomaterials, Washington State University, USA* Associate Editor, Jürgen Eckert, *Metallic materials, Montanuniversität Leoben, Austria* Associate Editor, Linda S. Schadler, *Polymeric materials, Rensselaer Polytechnic Institute, USA*

Guest Editors for Focus Issue: Achieving Superior Ceramics and Coating Properties Through Innovative Processing

Eugene Medvedovski, Endurance Technologies Inc., Canada Nahum Travitzky, Erlangen-Nurnberg University, Germany Xiaowei Yin, Northwestern Polytechnical University, P.R. China

2017 Principal Editors:

Amit Bandyopadhyay, Hard biomaterials, Additive manufacturing, Washington State University, USA

- Jinju Chen, Soft materials/thin films, Nanoindentation, Newcastle University, United Kingdom Xiaobo Chen, Photocatalysis and batteries,
- University of Missouri-Kansas City, USA
- Yang-T. Cheng, Mechanical behavior, Electrochemical energy storage, University of Kentucky, USA
- Sung-Yoon Chung, Energy, Electron microscopy, Interface science, KAIST, Korea

Paolo Colombo, Preceramic polymers, Porous ceramics, University of Padova, Italy; The Pennsylvania State University, USA

Franz Faupel, Functional nanomaterials, VPD, Metallic glasses, University of Kiel, Germany

Mathias Göken, Superalloys, Nanomaterials, Nanomechanics, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Amit Goyal, Superconductors, Photovoltaics, 2D materials, Self-assembly, State University of New York at Buffalo, USA

- Erik G. Herbert, Nanoindentation, Small-scale mechanical behavior Michigan Technological University, USA
- Himanshu Jain, Inorganic glass, Optical, Electrical properties, Lehigh University, USA
- C. Robert Kao, Metallic materials, Diffusion and joining, National Taiwan University, Taiwan
- Edson Roberto Leite, Materials chemistry, Nanocrystals, Synthesis, Universidade Federal de São Carlos, Brazil
- Jörg Löffler, Metallic materials/synthesis and properties, ETH Zurich, Switzerland

Michele Manuel, Phase transformations, Materials design, University of Florida, USA

Michael E. McHenry, Magnetic materials, Carnegie Mellon University, USA

Scott T. Misture, In-situ diffraction, Electrochemically active ceramics, Alfred University, USA Sarah E. Morgan, Polymer surfaces and interfaces, The University of Southern Mississippi, USA

Paul Muralt, Thin films, Piezoelectric and ferroelectric materials, Ecole Polytechnique Federale de Lausanne, Switzerland

Lakshmi S. Nair, Biomaterials, Tissue regeneration, Drug delivery, University of Connecticut, USA

Akira Nakajima, Photocatalysis, Surface wettability, Ceramic processing, Tokyo Institute of Technology, Japan

Cewen Nan, Ferroelectric, Multiferroic materials, Tsinghua University, China

George M. Pharr, Mechanical behavior, Nanoindentation, Texas A&M University, USA

Ian M. Reaney, Electroceramics, TEM, Thin films, The University of Sheffield, United Kingdom

Edward M. Sabolsky, Electroceramics, Electrochemistry, Processing, West Virginia University, USA

Winston Schoenfeld, Optical materials, University of Central Florida, USA

Don W. Shaw, Epitaxy, Vapor deposition, Semiconductors, The University of Texas at Dallas, USA

Susan B. Sinnott, Computational materials science, The Pennsylvania State University, USA

Terry M. Tritt, *Thermoelectrics, Clemson University, USA*

- Chongmin Wang, Energy storage, Microscopy, In-situ/operando technique, Pacific Northwest National Laboratory, USA
- William J. Weber, Radiation effects, Nuclear ceramics, University of Tennessee; Oak Ridge National Laboratory, USA

Sam Zhang, Thin films/coatings, Nanyang Technological University, Singapore

Yanchun Zhou, Structural ceramics, Electronic structure, Aerospace Research Institute of Materials and Processing Technology, China

Editorial Office: Ellen W. Kracht, Publications Manager, Materials Research Society, Warrendale, PA Linda A. Baker, JMR Editorial Assistant, Materials Research Society, Warrendale, PA Kirby L. Morris, JMR Production Assistant, Materials Research Society, Warrendale, PA Eileen M. Kiley, Director of Communications, Materials Research Society, Warrendale, PA

Journal of MATERIALS RESEARCH

Volume 32, Number 17, September 14, 2017

ACHIEVING SUPERIOR CERAMICS AND COATING PROPERTIES THROUGH INNOVATIVE PROCESSING

3203–3204	Introduction	Eugene Medvedovski, Nahum Travitzky, Xiaowei Yin
INVITED REV	IEWS	
3205–3218	Cold sintering: Current status and prospects	Jon-Paul Maria, Xiaoyu Kang, Richard D. Floyd, Elizabeth C. Dickey, Hanzheng Guo, Jing Guo, Amanda Baker, Shuichi Funihashi, Clive A. Randall
3219–3241	Texture-engineered ceramics—Property enhancements through crystallographic tailoring	Gary L. Messing, Stephen Poterala, Yunfei Chang, Tobias Frueh, Elizabeth R. Kupp, Beecher H. Watson III, Rebecca L. Walton, Michael J. Brova, Anna-Katharina Hofer, Raul Bermejo, Richard J. Meyer Jr
INVITED ART	ICLES	
3242–3250	Liquid–liquid extraction of oxide particles and application in supercapacitors	Ri Chen, Mustafa S. Ata, Xinya Zhao, Ishwar Puri, Igor Zhitomirsky
3251–3259	High-porosity geopolymer foams with tailored porosity for thermal insulation and wastewater treatment	Chengying Bai, Giorgia Franchin, Hamada Elsayed, Alessandro Zaggia, Lino Conte, Hongqiang Li, Paolo Colombo
3260–3270	Processing of biphasic calcium phosphate ceramics for culturing of bone marrow stem cells	Qinghao Zhang, Qi Jiapeng, Wenfu Wang, Ian Nettleship
3271–3278	Microwave-assisted synthesis of Nb_2O_5 for photocatalytic application of nanopowders and thin films	Gilberto Falk, Mario Borlaf, María José López-Muñoz, Juan Carlos Fariñas, João Batista Rodrigues Neto, Rodrigo Moreno
3279–3285	Highly infrared transparent spark plasma sintered AION ceramics	Yingchun Shan, Xialu Wei, Xiannian Sun, Jiujun Xu, Qinghua Qin, Eugene A. Olevsky
3286–3293	Effect of gelatin gel strength on microstructures and mechanical properties of cellular ceramics created by gelation freezing route	Manabu Fukushima, Tatsuki Ohji, Hideki Hyuga, Chika Matsunaga,

Yu-ichi Yoshizawa

3309–3318	Comparison of apparent activation energies for densification of alumina powders by pulsed electric current sintering (spark plasma sintering) and conventional sintering—toward applications for transparent polycrystalline alumina	Michael Stuer, Claude Paul Carry, Paul Bowen, Zhe Zhao
3319–3325	Novel temperature sensors for SiC–SiC CMC engine components	Kevin Rivero, Tommy Muth, John Rhoat, Matt Ricci, Otto J. Gregory
3326–3332	Spiky niobium oxide nanoparticles through hydrothermal synthesis	Teruaki Fuchigami, Ken-ichi Kakimoto
3333–3343	Factors influencing the aqueous electrochemical response of TiC–Ni $_3$ Al cermets	Zhila Memarrashidi, Kevin P. Plucknett
3344–3352	Fabrication and strengthening of porous Si_3N_4 ceramics by replacement of oxide phase with Si_3N_4 at grain boundary through carbothermal nitridation	Qiang Zhi, Zhaoyun Xu, Huan Pan, Jianfeng Yang, Yuchen Deng, Bo Wang
3353–3361	Superconducting TaC nanoparticle-containing ceramic nanocomposites thermally transformed from mixed Ta and aromatic molecule precursors	Manoj Kolel-Veetil, Catherine Walker, Joseph Prestigiacomo, Boris Dyatkin, Syed Qadri, Ramasis Goswami, Kenan Fears, Matthew Laskoski, Michael Osofsky, Teddy Keller
3362–3371	SiC-bonded diamond materials produced by pressureless silicon infiltration	Björn Matthey, Steffen Kunze, Martin Hörner, Bernhard Blug, Maike van Geldern, Alexander Michaelis, Mathias Herrmann
3372–3382	Suspension- and solution-based freeze casting for porous ceramics	Maninpat Naviroj, Peter W. Voorhees, Katherine T. Faber
3383–3393	C/C–SiC sandwich structures manufactured via liquid silicon infiltration	Bernhard Heidenreich, Dietmar Koch, Harald Kraft, Yves Klett
3394–3401	Electromagnetic interference shielding and mechanical properties of Si $_3N_4$ –SiOC composites fabricated by 3D-printing combined with polymer infiltration and pyrolysis	Wenyan Duan, Zhe Fan, Hui Wang, Jingyi Zhang, Tianlu Qiao, Xiaowei Yin
3402–3408	Fabrication and characterization of YSZ/Al ₂ O ₃ nano-composite coatings on Inconel by electrophoretic deposition	Omid Khanali, Saeid Baghshahi, Masoud Rajabi
3409–3414	<i>In situ</i> synthesis of paper-derived Ti ₃ SiC ₂	Hannes Lorenz, Johannes Thäter, Mylena Mayara Matias Carrijo, Carlos R. Rambo, Peter Greil, Nahum Travitzky
3415–3424	Fabrication of dense alumina layer on Ti alloy hybrid by cold metal transfer and micro-arc oxidation methods	Rohit Khanna, Ganapathiyankavu Pisharam Rajeev, Hiroaki Takadama, Srinivasa Rao Bakshi
3425–3433	Continuum modeling of B₄C densification during Spark Plasma Sintering	Ji-an Liu, Fanhao Zeng, Zhihuan Zou, Yi Li, Yi Gu, Fuqin Zhang, Tongxiang Liang