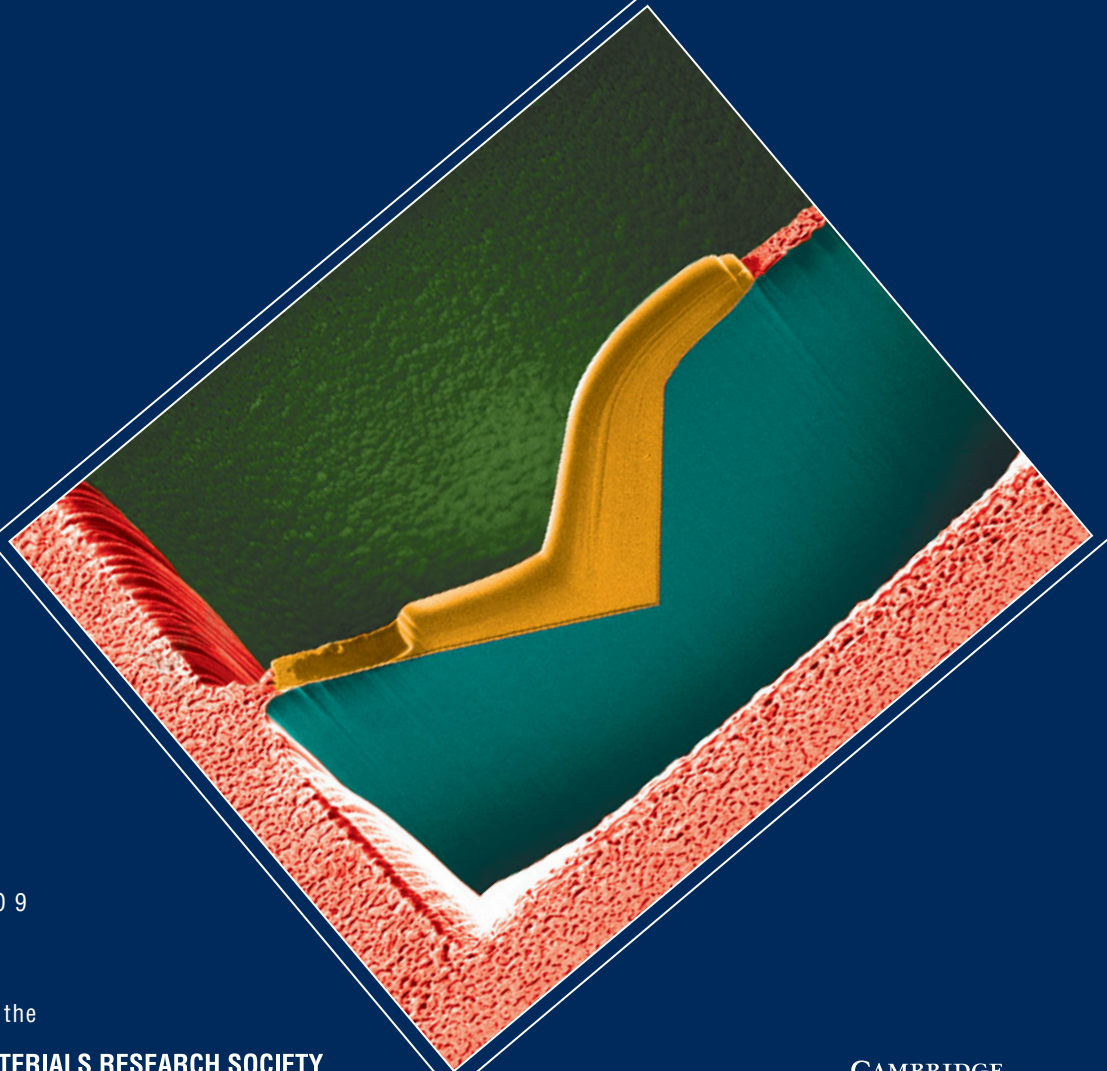




jmr Journal of
MATERIALS RESEARCH



VOLUME 27 • NO 9
MAY 14, 2012

A publication of the

MRS 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 x 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 edited 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 © 2012, 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 <http://www.copyright.com>, email: info@copyright.com.

Journal of Materials Research Subscription Prices (2012)

[includes on-line web access]

	USA and Poss.	Non-US	Online Only
MRS Regular and Student Members	\$236.00	\$289.00	\$100.00
Institutions	\$1445.00	\$1551.00	\$1373.00

Journal of Materials Research (ISSN: 0884-2914) is published twenty-four times a year by Cambridge University Press, 32 Avenue of the Americas, New York, NY 10013 – 2473 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, 100 Brook Hill Drive, West Nyack, NY 10994-2113, USA.

Subscriptions, renewals, address changes, and single-copy orders should be addressed to Subscription Fulfillment, *Journal of Materials Research*, Cambridge University Press, 100 Brook Hill Drive, West Nyack, NY 10994-2133, USA (for USA, Canada, and Mexico); or Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 8RU, 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.

Individual member subscriptions are for personal use only.

Journal of MATERIALS RESEARCH

Editor-in-Chief: Gary L. Messing, *The Pennsylvania State University*

Associate Editor, Biomaterials: Adrian Mann, *Rutgers University*

Associate Editor, Metallic Materials: Jürgen Eckert, *IFW Dresden, Germany*

Associate Editor, Polymers and Organic Materials: Howard E. Katz, *Johns Hopkins University*

Editorial Office: Eileen Kiley Novak, *Director of Communications, Materials Research Society, Warrendale, PA*
Ellen W. Kracht, *Publications Manager, Materials Research Society, Warrendale, PA*
Linda A. Baker, *JMR Editorial Assistant, Materials Research Society, Warrendale, PA*
Lorraine K. Wolf, *JMR Publishing Assistant, Materials Research Society, Warrendale, PA*

2012 Principal Editors:

Robert C. Cammarata, *Johns Hopkins University*

Edwin A. Chandross, *MaterialsChemistry LLC*

Ping Chen, *Dalian Institute of Chemical Physics, China*

Yang-T. Cheng, *University of Kentucky*

Franz Faupel, *Universität Kiel, Germany*

David S. Ginley, *National Renewable Energy Laboratory*

Amit Goyal, *UT-Battelle/Oak Ridge National Laboratory*

Mikko P. Haataja, *Princeton University*

Himanshu Jain, *Lehigh University*

Suk-Joong L. Kang, *Korean Advanced Institute of Science and Technology, Republic of Korea*

C. Robert Kao, *National Taiwan University, Taiwan*

Koichi Kugimiya, *Osaka University, Japan*

Sharvan Kumar, *Brown University*

Edson Roberto Leite, *Universidade Federal de São Carlos, Brazil*

Yadong Li, *Tsinghua University, China*

Scott T. Misture, *Alfred University*

Paul Murali, *Ecole Polytechnique Federale de Lausanne, Switzerland*

Cewen Nan, *Tsinghua University, China*

Michelle Oyen, *Cambridge University, United Kingdom*

Nitin P. Padture, *Brown University*

Ian M. Reaney, *The University of Sheffield, United Kingdom*

Joan M. Redwing, *The Pennsylvania State University*

Clifford L. Renschler, *Sandia National Laboratories*

Dale Schaefer, *University of Cincinnati*

Winston Schoenfeld, *University of Central Florida*

Christopher A. Schuh, *Massachusetts Institute of Technology*

Don W. Shaw, *The University of Texas at Dallas*

Jay A. Switzer, *Missouri University of Science and Technology*

Mauricio Terrones, *The Pennsylvania State University; and Shinshu University, Japan*

Terry M. Tritt, *Clemson University*

Yoshihisa Watanabe, *National Defense Academy, Japan*

William J. Weber, *University of Tennessee/Oak Ridge National Laboratory*

Sam Zhang, *Nanyang Technological University, Singapore*

Yanchun Zhou, *Aerospace Research Institute of Materials and Processing Technology, China*

Cover: Micrographs showing the sequence of sample preparation steps for the micro-sampling method by FIB, which was used to prepare site-specific TEM samples beneath the indentations. [H. Somekawa and C.A. Schuh: High-strain-rate nanoindentation behavior of fine-grained magnesium alloys. p. 1295.]

Journal of MATERIALS RESEARCH

Volume 27, Number 9, May 14, 2012

INVITED FEATURE PAPER

1211–1217 **Cost-effective waste heat recovery using thermoelectric systems** Kazuaki Yazawa, Ali Shakouri

ARTICLES

1218–1229 **Measurement of mechanical properties of alkaline-earth metal hexaboride one-dimensional nanostructures by nanoindentation** Xiaoxia Wu, Terry T. Xu

1230–1236 **Superstructural nanodomains of ordered carbon vacancies in nonstoichiometric $ZrC_{0.61}$** Wentao Hu, Jianyong Xiang, Yang Zhang, Shaocun Liu, Cankun Chen, Peng Wang, Haitao Wang, Fusheng Wen, Bo Xu, Julong He, Dongli Yu, Yongjun Tian, Zhongyuan Liu

1237–1244 **Shear strength and sliding behavior of Ni/Al_2O_3 interfaces: A first-principle study** Xiancong Guo, Fulin Shang

1245–1250 **On the validity regime of the bulge equations** Jan Neggers, Johan P.M. Hoefnagels, Marc G.D. Geers

1251–1256 **High-refractive-index tin sulfide core-shell spheres for photonic applications** Xiaotao Peng, Anthony D. Dinsmore

1257–1264 **Optical properties of high-performance liquid crystal-xerogel microcomposite electro-optical film** Martin Timusk, Martin Järvekülg, Aigi Salundi, Rünno Lõhmus, Silver Leinberg, Ilmar Kink, Kristjan Saal

1265–1270 **Preparation, characterization, and luminescent properties of $NaGd(WO_4)_2 \cdot Eu^{3+}$ nanotubes using carbon nanotubes as templates** Ying Huang, Liqun Zhou, Hejuan Song, Ting Wang, Lan Yang, Ling Li

1271–1284 **Residual stress in electrodeposited nanocrystalline nickel-tungsten coatings** Tiffany D. Ziebell, Christopher A. Schuh

1285–1294 **Grain boundary relaxation strengthening of nanocrystalline Ni-W alloys** Timothy J. Rupert, Jason R. Trelewicz, Christopher A. Schuh

1295–1302 **High-strain-rate nanoindentation behavior of fine-grained magnesium alloys** Hidetoshi Somekawa, Christopher A. Schuh

1303–1313 **Effect of substrate bias on the promotion of nanocrystalline silicon growth from He-diluted SiH_4 plasma at low temperature** Debajyoti Das, Debnath Raha, Wei-Chao Chen, Kuei-Hsien Chen, Chien-Ting Wu, Li-Chyong Chen

1314–1323 **Micro-Raman characterization of Ge diffusion and Si stress change in thin epitaxial $Si_{1-x}Ge_x$ layers on Si(100) after rapid thermal annealing** Chun-Wei Chang, Min-Hao Hong, Wei-Fan Lee, Kuan-Ching Lee, Li-De Tseng, Yi-Hann Chen, Yen Chuang, Yu-Ta Fan, Takeshi Ueda, Toshikazu Ishigaki, Kitaek Kang, Woo Sik Yoo