



jmr Journal of
MATERIALS RESEARCH



VOLUME 27 • NO 12
JUNE 28, 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*

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*

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: The whisker morphology after being exposed in different environment SD condition for 22 days. [A-P. Xian and M. Liu: Effect of humidity on tin whisker growth from Sn₃Nd intermetallic compound. p. 1652.]

Journal of MATERIALS RESEARCH

Volume 27, Number 12, June 28, 2012

ARTICLES

- 1543–1552 **Indentation size effect in FCC metals: An examination of experimental techniques and the bilinear behavior**
David E. Stegall,
Md. Abdullah Mamun,
Bryan Crawford,
Abdelmageed Elmustafa
- 1553–1564 **Volumes sampled for hardness and for modulus of elasticity during nanoindentation testing**
Mahdi Saket Kashani,
Akbar Aftabi Gilvan, Vis Madhavan
- 1565–1572 **Determination of shear creep compliance of linear viscoelastic solids by instrumented indentation when the contact area has a single maximum**
Guangjian Peng, Taihua Zhang,
Yihui Feng, Rong Yang
- 1573–1579 **Local characterization of austenite and ferrite phases in duplex stainless steel using MFM and nanoindentation**
Karim Raafat Gadelrab, Guang Li,
Matteo Chiesa, Tewfik Souier
- 1580–1588 **Effect of surface conditions and strain hardening on the passivity breakdown of 304 stainless steel**
Tewfik Souier, Matteo Chiesa
- 1589–1597 **Enhanced grain boundary embrittlement of an Fe grain boundary segregated by hydrogen (H)**
Motohiro Yuasa,
Takashi Amemiya,
Mamoru Mabuchi
- 1598–1611 **Optimal microstructures for martensitic steels**
P. Shanthraj, M.A. Zikry
- 1612–1620 **Formation and control of nanoporous Ag through electrochemical dealloying of the melt-spun Cu-Ag-Ce alloys**
Guijing Li, Xiaoping Song,
Feifei Lu, Zhanbo Sun,
Zhimao Yang, Shengchun Yang,
Bingjun Ding
- 1621–1630 **Forced chemical mixing at Cu-Nb interfaces under severe plastic deformation**
Nhon Q. Vo, Robert S. Averback,
Yinon Ashkenazy, Pascal Bellon,
Jian Wang
- 1631–1637 **A first-principles study on hot crack mechanism in Mg-Al-Ca alloys**
Hui Zhang, Shaoqing Wang
- 1638–1651 **Towards electroformed nanostructured aluminum alloys with high strength and ductility**
Shiyun Ruan,
Christopher A. Schuh
- 1652–1662 **Effect of humidity on tin whisker growth from Sn₃Nd intermetallic compound**
Ai-Ping Xian, Meng Liu