## About the Materials **Research Society**

The Materials Research Society (MRS), a not-forprofit scientific association founded in 1973, promotes interdisciplinary goal-oriented basic research on materials of technological importance. Membership in the Society includes over 12,000 scientists, engineers, and research managers from industrial, government, and university research labo-ratories in the United States and nearly 68 countries.

The Society's interdisciplinary approach differs from that of single-discipline professional societies because it promotes information exchange across the many technical fields touching materials development. MRS sponsors two major international annual meetings encompassing approximately 70 topical symposia, and also sponsors numerous single-topic scientific meetings. The Society recog-nizes professional and technical excellence and fosters technical interaction in local geographic regions through Sections and University Chapters.

MRS participates in the international arena of materials research through the International Union of Materials Research Societies (IUMRS). MRS is a member of the Federation of Materials Societies and is an affiliate of the American Institute of Physics.

MRS publishes symposium proceedings, MRS Bulletin, Journal of Materials Research, and other publications related to current research activities.

MRS Bulletin (ISSN: 0883-7694) is published 12 times a year by the Materials Research Society, 506 Keystone Drive, Warrendale, PA, 15086-7573. Periodical postage paid at Warrendale, PA and at additional mailing offices. POSTMASTER: Send address changes to *MRS Bulletin* in care of the Materials Research Society, at the address listed; tel. 724-779-3003; fax 724-779-8313. Printed in the U.S.A. Membership in MRS is \$100 annually for regular

members, \$25 for students. Dues include an allocation of \$29 (\$17 for students) to a subscription to *MRS Bulletin*. Individual member subscriptions are for personal use only. Non-member subscription rates are \$180 for one calendar year (12 issues) within the U.S.A. and \$235 elsewhere. Single copies may be purchased for \$20 each. 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.

MRS Bulletin is included in Current Contents®/ Engineering, Computing, and Technology; Current Contents®/Physical, Chemical, and Earth Sciences, the SciSearch® online database, Research Alert®, Science Citation Index<sup>®</sup>, and the Materials Science Citation Index<sup>™</sup>. Back volumes of MRS Bulletin are available in 16 mm microfilm, 35 mm microfilm, or 105 mm microfiche through University Microfilms Inc., 300 North Zeeb Road, Ann Arbor, Michigan 48106, USA.

Send Letters to the Editor to:

**MRS Bulletin** Materials Research Society **506 Keystone Drive** Warrendale, PA 15086-7573 USA Fax 724-779-8313 Bulletin@mrs.org

Letters must include your name, affiliation, and full contact information.

# BULLE

Editorial Office • 506 Keystone Drive • Warrendale, PA 15086-7573 USA Tel. 724-779-3004 ext. 522; fax 724-779-8313; Bulletin@mrs.org; http://www.mrs.org/

Editor E.L. Fleischer

**Managing Editor** J. Meiksin

**Technical Editor** 

A. Bertram Wilson Art Director E. Stiller

**Design/Production** S Franklin

**Editorial Assistants** M. Andrews and M. Wilmoth

Advertising M.E. Kaufold and D.L. Watterson

## **EDITORIAL BOARD** -

A.L. Greer, Chair Cambridge University Cambridge, UK V.S. Arunachalam Carnegie Mellon University Pittsburgh, PA E. Arzt

Max-Planck-Institut für Metallforschung and University of Stuttgart Stuttgart, Germany

R.W. Cahn Cambridge University Cambridge, UK

#### **VOLUME ORGANIZERS**

### 2002

R.W. Cahn Cambridge University Cambridge, UK

## 2003

L.A. Clevenger IBM Microelectronics Hopewell Junction, NY

## 2004

President

M.J. Mayo

Purdue University

S.-G. Kang, Hanyang University

Vice President and President-Elect

GUIRR, National Research Council

A.H. King

P.S. Drzaic Alien Technology Corp. Morgan Hill, CA

G.K. Celler SOITEC/USA Summit, NJ

Cambridge University

T.E. Havnes Oak Ridge National Laboratory Oak Ridge, TN

#### 2002 MRS OFFICERS

Secretary A.J. Hurd Los Alamos National Laboratory **Immediate Past President** 

M.L. Green Agere Systems Associate Editor—Europe

I.W. Boyd, University College London Dept. of Electronic and Electrical Engineering Torrington Place London WCI E7 JE, UK Tel. 44-171-380-7300 or 7302

#### **Book Review Board**

J.M. Phillips (Chair), R.W. Cahn, J. Curro, E.D. Jones, and G.G. Long

#### **MRS Office of Public Affairs**

499 South Capitol Street SW, Suite 420, Washington DC 20003 Tel. 202-256-5211

S.T. Picraux Arizona State University Tempe, AZ Y. Shiohara ISTEC Tokyo, Japan C.C. Tsai Quanta Display Inc. Taiwan J.H. Westbrook Brookline Technologies Ballston Spa, NY

M F Galvin University of Delaware Newark, DE

J.R. Weertman Northwestern University Evanston, IL

H. Van Swygenhoven Paul Scherrer Institute Villigen, Switzerland

Executive Director Materials Research Society J.B. Ballance

L.M. Torres Guerra. Universidad Autónoma de Nuevo León

**INTERNATIONAL UNION OF MATERIALS RESEARCH SOCIETIES** 

| <b>President</b><br>P.A. Glasow<br>Erlangen, Germany  | First Vice President<br>R.J. Nemanich<br>North Carolina State Univ.<br>Raleigh, NC, USA | P. Ram<br>Univers | <b>Vice President</b><br>a Rao<br>ity of Hyderabad<br>bad, India   | <b>Secretary</b><br>E.N. Kaufmann<br>Argonne National<br>Laboratory<br>Argonne, IL, USA | <b>Treasurer</b><br>H. Habermeier<br>Max-Planck-Instit<br>Stuttgart, German |  | <b>General Secretary</b><br>R.P.H. Chang<br>Northwestern University<br>Evanston, IL, USA |
|---|---|-------------------|--|---|---|--|--|
| IUMRS ADHERING  | BODIES  |                   |  |   |   |  |  |
| Australian Materials Research Society (A-MRS)<br>J.S. Williams, Australian National University    |   |                   | Materials Research Society of Argentina (MRS-Argentina)<br>R. Romero, IFIMAT                                     |   |   | Materials Research Society of Russia (MRS-Russia)<br>N.Z. Lyakhov, Russian Academy of Sciences       |  |
| Chinese Materials Research Society (C-MRS)<br>L. Zhou, NW Institute for Nonferrous Metal Research |   |                   | Materials Research Society of India (MRS-I)<br>D. Chakravorty, Indian Association for the Cultivation of Science |   |   | Materials Research Society of Singapore (MRS-S)<br>B.V.R. Chowdari, National University of Singapore |  |
| European Materials Research Society (E-MRS)<br>G. Marletta, Univerita degli Studi di Catania      |   |                   | Materials Research Society of Japan (MRS-J)<br>T. Kishi, National Institute for Materials Science                |   |   | Materials Research Society of Taiwan (MRS-T)<br>L.J. Chen, National Tsing Hua University             |  |
| Materials Research Society (MRS)  |   |                   | Materials Research Society of Korea (MRS-K)  |   |   | Mexican Materials Research Society (Mexican-MRS)   |  |

A.H. King, Purdue University

Circulation S. Forrest **Guest Editors** 

R.K. Singh and R. Bajaj

**Special Contributors** A.A. Eliseev, A. Goyal, B. Holloway, Y. Hu, T. Izumi, G. Khitrov, M.P. Paranthaman, C. Russell, V. Selvamanickam, E.A. Shack,

L. Snyder, S.S. Sosa, and S. Trohalaki **Special Consultants** 

M.-I. Baraton, T. Besmann, and G Jabbour

**Associate Technical Editor** T. Palucka

D.J. Eaglesham South Orange, NJ E.J. Kramer University of California-Santa Barbara Santa Barbara, CA G.G. Long National Institute of Standards and Technology Gaithersburg, MD S.C. Moss Aerospace Corporation Los Angeles, CA

A M Donald Cambridge, UK