

# MRS BULLETIN

October 1997

A Publication of the Materials Research Society

Volume 22, Number 10 ISSN: 0883-7694 CODEN: MRSBEA

## LOW-DIELECTRIC-CONSTANT MATERIALS

- 19 Low-Dielectric-Constant Materials for ULSI Interlayer-Dielectric Applications**  
W.W. Lee and P.S. Ho,  
Guest Editors
- 28 Vapor Deposition of Low-Dielectric-Constant Polymeric Thin Films**  
T-M. Lu and J.A. Moore
- 33 Organic and Inorganic Spin-On Polymers for Low-Dielectric-Constant Applications**  
N.P. Hacker
- 39 Nanoporous Silica as an Ultralow-*k* Dielectric**  
C. Jin, J.D. Luttmner, D.M. Smith,  
and T.A. Ramos
- 44 Phase-Separated Inorganic-Organic Hybrids for Microelectronic Applications**  
R.D. Miller, J.L. Hedrick, D.Y.  
Yoon, R.F. Cook, and J.P. Hummel
- 49 Materials Issues and Characterization of Low-*k* Dielectric Materials**  
E.T. Ryan, A.J. McKerrow, J. Leu,  
and P.S. Ho
- 55 Fluorinated Amorphous Carbon as a Low-Dielectric-Constant Interlayer Dielectric**  
K. Endo
- 61 Integration of Low-*k* Dielectric Materials Into Sub-0.25- $\mu\text{m}$  Interconnects**  
R.S. List, A. Singh, A. Ralston, and  
G. Dixit

## MRS NEWS

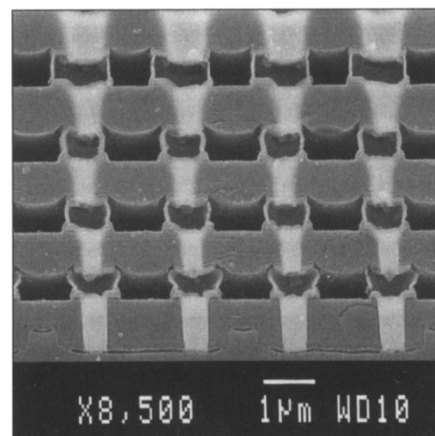
- 72 1997 MRS Fall Meeting Preview**
- 79 1997 Von Hippel Award Goes to Gabor A. Somorjai for Broad Contributions to Surface Science**
- 80 Merton C. Flemings Selected for 1997 David Turnbull Lectureship for Contributions to Solidification Processing**
- 81 Shuji Nakamura Named 1997 MRS Medalist**
- 81 Plenary Speaker Harry Y. McSween Jr. to Address Materials Findings of the Mars Pathfinder**

## ABSTRACTS

- 95 Abstracts for December 1997**  
*Journal of Materials Research*

## DEPARTMENTS

- 5 Material Matters**  
*The Recent Revolution in High Performance Computing,*  
H.D. Simon
- 8 Research/Researchers**
- 14 Washington News**
- 16 Public Affairs Forum**
- 17 Resources**
- 18 Editor's Choice**
- 70 Advertisers in This Issue**
- 93 Career Clips**
- 94 Historical Note**
- 102 Classified**



**ON THE COVER:** Hydrogen silsesquioxane (HSQ) has been successfully integrated into a five-level W-plug multilevel interconnect technology. This figure represents a scanning-electron-microscopy cross section showing a pentalevel W-plug and low-dielectric-constant (*k*) HSQ interconnect system. The low-*k* HSQ appears as the dark regions between the metal lines while the W-plugs appear as the bright regions connecting metal lines. Provided by G. Dixit, Texas Instruments, Inc. For more information, see "Integration of Low-*k* Dielectric Materials into Sub-0.25- $\mu\text{m}$  Interconnects" by R.S. List, A. Singh, A. Ralston, and G. Dixit on p. 61 of this issue.

## About the Materials Research Society

The Materials Research Society (MRS), a nonprofit 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 laboratories in the United States and nearly 50 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 60 topical symposia, and also sponsors numerous single-topic scientific meetings. The Society recognizes 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. Application to mail at periodicals rates has been approved 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; phone 412-779-3003; fax 412-779-8313. Printed in the U.S.A.

Additional copies of articles in *MRS Bulletin* may be made at \$2.50 per article. This fee can be paid to the Materials Research Society through the Copyright Clearance Center, Inc., 27 Congress Street, Salem, MA 01970.

Membership in MRS is \$75 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 \$142 for one calendar year (12 issues) within the U.S.A. and \$195 elsewhere. Single copies may be purchased for \$16 each. Send subscription orders to Subscription Department, Materials Research Society, 506 Keystone Drive, Warrendale, PA 15086-7573.

*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®*, and the *Materials Science Citation Index™*. 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.

**Materials Research Society**  
506 Keystone Drive  
Warrendale, PA 15086-7573 USA  
Tel. 412-779-3003; Fax 412-779-8313  
<http://www.mrs.org/>

# MRS BULLETIN

Editorial Office • 506 Keystone Drive • Warrendale, PA 15086-7573 USA  
Tel. 412-779-3004 ext. 522; fax 412-779-8313; <http://www.mrs.org/>

**Editor**  
E.L. Fleischer

**Managing Editor**  
J. Meiksin

**Assistant Editor**  
L.R. Gallagher

**Art Director**  
E. Stiller

**Design/Production**  
T. Aiello and S. Franklin

**Editorial Assistants**  
J. Dininny and  
M. Wilmoth

### EDITORIAL BOARD

M.A. Nastasi, Chair  
Los Alamos National Laboratory  
Los Alamos, NM

W.L. Brown  
Bell Laboratories, Lucent Technologies  
Murray Hill, NJ

R.W. Cahn (1997 Visiting Scientist)  
Cambridge University  
Cambridge, UK

D.J. Eaglesham  
Bell Laboratories, Lucent Technologies  
Murray Hill, NJ

### VOLUME ORGANIZERS

O. Auciello  
Argonne National Laboratory  
Argonne, IL

### MRS BULLETIN PUBLICATIONS SUBCOMMITTEE

M.A. Nastasi, Chair  
Los Alamos National Laboratory  
Los Alamos, NM

F.W. Clinard (1996 Visiting Scientist)  
Los Alamos National Laboratory  
Los Alamos, NM

R.C. Ewing  
University of Michigan  
Ann Arbor, MI

**Advertising**  
M.E. Kaufold

**Circulation**  
S. Krasa

**Guest Editors**  
W.W. Lee and P.S. Ho

**Special Contributors**  
S. Beckerman, E.N. Kaufmann,  
J.M. Phillips, D. Sankey,  
H.D. Simon, and L.A. Snyder

**Special Consultant**  
M. Goodway

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

W.D. Nix  
Stanford University  
Stanford, CA

R.J. Composto  
University of Pennsylvania  
Philadelphia, PA

R.L. Fleischer (1995 Visiting Scientist)  
Union College  
Schenectady, NY

A.J. Hurd  
Sandia National Laboratories  
Albuquerque, NM

M. Libera  
Stevens Institute of Technology  
Hoboken, NJ

**Associate Editor—Europe**  
I.W. Boyd, University College London  
Dept. of Electronic and  
Electrical Engineering  
Torrington Place  
London WC1E 7JE, U.K.  
Tel. 44-171-380-7300 or 7302

**Book Review Board**  
M.A. Nastasi (Chair), J.C. Bravman,  
R.W. Cahn, M.L. Green, and  
E.J. Kramer

**MRS Office of Public Affairs**  
601 13th Street, NW, Suite 1000 South  
Washington, DC 20005-3807  
Tel. 202-661-2285, Fax 202-661-2299

S.J. Pearton  
University of Florida  
Gainesville, FL

S.T. Picraux  
Sandia National Laboratories  
Albuquerque, NM

Y. Shiohara  
ISTEC  
Tokyo, Japan

C.C. Tsai  
Applied Komatsu Technology  
Santa Clara, CA

P.M. Fauchet  
University of Rochester  
Rochester, NY

C.W. White  
Oak Ridge National Laboratory  
Oak Ridge, TN

### 1997 MRS EXECUTIVE COMMITTEE

**President**  
R. Hull  
University of Virginia

**Vice President and President-Elect**  
R.J. Nemanich  
North Carolina State University

**Secretary**  
K.S. Jones  
University of Florida

**Treasurer**  
A. Hurd  
Sandia National Laboratories

**Immediate Past President**  
C.V. Thompson  
Massachusetts Institute of  
Technology

**Councillors**  
R. Gibala  
University of Michigan

A.I. Taub  
Ford Research Laboratory

**Executive Director**  
**Materials Research Society**  
John B. Ballance

### INTERNATIONAL UNION OF MATERIALS RESEARCH SOCIETIES

**President**  
R.C. Ewing  
University of Michigan  
Ann Arbor, MI, USA

**Vice President**  
H-D. Li  
Tsinghua University  
Beijing, China

**Secretary**  
C. Li  
Aviation Industries of China  
Beijing, China

**Treasurer**  
G.M. Crean  
University College  
Cork, Ireland

**Immediate Past President**  
M. Doyama  
Nishi-Tokyo University  
Tokyo, Japan

**General Secretary**  
R.P.H. Chang  
Northwestern University  
Evanston, Illinois, USA

#### IUMRS ADHERING BODIES

Australian Materials Research Society (A-MRS)  
J.S. Williams, Australian National University

Chinese Materials Research Society (C-MRS)  
H-D. Li, Tsinghua University

European Materials Research Society (E-MRS)  
G.M. Crean, University College

Materials Research Society (MRS)  
R. Hull, University of Virginia

Materials Research Society of India (MRS-I)  
S.K. Joshi, JNCASR, New Delhi

Materials Research Society of Japan (MRS-J)  
R-I. Yamamoto, University of Tokyo

Materials Research Society of Korea (MRS-Korea)  
S-J. Park, Seoul National University

Materials Research Society of Russia (MRS-Russia)  
I.V. Gorynin, Prometey Institute

Materials Research Society of Taiwan (MRS-T)  
L.J. Chen, National Tsing Hua University

Mexican Materials Research Society (Mexican-MRS)  
L.M. Gomez, Instituto de Fisica-Cuernavaca, UNAM