

MRS BULLETIN

September 1998

A Publication of the Materials Research Society

Volume 23, Number 9 ISSN: 0883-7694 CODEN: MRSBEA

DIAMOND FILMS: RECENT DEVELOPMENTS

- 16 Diamond Films: Recent Developments**
D.M. Gruen and I. Buckley-Golder,
Guest Editors
- 22 Developments in CVD-Diamond Synthesis During the Past Decade**
J.E. Butler and H. Windischmann
- 28 Diamond Films: Recent Developments in Theory and Practice**
A.M. Stoneham, I.J. Ford, and
P.R. Chalker
- 32 Nucleation, Growth, and Microstructure of Nanocrystalline Diamond Films**
D.M. Gruen
- 36 On the Nature of Grain Boundaries in Nanocrystalline Diamond**
P. Koblinski, D. Wolf, F. Cleri,
S.R. Phillpot, and H. Gleiter
- 42 Electron Emission From Diamond Films**
V.V. Zhirnov and J.J. Hren
- 49 Diamond for Electronics: Future Prospects of Diamond SAW Devices**
J.T. Glass, B.A. Fox, D.L. Dreifus,
and B.R. Stoner
- 56 Applications of Diamond Thin Films in Electrochemistry**
G.M. Swain, A.B. Anderson, and
J.C. Angus
- 61 The Road to Commercialization of Vapor-Phase-Grown Diamond**
S. Shikata

MRS NEWS

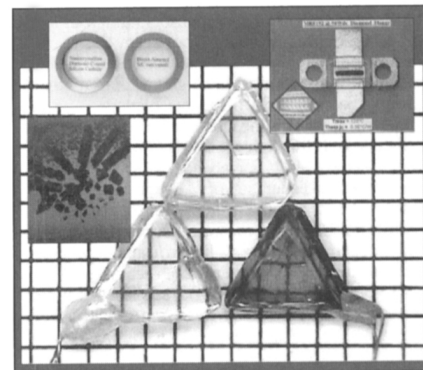
- 65 Merrilea J. Mayo Appointed OSA/MRS Congressional Fellow for 1998-99**

ABSTRACTS

- 72 Abstracts for November 1998**
Journal of Materials Research

DEPARTMENTS

- 3 Editorial**
- 4 Research/Researchers**
- 11 Washington News**
- 14 Public Affairs Forum**
- 15 Resources**
- 35 Advertisers in This Issue**
- 65 Upcoming Conference**
- 67 Profiles & Perspectives**
A Passage From India:
A Conversation With P. Rama Rao
- 71 Historical Note**
- 80 Calendar**
- 84 Classified**
- 87 Postterminaries**



ON THE COVER: (Middle) Boron-doped single-crystal diamond electrodes. The blue color arises from absorption due to boron doping, which is the source of color in the famous Hope diamond. For more information, see the article by G.M. Swain on p. 56 of this issue.

(Bottom Left Inset) Examples of chemical-vapor-deposition (CVD) diamond thick-film- and thin-film-coated flat tools and thin-film-coated round tools for nonferrous, dry-machining operation. The diamond film was produced by direct-current arc-jet technology at Norton Diamond Film extending the life of the tool five to 10 times.

(Top Left Inset) SiC rotary pump seals. One ring is coated with 5 μm of nanocrystalline diamond using a technology developed at Argonne National Laboratory. The other ring is uncoated.

(Top Right Inset) Electronic package using thick-film CVD diamond, which acts as a heat spreader beneath a 90-W Motorola LDMOS radio-frequency transistor. Using diamond lowers the integrated-circuit operating temperature to 120°C compared to 213°C for a conventional package with a metal heat spreader. The inset is the thermal image of the operating device. Note the low thermal resistance: 0.56°C/W.

About the Materials Research Society

The Materials Research Society (MRS), a not-for-profit 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 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 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. 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; phone 724-779-3003; fax 724-779-8313. 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 \$155 for one calendar year (12 issues) within the U.S.A. and \$215 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. 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®*, 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. 724-779-3003; Fax 724-779-8313
<http://www.mrs.org/>

MRS BULLETIN

Editorial Office • 506 Keystone Drive • Warrendale, PA 15086-7573 USA
Tel. 724-779-3004 ext. 522; fax 724-779-8313; <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, M. Wilmoth, and
T. Windisch

EDITORIAL BOARD

A.L. Greer, Chair
Cambridge University
Cambridge, UK

V.S. Arunachalam
Carnegie Mellon University
Pittsburgh, PA

E. Arzt
Max-Planck-Institute
Für Metallforschung und
University of Stuttgart
Stuttgart, Germany

R.W. Cahn
Cambridge University
Cambridge, UK

VOLUME ORGANIZERS

1998
O. Auciello
Argonne National Laboratory
Argonne, IL

1999
M.I. Baraton
University of Limoges
Limoges, France

VISITING SCIENTISTS

V.S. Arunachalam (1998)
Carnegie Mellon University
Pittsburgh, PA

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

Advertising
M.E. Kaufold

Circulation
S. Forrest

Guest Editors
D.M. Gruen and I. Buckley-Golder

Special Contributors
P. Berardelli, A.I. Fultz, R. Kelley,
A. King, J.M. Phillips, L.A. Snyder

Special Consultants
M. Goodway and T.M. Besmann

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

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

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

S.T. Picraux
Sandia National Laboratories
Albuquerque, NM

Y. Shiohara
ISTEC
Tokyo, Japan

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

J.H. Westbrook
Brookline Technologies
Ballston Spa, NY

R.J. Composto
University of Pennsylvania
Philadelphia, PA

P.M. Fauchet
University of Rochester
Rochester, NY

R.C. Cammarata
Johns Hopkins University
Baltimore, MD

S.M. Yaliso
University of Michigan
Ann Arbor, MI

R.W. Cahn (1997)
Carnegie Mellon University
Cambridge, UK

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

1998 MRS EXECUTIVE COMMITTEE

President
R.J. Nemanich
North Carolina State University

Vice President and President-Elect
R. Gibala
University of Michigan

Secretary
C.C. Tsai
Applied Komatsu Technology

Treasurer
A. Hurd
Sandia National Laboratories

Immediate Past President
R. Hull
University of Virginia

Councillors
H.A. Atwater
California Institute of Technology

M.L. Green
Bell Laboratories/Lucent
Technologies

Executive Director
Materials Research Society
John B. Ballance

INTERNATIONAL UNION OF MATERIALS RESEARCH SOCIETIES

President	First Vice President	Second Vice President	Secretary	Treasurer	Immediate Past President	General Secretary
R.C. Ewing University of Michigan Ann Arbor, MI, USA	H-D. Li Tsinghua University Beijing, China	P.A. Glasow Erlangen, Germany	C-G. Li Beijing, China	R-I. Yamamoto University of Tokyo Tokyo, Japan	M. Doyama Nishi-Tokyo University Tokyo, Japan	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.J. Nemanich, North Carolina State University

Materials Research Society of India (MRS-I)
R. Chidambaram, Atomic Energy Commission

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, Prometei 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