Inside: Energy Quarterly EQ

MRS Bulletin

CELEBRATING 45 YEARS

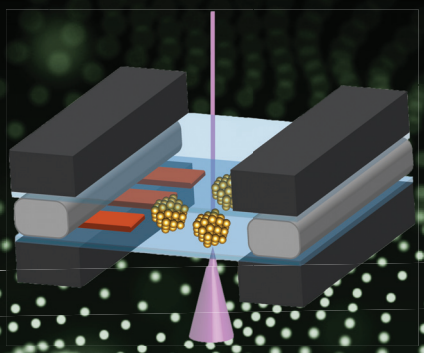
MRS MATERIALS RESEARCH SOCIETY®
Advancing materials. Improving the quality of life.

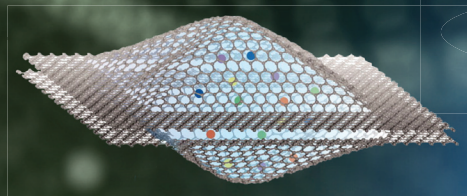
September 2020 Vol. 45 No. 9
mrs.org/bulletin

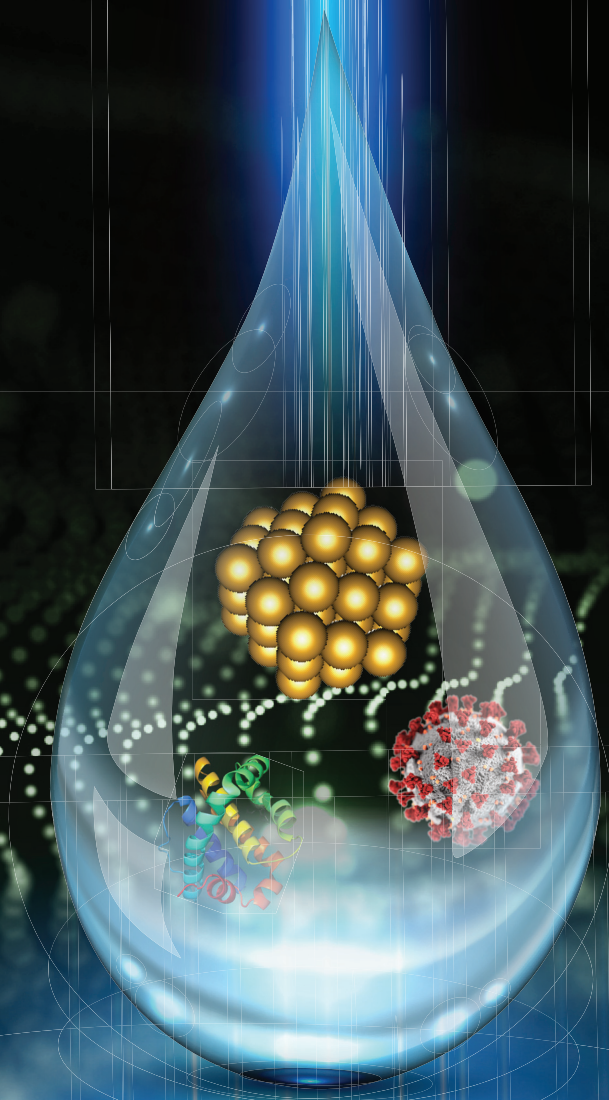
Liquid phase electron microscopy

ALSO IN THIS ISSUE

Nanophotonic materials for space applications



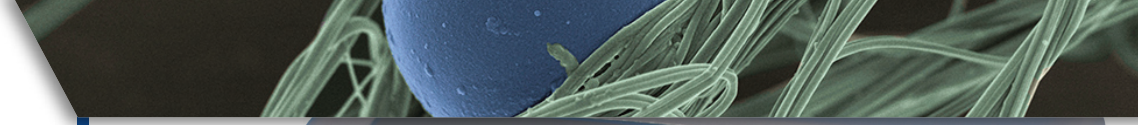




CAMBRIDGE UNIVERSITY PRESS

https://doi.org/10.1557/mrs.2020.232 Published online by Cambridge University Press

https://doi.org/10.1557/mrs.2020.232 Published online by Cambridge University Press



your source for cutting-edge sample preparation equipment...

GloQube® Plus Glow Discharge System for TEM Grids and Surface Modification

A cost-effective, compact and easy-to-use glow discharge system, designed to modify the surface of TEM grids to meet the requirements for imaging a variety of macromolecules.

Q150V Plus Automatic Coater

Optimized for high-vacuum applications, with an ultimate vacuum of 1 x 10^{-6} mbar. Use with a wide-range Penning/Pirani gauge enables the sputtering of oxidizing metals with ultra-fine grain sizes.

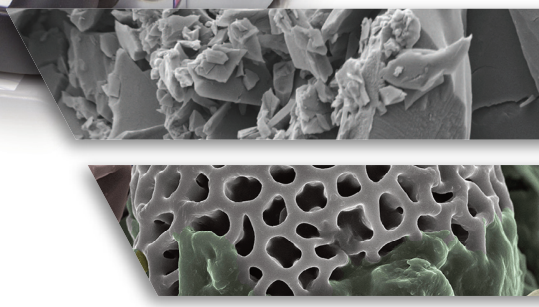
Q300T T Plus Triple Target Large Chamber, Turbo-Pumped Sputter Coater

Ideally suited for sputtering a single large diameter specimen up to 8"/200 mm or multiple smaller specimens over a similar diameter. Ideal for thin-film applications and SEM/FE-SEM.

Q300T D Plus Dual Target Sequential Sputtering System

Suitable for multi-layer sequential sputtering of two materials, with two independent sputtering heads, which allow sequential sputtering of two metals without the need to break vacuum.

GloQube® Plus



EMS has it!

E M S Quorum

Q300T D Plus

Q300T T Plus

Q150V Plus

PLEASE CONTACT US FOR MORE INFORMATION...

OUR MAIN INTERACTIVE WEBSITE:

www.emsdiasum.com

Electron Microscopy Sciences

P.O. Box 550 • 1560 Industry Rd.
Hatfield, Pa 19440
Tel: (215) 412-8400 • Fax: (215) 412-8450
email: info@emsdiasum.com
or stacie@ems-secure.com

https://doi.org/10.1557/mrs.2020.232 Published online by Cambridge University Press

MRS Bulletin
SEPTEMBER 2020 VOLUME 45 Number 9 ISSN: 0883-7694 CODEN: MRSBEA

CONTENTS

LIQUID PHASE ELECTRON MICROSCOPY

TECHNICAL FEATURE

Energy Quarterly

https://doi.org/10.1557/mrs.2020.232 Published online by Cambridge University Press

DEPARTMENTS

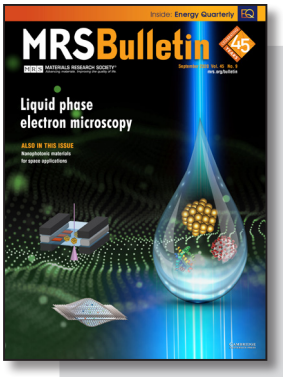
NEWS & ANALYSIS

SOCIETY NEWS

FEATURES

CAREER CENTRAL

ADVERTISERS IN THIS ISSUE Page No.



ON THE COVER

Liquid phase electron microscopy. Liquid phase or liquid cell transmission electron microscopy (TEM) is a powerful and emergent platform for nanoscale imaging and characterization of physical, chemical, and biological processes of materials in liquids. It can be used to explore nanoscale details of solution processes directly. Details of the development and applications of liquid cell TEM are discussed in this issue of *MRS Bulletin*. The cover shows a stylized representation of liquid phase TEM. The smaller image in the top left is a microfabricated flow liquid cell that sandwiches a thin layer of solution containing either a precursor solution or nanoparticles between two ultrathin SiN_x membrane windows that are separated by a spacer. On the bottom left is a static graphene liquid cell that sandwiches nanodroplet pockets of precursor solution between two graphene layers. See the technical theme that begins on p. **704**.

COMING IN OCTOBER 2020
Functional materials and devices by self-assembly

connect
mrs.org/bulletin
mrs.org/energy-quarterly
mrs.org/mymrs
journals.cambridge.org
mrs.org/bulletin-podcast
@mrsbulletin

https://doi.org/10.1557/mrs.2020.232 Published online by Cambridge University Press

MRS MATERIALS RESEARCH SOCIETY®
Advancing materials. Improving the quality of life.

MRS Bulletin

EDITORIAL OFFICE 506 Keystone Drive, Warrendale, PA 15086-7573 USA
Bulletin@mrs.org tel 724.779.2747 fax 724.779.8313 mrs.org

About the Materials Research Society

The Materials Research Society (MRS), a not-for-profit scientific association founded in 1973 and headquartered in Warrendale, Pennsylvania, USA, promotes interdisciplinary materials research. Today, MRS is a growing, vibrant, member-driven organization of more than 14,000 materials researchers spanning over 80 countries, from academia, industry, and government, and a recognized leader in the advancement of interdisciplinary materials research.

The Society's interdisciplinary approach differs from that of single-discipline professional societies because it promotes information exchange across many scientific and technical fields touching materials development. MRS conducts three major international annual meetings and also sponsors numerous single-topic scientific meetings. The Society recognizes professional and technical excellence and fosters technical interaction through University Chapters. In the international arena, MRS implements bilateral projects with partner organizations to benefit the worldwide materials community. The Materials Research Society Foundation helps the Society advance its mission by supporting various projects and initiatives.

Chief Editor for Technical Content
Gopal R. Rao, rao@mrs.org

***Impact* Editor**
Markus J. Buehler

Managing Editor
Lori A. Wilson, lwilson@mrs.org

News Editor
Judy Meiksin, meiksin@mrs.org

Technical Editor
Lisa C. Oldham, oldham@mrs.org

Editorial Assistants
Suzanne Hite, hite@mrs.org,
Mary Wilmoth

Director of Communications
Eileen M. Kiley

Guest Editors
Utkur Mirsaidov, Joseph P. Patterson, and Haimei Zheng

Special Consultants
Ken Haenen and Enrico Traversa

Production/Design
Stephanie Gabborin, Heather Shick, Felicia Turano, and Tech-Set Ltd

Production Editor
Rachel Altizio

Advertising/Sponsorship
Mary E. Kaufold, kaufold@mrs.org
Donna L. Watterson, watterson@mrs.org

Member Subscriptions
Michelle Judt, judt@mrs.org

Non-Member Subscriptions
subscriptions_newyork@cambridge.org

MRS Bulletin (ISSN: 0883-7694, print; ISSN 1938-1425, online) is published monthly by the Materials Research Society, 506 Keystone Drive, Warrendale, PA 15086-7573. Permission required to reproduce content. Periodical postage paid at New York, NY, and at additional mailing offices. POSTMASTER: Send address changes to *MRS Bulletin* in care of the Journals Department, Cambridge University Press, 100 Brook Hill Drive, West Nyack, NY 10994-2113, USA. Printed in the U.S.A.

Membership in MRS is $135 annually for regular members, $35 for students, and includes an electronic subscription to *MRS Bulletin.* Print subscriptions are available to MRS members for an additional $25. Individual member subscriptions are for personal use only. Nonmember subscription rates are $618 (USD) for one calendar year (12 issues). 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.

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®, Materials Science Citation Index™, and Scopus.

Authors of each technical article appearing in *MRS Bulletin* are solely responsible for all content in their article(s), including accuracy of the facts, statements, and citing resources. Facts and opinions are solely the personal statements of the respective authors and do not necessarily represent the views of the editors, the Materials Research Society, or Cambridge University Press.

Send Letters to the Editor to **Bulletin@mrs.org**. Include your name, affiliation, and full contact information.

https://doi.org/10.1557/mrs.2020.232 Published online by Cambridge University Press