

Journal of COMPOSITES Technology & Research

EDITORS

G. P. Sendeckyj, *Coeditor*
Air Force Wright
Aeronautical Laboratories
Dayton, OH 45433

S. S. Wang, *Coeditor*
University of Illinois
Urbana, IL 61801

W. Steven Johnson, *Associate Editor*
NASA Langley
Hampton, VA 24061

W. W. Stinchcomb, *Associate Editor*
Virginia Polytechnic Institute and State
University, Blacksburg, VA 24061

N. J. Pagano, *Associate Editor*
AFWAL/MLBM
Wright Patterson AFB, OH 45433

H. T. Hahn
Pennsylvania State University
Engineering Science and Mechanics
Dept.
State College, PA 16802

T. Johansson
Linköping University
Institute of Technology
Department of Mechanical Engineering
S-581-83 Linköping, Sweden

N. J. Johnston
NASA Langley Research Center
Mail Stop 226
Hampton, VA 23665

P. K. Mallick
University of Michigan-Dearborn
Department of Mechanical Engineering
Dearborn, MI 48128

J. F. Mandell
Massachusetts Institute of Technology
Department of Materials Science and En-
gineering
Cambridge, MA 02139

R. J. Morgan
Michigan Molecular Institute
1910 W. St. Andrews Rd.
Midland, MI 48640-2696

E. Morris, *President*
Structural Composites Industries, Inc.
Pomona, CA 91768

T. K. O'Brien
NASA Langley Research Center
Hampton, VA 23665

L. Penn
Chemical Engineering Dept.
Polytechnic University
Brooklyn, NY 11201

Michael R. Piggott
University of Toronto
Department of Chemical Engineering
and Applied Chemistry
Toronto, Ontario M5S 1A4, Canada

R. L. Sierakowski
Ohio State University
Columbus, OH 43210

C. T. Sun
Purdue University
West Lafayette, IN 47907

R. Talreja, *International Coordinator*
The Technical University of Denmark
Department of Solid Mechanics
Lyngby, Denmark

S. W. Tsai
AFWAL/MLBM
Wright Patterson AFB, OH 45433

J. M. Whitney
4371 Round Tree Dr.
Dayton, OH 45432

Dick Wilkins
College of Engineering
University of Delaware
Newark, DE 19716

C. Zweben
General Electric Co.
Space Division
Valley Forge Space Center
Philadelphia, PA 19101

EDITORIAL BOARD

R. J. Arsenault
Dept. of Chemical and Nuclear Engineer-
ing
University of Maryland
College Park, MD 20742

R. Badaliance
Naval Research Laboratory
Washington, DC 20375

H. W. Bergmann
Director, Institut für Strukturmechanik
DFVLR
3300 Braunschweig, West Germany

C. C. Chamis
NASA Lewis Research Center
Cleveland, OH 44135

L. J. Cohen, *Industry Coordinator*
McDonnell Douglas Astronautics Com-
pany
Advanced Programs Design and Tech-
nology
Engineering Division
Huntington Beach, CA 92647

I. M. Daniel
Department of Civil Engineering
Northwestern University
Evanston, IL 60201

W. W. Feng
Lawrence Livermore National Labora-
tory
Livermore, CA 94550

R. F. Gibson
Wayne State University
Mechanical Engineering Dept.
Detroit, MI 48202

Purpose and Scope

The objectives of *Journal of Composites Technology & Research* are (1) to provide a forum for the presentation, discussion, and dissemination of information on composite materials and their response to the environments in which they are used, especially the engineering and technology of their application to components and structures, and (2) to provide a means of communication for researchers, developers, producers, users, suppliers, and professional organizations concerned with composite materials.

The editorial scope includes full-length technical articles, technical notes (Composites Review), preliminary technical communications (Research Briefs), news articles and announcements (World of Composites), book reviews, letters, and discussions of previously published work.

The American Society for Testing and Materials is not responsible, as a body, for the statements and opinions advanced in this publication.

Journal of Composites Technology & Research (ISSN 0885-6804; previous title, *Composites Technology Review*) is published quarterly by the American Society for Testing and Materials. Editorial office at the Headquarters of the Society, 1916 Race St., Philadelphia, PA 19103.

Subscriptions: *United States and Canada* for 1 year \$38.00 (members \$28.00), for 2 years \$66.00 (members \$48.00), for 3 years \$87.00 (members \$60.00). *Foreign* for 1 year \$43.00 (members \$32.00), for 2 years \$76.00 (members \$56.00), for 3 years \$102.00 (members \$72.00). Single copies are \$14.00. To subscribe, please send prepaid order to ASTM, Subscription Dept.—CTR, 1916 Race St., Philadelphia, PA 19103. *Journal of Composites Technology & Research* is indexed regularly by Engineering Index, Inc., and is available on microfilm from University Microfilms, a Xerox company, Ann Arbor, MI. Copyright 1989 by the American Society for Testing and Materials.

Change of address: Please return entire addressing label on wrapper to *Journal of Composites Technology & Research*, ASTM, Subscription Dept.—CTR, 1916 Race St., Philadelphia, PA 19103 along with new address.

General Information

This publication is one of many issued by ASTM in connection with its work in promoting knowledge of the properties and performance of materials, products, systems, and services and in developing standard specifications and test measurement techniques. Much of the information results from voluntary contributions of many of the leading technical authorities from industry, scientific agencies, and government. A list of ASTM publications and additional information will be furnished on request.

Information for Authors

All contributions to *Journal of Composites Technology & Research* are subject to editing to bring them into accordance with ASTM style. Technical articles are also subject to peer review. Emphasis is placed on composites technology that bridges the gap between industry and the research and development community. Papers must contribute to the permanent literature, be of immediate interest to ASTM members, or be of general interest to a substantial part of the technical community. Articles that have been published or submitted for publication elsewhere or papers of an advertising or promotional nature cannot be printed in the *Journal of Composites Technology & Research*. The paper must not be seriously defective as to literary form and structure, continuity of thought, and clarity of expression. Authors should observe the conventions of style explained in the ASTM Style Manual. Since the journal does not request page charges, the author is expected to conform to these standard conventions. The original manuscript and five clear copies, including original illustrations, should be sent to Kathy Greene, Manager, Acquisitions and Review, ASTM, 1916 Race St., Philadelphia, PA 19103 (215-299-5581).

In Appreciation

The high quality of the technical papers in this publication is a tribute not only to the obvious efforts of the authors represented but also to the unheralded, though essential, efforts of their reviewers. It is to the reviewers' dedication to upholding the high standards of their profession that this note pays tribute. On behalf of ASTM and the authors as well, we acknowledge with appreciation their important contribution to the success of this journal.



EDITORIAL STAFF

Susan L. Gebremedhin, *Editor*
Bette Grugan, *Secretary, Acquisition & Review*
Kathy Greene, *Manager, Acquisition & Review*
Janet R. Schroeder, *Managing Editor*
M. Bruce Vieth, *Manager of Production*
Robert L. Meltzer, *Vice-President, Publications and Marketing*

ASTM OFFICERS

David M. Greason, *Chairman*
Albert J. Bartosic, *Vice-Chairman*
John A. Millane, *Vice-Chairman*
Nancy M. Trahey, *Treasurer*
Joseph G. O'Grady, *President*

Directors

Robert Baboian
Albert J. Bartosic
Richard H. Brown
Arthur Cohen
Rebecca A. Cohen
Edward F. Diekmann
Emery Farkas
John E. Foster
W. DeWayne France, Jr.
Connie Glover
John J. Henry
Thomas M. Hopkins
Mary W. Jenkins
A. Ivan Johnson
Raymond G. Kammer, Jr.
Anthony G. Keane
Kenry J. Roux
Eberhard L. Schuerer
Paul L. Strigner
C. Ross Thomson
Grover C. Williams

Past Chairmen

Robert Baboian
W. DeWayne France

Committee on Publications

Sheldon W. Dean, *Chairman*
James S. Perrin, *Vice-Chairman*
David M. Greason, *Ex-officio*
John M. Barsom
Edward P. Bartkus, *Ex-officio*
Thomas W. Crooker
Gerald David
Larry P. Jackson
W. Steve Johnson
Leonard Mordfin
John Rumble, Jr.
Kenneth R. St. John
William Selconis
Kurt H. Strauss
Frank T. Wagner

MOVING?

To insure uninterrupted service on your CTR subscription, please notify us at least six weeks before you move.

1. Attach your address label from a recent issue in the space provided opposite. (If label is not available, be sure to give your old address, including Zip Code)

A large, empty rectangular box with a thin black border, intended for the user to attach an address label from a recent issue of the journal.

2. Print your name, membership no., and address below. (Be sure to include Zip Code)

3. Mail entire notice to: **ASTM-CTR**
1916 Race St.
Philadelphia, PA 19103

Name _____ Membership No. _____

New Address _____

City _____ State _____ Zip Code _____

(please print or type the above information)