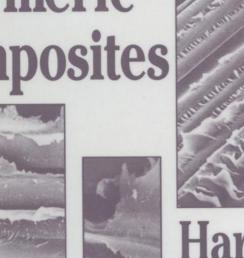
# High Temperature and Environmental

Effects on Polymeric Composites















**STP 1174** 

#### **STP 1174**

## High Temperature and Environmental Effects on Polymeric Composites

Charles E. Harris and Thomas S. Gates, editors

ASTM Publication Code Number (PCN) 04-011740-33



#### Library of Congress Cataloging-in-Publication Data

High temperature and environmental effects on polymeric composites / Charles E. Harris and Thomas S. Gates, editors.

(STP: 1174)

"ASTM Publication Code Number (PCN) 04-011740-33."

Includes bibliographical references and index.

ISBN 0-8031-1491-5

1. Polymeric composites—Effect of temperature on. 2 Polymeric composites—Environmental testing. I. Harris, Charles E., 1950—. II. Gates, Thomas S., 1959—. III. Series: ASTP special technical

publication; 1174.

TA418.9.C6H544 1993

620.1'92—dc20

93-22100 CIP

ASTM Publication Code Number (PCN): 04-011740-33

ISBN: 9-8031-1481-5

Copyright © 1993 AMERICAN SOCIETY FOR TESTING AND MATERIALS, Philadelphia, PA. All rights reserved. This material may not be reproduced or copied, in whole or in part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of the publisher.

#### Photocopy Rights

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by the AMERICAN SOCIETY FOR TESTING AND MATERIALS for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$2.50 per copy, plus \$0.50 per page is paid directly to CCC, 27 Congress St., Salem, MA 01970; (508) 744-3350. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Service is 0-8031-1491-5/93 \$2.50 + .50.

#### **Peer Review Policy**

Each paper published in this volume was evaluated by three peer reviewers. The authors addressed all of the reviewers' comments to the satisfaction of both the technical editor(s) and the ASTM Committee on Publications.

The quality of the papers in this publication reflects not only the obvious efforts of the authors and the technical editor(s), but also the work of these peer reviewers. The ASTM Committee on Publications acknowledges with appreciation their dedication and contribution to time and effort on behalf of ASTM.

Printed in Virginia April 1993

#### **FOREWORD**

This publication, High Temperature and Environmental Effects on Polymeric Composites, contains papers presented at the symposium of the same name, held in San Diego, CA on October 15, 1991. The symposium was sponsored by ASTM Committee D-30 on High Modulus Fibers and Their Composites. Charles E. Harris and Thomas S. Gates of NASA Langley Research Center in Hampton, VA acted as symposium chairmen and are editors of the resulting publication.

### Contents

Overview	1
Damage Mechanisms and Failure	
Measurement of Stress Corrosion Crack Growth in Sheet Molding Compounds—Y. ARSLANIAN AND P. J. HOGG	7
Mode I Delamination of Carbon Fiber Reinforced Thermoplastic Polymer Under Static and Cyclic Creep at Elevated Temperatures—	
R. OHTANI, T. KITAMURA, Y. UEMATSU, AND M. HOJO	23
Delamination Onset and Accumulation in Polymeric Composite Laminates Under Thermal and Mechanical Loads—R. H. MARTIN	39
High-Temperature Behaviors of an Innovative Polymeric Matrix Composite— YJ. LO, CH. LIU, DG. HWANG, JF. CHANG, JC. CHEN, WY. CHEN, AND SE. HSU	66
Materials Behavior Under Combined Effects	
The Effect of Seawater Environment on the Galvanic Corrosion Behavior of Graphite/Epoxy Composites Coupled to Metals—D. M. AYLOR	81
The Simulation and Detection of Electrochemical Damage in BMI/Graphite Fiber Composites Using Electrochemical Impedance Spectroscopy—F. D. WALL, S. R. TAYLOR, AND G. L. CAHEN	95
The Effect of the Interphase/Interface Region on Creep and Creep Rupture of Thermoplastic Composites—Y. S. CHANG, J. J. LESKO, K. L. REIFSNIDER, AND D. A. DILLARD	114
Determination of a Load, Heat, Time-to-Failure Surface of Polymeric Composites— J. A. MILKE AND A. J. VIZZINI	135
Property Improvements of Polymer Composites After Loading at High Temperatures—G. MAIER AND K. FRIEDRICH	147
Constitutive Models	
The Effects of Physical Aging on the Creep Response of a Thermoplastic Composite—R. L. HASTIE, JR. AND D. H. MORRIS	163

The Effects of Moisture Sorption on the Creep Behavior of Fibers—J. Z. WANG, V. DAVÉ, W. GLASSER, AND D. A. DILLARD	186
Effects of Elevated Temperature on the Viscoplastic Modeling of Graphite/Polymeric Composites—T. S. GATES	201