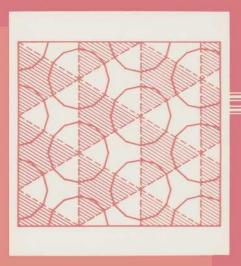
# METAL MATRIX COMPOSITES





Testing, Analysis, and Failure Modes

W. S. JOHNSON editor



# METAL MATRIX COMPOSITES: TESTING, ANALYSIS, AND FAILURE MODES

W. S. Johnson, Editor



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

Metal matrix composites—testing, analysis, and failure/W.S.

Johnson, editor.

(STP: 1032)

Papers from the Symposium on Metal Matrix Composites: Testing, Analysis, and Failure Modes, held Apr. 25-26, 1988, sponsored by ASTM Committee D-30 on High Modulus Fibers and Their Composites and by the National Aeronautics and Space Administration.

Includes bibliographical references.

"ASTM publication code number (PCN) 04-01032033"—T.p. verso. ISBN 0-8301-1270-X

1. Metallic composites—Congresses. I. Johnson, W. S. (W.

Steven) II. Symposium on Metal Matrix Composites: Testing, Analysis, and Failure Modes (1988: Sparks, Nev.) III. ASTM

Committee D-30 on High Modulus Fibers and Their Composites. IV. United States. National Aeronautics and Space Administration.

V. Series: ASTM special technical publication: 1032.

TA481.M45 1989

620.1'6-dc20

89-17661

CIP

Copyright © by American Society for Testing and Materials 1989

### NOTE

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

### **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 of time and effort on behalf of ASTM.

## **Foreword**

The Symposium on Metal Matrix Composites: Testing, Analysis, and Failure Modes was held at Sparks, NV, on 25-26 April 1988. ASTM Committee D-30 on High Modulus Fibers and Their Composites: Testing, Analysis, and Failure Modes and the National Aeronautics and Space Administration (NASA) sponsored the symposium. W. S. Johnson, NASA Langley Research Center, chaired the symposium and is editor of the resulting publication.

# Contents

Overview	1
Testing	
Tension and Compression Testing of Metal Matrix Composite Materials— JOHN M. KENNEDY	7
Shear Testing of Fiber Reinforced Metal Matrix Composites— MAREK-JERZY PINDERA	19
Techniques for Mechanical and Thermal Testing of Ti <sub>3</sub> Al/SCS-6 Metal Matrix Composites—GEORGE A. HARTMAN AND STEPHAN M. RUSS	43
Techniques for Measurement of the Thermal Expansion of Advanced Composite  Materials—STEPHEN S. TOMPKINS	54
On the Applicability of Acoustic Emission for Monitoring Damage Progression in Metal Matrix Composites—Jonathan Awerbuch and John G. Bakuckas	68
Analysis	
A Review of Plasticity Theory of Fibrous Composite Materials— YEHIA A. BAHEI-EL-DIN AND GEORGE J. DVORAK	103
Analysis of Notched Metal Matrix Composites Under Tensile Loading—  C. A. BIGELOW	130
Modeling Continuous Fiber Metal Matrix Composite as an Orthotropic Elastic- Plastic Material—C. T. SUN	148
Deformation Analysis of Boron/Aluminum Specimens by Moire Interferometry— DANIEL POST, YIFAN GUO, AND ROBERT CZARNEK	161
Failure Modes	
Strain Intensity Factor Approach for Predicting the Strength of Continuously Reinforced Metal Matrix Composites—CLARENCE C. POE, JR.	173
Fatigue Testing and Damage Development in Continuous Fiber Reinforced Metal Matrix Composites—w. s. JOHNSON	194
Strength Predictions for Metal Matrix Composites—D. M. HARMON, C. R. SAFF, AND D. L. GRAVES	222

Damage Initiation and Growth in Fiber Reinforced Metal Matrix Composites—	237
DAVID HARMON AND CHARLES SAFF	
Crack Growth and Fracture of Continuous Fiber Metal Matrix Composites: Analysis and Experiments—JAMES G. GOREE, L. R. DHARANI, AND WALTER F. JONES	251
Fiber-Matrix Interface Failures—hun sub park, gui sheng zong, lloyd d. brown, lew rabenberg, and harris l. marcus	270
Index	281

X-0751-1608-0 NBZI