

Thermal and Mechanical Behavior of Metal Matrix and Ceramic Matrix Composites

Kennedy/Moeller/Johnson

editors



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***Thermal and Mechanical Behavior
of Metal Matrix and
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John M. Kennedy, Helen H. Moeller, and W. S. Johnson, editors



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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 Thermal and Mechanical Behavior of Metal Matrix and Ceramic Matrix Composites was held in Atlanta, Georgia, 7–8 November 1988. ASTM Committee D-30 on High Modulus Fibers and Their Composites and ASTM Committee E-24 on Fracture Testing sponsored the symposium. John M. Kennedy, Clemson University, Helen H. Moeller, Babcock and Wilcox, and W. S. Johnson, Nasa Langley Research Center, are editors of this publication.

Contents

Overview	vii
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ANALYSIS AND MODELING

Local Stresses in Metal Matrix Composites Subjected to Thermal and Mechanical Loading—A. L. HIGHSMITH, D. SHIN, AND R. A. NAIK	3
Plasticity Analysis of Fibrous Composite Laminates Under Thermomechanical Loads—Y. A. BAHEI-EL-DIN	20
Thermomechanical, Time-Dependent Analysis of Layered Metal Matrix Composites—K.-D. LEE AND E. KREMPL	40
Computational Simulation of High-Temperature Metal Matrix Composites Cyclic Behavior—C. C. CHAMIS, P. L. N. MURTHY, AND D. A. HOPKINS	56
Effects of Environmental and Microstructural Variables on the Plastic Deformation of Metal Matrix Composites Under Changing Temperature Conditions—G. S. DAEHN	70
Analysis of a Ceramic Matrix Composite Flexure Specimen—L. R. DHARANI	87

BEHAVIOR OF CERAMIC MATRIX COMPOSITES

Toughness Models of Whisker-Reinforced Ceramic Matrix Composites—Y.-C. CHIANG AND T.-W. CHOU	101
Comparison of High-Temperature Tension Testing Results of Ceramic Fibers—M. A. RIGDON AND W. S. HONG	116
Comparison of Methods for Determining Fiber/Matrix Interface Frictional Stresses in Ceramic Matrix Composites—D. C. CRANMER, U. V. DESHMUKH, AND T. W. COYLE	124
Monotonic and Cyclic Behavior of a Silicon Carbide/Calcium-Aluminosilicate Ceramic Composite—C. Q. ROUSSEAU	136

BEHAVIOR OF METAL MATRIX COMPOSITES

Mechanical and Thermal Properties of Silicon-Carbide Particle-Reinforced Aluminum —K. SCHMIDT, C. ZWEBEN, AND R. ARSENAULT	155
Temperature-Dependent Tensile and Shear Response of P100/6061 Graphite-Aluminum —T. FUJITA, M.-J. PINDER, AND C. T. HERAKOVICH	165
The Bonding Strength at the Fiber/Matrix Interface of Metal Matrix Composites —J. KIM, S.-K. LEE, AND E.-J. JUN	183
Mechanical Characterization of Unnotched SCS₆/Ti-15-3 Metal Matrix Composites at Room Temperature —W. S. JOHNSON, S. J. LUBOWINSKI, AND A. L. HIGHSMITH	193
Fatigue Crack Growth in an Al₂O₃ Short Fiber Reinforced Al-2Mg Alloy —S. PRESTON, A. MELANDER, H. L. GROTH, AND A. F. BLOM	219

TEST METHODS

Ceramics Tensile Grip —C. G. LARSEN	235
--	-----

SUMMARY

Summary	249
----------------	-----

INDEXES

Author Index	255
Subject Index	257

Overview

In the past twenty five years, Committee D-30 of ASTM has provided a major forum for promoting the transfer of information on advanced composite materials. Similarly, for the past thirty years, Committee E-24 has been involved in fracture testing, both developing standards and transferring information. This publication and the Symposium on Thermal and Mechanical Behavior of Ceramic and Metal Matrix Composites which was held in Atlanta, Georgia on 7–8 November 1989 were sponsored to continue these efforts. Twenty three papers were presented at the symposium, and this publication contains sixteen peer reviewed articles on the subject.

As history has shown, the advancement of technology in many cases is limited by the availability and understanding of materials. This is certainly true for today's technology. The government is currently supporting programs such as the National Aerospace Plane which will require new materials with thermal/mechanical operating conditions which are far beyond the capability of materials currently used in production of high-temperature components. To support this program and numerous others, industry and government are developing new material systems which can satisfy the material design requirements. In many cases, it appears that ceramic or metal matrix composites are the only viable material systems. Before these materials can be extensively used in DOD, NASA, and commercial systems, optimized cost effective material processes must be developed. In developing these processes and also after the materials are commercially available, extensive material characterization programs must be conducted to provide a database so that the end user of the material will have confidence in the performance of the material.

Developing test methods and generating design data for materials which will be used in thermomechanical environments is extremely expensive. High-temperature composite materials cost much more than homogenous materials or standard resin matrix composites. Equipment for testing at elevated temperature is highly specialized and very expensive. Specialized test methods must be developed which take into consideration thermal stresses, stress gradients, measurement capabilities, gripping methods and limited material quantities. It is therefore important that test methods be carefully developed and standardized so that accurate data are generated and duplication of test data is avoided in test programs.

The papers contained in this proceedings provide current results of research and development programs on ceramic and metal matrix composites. The papers are divided into four categories:

1. Analysis and Modeling
2. Behavior of Ceramic Matrix Composites

3. Behavior of Metal Matrix Composites
4. Test Methods

The sections include papers which address both continuous and discontinuous ceramic and metal matrix composites. The Analysis and Modeling section includes papers on plasticity analysis of composite laminates during thermomechanical loading, micromechanical stress analysis of continuous reinforced metal matrix composites, creep models for discontinuous and laminated metal matrix composites, and simulation of the cyclic behavior of metal matrix composites. The section on Behavior of Ceramic Matrix Composites includes papers on fracture of whisker reinforced ceramic composites, mechanical characterization of ceramic fibers, frictional stresses at the fiber/matrix interface of ceramic composites, and mechanical behavior of selected ceramic matrix composites. The papers in the section on Behavior of Metal Matrix Composites address mechanical and thermal behavior of continuous and discontinuous reinforced metal matrix composites. Experimental results were reported from static and fatigue tension test programs as well as fracture studies. Another paper presented an indentation test method to derive the optimal manufacturing process of metal matrix composites. The paper included in the section on Test Methods addressed specific test methods and experimental hardware which may be applied to either ceramic or metal matrix composites.

With this symposium and the resulting special technical publication, ASTM has made another stride forward by providing a wealth of information on ceramic and metal matrix composites which will assist the research and design community in better understanding the behavior of these materials. This information will be also invaluable as test methods are developed for ceramic and metal matrix composites.

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