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Ceramic Matrix Composites— Advanced High-Temperature Structural Materials

Symposium held November 28–December 2, 1994, Boston, Massachusetts, U.S.A.

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The papers contained within this volume were originally presented at the symposium on Ceramic Matrix Composites: Advanced High-Temperature Structural Materials held at the 1994 MRS Fall Meeting in Boston, Massachusetts on November 28-December 2. The symposium was sponsored by the Department of Energy's Office of Industrial Technology's Continuous Fiber Ceramic Composites Program, the Air Force Office of Scientific Research, and NASA Lewis Research Center. Among the competing materials for advanced, high-temperature applications, ceramic matrix composites are leading candidates. The objective of the symposium was to bring together researchers concerned with the various aspects of ceramic composites to stimulate interaction between the multiplicity of disciplines involved in the successful utilization of these advanced structural materials.

The excellent attendance at the over 100 papers presented in the symposium demonstrated the continued interest in, and importance of, ceramic matrix composites. Many of the well-established leaders in the field were present, as well as some welcome new researchers. The opening presentation described the benefits of the utilization of continuous fiber reinforced ceramic matrix composites in industrial and power generation applications. The projected cost and energy savings and pollution reductions resulting from the insertion of these materials in only a fraction of the available Systems are significant, lending great credibility to the continued pursuit and investigation of this class of advanced materials

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Preface

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The symposium was organized such that papers concerning constituents—fibers and matrices—were presented first, followed by composite processing, modeling of mechanical behavior, and thermomechanical testing. More stable reinforcements are necessary to enhance the performance and life of fiber-reinforced ceramic composites, and to ensure final acceptance of these materials for high-temperature applications. Encouraging results in the areas of polymer-derived SiC fibers and single crystal oxide filaments were given, suggesting composites with improved thermomechanical properties and stability will be realized in the near future. A significant number of the presentations about matrices dealt with reduction or displacement reactions, also known as "thermite" reactions. Controlled chemical interactions between two materials, which in the described systems are typically exothermic, are used to form different, more stable "composite" compositions with fascinating microstructures. Interesting combinations of materials were explored, many having great promise for use as composite matrices and/or stand-alone compounds. Continued improvements in the mechanical models, combined with more extensive testing, also supported the fundamental premise for examining continuous fiber ceramic composites, i.e., low modulus ceramic fibers can be added to stiff ceramic matrices to produce materials with good strength and high-temperature performance, and exceptional toughness.

Two days of the symposium were devoted to fiber-matrix interfaces in continuous fiber reinforced ceramic matrix composites. The talks were organized into four sessions: mechanical modeling, test methods, interface behavior, and modification and control. The significance of the fiber-matrix interface in the design and performance of these materials is evident. Numerous mechanical models to relate interface properties to composite behavior, and interpret test methods and data, were enthusiastically discussed. Issues such as residual stresses, load transfer, fiber roughness, fiber coatings, and environmental stability were noted. Improved test methods and data analysis have provided more accurate and detailed information about the forces acting at this boundary and enhanced the understanding of fiber debonding and sliding. A variety of new coating systems for improved performance and stability are being developed with some interesting new developments in interlayers for oxide-oxide composites.

One issue of great concern for any advanced material for use in extreme environments is stability. This theme arose frequently throughout the symposium and was the topic of focus on the final day. Corrosion, thermal shock resistance, and cyclic thermomechanical loading were primary concerns for limiting the life of ceramic composites in many of the potential applications. Although great progress has been, and continues to be made in the advancement and improvement of ceramic matrix composites, much more must be accomplished to fully understand these materials and optimize the properties of each system for specific applications.

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