Supporting Technologies

Performance-Related Phenomena

Objectives

The objectives of the Performance-Related Phenomena subtask are to:

- evaluate sensitivities of CFCCs to possible life-limiting phenomena
- identify the critical composite parameters and environmental reactions controlling damage processes
- establish trends and models as appropriate
- develop CFCC-specific performance simulation tools

These objectives are pursued through several interrelated projects that examine: environmental effects, time-dependent behavior, thermal shock, and performance simulation. The results generated in the first three work elements, in coordination with the output of the other Supporting Technologies projects, are used to assure the quality and relevance of the information needed for performance simulation and for providing guidance for improving the environmental stability of the composites through changes in composition, structure, and design.

Environmental Effects

The trends associated with high-temperature degradation and the effects of environmental reactions on the properties and life of CFCCs are being investigated for various combinations of composite constituents. Efforts involve determination of changes in microstructure and properties after controlled exposures at high temperature, evaluation and modeling of the combined effects of stress and corrosion, and material exposures in simulated industrial environments.

Time-Dependent Behavior

This project evaluates the static fatigue resistance of CFCCs and the associated material parameters that can be used to improve the mechanical reliability of these composites. Stress-rupture is used to characterize the time-dependent behavior and to determine the time-temperature-stress conditions under which a particular CFCC is susceptible to environmental and mechanical degradation. This work also includes microstructural characterization of failure processes as a function of material, environmental, and stress conditions.

Thermal Shock

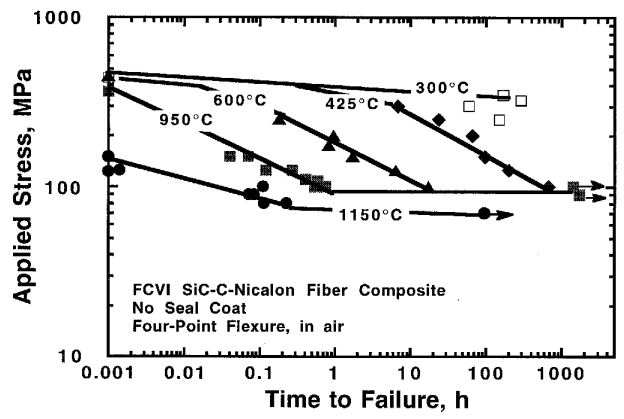
This work is developing a knowledge-base for assessing the thermal shock behavior of CFCCs. It includes testing of composites under simulated transients, characterization of damage and mechanical behavior before and after thermal cycling, and development of analytical models for predicting thermal shock damage. The effects of thermal shock on oxidation resistance and thermal conductivity are also being evaluated.

Performance Simulation

A life prediction capability specifically for CFCCs, based on the MRLife code, is being developed in order to provide predictive capabilities for remaining strength under the influence of applied stress, temperature, environment, and time for a given CFCC material and component. The various macro and micromechanical representations of stress and strength that comprise the code are evaluated for CFCCs by comparing their output to measured values. The code is being used to determine the reliability of actual components of interest to the CFCC industrial participants.

Key Capabilities

- thermogravimetric analyses/mechanical testing (flexure, tensile, and C-(O-)ring) in high-temperature, corrosive environments (including long-term exposures under stress)
- exposures in mixed gases at high temperatures and pressures (up to 200 psi) conditions
- thermal shock testing
- models and code for life prediction of CFCCs



Stress Rupture Is Used To Determine Regimes of Environmental Susceptibility

Team Members

Oak Ridge National Laboratory
Oak Ridge, TN

University of Cincinnati
Cincinnati, OH

Virginia Polytechnic Institute
Blacksburg, VA

Team Contact

Peter Tortorelli
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6156
TEL: (423) 574-5119
FAX: (423) 574-5118
e-mail: tortorellipf@ornl.gov

CFCC

Continuous Fiber Ceramic Composite Program

A 10-year joint R&D effort initiated in 1992 to develop processing methods to produce reliable and cost-effective CFCC components for industrial applications.

CFCCs are light, strong, and corrosion-resistant materials capable of performing at high temperatures.

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