Characterization of Ceramic Matrix Composite Combustor Components: Pre and Post Exposure

G. OJARD

United Technologies Research Center
411 Silver Lane M/S 129-24
East Hartford, CT 06108 USA
Phone: 860-610-7013
E-mail: OjardGC@utrc.utc.com

G. Linsey and J. Brennan
United Technologies Research Center
411 Silver Lane
East Hartford, CT 06108 USA

R. Naik, R. Cairo, R. Stephan, and J. Hornick
Pratt & Whitney
United Technologies Corporation
400 Main Street
East Hartford, CT 06108 USA

D. Brewer
Glenn Research Center/MS 49 - 7
21000 Brookpark Road
Cleveland, OH 44135 USA
Phone: 216-433-3304
Fax: 216-433-8000
E-mail: David.N.Brewer@lerc.nasa.gov

The pursuit of lower emissions and higher performance from gas turbine engines requires the development of innovative concepts and the use of advanced materials for key engine components. One key engine component is the combustor, where innovative design and material improvements have the potential to lower emissions. Efforts to develop a High Speed Civil Transport with low emissions were focused on the evaluation of combustor concepts with liners fabricated from a ceramic matrix composite of silicon carbide fibers in a silicon carbide matrix (SiC/SiC). The evaluation of SiC/SiC composites progressed from simple coupons (to establish a first-order database and identify operant failure mechanisms and damage accumulation processes), to feature-based subelements (to assess fabricability and *in situ* material response), to actual components (to assess structural integrity, dimensional, and compositional fidelity) tested under simulated engine conditions.

As in the case of all evolutionary material and process work, a key element to resolving fabrication issues is the evaluation of witness areas taken from fabricated components before testing the actual component. The witness material from these components allowed microstructural and mechanical testing to be performed and compared to the ideal, flat panel, conditions and data that are typical of basic characterization. This also allowed samples of similar design to be taken from components after 115 hours of combustion exposure. Testing consisted of tensile, double notch shear, ring burst, and thermal conductivity that sampled various regions of the components. The evaluation of the witness material allowed an understanding of the fabrication process, highlighting critical issues, in an early phase of the learning curve development of these configuration and material unique parts. Residual property testing, after exposure, showed if degradation of the material under actual service conditions was occurring. This paper will present the results of this critical testing. Evaluations that consider the degree of complexity of the fabricated part were established to relate *in situ* performance to that of flat panel based coupons. Nondestructive evaluation was used throughout the evaluation process. These results will also be discussed as an aid in understanding the test results.