Composites for Industrial Gas Turbines

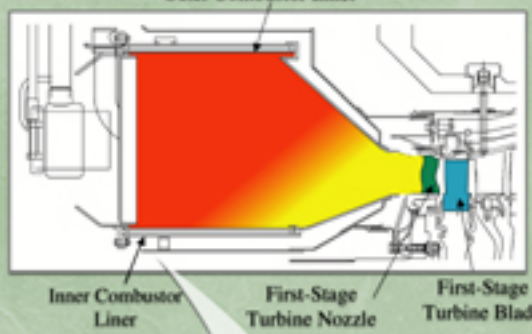
Solar Turbines has been investigating the use of ceramics in industrial gas turbines to improve fuel efficiency and to reduce exhaust emissions of NO_x and CO. Large air-cooled metallic combustor liners have been successfully replaced by uncooled continuous fiber-reinforced ceramic-matrix composites (CFCCs). Field tests in Bakersfield, CA, and Lawrence, MA have verified that ceramic composites can survive for extended periods and significantly reduce exhaust emissions (<15 ppm NO_x, <10 ppm CO).

Combustor Field Testing

Development and Characterization of CFCC Combustor Liners is a Collaborative Effort:

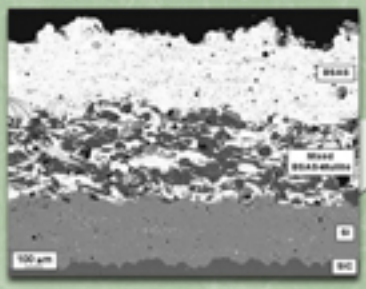
- Solar Turbines, Inc. – Engine Manufacturer
  - Chevron, Bakersfield, CA >> Engine test site
  - Malden Mills, Lawrence, MA >> Cogeneration facility
- CFCC liner manufacturers
  - GE Power Systems Composites, Inc.
  - Goodrich, Inc.
- United Technologies Research Center
  - Environmental Barrier Coating (EBC) Development
- Oak Ridge National Laboratory
  - Laboratory-scale exposure of CFCCs (Keiser Rig)
  - Microstructural characterization of oxidation-induced surface damage
  - Mechanical evaluation of exposed liners
- Argonne National Laboratory
  - Nondestructive Evaluation of liners

Solar Turbines Centaur 50S Industrial Gas Turbine

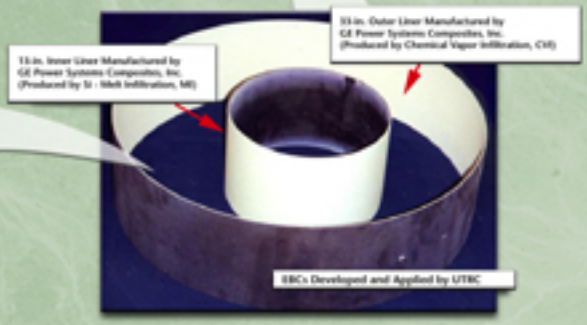


Environmental Barrier Coatings (EBCs) Are Currently Being Evaluated On CFCC Liners

Plasma-sprayed coatings consist of two layers on a Si bond coat and CVD SiC seal coat



EBCs are Applied to Working Surfaces of CFCC Combustor Liners for Engine Tests



Summary

- Nearly 40,000 hours of total accumulated field testing proved that CFCC liners reduce exhaust emissions to <15 ppm NO_x and <10 ppm CO.
- A single CFCC liner set with EBCs survived ~14,000 hours in Chevron field test in Bakersfield, CA.
- A second industrial gas turbine is operating after ~15,000 hours and 150 starts at the Malden Mills facility in Lawrence, MA.

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Office of Power Technologies

http://www.eren.doe.gov/der/microturbines/microturbines.html