EFFECT OF SPECIMEN GEOMETRY AND APS FLASH BOND COATING ON TBC LIFETIME

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Thermal barrier coatings (TBCs) for land-based gas turbines are primarily thermally sprayed and are unlikely to contain precious metals. For regions of the world where natural gas prices are high, turbine efficiency is a critical issue, however, durability and reliability also are very important for large scale generation. Seeking pathways for improved performance and lifetime model development, a variety of TBC performance parameters have been investigated over the years using furnace cycle testing, including bond coating composition, substrate composition, cycle frequency and environment (i.e. additions of H_2O, CO_2, etc.). The baseline system has been superalloy 247 substrates with high velocity oxygen fuel (HVOF) NiCoCrAlYHfSi bond coatings and air plasma sprayed yttria-stabilized zirconia (YSZ) top coatings tested in "wet" air (10%H_2O) at 900°-1150°C.

Recently, specimen geometry was changed from flat disks to rods. Using similar coating parameters, FCT lifetime in 100-h cycles at 1100°C in air with 10%H_2O dropped by ~5X for rods compared to disks. Coating architectures that were developed for flat disk specimens did not appear to be effective in improving lifetime in FCT for rod specimens. The addition of an APS "flash" coating resulted in a significant increase in FCT lifetime in rod specimens. The benefit of this additional bond coating layer has generally thought to be due to increased interface roughness compared to a conventional HVOF coating. The most recent testing has returned to 1-h FCT of disk specimens using ~50µm APS flash coatings of both NiCoCrAlYHfSi and NiCoCrAlY flash coatings deposited on HVOF NiCoCrAlYHfSi. A similar set of rod specimens also is being evaluated in 100-h cycles. Both tests are being conducted at 1100°C in air with 10%H_2O. Both flash coatings show a statistically significant increase in FCT TBC lifetime in 1-h cycles. Surprisingly, the Y only flash coating has significantly outperformed the YHfSi flash coating with some work still in progress. Residual stress in the thermally grown alumina scale has been tracked every 100 1-h cycles and 5, 100-h cycles for one sample of each coating type to quantify the evolution of the reaction product and better understand the FCT results. Failed specimens are being characterized to better understand the benefit of flash coatings on TBC lifetime. Research was sponsored by the U. S. Department of Energy, Office of Fossil Energy, Turbine Program.