MATERIALS

OVERVIEW

As a substitute for metallic combustor cans, advanced ceramic composites and carbon matrix composite materials have been proposed. NASA has identified these advanced materials as "enabling propulsion materials" also known as EPM. However, more accurate models of the behavior of these materials in the high temperature rich combustion environment are required. Test facilities to expose material specimens to the anticipated rich combustion environment (temperature, pressure, and gas species composition) are not readily available. One facility at NASA-Lewis in Cleveland exposes two specimens simultaeously to a nominal "rich" environment. However, their facility does not have the capability of extracting a gas sample for verification of composition. Additionally, the NASA-Lewis facility exposes the specimens perpendicular to the flow rather than parallel to the flow. Additional facilites to provide corroboration of the data obtained by NASA in their facility as well as provide actual gas composition measurements.

The EPM test program at UCICL is looking at a variety of advance ceramic and carbon matrix composites in both "coated" and "uncoated" configurations. The specimens are exposed to the desired environment (rich combustion region equivalence ratio of 1.8, gas temperatures ranging from 2200 F to 2600 F, reaction pressures of 4, 6 , 8 and 10 atmospheres).

GOALS

The goals of the UCICL EPM/High Temperature Material Exposure Facility are:

1. Characterize the chemical environment found near the combustor liner surface at the fuel rich operating conditions anticipated for the next generation gas turbine engines.
2. Characterize the response of the the advanced material to exposure in the fuel rich environment.

RESULTS

The UCI Combustion Lab, under contract with NASA-Lewis, has designed and fabricated a high pressure combustion facility in support of the NASA EPM program ; the UCICL facility addresses some of the short comings of the NASA facility. The UCICL facility is capable of exposing up to 8 specimens simultaneously, arranged around the circumference of the combustor section to a "rich" combustion environment. Gas samples can be extracted via a traversible, water cooled probe located just downstream of the sample section. The combustion zone environment is flexible and controllable over a wide range of fuel and air flow rate (providing a wide range of fuel to air ratios), maximum combustor pressures 10 atmospheres and maximum air preheat temperatures of 1200 F. The combustor utilizes a "commerical" gas turbine engine dome section to produce "real world" combustion flow fields. The uniformity of the flow field presented to the specimens afforded by the commercial dome section is valuable in providing a controlled environment of the specimens. The UCICL facility incorporates a unique "quick-mix" region below the gas sampling port that permits the completion of the reaction within the test facility rather than requiring an external "oxidizer". Sufficient air is injected at the "quick-mix" zone to result in an overall fuel lean reaction for the facility, minimizing the emission of soot and other undesirable pollutants.

A series of tests on a wide variety of test specimens has shown good agreement with the NASA developed material response models. Gas composition measurements show good agreement with the predicted equilibrium gas compositions. This data is propietary to NASA and the engine development teams and cannot be published at this time.

PERSONNEL

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