NASA SBIR/STTR Technologies

T12.02-9894 - In-Situ EBCs for High Performance Composite Propulsion Components

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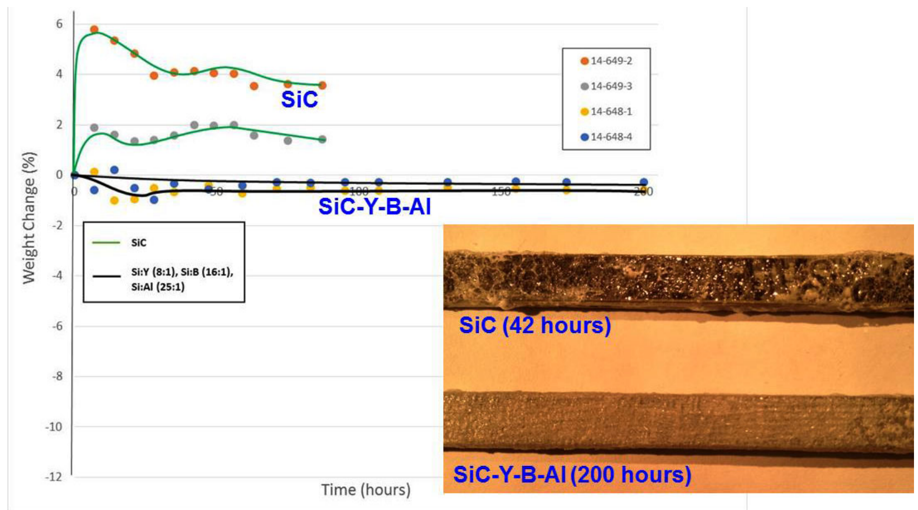
Identification and Significance of Innovation

Silicon Carbide based ceramic matrix composites (CMCs) offer the potential to fundamentally change the design and manufacture of aeronautical and space propulsion systems to significantly increase performance and fuel efficiency over current metal-based designs. Physical Sciences Inc. (PSI) and our team members at the University of California Santa Barbara (UCSB) are developing, designing and fabricating enhanced SiC-based matrices capable of long term operation at 2750 deg F to 3000 deg F in the combustion environment. The team is successfully incorporating refractory and rare earth species into the SiC matrix to increase the CMC use temperatures and life-time capabilities by improving the protective oxide passivation layer that forms during use. As part of this work we are creating physics based-materials and process models that qualitatively define methods of improving matrix properties and the interaction of the fibers, interphases and matrix with each other.

Estimated TRL at beginning and end of contract: (Begin: 2 End: 5)



Technical Objectives and Work Plan

The purpose of the Phase II program is to develop and demonstrate SiC-based CMCs for demonstrated long term operation at 2700F. By the end of the program we will have developed and demonstrated CMCs having appropriate lifetimes in an atmospheric burner rig, demonstrating a TRL of 5.
1. Produced CMC with oxidation rates less than 1/2 those of monolithic SiC matrix CMCs at 2700F in wet air,
2. Validated that CMC strengths exceed 28 KSI after oxidization
3. Demonstrated non-brittle failure of the CMC
4. Defined physical differences between rapid (1000F/min) and slow heating,
5. Demonstrated no material degradation after 300-500 hours burner test rig exposure,
6. Defined physics based models for oxidation

Task 1: Management
Task 2. Optimization of Robust CMC Matrix
Optimize matrix compositions that demonstrate enhanced oxidation resistance at 2700F and refine our physics based models.
Task 3. CMC Fabrication
Task 4. Oxidation Testing
At UCSB we will perform oxidation and phase evolution tests on the CMCs using a variety of techniques . At PSI we will perform rapid oxidation experiments using the 3kW laser.

NASA Applications

Use of 2700 deg F CMC-based components such as combustor liners, turbine shrouds, and turbine vanes will enable higher temperature operation of turbine engines in subsonic, supersonic, and hypersonic aircraft. The lighter weight of the CMC components will reduce fuel consumption and their higher temperature operation will reduce air cooling requirements, decrease NOx emissions, and improve overall engine efficiency.

Non-NASA Applications

Commercial aircraft engines, both large and small, will benefit from low-cost, technically superior CMCs that enable higher temperature operation of CMC-based components. In addition, CMCs are currently being tested in ground-based gas turbines for power generation, where long-life high temperature survival is of particular importance.

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