TITLE: **A STUDY OF ADVANCED MATERIALS FOR GAS TURBINE COATINGS AT ELEVATED TEMPERATURES USING SELECTED MICROSTRUCTURES AND CHARACTERISTIC ENVIRONMENTS FOR SYNGAS COMBUSTION**

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GRANT NO.: DE-PS26-07NT43114-03B

PERIOD OF

PERFORMANCE: February 2008 – April, 2008

DATE: April 15, 2008

1. ABSTRACT

Program Introduction: Rationale and Objective

The overall objective of the proposed project is to study the effects of the air plasma spray (APS) coated microstructures for making thermal barrier coatings (TBCs) that are suitable for use in industrial gas turbine engines and compare these with electron beam physical vapor deposition (EBPVD) microstructures for applications in advanced gas turbines that use coal-derived synthesis gas. In the design for the coatings of the turbine blades, a phenomenological approach has been used and this study will analyze the applications of selected coatings with the potential of dramatic improvement in engine efficiencies and life expectancy of the TBCs in conditions using syngas combustion. The role of TBC microstructures in contact with deleterious substances is of significant interest to increase the life and reliability of materials used in turbine hot path components. It is of critical interest for advanced applications that materials can be used for temperatures above 1300^{o}C with improved durability and enhanced performance. While TBCs are commercially being used in gas turbine applications, there is critical need to analyze the potential use in syngas environments where contaminants and elevated temperature conditions can affect the thermo-physical properties and thus performance of the advanced turbine materials.

Commercial turbine materials will be evaluated at elevated temperatures for their long-term survivability of base metal/bond coat/top coat and analysis of structure-property-performance relationships of TBC materials with horizontal (lamellae) and vertically (columnar) produced microstructures used on land based turbines. In addition, syngas contaminants such as sulfur environment, heavy metals, As, P, V etc, which are not found in natural gas, can further affect the performance of these materials under high temperature conditions. The effect of moisture at elevated temperatures will also be investigated for reliability/durability. Lastly, analytical modeling based on laminated plate theory will be conducted to evaluate the effect of various design parameters on the failure of the TBCs.

Accomplishments Achieved During the Current Period of Performance

This research project got recently funded in February 2008 and we are in process of procuring materials and processing of test samples. A set of samples are being processed at MSI. TX for bond coat of selected IN 738 samples for further top coat processing using Air Plasma Spray coating. In addition, selected bond coated samples will be processed with EBPVD technique for comparative studies of processing effects of microstructures at Pennsylvania State University. The thermophysical properties and processing effects will be further studied at Southern University and research results related to processing conditions. Preliminary studies conducted earlier have been presented and reported in ongoing related research efforts.

Plans for the Remaining Period of Performance

The work planned for the remaining months of PhaseI of this research program include the following tasks:

Continue the processing and characterization of APS and EBPVD samples under different elevated temperature test conditions to develop APS and EBPVD test samples for optimal processing parameters

- Benchmark thermo-physical properties experimental testing of APS processed and EBPVD TBCs
- Publish the outcome of these investigations.

2. LIST OF PUBLISHED JOURNAL ARTICLES, COMPLETED PRESENTATIONS AND STUDENTS RECEIVING SUPPORT FROM THE GRANT

Conference Presentations

Following are ongoing related research publications

- Effect of 8%wt YSZ Air Plasma Spray Processed Thermal Barrier Coating Thickness on Thermal Cycling Failure and Thermo-Physical Properties Measurements, Patrick F. Mensah[a], Ravinder Diwan[a], N. Uppu[a], and Purush Sahoo, [a]Department of Mechanical Engineering, Southern University, Baton Rouge, LA, USA, [b]Materials Solution Incorporated, Houston, TX, USA, AMRS, Dar es Salaam, Tanzania, December 8-14,2007.

- **Students Supported Under this Grant**
- None- to be appointed in the summer.