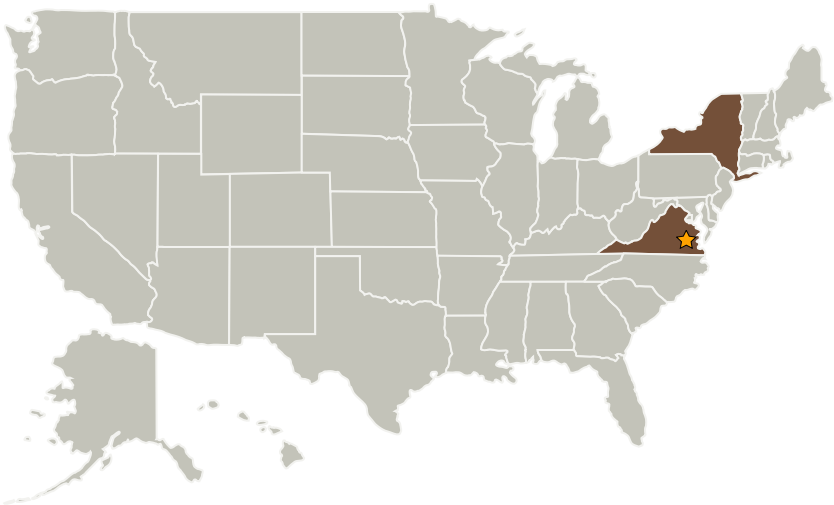
Material Characterization for Hypersonic Vehicles by the Fast Mutipole Boundary Element Method, Phase I

Completed Technology Project (2007 - 2007)

Project Introduction

Hypersonic aircraft are subjected to extreme conditions with respect to mechanical thermal and acoustic loads. Materials with complex microstructure, such as Functionally Graded (FGM) and honeycomb, are expected to play a key role in such vehicles. Detailed numerical stress and thermal analysis of such materials, with conventional Finite Element Methods (FEM), is extremely difficult. The Fast Multipole Boundary Element Method (FMBEM) is a very promising candidate for carrying out such calculations efficiently and accurately. This is an O(N) method (where N is the size of a problem) with respect to both matrix formulation and solution of linear systems. It is proposed that two user-friendly software packages based on the FMBEM, to be called AvantFGM and AvantHoneycomb, will be developed in this proposed Phase I project. These packages will be used to carry out mechanical and thermal characterization of these complex materials. The output of these packages will deliver material properties as functions of spatial coordinates, which can then be used to carry out conventional FEM analyses of aircraft components of complex geometrical shape. Plans for Phase II call for development of fully functioning commercial software capable of analyzing many realistic situations pertaining to hypersonic aircraft. Phase III will be concerned with further development of the software to include damage accumulation (due to, for example, mechanical, creep and thermo-acoustic fatigue) and risk analysis.

Primary U.S. Work Locations and Key Partners



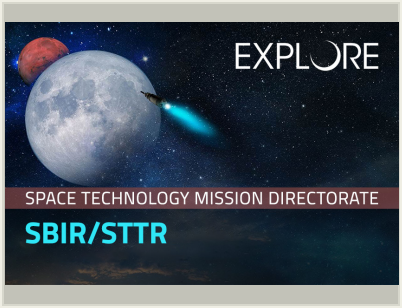


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Table of Contents

Project Introduction 1
Primary U.S. Work Locations and Key Partners 1
Organizational Responsibility 1
Project Management 2
Technology Areas 2

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Avant Analysis Technology	Supporting Organization	Industry	Ithaca, New York

Primary U.S. Work Locations	
New York	Virginia

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  └ TX09.4 Vehicle Systems
    └ TX09.4.5 Modeling and Simulation for EDL