Calculation of Effective Material Strengths for 3D Woven Hybrid Preforms and Composites, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The design concepts being considered for Heatshield for Extreme Entry Environment Technology (HEEET) rely on the use of 3D woven carbon fiber preforms. Therefore, there is a need to be able to predict the properties and performance of a woven material. Validation of predictive modeling tools would allow for the use of these tools to design and optimize the 3D weaves, significantly reducing the cost of fabrication and testing of a variety of configurations. While there are proven tools for the prediction of laminate composite properties, textile composites are relatively new materials and much less effort has been focused on modeling this class of materials. Therefore, MR&D is proposing to use the lessons learned from the Phase I effort, to improve the strength prediction capabilities, evaluate the effects of porosity and molding of curved panels, and deliver a beta version of a 3D weave design optimization tool. A combined analytical and experimental program has been proposed. The analytical effort involves modifying the current version of the 3D weave modeling tool, based on the lessons learned in the Phase I program, to include things such as unique bundle strengths for the different yarn types and improved failure criteria to improve the strength prediction capabilities. It also includes increasing the current capabilities to allow for estimating properties of 3D woven composites with varying levels of porosity or that have been molded into curved panels. The experimental effort involves fabrication and testing of various 3D woven reinforced composites (flat, curved, partially densified). The properties obtained from this experimental effort will enable improved calibration of the modeling tools. Finally, the final portion of the Phase II effort will focus on the preparation of a beta version of the 3D weave design optimization tool for delivery to NASA for use in heat shield design as well as other applications requiring the use of 3D woven preforms.

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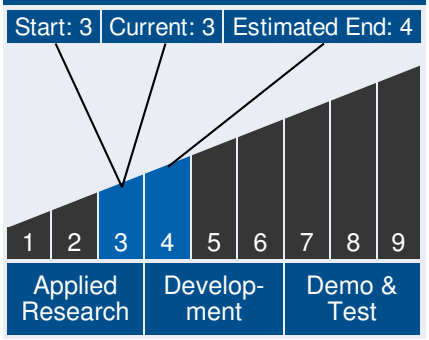
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

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ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The successful completion of the Phase II program would directly benefit the Heatshield for Extreme Entry Environment Technology (HEEET) project, which is using 3D woven preforms in the current designs. The ability of a predictive tool to generate material properties and strengths for a variety of 3D weaves would allow for the evaluation of multiple design configurations and fiber types to be evaluated in a much more efficient and cost effective manner than having to fabricate and test panels to generate data to be used for downselection of the best candidate designs. In addition, a validated design tool of this kind would also be very useful to the mission design community to optimize materials for specific missions.

To the commercial space industry:

Potential Non-NASA Commercial Applications: In addition to the potential NASA applications, there is also potential for applications within the Department of Defense (DoD). The use of 3D woven preforms in ballistic armor applications creates a need for design and predictive modeling capabilities of these materials as well. Finally, there would also be potential for applications from the weavers themselves. Companies such as Textile Engineering and Manufacturing and Bally Ribbon Mills have an interest in the predictive capabilities of both material properties and strengths for various weave configurations.

Management Team *(cont.)*

Project Manager:

- Robin Beck

Principal Investigator:

- Kerry Hopp

Technology Areas

Primary Technology Area:
Entry, Descent, and Landing Systems (TA 9)
└ Aeroassist and Atmospheric Entry (TA 9.1)
└ Thermal Protection Systems for Rigid Decelerators (TA 9.1.1)
└ Extreme Environment Ablative Thermal Protection System (TPS) (TA 9.1.1.1)

Additional Technology Areas:
Entry, Descent, and Landing Systems (TA 9)
└ Aeroassist and Atmospheric Entry (TA 9.1)
└ Thermal Protection Systems for Rigid Decelerators (TA 9.1.1)
└ Multifunctional, Micrometeoroid Orbital Debris (MMOD)-Tolerant Materials (TA 9.1.1.5)

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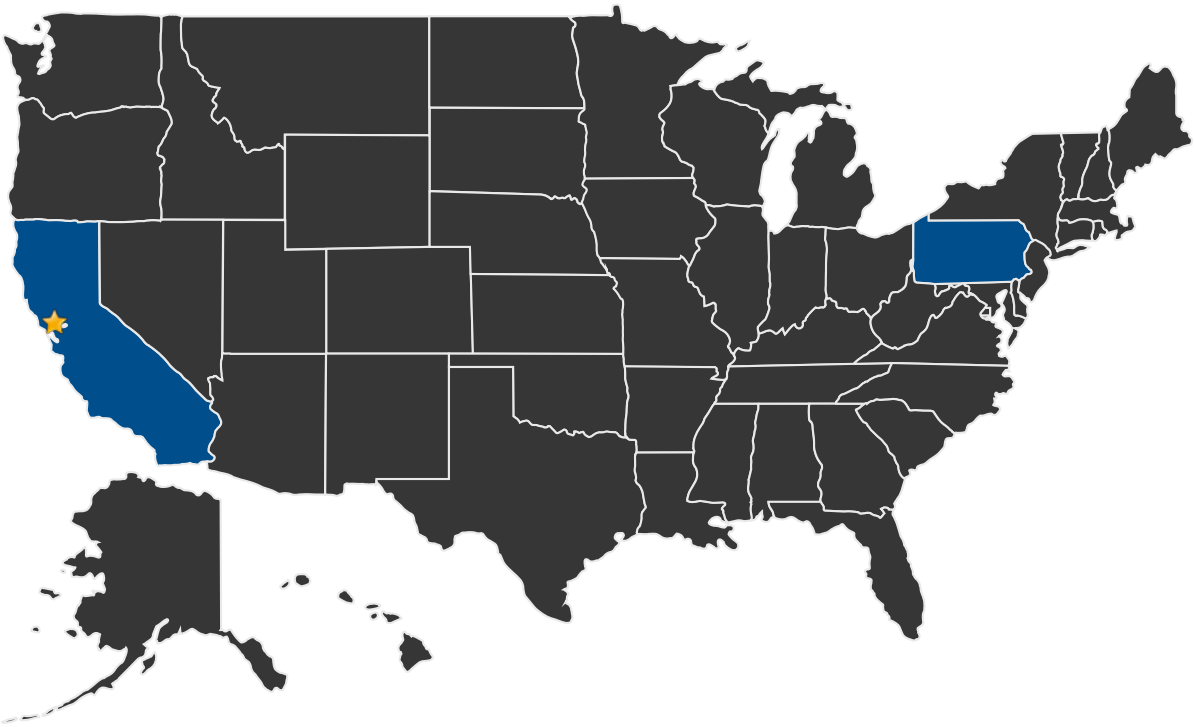
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Other Organizations Performing Work:

- Materials Research and Design, Inc. (Wayne, PA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23082)

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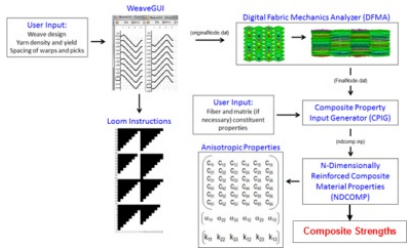
IMAGE GALLERY



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DETAILS FOR TECHNOLOGY 1

Technology Title

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Potential Applications

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