



3D Printing Heat Shields

TRL: start 2/ current 3



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TA: 9.1 EDL Tech.; 12.1 & 12.4 Materials and Processes; 14.3 Robust Ablative Heat Shields

OVERVIEW

Heat shields that protect spacecraft from the heat of entering a planet's atmosphere are labor intensive to manufacture, cost prohibitive and the heat shield design is constrained by the manufacturing process. Little, if any, automation is used to manufacture and install the thermal protection system (TPS) on the vehicles and most heat shields are segmented with many seams and gaps.

INNOVATION

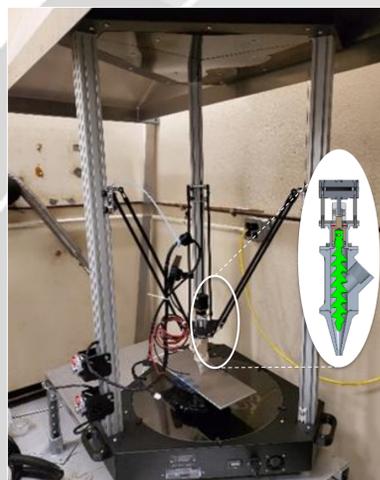
The goal of this project is to change this paradigm by developing new TPS materials and taking advantage of additive manufacturing technology to automate the processes for making and installing monolithic, ablative TPS on large entry vehicles.

INFUSION SPACE / EARTH

With feasibility demonstrated, the technology is being used to print a heat shield for a small capsule flight test. The technology is being transferred to small businesses through the SBIR/STTR programs.

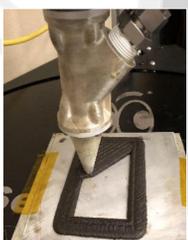
OUTCOME

- Based upon test data, focus is now on thermoset resin-based materials with fillers
- Custom extruder for thermoset resin mixtures was designed and built.
- Custom extruder was installed on new printer and functionality demonstrated.



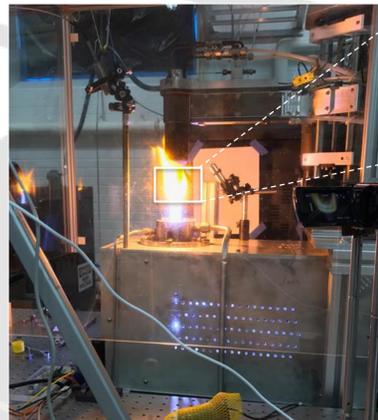
Thermoset Resin Printing

- Printing capability for three different resin systems.
- With help from Oak Ridge National Lab (ORNL), test articles printed for aerothermal testing and material property testing.



3" x 5" x .5" Slab

UT Austin Aerothermal Testing

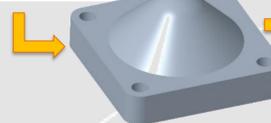
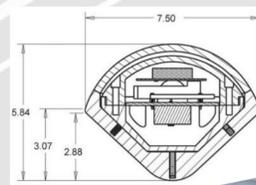


Puck in plasma torch

Eleven test articles printed from thermoset resin mixtures exhibited stable char and good aerothermal performance in relevant reentry heating environments.

Printing Heat Shield Shapes

Capability to print a heat shield on a small sphere-cone was demonstrated.



PARTNERSHIPS / COLLABORATIONS



Oak Ridge National Laboratory (ORNL) is collaborating to reformulate materials for printability and conducting material property testing. University of Texas at Austin is providing aerothermal testing. Texas State is investigating formulation of a thermoset resin system.

PAPERS / PRESENTATIONS

Presentation was given at National Space & Missiles Materials Symposium June 2019.

FUTURE WORK

In collaboration with ORNL, the team is developing a system to print graded materials, with an insulative layer near the structure and a denser, robust outer layer. The capability to print on larger, heat shield shape structures will also be developed. Additionally, a heat shield for a small capsule, to be deployed during reentry of a Cygnus module from ISS, will be printed with a new collaborator – Univ. of Kentucky.