National Aeronautics and **Space Administration** 



# Additive Manufacturing of Thermal Protection Systems (AMTPS)

#### TRL: Start 4 / Current 5

2022 JSC Technology Showcase

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### **OVERVIEW**

#### Heat shield manufacturing has changed little in the last 60

years. State of the art designs utilize tiled, or block, configurations fabricated in segments and individually bonded to the vehicle structure. Gaps between blocks are then filled. These processes are manual, labor intensive, and involve long lead times. AMTPS seeks to change that.

#### INNOVATION

Additive manufacturing of thermal protection systems (AMTPS) allows a TPS material to be **robotically deposited and cured** directly on a structure in a monolithic segment, reducing hands-on labor and simplifying integration.

# **INFUSION SPACE / EARTH**

Flight tests and building a manufacturing demonstration unit (MDU) will demonstrate viability of the material system and the manufacturing process at scale.

Exploring collaborations with **commercial space** for mission infusion.

## **PARTNERSHIPS / COLLABORATIONS**

- Johnson Space Center (lead)
- Ames Research Center
- Langley Research Center
- Oak Ridge National Lab (ORNL)





In this work, NASA is developing printable ablative TPS materials for the forebody and backshell of an entry vehicle.

## **OUTCOMES**

First 3D printed entry heat shield in history flown on Cygnus NG-16 in partnership with University of Kentucky

Kentucky Reentry Probe Experiment (KREPE)



Development and characterization of a **customizable**, dual layer, printable, phenolic resin-based TPS material





University of Kentucky



# **ONGOING WORK**

**Manufacturing scale up** to a ~1.0 meter sized demonstration unit in the AMTPS Robotic Cell at ORNL

#### Printing in AMTPS Robotic Cell





- Test, test, test: •
  - (1) More high enthalpy ground testing / Ames AHF and Univ. of Illinois Plasmatron X
  - (2) KREPE2 entry capsule / manifested on NG-20 in 2023
  - (3) H4H program sounding rocket experiment / led by Johns Hopkins APL NG-20 launching in Aug 2023





#### Arcjet Testing at Ames AHF Facility

30 sec @ 132 W/cm<sup>2</sup>









#### Small capsule test in Ames AHF

