Conformal Ablative Thermal Protection System for Small and Large Scale Missions: Approaching TRL 6 for Planetary and Human Exploration Missions and TRL 9 for Small Probe Missions

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Problem: Current SOA materials require complicated installation techniques and/or high touch labor costs (PICA, Avcoat, SLA) and with adequate thermal and poor-to-moderate mechanical performance

Solution: Develop a conformal TPS ablator with a significantly lower areal mass and more compliant for ease of integration (direct bonding, no gap fill)

Materials response models tested – $\Delta T = \Delta T_{\text{PICA}}/2$

Seam development models tested – no gap filler

PICA failure <750 lb, ROC ~145”
C-PICA no failure at 1500 lb, ROC <65”
CA-TPS TRL Progression

Conformal PICA (C-PICA) Small Scale
Conformal PICA (C-PICA) Large Scale
Conformal Silica/Silicone (C-SIRCA) RF-transparent matl
Mid-fidelity thermal response model complete
Scale up vendor under contract
Industry outreach workshop
Complete all arc jet testing
Deliver Flight Test Articles
Complete seam and thermal response arc jet testing
Downselect Conformal Ablator
Complete materials screening arc jet testing
Deliver MDU
Deliver PDU

Mission Infusion KDP (Small Scale)
Mission Infusion KDP Large Scale
CA-TPS Mission Infusion Efforts
Small Probe Development with Terminal Velocity Aerospace
Design and Hardware Roles and Responsibilities

- Small probe vehicle designed for break-up evaluation
- TVA responsible for entire design
  - Ames responsible for TPS selection and sizing
- Ames hardware
  - Backshell TPS bonded to carrier structure
    - RF transparent Silica/silicone (C-SIRCA)
    - In-depth instrumentation included
  - Heatshield TPS bonded to carrier structure
    - C-PICA
    - In-depth instrumentation included
- Remaining hardware is TVA’s responsibility
CA-TPS Mission Infusion Efforts
Small Probe Development with Terminal Velocity Aerospace
Arc Jet Test Article Design and Build

- Vehicle and arc jet test article configuration iterations completed
  - Trajectory analyses performed, environments defined, TPS sizing completed
- TPS parts designed
- TPS processing molds designed and manufactured
- Segments processed and machined

Flight Article
Arc jet test article

- TVA tested their mock-up in balloon-drop out of Tillamook, Oregon
  - Charred RF transparent conformal ablator flew
• Arc jet test planning completed
  ▪ Arc jet environments defined
  ▪ Arc jet aeroshells received from TVA
  ▪ Test article assembly nearly complete
  ▪ Testing scheduled Aug 3-7

• Vibe test planning underway
  ▪ Testing PICA, C-PICA and C-SIRCA
  ▪ Test fixture
  ▪ Fixtures and specimens in manufacturing
  ▪ Testing scheduled in July

TVA RED-Data2 has a flight manifest – late CY17
CA-TPS Scale-Up – Step 1
Vendor Demonstration of C-PICA Processing (Small articles)

- Material processing duplicated on small scale by Applied Research Associates, Ablative Laboratory (ARA-ABL)
- NASA provided molds and process descriptions used and first parts produced
  - Flat panels for characterization
  - Molded parts for use on arc jet test models
- NASA process duplicated with no changes provided delivered parts
- Testing to occur June 24-25
• Pathfinder Demonstration Unit for delivery this year
  • Design new metallic molds for large-scale parts
  • Infiltrate thin and thick felt to demonstrate uniform infiltration and evaluate extent of warping (parts ~0.6m x 0.7m)
  • Install on foam “body”
• Manufacturing Demonstration Unit for delivery mid FY16 (if funded)
  • ~1-m length mid L/D vehicle design
  • Build 3-4 panels
  • Side panel(s) demonstrates complex curvature
  • Install on foam “body”